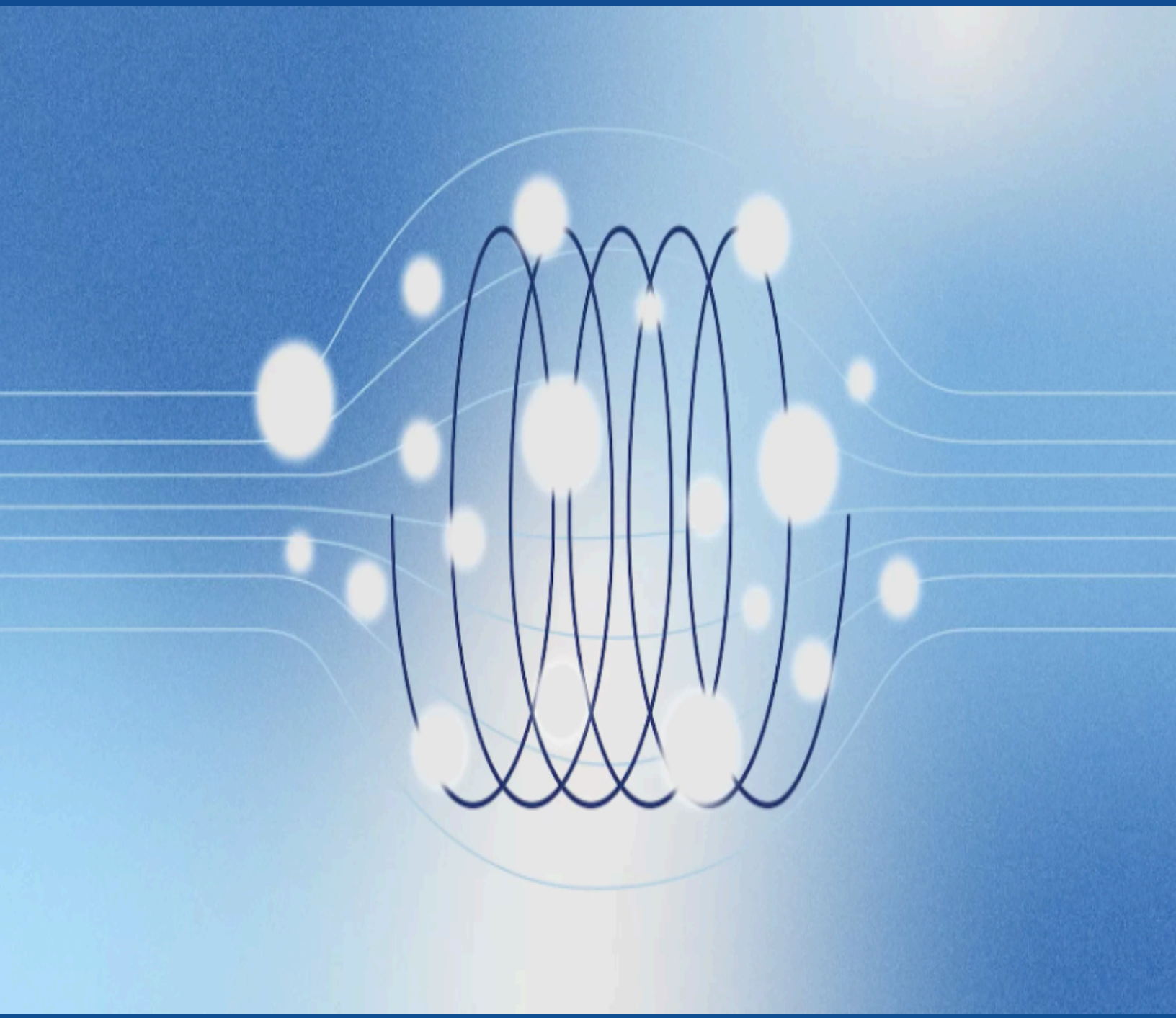
COLUMBIA ENGINEERING



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COLUMBIA ENGINEERING

Columbia Engineering Bulletin 2026-2027

Credit: Isometric Studio

The Columbia Fusion Research Center, established in 2025, aims to accelerate the development of fusion energy science and technology to provide a sustainable and scalable energy source for the benefit of society.

Columbia Engineering

500 West 120th Street
New York, NY 10027

Undergraduate Admissions

Office of Undergraduate Admissions
212 Hamilton Hall, Mail Code 2807
1130 Amsterdam Avenue
New York, NY 10027
Phone: 212-854-2522
Fax: 212-854-3393
ugrad-ask@columbia.edu
undergrad.admissions.columbia.edu

Graduate Admissions

Graduate Admissions
1220 S. W. Mudd, Mail Code 4708
500 West 120th Street
New York, NY 10027
212-854-4688
seasgradmit@columbia.edu
gradengineering.columbia.edu

Financial Aid

Office of Financial Aid and Educational Financing
Office: 618 Lerner Hall
Mailing: 100 Hamilton Hall, Mail Code 2802
1130 Amsterdam Avenue
New York, NY 10027
Phone: 212-854-3711
Fax: 212-854-5353
ugrad-finaid@columbia.edu
cc-seas.financialaid.columbia.edu

Need More Information?

You can find the contact information in the Columbia University Resource List (p. 347) or visit the Columbia Engineering website, engineering.columbia.edu.

Academic Calendar

Information on the 2026-2027 Academic Calendar may be obtained at registrar.columbia.edu.

About the School

A Message from the Dean

Each year, Columbia engineers pursue a robust course of study of great depth and breadth, one that prepares them for a variety of pursuits in engineering and applied science, as well as many other fields and industries.

Columbia Engineering has a proud history of innovation that has made a profound impact on our daily lives. From mass production of antibiotics, New York City's first subway line, and the earliest computer systems, our faculty and alumni have contributed technical breakthroughs that changed our world forever.

Today, we are equally committed to teaching, research, and translation that will better society and bring our engineering for humanity vision to life. Our students are a central part of this mission. Coming to Columbia Engineering means choosing a course of study that will broaden and deepen your knowledge, skills, and capacity. Combining technical prowess with courses in the liberal arts from Columbia's Core prepares students to be 21st Century Engineers. You will learn to question, to investigate, and to think deeply about how technology intersects with society.

Our programs and courses cultivate students who will be leaders in whatever field they choose to pursue and make a contribution to their communities, to the nation, and to the world.

Here at Columbia, faculty and students work together, collaborating at the intersection of disciplines to address the most exciting and challenging questions of our time. With the help of staff, advisors, state-of-the-art facilities and labs, and countless resources, students receive the support they need to succeed.

I encourage all of you to pursue the many possibilities available to you here at Columbia in the City of New York.

With best wishes for the academic year,

Shih-Fu Chang
Dean, Columbia Engineering
Morris A. and Alma Schapiro Professor

Mission

The mission of Columbia Engineering (The Fu Foundation School of Engineering and Applied Science) is to expand knowledge and advance technology through research, while educating students to become leaders and innovators informed by an engineering foundation. Enriched with the intellectual resources of a global university in the City of New York, we push disciplinary frontiers, confront complex issues, and engineer innovative solutions to address the grand challenges of our time. We create a collaborative environment that embraces interdisciplinary thought, creativity, integrated entrepreneurship, cultural awareness, and social responsibility, and advances the translation of ideas into innovations that impact humanity.

Columbia Engineering - Yesterday and Today

A Colonial Charter

Since its founding in 1754, as King's College, Columbia University has always been an institution both of and for the City of New York. And it has always been an institution of and for engineers. In its original charter, the College stated that it would teach, among other things, "the arts of Number and Measuring, of Surveying and Navigation, . . . the knowledge of . . . Meteors, Stones, Mines and Minerals, Plants and Animals, and everything useful for the Comfort, the Convenience and Elegance of Life."

The Gilded Age

As the city grew, so did the School. King's College was rechartered as Columbia College in 1784 and relocated from the Wall Street area to what is now Midtown in 1857. Students began entering the new School of Mines in 1864. Trained in mining, mineralogy, and engineering, Columbia graduates continued to make their mark both at home and abroad.

Working around the globe, William Barclay Parsons, Class of 1882, was an engineer on the Chinese railway and the Cape Cod and Panama Canals. Most important for New York, he was chief engineer of the city's first subway. Opened in 1904, the subway's electric cars took passengers from City Hall to Brooklyn, the Bronx, and the newly renamed and relocated Columbia University in Morningside Heights.

A Modern School for Modern Times

The School of Mines became the School of Mines, Engineering, and Chemistry in 1896, and its professors included Michael Idvorsky Pupin, a graduate of the Columbia College Class of 1883. As a professor at Columbia, Pupin did pioneering work in carrier-wave detection and current analysis, with important applications in radio broadcasting. He is perhaps most famous for having invented the "Pupin coil," which extended the range of long-distance telephones.

An early student of Pupin's was Irving Langmuir. Langmuir, Class of 1903, enjoyed a long career at the General Electric research laboratory. There he invented a gas-filled tungsten lamp, contributed to the development of the radio vacuum tube, and extended Gilbert Lewis's work on electron bonding and atomic structure. His research in monolayering and surface chemistry led to a Nobel Prize in Chemistry in 1932.

But early work on radio vacuum tubes was not restricted to private industry. Working with Pupin, an engineering student named Edwin Howard Armstrong was conducting experiments with the Audion tube in the basement of Philosophy Hall when he discovered how to amplify radio signals through regenerative circuits. Armstrong, Class of 1913, was stationed in France during the First World War, where he invented the superheterodyne circuit to tune in and detect the frequencies of enemy aircraft ignition systems. After the war, Armstrong improved his method of frequency modulation (FM), and by 1931, had both eliminated the static and improved the fidelity of radio broadcasting forever. The historic significance of Armstrong's contributions was recognized by the U.S. government when the Philosophy Hall laboratory was designated a National Historic Landmark in 2003.

As the United States evolved into a major twentieth-century political power, the University continued to build onto its undergraduate curriculum the broad range of influential graduate and professional schools that define it today. Renamed once again in 1926, the School of Engineering prepared students for careers not only as engineers of nuclear-age technology, but as leaders engaged with the far-reaching political implications of that technology as well.

After receiving a master's degree from the School in 1929, Admiral Hyman George Rickover served during the Second World War as head of the electrical section of the Navy's Bureau of Ships. A proponent of nuclear sea power, Rickover directed the planning and construction of the world's first nuclear submarine, the 300-foot-long *Nautilus*, launched in 1954.

Technology and Beyond

Today, The Fu Foundation School of Engineering and Applied Science, as it was named in 1997, continues to provide leadership for scientific and educational advances. Even Joseph Engelberger, Class of 1946, the father of modern robotics, could not have anticipated the revolutionary speed with which cumbersome and expensive "big science" computers would shrink to the size of a wallet.

No one could have imagined the explosive growth of technology and its interdisciplinary impact. Columbia Engineering is in a unique position to take advantage of the research facilities and talents housed at Columbia to form relationships among and between other schools and departments within the University. Biomedical Engineering, with close ties to the Medical School, is but one example. Interdisciplinary centers are the norm, with cross-disciplinary research going on in biomedical imaging, environmental chemistry, materials science, nanotechnology, digital, and new media technologies. The School and its departments have links to the Departments of Physics, Chemistry, Earth Science, and Mathematics, as well as the College of Physicians and Surgeons, the Graduate School of Journalism, Lamont-Doherty Earth Observatory, The Climate School, Teachers College, Columbia Business School, and the Graduate School of Architecture, Planning and Preservation. The transforming gift of The Fu Foundation has catapulted the School into the forefront of collaborative research and teaching and has given students the opportunity to work with prize-winning academicians, including Nobel laureates from many disciplines.

New Research Frontiers

Columbia's technology transfer office, Columbia Technology Ventures, works with faculty inventors to commercialize ideas and brings in millions in licensing revenue annually. Columbia Engineering faculty have been instrumental in developing some of the most successful inventions in consumer electronics, as well as establishing many of the widely accepted global standards for storage and transmission of high-quality audio and video data. Columbia is the only university actively participating in a broad range of standards-based patent pools, including AVC (Advanced Video Coding), the world standard for audio/video compression that is now one of the most commonly used HD formats and most commonly employed in streaming media; and ATSC, a standard developed by the Advanced Television Systems Committee for digital television transmission. It is now the U.S. standard for recording and retrieval of data and HD audio-visual media. In addition to the standards, Columbia Engineering faculty have patents in areas as diverse as modular cameras, carbon capture, a search engine that matches facial features, and even methods to combat virtual reality sickness.

Increasingly, the inventions emerging from Columbia Engineering are developed in collaboration with other researchers, expanding the potential applications for their important work. Programs such as the COSMOS Wireless Testbed, the Columbia Center of AI Technology, the Columbia Electrochemical Energy Center, and the CS3 Center for Smart Streetscapes are strengthening interdisciplinary capacity and fostering

an entrepreneurial and inventive energy within the School. Some of these programs and centers have helped prepare ideas for commercialization, including personalized robotics for use in physical rehabilitation and an implantable device that acts as a minimally-invasive glucose sensor for diabetic patients.

Entrepreneurship

Throughout the academic year, the School hosts many activities and networking events to support its active startup community, including the Columbia Engineering Fast Pitch Competition, Columbia Venture Competition, Design Challenges, Hackathons, and the Ignition Grants program, which funds ventures started by current students.

Entrepreneurship remains an important central educational theme at Columbia Engineering. The School offers a range of programs and a 15-credit, interdisciplinary minor in entrepreneurship, as well as a dual degree program with Columbia Business School (CBS), the MBAxMS, which consists of a MBA from CBS and an Executive MS in Engineering and Applied Science from Columbia Engineering. The School also provides a four-year entrepreneurship experience for all interested Columbia Engineering students, regardless of major.

And for alumni, entrepreneurial support continues. The Columbia Startup Lab, a coworking facility located in SoHo, provides subsidized space for Columbia alumni entrepreneurs to house and nurture their fledgling ventures. The Lab is the result of a unique partnership between the deans of Columbia College and the Schools of Business, Engineering, Law, and International and Public Affairs.

A Forward-Looking Tradition

But, for all its change, there is still a continuous educational thread that remains the same. Committed to the educational philosophy that a broad, rigorous exposure to the liberal arts provides the surest chart with which an engineer can navigate the future, all undergraduates must complete a modified but equally rigorous version of Columbia College's celebrated Core Curriculum. It is these selected courses in contemporary civilization in the West and other global cultures that best prepare a student for advanced coursework; a wide range of eventual professions; and a continuing, life-long pursuit of knowledge, understanding, and social perspective. It is also these Core courses that most closely tie today's students to the alumni of centuries past. Through a shared exposure to the nontechnical areas, all Columbia Engineering students—past, present, and future—gain the humanistic tools needed to build lives not solely as technical innovators, but as social and political ones as well.

A College within the University

Combining the advantages of a small college with the extensive resources of a major research university, students at Columbia Engineering pursue their academic interests under the guidance of outstanding senior faculty members who teach both undergraduate- and graduate-level courses. Encouraged by the faculty to undertake research at all levels, students at the School receive the kind of personal attention that only Columbia's exceptionally high faculty-student ratio affords.

The New York Advantage

Besides the faculty, the single greatest resource for students is without doubt the City of New York. Within easy reach by walking, bus, subway, or taxi, New York's broad range of social, cultural, and business communities offer an unparalleled opportunity for students to expand their horizons or deepen their understanding of almost any human endeavor imaginable. With art from small Chelsea galleries to major museums; music from Harlem jazz clubs to the Metropolitan Opera; theater from performance art in the East Village to musicals on Broadway; food from around the world; and every sport imaginable, New York is the cultural crossroads of the world.

New York is also a major player in high-tech research and development, where Fortune 500 companies traded on Wall Street seek partnerships with high-tech startups in Tribeca and Brooklyn. As part of the research community themselves, Columbia students have exceptional opportunities for contact with industry both on and off campus. Senior representatives of these companies often visit Columbia to lecture as adjunct faculty members or as guest speakers, and undergraduate and graduate students frequently undertake research or internships with these and other companies, oftentimes leading to offers of full-time employment after graduation.

In addition to its ties to private industry, Columbia also has a historically close relationship with the public sector of New York, stretching back to the eighteenth century. No other city in the world offers as many impressive examples of the built environment—the world's most famous collection of skyscrapers, long-span bridges, road and railroad tunnels, and one of the world's largest subway and water supply systems. Involved in all aspects of the city's growth and capital improvements over the years, Columbia engineers have been responsible for the design, analysis, and maintenance of New York's enormous infrastructure of municipal services and communications links, as well as its great buildings, bridges, tunnels, and monuments.

The University at Large

Columbia University occupies three major campuses, as well as additional special-purpose facilities throughout the area. The main campus is located on the Upper West Side in Morningside Heights, and the Manhattanville campus is the newest addition to Columbia University. This open and environmentally sustainable campus will grow over the next decade to encompass more than 17 acres. Further uptown in Washington Heights is the Columbia University Irving Medical Center (CUIMC), which includes Columbia's College of Physicians and Surgeons, the Mailman School of Public Health, the New York State Psychiatric Institute, College of Dental Medicine, and School of Nursing. CUIMC opened in 1928 and is the world's first academic medical center. Columbia Engineering's Biomedical Engineering Department has offices on both the Morningside campus and CUIMC.

Beyond its schools and programs, the measure of Columbia's true breadth and depth must take into account its internationally recognized centers and institutions for specialized research. These centers study everything from human rights to molecular recognition and hold close affiliations with Teachers College, Barnard College, the Juilliard School, and both the Jewish and Union Theological Seminaries. Columbia also maintains major off-campus facilities such as the Lamont-Doherty Earth Observatory in Palisades, NY, and the Nevis Laboratories in Irvington, NY. Involved in many cooperative ventures, Columbia also conducts ongoing research at such facilities as Brookhaven National Laboratory in Upton, NY, and the NASA Goddard Institute for Space Studies located just off the Morningside campus.

The Morningside Heights Campus

Columbia Engineering is located on Columbia's Morningside campus. One of the handsomest urban institutions in the country, the 13.1 million gross square feet (gsf) of the Morningside campus comprise more than 200 buildings of housing; off-campus apartments and commercial

buildings; recreation and research facilities; centers for the humanities and social and pure sciences; and professional schools in architecture, business, the fine arts, journalism, law, and many other fields.

Manhattanville Campus

From Broadway and 125th Street West to a revitalized Hudson River waterfront, Columbia's 17-acre Manhattanville campus is a welcoming environment of publicly accessible open space, tree-lined streets, neighborhood-friendly retail, and innovative academic buildings that invite community engagement. It is home to the Jerome L. Greene Science Center, Columbia's Mortimer B. Zuckerman Mind Brain Behavior Institute, the Lenfest Center for the Arts, and the Lee C. Bollinger Forum at Columbia University, an event and meeting space. These spaces house cutting-edge research and teaching in brain science, an art gallery, screening room, and performance spaces, and space for active community engagement. Columbia Business School has relocated to this campus, and plans are underway to develop a new building here for Columbia Engineering, as well.

Columbia Engineering

Columbia Engineering occupies laboratory and classroom buildings at the north end of the Morningside campus, including the Northwest Corner Science and Engineering Building, an interdisciplinary teaching and research building. In this building, researchers from across the University work together to create new areas of knowledge, in fields where the biological, physical, and digital worlds fuse. This pandisciplinary frontier will advance some of modern society's most challenging problems in a wide range of sectors, from health to cybersecurity, from smart infrastructure to the environment.

Supporting multiple programs of study, the School's facilities are designed and equipped to meet the laboratory and research needs of both undergraduate and graduate students. The School is also the site of an almost overwhelming array of basic and advanced research installations, such as the Columbia Genome Center and the Columbia Nano Initiative, established to serve as the hub for multidisciplinary and collaborative research programs in nanoscale science and engineering. Shared facilities and equipment to support nano research at the Engineering School include a state-of-the-art clean room in the Schapiro Center for Engineering and Physical Science Research (CEPSR) and a Transmission Electron Microscope (TEM) Laboratory on the first floor of Havemeyer.

Details about specific programs' laboratories and equipment can be found in the sections describing those programs.

The Makerspace

Columbia Engineering's Makerspace provides students with a dedicated place to collaborate, learn, explore, experiment, and create prototypes. Students can utilize the space to work on a variety of innovative projects, including independent or group design projects, product development, and new venture plans. This facility fosters student creativity by bringing together the workspace and tools for 3D printing, laser cutting, computer-aided design, physical prototyping, fabric arts, wood- and metalworking, jewelry making, sewing and embroidery, stained glass making, electronics, and software.

Columbia Engineering Computing Facilities and Computer Science Student Learning Center

The Botwinick Multimedia Learning Laboratory at Columbia University has redefined the way engineers are educated here.

Designed with both education and interaction in mind, the lab provides students and instructors with:

- 48 desktops
- A full set of professional-grade engineering software tools
- A collaborative classroom learning environment

The lab is utilized in some of the School's introductory first-year engineering projects, as well as advanced classes in modeling and animation, technology and society, and entrepreneurship.

In 2026, the Engineering School opened the Computer Science Student Learning Center on the 300 level of Schermerhorn Hall. The Center includes student collaboration space, breakout rooms for student team discussions, an open lounge, and pantry.

Carleton Commons

Located on the fourth floor (campus level) of the Mudd Building, Carleton Commons and Blue Java Café/Chef Don's Pizza comprise 3,200 square feet with seating for 160 and areas for casual meetings, individual and group work, and quiet study. Carleton Commons gives students a dedicated and comfortable space to gather, relax between classes, or meet and work with one another on problem sets or projects. The new design also enables flexible and reconfigurable use of the space for larger gatherings and special events.

Undergraduate Studies

- Undergraduate Programs (p. 7)
- Undergraduate Admissions (p. 16)
- Undergraduate Tuition, Fees and Payment (p. 16)
- Financial Aid for Undergraduate Study (p. 17)

Undergraduate Programs

The undergraduate programs at Columbia Engineering not only are academically exciting and technically innovative but also lead into a wide range of career paths for the educated citizen of the twenty-first century. Whether you want to become a professional engineer, work in industry or government, or plan to pursue a career in the physical and social sciences, medicine, law, business, or education, Columbia Engineering will provide you with an unparalleled education.

The School firmly believes that students gain the most when engineering is brought up front, early in the four-year curriculum. Therefore, each first-year student takes the Art of Engineering, which addresses the fundamental concepts of math and science in an engineering context, as well as nontechnical issues in professional engineering practice such as ethics and project management. Students in the Art of Engineering choose a half-semester, hands-on project in one of the School's nine undergraduate engineering disciplines, followed by a half-semester general project that changes each year. Depending on the project chosen, students will solder, 3D print, laser cut, simulate, design websites, and much more. These skills are further developed as students progress

toward their senior year projects. Since the fall of 2014, Columbia Engineering students have been able to utilize the School's brand new Makerspace, a collaborative environment where students can learn, explore, experiment, and create prototypes.

While pursuing their own interests, undergraduate students are encouraged to participate in a broad range of ongoing faculty research projects encompassed by the Student Research Program. Students can apply for available research positions in Columbia Labs through the website at studentresearch.engineering.columbia.edu.

In addition to in-depth exploration of engineering and applied science, Columbia Engineering undergraduates explore the humanities and social sciences with Columbia College students through intellectually challenging Core Curriculum courses taught by the Faculty of Arts and Sciences. These courses in art, literature, music, major cultures, and economics, among others, provide students with a broad, intellectually disciplined, cultural perspective on the times they live in and the work they do.

Policy on Degree Requirements

The Committee on Instruction and faculty of The Fu Foundation School of Engineering and Applied Science review degree requirements and curricula matters each year, and the bulletin reflects these faculty recommendations and curricular changes in its yearly reprinting. School policy requires students to fulfill all general degree requirements as stated in the bulletin of the first year of their matriculation into the School. Students declare their major during the first semester of their sophomore year. Requirements for the major or minor are in accordance with the bulletin during the year in which the student declares the major or minor.

The First Year/Sophomore Program

Students entering Columbia Engineering are encouraged to consider the wide range of possibilities open to them, both academically and professionally. To this end, the first and second years of the four-year undergraduate program comprise approximately half the total number of credits required for the degree, which expose students to a cross-fertilization of ideas from different disciplines within the University. The sequence of study proceeds from an engagement with engineering and scientific fundamentals, along with humanities and social sciences, toward an increasingly focused training in the third and fourth years, designed to give students mastery of certain principles and arts central to engineering and applied science.

Liberal Arts Core for Columbia Engineering Students

27-Point Nontechnical Requirement

This requirement provides a broad liberal arts component that enhances the Engineering professional curriculum to help students meet the challenges of the twenty-first century. Our students are destined to be leaders in their professions and will require sophisticated communication, planning, and management skills. The Committee on Instruction established the School's nontechnical requirement so that students would learn perspectives and principles of the humanities and social sciences as part of a well-rounded and multiperspective education. Through discussion, debate, and writing, students improve their abilities to engage in ethical, analytic, discursive, and imaginative thinking that will prove indispensable later in life.

- Engineering students must take 16 to 18 points of credit of required courses in list A and 9 to 11 elective points chosen from the approved courses in list B. The total combined number of nontechnical points (from lists A and B, below) must add up to at least 27. Neither list can be modified by advising deans or faculty advisers.
- Advanced Placement (AP) credit in appropriate subject areas can be applied toward the 9-point elective nontechnical requirement and for Principles of Economics.

A. Required Nontechnical Courses

(16–18 points of credit)
These courses must be taken at Columbia.

1. ENGL CC1010 UNIVERSITY WRITING
2. One of the following two-semester sequences: HUMA CC1001 Literature Humanities I-HUMA CC1002 Literature Humanities II: Masterpieces of Western literature and philosophy or COCI CC1101 CONTEMP WESTERN CIVILIZATION I-COCI CC1102 CONTEMP WESTRN CIVILIZATION II: Any two courses from approved list (6–8 points). If electing Global Core, students must take two courses from the List of Approved Courses for a letter grade.Visit bulletin.columbia.edu/columbia-college/core-curriculum/global-core-requirement for more information.
3. One of the following two courses:
   HUMA UN1121 Art Humanities or HUMA UN1123 Music Humanities
4. ECON UN1105 PRINCIPLES OF ECONOMICS (This course can be satisfied through Advanced Placement; see the Advanced Placement chart.) Note: Engineering students may not take any Barnard class as a substitute for ECON UN1105 PRINCIPLES OF ECONOMICS. (4 points)

B. Elective Nontechnical Courses

(9–11 points of credit)
The following course listing by department specifies the Columbia College, Barnard, or Columbia Engineering courses that either fulfill or do not fulfill the nontechnical requirement.
(Professional, workshop, lab, project, scientific, studio, music instruction, and master's-level professional courses do not satisfy the 27-point nontechnical requirement.)

African-American Studies: All courses	
American Studies: All courses	
Ancient Studies: All courses	
Anthropology: All courses in sociocultural anthropology	
All courses in archaeology except fieldwork	
No courses in biological/physical anthropology [1]	
Architecture: Only	
ARCH UN2505	Architectural Histories of Colonialism and Humanitarianism
ARCH UN2530	Life Beyond Emergency: Domesticities of Displacement, Inhabitations of Migration
ARCH UN3117	MOD ARCHITECTURE IN THE WORLD
ARCH UN3120	CITY,LANDSCAPE, # ECOLOGY
ARCH UN3123	Spaces and Territories of Housing
ARCH UN3501	Modern Architecture of South Asia
ARCH UN3502	URBANIZING CHINA
Art History and Archeology: All courses	
Asian American Studies: All courses	
Astronomy: No courses	
Biological Sciences: No courses	

Business: No courses	
Chemistry: No courses	
Classics: All courses	
Colloquia: All courses	
Comparative Ethnic Studies: All courses	
Comparative Literature and Society: All courses	
Computer Science: No courses	
Creative Writing: All courses (This is an exception to the workshop rule.)	
Dance: All courses except performance classes	
Drama and Theatre Arts: All courses except workshops, rehearsal, or performance classes	
Earth and Environmental Sciences: No courses	
East Asian Languages and Culture: All courses	
Ecology, Evolution, and Environmental Biology: No courses except	
EEEB GU4321	HUM NATURE:DNA,RACE # IDENTITY
EEEB GU4700	RACE:TANGLED HIST-BIOL CONCEPT
Economics: All courses except:	
ECON UN3025	FINANCIAL ECONOMICS
ECON UN3211	INTERMEDIATE MICROECONOMICS
ECON UN3213	INTERMEDIATE MACROECONOMICS
ECON UN3412	INTRODUCTION TO ECONOMETRICS
ECON UN3981	APPLIED ECONOMETRICS
ECON GU4020	ECON OF UNCERTAINTY # INFORMTN
ECON GU4211	ADVANCED MICROECONOMICS
ECON GU4213	ADVANCED MACROECONOMICS
ECON GU4251	INDUSTRIAL ORGANIZATION
ECON GU4260	MARKET DESIGN
ECON GU4280	CORPORATE FINANCE
ECON GU4301	ECONOMIC GROWTH # DEVELOPMNT I
ECON GU4412	ADVANCED ECONOMETRICS
ECON GU4413	Econometrics of Time Series and Forecasting
ECON GU4415	GAME THEORY
ECON GU4505	INTERNATIONAL MACROECONOMICS
ECON GU4526	Transition Reforms, Globalization and Financial Crisis
ECON GU4911	MICROECONOMICS SEMINAR
ECON GU4913	MACROECONOMICS SEMINAR
ECON GU4918	SEMINAR IN ECONOMETRICS
ECON BC1003	Introduction to Economic Reasoning [2]
ECON BC1007	MATH METHODS FOR ECONOMICS
ECON BC2411	STATISTICS FOR ECONOMICS
ECON BC3014	Entrepreneurship
ECON BC3018	ECONOMETRICS
ECON BC3033	INTERMEDTE MACROECONOMC THEORY
ECON BC3035	INTERMEDIATE MICROECONOMICS
ECON BC3038	INTERNATIONAL MONEY # FINANCE
Education: All courses	
Engineering: Only	
BMEN E4010	
CHEN E4020	PROTECTN OF INDUST/INTELL PROP
EEHS E3900	
English and Comparative Literature: All courses	
Film Studies: All courses except lab courses, and	
FILM UN3920	SENIOR SEM IN SCREENWRITING
FILM UN2400	Script Analysis
French and Romance Philology: All courses	
Germanic Languages: All courses	
Greek: All courses	
History: All courses	
History and Philosophy of Science: All courses	
Human Rights: All courses	
Italian: All courses	
Jazz Studies: All course	
Latin: All courses	
Latino Studies: All courses	
Linguistics: All courses except	
CLLN GU4202	COGNITIVE LINGUISTICS
Mathematics: No courses	
Medieval and Renaissance Studies: All courses	
Middle Eastern and Asian Language and Cultures: All courses	
Music: All courses except performance courses, instrument instruction courses, and workshops	
Philosophy: All courses except	
PHIL UN1401	INTRODUCTION TO LOGIC
PHIL UN3411	SYMBOLIC LOGIC
PHIL GU4137	Non-Classical Logics
PHIL GU4431	INTRODUCTION TO SET THEORY
PHIL GU4424	MODAL LOGIC
CSPH GU4801	MATH LOGIC I
CSPH GU4802	Math Logic II: Incompletness
PHIL GU4810	LATTICES AND BOOLEAN ALGEBRA
Courses in logic	
Physical Education: No courses	
Physics: No courses	
Political Science: All courses except	
POLS UN3220	Logic/Paradox in Social Choice
POLS UN3704	RESEARCH DESIGN: DATA ANALYSIS
POLS UN3720	RESEARCH DESIGN: SCOPE AND METHODS
POLS GU4730	GAME THEORY # POLIT THEORY
POLS GU4732	RESEARCH TOPICS IN GAME THEORY
POLS GU4791	Advanced Topics in Quantitative Research-Discussion
POLS GU4792	Quantitative Methods: Research Topics
POLS GU4700	MATH # STATS FOR POLI SCI
POLS GU4768	Experimental Research: Design, Analysis and Interpretation
POLS GU4710	PRINC OF QUANT POL RESEARCH 1
POLS GU4711	PRINC OF QUANT POL RESEARCH 1-DISC
POLS GU4712	PRINC OF QUANT POL RESEARCH 2
PSAM UN3707	Persuasion at scale: causal inference, machine learning, and evidence-based understanding of the information environment
Psychology: Only	
PSYC UN1001	THE SCIENCE OF PSYCHOLOGY
PSYC UN2280	Developmental Psychology
All courses on perception, attention, and cognition topics numbered 2200s, 3200s, or 4200s can be taken as nontech electives except for PSYC UN2235 and PSYC UN4289	
All courses on social, personality, and abnormal numbered 2600s, 3600s, or 4600s can be taken as nontech electives	

Religion: All courses	
Slavic Languages: All courses	
Sociology: All courses except	
SOCI UN3020	Social Statistics
Spanish and Portuguese: All courses	
Speech: No courses	
Statistics: No courses	
Sustainable Development: Only	
SDEV UN2050	ENVIRONMENTAL POLICY AND GOVERNANCE
SDEV UN2100	Introduction to Climate Justice
SDEV UN2300	CHALLENGES OF SUSTAINABLE DEV
SDEV UN3310	ETHICS OF SUSTAINABLE DEVPT
SDEV UN3400	HUMAN POPULATIONS # SDEV
SDEV GU4050	US WATER # ENERGY POLICY
SDEV GU4501	History of the Climate Crisis
Urban Studies: All courses	
Visual Arts: No more than one course, which must be at the 3000-level or higher (This is an exception to the workshop rule.)	
Women and Gender Studies: All courses	

[1] UN1010, UN1011, UN3204, UN3940, GU4147-GU4148, GU4200, GU4700
[2] Equivalent to ECON UN1105 PRINCIPLES OF ECONOMICS

Music Instruction Courses

Music instruction and performance courses do not count toward the 128 points of credit required for a B.S. degree. Please note that this includes courses taken at Teachers College, Columbia College, and the School of the Arts.

Visual Arts Courses

Students are allowed to take courses in the Visual Arts Department for general credit to be applied toward the B.S. degree. However, no more than one visual arts course, which must be taken at the 3000-level or higher, may count toward the nontechnical elective requirement. This 3000-level course is an exception to the rule that no workshop classes can fulfill the nontech elective requirement.

Technical Course Requirements

The prescribed First-Year/Sophomore Program curriculum requires students to complete a program of technical coursework introducing them to five major areas of technical inquiry: engineering, mathematics, physics, chemistry, and computer science.

All first-year Engineering undergraduate students take ENGI E1102 THE ART OF ENGINEERING (4 points). In this course, students see how their high school science and math knowledge can be applied in an engineering context to solve real-world problems through classroom presentations and participation in an in-depth, hands-on project. Along the way, guest lecturers discuss social implications of technology, entrepreneurship, project management, and other important nontechnical issues affecting the practicing engineer.

While students need not officially commit to a particular branch of engineering until the third semester, most programs recommend, and in some cases may require, that particular courses be taken earlier for maximum efficiency in program planning. For information concerning these requirements, students should navigate to the individual program sections in this bulletin.

Professional Development

Professional-Level Courses

The courses listed below may be taken by first- and second-year students. Some departments require one of these courses; please consult with departmental charts for more information.

Each course serves as an introduction to the area of study and is taught by department faculty. The courses are:

BMEN E2910 Introduction to Biomedical Engineering Design. *3.00 points*.
An introduction to prototyping techniques needed for medical device development, including computer-aided design (CAD), 3D printing, laser cutting, circuit design, and microcontrollers. Students will work collaboratively to design, fabricate, and evaluate a medical device, demonstrating competency in fabrication methods and iterative engineering design

CHEN E2100 Material and Energy Balances. *3.00 points*.
Lect: 2.5

Prerequisites: First-year chemistry and physics or equivalent.
Serves as an introduction to the chemical engineering profession. Students are exposed to concepts used in the analysis of chemical engineering problems. Rigorous analysis of material and energy balances on open and closed systems is emphasized. An introduction to important processes in the chemical and biochemical industries is provided

Fall 2026: CHEN E2100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 2100	001/11399	T Th 10:10am - 11:25am 140 Uris Hall	Christopher Vic Chen	3.00	34/50

CIEN E3000 THE ART OF STRUCTURAL DESIGN. *3.00 points*.
Lect: 3.

Basic scientific and engineering principles used for the design of buildings, bridges, and other parts of the built infrastructure. Application of principles to analysis and design of actual large-scale structures. Coverage of the history of major structural design innovations and of the engineers who introduced them. Critical examination of the unique aesthetic/artistic perspectives inherent in structural design. Consideration of management, socioeconomic, and ethical issues involved in design and construction of large-scale structures. Introduction to recent developments in sustainable engineering, including green building design and adaptable structural systems

Spring 2026: CIEN E3000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3000	001/11695	M W 2:40pm - 3:55pm 313 Fayerweather	George Deodatis	3.00	58/75

EAEE E2100 A BETTER PLANET BY DESIGN. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lect: 3.

Introduction to design for a sustainable planet. Scientific understanding of the challenges. Innovative technologies for water, energy, food, materials provision. Multi-scale modeling and conceptual framework for understanding environmental, resource, human, ecological and economic impacts and design performance evaluation. Focus on the linkages between planetary, regional and urban water, energy, mineral, food, climate, economic and ecological cycles. Solution strategies for developed and developing country settings

Fall 2026: EAEE E2100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 2100	001/14400	M W 2:40pm - 3:55pm 633 Seeley W. Mudd Building	Adeyemi Adeleye	3.00	68/70

ELEN E1201 INTRO-ELECTRICAL ENGINEERING. *3.50 points*.
Lect: 3. Lab:1.

Prerequisites: (MATH UN1101)
Basic concepts of electrical engineering. Exploration of selected topics and their application. Electrical variables, circuit laws, nonlinear and linear elements, ideal and real sources, transducers, operational amplifiers in simple circuits, external behavior of diodes and transistors, first order RC and RL circuits. Digital representation of a signal, digital logic gates, flipflops. A lab is an integral part of the course. Required of electrical engineering and computer engineering majors.

Spring 2026: ELEN E1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 1201	001/11494	M W 4:10pm - 5:25pm 501 Northwest Corner	David Vallancourt	3.50	129/160

Fall 2026: ELEN E1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 1201	001/11256	T Th 4:10pm - 5:25pm 301 Pupin Laboratories	David Vallancourt	3.50	81/120

Physical Education

Two terms of physical education (PHED UN1001 PHYSICAL EDUCATION ACTIVITIES or PHED UN1002 PHYSICAL EDUCATION ACTIVITIES or PHED UN1003 Club Sports) are a degree requirement for Columbia Engineering students. No more than 4 points of physical education courses may be counted toward the degree. The physical education requirement can be fulfilled with Barnard dance studio/technique courses. Students can also earn physical education credits by participating in select club sports, PHED UN1003 Club Sports. A student who intends to participate in an intercollegiate sport should register for the appropriate section of PHED UN1005 INTERCOLLEGIATE ATHLETICS. Intercollegiate athletes who attend regularly receive 1 point of credit up to a maximum of 4. Student-athletes who leave the team in mid-term but still wish to receive academic credit must notify the Physical Education Office and be placed in another physical education activity to complete the attendance requirement. Students who are advised to follow a restricted or adapted activity program should contact the Director of Physical Education and Recreation. The physical education program offers a variety of activities in the areas of aquatics, fitness, martial arts, individual and dual sports, team sports, and outdoor education. Most activities are designed for the introductory/beginner levels. Intermediate/advanced courses are indicated on the schedule.

The majority of the activities are offered in ten time preferences. Additionally, there are early-morning conditioning activities, Friday-only classes at Baker Athletics Complex, and special courses that utilize off-campus facilities during weekends and vacation periods. The courses offered by the department for each term are included in the online Directory of Classes, and a description of the scheduled activities for each time preference is posted on perec.columbia.edu. Students may only register for one section of physical education each term.

Advanced Placement Credit Chart

In order to receive AP credit, students must be in possession of appropriate transcripts or scores and send official score reports to Columbia. The CEEB code is 2116.

Subject	AP Score	AP Credit	Requriements or Placement Status Credit
Art History	5	3	No exemption from HUMA UN1121
Biology	5	3	No exemption
Chemistry	4 or 5	3	Requires completion of CHEM UN1604 with grade of C or better
	4 or 5	6	Requires completion of CHEM UN2045-CHEM UN2046 with grade of C or better
Computer Science A	4 or 5	3	Exemption from COMS W1004
Computer Principles	4 or 5	3	Exemption from COMS W1001
Economics Micro & Macro	5 and 4	4	Exemption from ECON UN1105. Exams must be taken in both micro and macro, with a score of 5 in one and at least a 4 in the other.
English Language and Composition	5	3	No exemption
English Literature and Composition	5	3	No Exemption
French	4 or 5	3	
German Language	4 or 5	3	
Government and Politics United States	5	4[1]	Exemption from POLS UN2201.
Government and Politics Comparative	5	4[1]	Exemption from POLS UN2501.
History European	5	3	
History United States	5	3	
Italian Language	4 or 5	3	
Latin Literature	5	3	
Mathematics Calculus AB[2]	4 or 5	3	Requires completion of MATH UN1102 with a grade of C or better. Credit is reduced to 0 if MATH UN1101 is taken.

Mathematics Calculus BC[2]	4	3	Requires completion of MATH UN1102 with a grade of C or better. Credit is reduced to 0 if MATH UN1101 is taken.
Mathematics Calculus BC[2]	5	6	Requires completion of APMA E2000 with a grade of C or better. Credit is reduced to 0 if MATH UN1101 is taken, or to 3 if MATH UN1102 is taken.
Physics C-E&M	4 or 5	3	Maximum of six credits. Credit is reduced to 0 if PHYS UN1401 or 1601 is taken. Credit is reduced to 0 if PHYS UN2801 is taken and the final grade is C- or lower.
Physics C-MECH	4 or 5	3	Credit is reduced to 0 if PHYS UN1401 or 1601 is taken. Credit is reduced to 0 if PHYS UN2801 is taken and the final grade is C- or lower.
Physics 1 and 2	4 or 5	3	No exemption. Both AP Physics 1 and 2 must be taken to receive credit.
Spanish Language	4 or 5	3	
Spanish Literature	4 or 5	3	

[1] AP credits may be applied toward minor requirements depending on the specific rules of the minor. When the rules of the minor allow AP credit to fulfill a requirement, then only one course for a minor may be replaced by advanced placement credit.

[2] Columbia Engineering students with a 4 or 5 on Calculus AB or a 4 on Calculus BC must begin with MATH UN1101 CALCULUS I or MATH UN1102 CALCULUS II. If a Columbia Engineering student with these scores goes directly into APMA E2000 MULTV. CALC. FOR ENGI # APP SCI, they will have to go back and complete MATH UN1102 CALCULUS II. Students with A-level or IB calculus credit must start with MATH UN1102 CALCULUS II. They cannot self place into APMA E2000 MULTV. CALC. FOR ENGI # APP SCI. If they start with MATH UN1101 CALCULUS I, they will not receive any advanced standing credit.

Advanced Placement

Prior to entering Columbia, students may have taken Advanced Placement examinations through the College Entrance Examination Board (CEEB) in a number of technical and nontechnical areas. A maximum of 16 points may be applied. Students may be assigned to an advanced-level course in mathematics or physics based on their AP scores.

The benefit of advanced placement is acceleration through certain First-Year/Sophomore Program requirements and thus the opportunity of taking specialized courses earlier.

Each year, the School reviews the CEEB advanced placement curriculum and makes determinations as to appropriate placements, credit, and/or exemption. Please see the Advanced Placement Credit Chart.

International Baccalaureate (IB)

Entering students may be granted 6 points of credit for each score of 6 or 7 on IB Higher Level Examinations if taken in disciplines offered as undergraduate programs at Columbia. Students should consult their adviser at the James H. and Christine Turk Berick Center for Student Advising for further clarification. A maximum of 16 points may be applied.

British Advanced Level Examinations

Students with grades of A*, A, or B on British Advanced Level examinations may be granted 6 points of credit if the examinations were taken in disciplines offered as undergraduate programs at Columbia University. The appropriate transcript should be submitted to the James H. and Christine Turk Berick Center for Student Advising, 403 Lerner. A maximum of 16 points may be applied.

Other National Systems

Students whose secondary school work was in other national systems, such as the French Baccalauréat, may be granted credit in certain disciplines for sufficiently high scores. The appropriate transcript should be submitted to the James H. and Christine Turk Berick Center for Student Advising, 403 Lerner. A maximum of 16 points may be applied.

James H. and Christine Turk Berick Center for Student Advising

403 Lerner Hall, MC 1201
212-854-6378
csa@columbia.edu
cc-seas.columbia.edu/csa

The James H. and Christine Turk Berick Center for Student Advising (CSA) guides and supports undergraduates at Columbia College and Columbia Engineering as they navigate their educations and lives at Columbia University. Individually and collaboratively, each advising dean:

- provides individual and group academic advisement and counseling
- provides information on preprofessional studies, major declaration, and progress towards the completion of the degree, as well as various leadership, career, graduate school, and research opportunities
- interprets and disseminates information regarding University policies, procedures, resources, and programs
- educates and empowers students to take responsibility in making informed decisions
- refers students to additional campus resources

Every undergraduate is assigned an adviser from the Berick Center for Student Advising for the duration of their undergraduate career. Generally, each matriculating student is assigned to an advising dean who is a liaison to the department the student indicated as their first intended major on the admissions application. When a student declares a major, a faculty member is also appointed to advise them for the next two years. Depending on their chosen major, students may be assigned to a new advising dean who is a CSA liaison to their department. Advising deans regularly refer students to their academic departments to receive expert advice about their engineering course selections.

Preprofessional Advising

Preprofessional Advising is a specialized advising unit within the James H. and Christine Turk Berick Center for Student Advising. It is dedicated to providing information and guidance to students who plan a career in law, business, or the health professions, through individual advising, workshops, and other events related to professions of law and health. Preprofessional advisers work closely with other CSA advisers to support students during their undergraduate program of study. They also provide

extensive individualized support to students and alumni through their application process to professional schools.

Study Abroad

Engineering today is a global profession. Study abroad allows engineering students to discover the field through the perspective of engineers working in a different language and culture, enabling them to learn the relationship of culture to science and develop the range of transferable skills that employers are seeking today. Study abroad will help students develop intellectually, emotionally, culturally, and socially.

Columbia Engineering undergraduate students can study abroad for either a semester (fall, spring, or summer) or, exceptionally, for a full academic year. Students from every engineering major have studied abroad, and most do so in the spring semester of their sophomore year or in their junior year. Although not a requirement, students are encouraged to have some foreign language skills in order to enhance their cultural competency and their overall study abroad experience.

The Center for Undergraduate Global Engagement will help students identify the appropriate choice for their country of interest and their major. Departmental advisers and faculty will help students with their course equivalencies for approved programs so they can graduate on time. Students can take nontechnical electives overseas, or with departmental permission, they may choose technical electives or courses in their major.

It is essential that students begin planning as early as possible. Students are encouraged to meet with advisers in the Center for Undergraduate Global Engagement to review possible global opportunities. Students must obtain approval from their departmental advisers to ensure that their work abroad meets the requirements of their majors, as well as clearance from their Advising Dean in the James H. and Christine Turk Berick Center for Student Advising.

Eligibility Requirements

- Currently enrolled student in good academic and disciplinary standing
- 3.0 GPA
- Making adequate progress toward finishing the first and second year requirements
- Declared a major

Finances

- Fall/Spring (academic year)
  - Billed by Columbia: tuition and health insurance
  - Billed by abroad institution/external vendors: room, board, living and travel expenses
  - Still eligible for financial aid
- Summer
  - Student pays most expenses directly to the program and external vendors
  - Not eligible for financial aid

Academic Credit

- Students in Columbia-sponsored programs receive direct Columbia credit, and the courses and grades appear on students' academic transcripts.
- Credit from approved programs that are not Columbia-sponsored is certified as transfer credit toward the Columbia degree upon successful completion of the program, verifiable by academic transcript. Students must earn a grade of C or better in order for credits to be transferred. Course titles and grades for approved programs do not appear on the Columbia transcript, and grades are not factored into students' GPAs.
- Faculty from the Columbia Engineering academic departments have the responsibility to assess all work completed abroad and make decisions about how these courses fit into major requirements. It is imperative that students gain course-by-course approval from their department prior to departure for a study-abroad program.

Deadlines

- Early to mid-March: to study abroad during the fall semester or for year-long trips
- Early October: to study abroad during the spring semester
- Early May: to study abroad during the summer term

For more information on study abroad, students should contact:

Center for Undergraduate Global Engagement
606 Kent Hall, MC 3948
1140 Amsterdam Avenue
New York, NY 10027
212-854-2559
uge@columbia.edu
uge.columbia.edu

SEAS Undergraduate Student Affairs
ask-seas@columbia.edu

Combined Plan Programs

Undergraduate Admissions
212 Hamilton Hall, MC 2807
1130 Amsterdam Avenue
New York, NY 10027
212-854-2522
combinedplan@columbia.edu
undergrad.admissions.columbia.edu/apply/combined-plan

Columbia Engineering maintains cooperative program relationships with institutions nationwide and with other Columbia University undergraduate divisions. The Combined Plan programs (3-2 and 4-2) allow students to receive a degree both in the liberal arts and in engineering. Combined Plan students complete the requirements for the liberal arts degree along with required prerequisite coursework for their studies in engineering during the three or four years at their liberal arts college before entering the School of Engineering and Applied Science. They then must complete all the requirements for the B.S. degree within four semesters.

The Combined Plan Program within Columbia University

Under this plan, the pre-engineering student studies in Columbia College, Barnard College, or the School of General Studies for three or four years, then attends The Fu Foundation School of Engineering and Applied Science for two years, and is awarded the Bachelor of Arts degree and the Bachelor of Science degree in engineering upon completion of the fifth or sixth year. This program is optional at Columbia, but the School

recommends it to all students who wish greater enrichment in the liberal arts and pure sciences.

The Combined Plan with Other Affiliated Colleges

There are more than one hundred affiliated liberal arts colleges, including those at Columbia, in which a student can enroll in a Combined Plan program leading to two degrees. Each college requires the completion of a specified curriculum, including major and degree requirements, to qualify for the baccalaureate from that institution. Every affiliated school has a liaison officer who coordinates the program at their home institution. Students interested in this program should inform the liaison officer as early as possible, preferably in the first year, in order to receive guidance about completing program requirements. Applicants from non-affiliated schools are welcome to apply.

Visit the Undergraduate Admissions website for a complete list of affiliated schools, admission application instructions, information on financial aid, and curriculum requirements for Combined Plan program admission. Please note that no change of major is allowed after an admission decision has been rendered.

For more information, see 4-2 Master of Science Program (p. 18), BS/MS Program (p. 23), MS Express Application (p. 23), and Barnard 4+1 Pathway (p. 23), which are administered through the Office of Engineering Student Affairs.

The Junior-Senior Programs

Students may review degree progress via Stellic. Required courses should be completed according to the academic charts in the department sections of the bulletin. Until they are completed, they are listed as deficiencies in Stellic. If they are not completed according to the departmental plans, it may be necessary to complete these courses either over the summer or be carried as overload courses in later semesters.

Having chosen their program major in the first semester of their sophomore year, students are assigned to a faculty adviser in the department in which the program is offered. In addition to the courses required by their program, students must continue to satisfy certain distributive requirements, choosing elective courses that provide sufficient content in engineering sciences and engineering design. The order and distribution of the prescribed coursework may be changed with the adviser's approval. Specific questions concerning course requirements should be addressed to the appropriate department or division.

Double Major

Students who wish to apply for a second major must consult their Advising Dean about next steps. A proposal to double major must be approved by both departments and then forwarded to the Senior Vice Dean of Academic Programs for a final decision.

Major courses cannot be cross-counted between dual majors. Please consult with an Advising Dean and the respective departmental advisors to find alternative courses for duplicate requirements.

3-2 students are not eligible to have a second major because of the time constraints of their program.

Tau Beta Pi

Tau Beta Pi is the nation's second-oldest honor society, founded at Lehigh University in 1885. With the creed "Integrity and excellence in engineering," it is the only engineering honor society representing the entire engineering profession. Columbia's chapter, New York Alpha, is the ninth oldest and was founded in 1902. Many Columbia buildings have been named for some of the more prominent chapter alumni: Charles Fredrick Chandler, Michael Idvorsky Pupin, Augustus Schermerhorn, and, of course, Harvey Seeley Mudd.

Undergraduate students whose scholarship places them in the top eighth of their class in their next-to-last year or in the top fifth of their class in their last college year are eligible for membership consideration. These scholastically eligible students are further considered on the basis of personal integrity, breadth of interest both inside and outside engineering, adaptability, and unselfish activity. Benefits of membership include exclusive scholarships and fellowships. Many networking opportunities for jobs and internships are also available, with 230 collegiate chapters and more than 500,000 members in Tau Beta Pi.

Taking Graduate Courses as an Undergraduate Student & Advanced Standing

With the faculty adviser's approval, a student may take graduate courses while still an undergraduate in the School. Such work may be credited toward one of the graduate degrees offered by the Engineering Faculty, subject to the following conditions:

1. The course must be accepted as part of an approved graduate program of study;
2. The course must not have been used to fulfill a requirement for the B.S. degree and must be so certified by Engineering Student Affairs; and
3. The amount of graduate credit earned by an undergraduate cannot exceed 15 points.

Undergraduates may not take CVN courses.

The Bachelor of Science Degree

Columbia Engineering's undergraduate degrees are offered by the following departments: Applied Physics and Applied Mathematics, Biomedical Engineering, Chemical Engineering, Civil Engineering and Engineering Mechanics, Computer Science, Earth and Environmental Engineering, Electrical Engineering, Industrial Engineering and Operations Research, and Mechanical Engineering.

Students who complete a four-year sequence of prescribed study are awarded the Bachelor of Science degree. The general requirement for the Bachelor of Science degree is the completion of a minimum of 128 academic credits with a minimum cumulative grade-point average (GPA) of 2.0 (C) at the time of graduation. The program requirements, specified elsewhere in this bulletin, include the first-year/sophomore course requirements, the major departmental requirements, and technical and nontechnical elective requirements. Students who wish to transfer points of credit may count no more than 68 transfer points toward the degree and must satisfy the University's residence requirements by taking at least 60 points of credit that count for Bachelor of Science Degree while enrolled in The Fu Foundation School of Engineering and

Applied Science. Courses may not be repeated for credit unless it is stated otherwise in the course description.

The bachelor's degree in engineering and applied science earned at Columbia University prepares students to enter a wide range of professions. Students are, however, encouraged to consider graduate work, at least to the master's degree level, which is increasingly considered necessary for many professional careers.

The Engineering Accreditation Commission (EAC) of ABET, an organization formed by the major engineering professional societies, accredits university engineering programs on a nationwide basis. Completion of an accredited program of study is usually the first step toward a professional engineering license. Advanced study in engineering at a graduate school sometimes presupposes the completion of an accredited program of undergraduate study.

The following undergraduate programs are accredited by the EAC of ABET: Biomedical Engineering; Chemical Engineering; Civil Engineering; Earth and Environmental Engineering; Electrical Engineering; and Mechanical Engineering.

Minors

Columbia Engineering undergraduates may choose to add minors to their programs. This choice should be made in the fall of their sophomore year, when they also decide on a major.

In considering a minor, students must understand that not all minors are available to all students. Additionally, no class substitutions are permitted when completing a minor. The potential for the successful completion of a minor depends on the student's major and the minor chosen, as well as the course schedules and availability, which may change from year to year. The list of minors, as well as their requirements, can be found in the Undergraduate Minors (p. 325) section.

Programs in Preparation for Other Professions

James H. and Christine Turk Berick Center for Student Advising
403 Lerner Hall, MC 1201
212-854-6378
preprofessional@columbia.edu
cc-seas.columbia.edu/preprofessional

The Fu Foundation School of Engineering and Applied Science prepares its students to enter any number of graduate programs and professions outside of what is generally thought of as the engineering field. In an increasingly technological society, where the line between humanities and technology is becoming blurred, individuals with a thorough grounding in applied sciences and engineering find themselves highly sought after as professionals in practically all fields of endeavor.

Engineering students interested in pursuing graduate work in such areas as architecture, business, education, journalism, or law will find themselves well prepared to meet the generally flexible admissions requirements of most professional schools. Undergraduate students should, however, make careful inquiry into the kinds of specific preparatory work that may be required for admission into highly specialized programs such as medicine.

Premed

Medical, dental, and other health professional schools prefer that undergraduates complete a four-year program of study toward the bachelor's degree. All health professional schools require prerequisite coursework, but they do not prefer one type of major or scholarly concentration. Students with all types of engineering backgrounds are highly valued.

It is important to note, however, that each medical school in the United States and Canada individually determines its own entrance requirements, including prerequisite coursework and/or competencies. Each medical school also sets its own rules regarding acceptable courses or course equivalents. It is therefore essential that students plan early and confirm the premedical requirements for those schools to which they intend to apply. The Engineering curriculum covers many of the prerequisite courses required by medical schools; however, in addition to completing the mathematics, chemistry, and physics courses required by the First-Year/Sophomore Program, most schools ask for a full year of organic chemistry, a full year of biology, a full year of English, a semester of statistics, and a semester of biochemistry. Advanced Placement credit is accepted in fulfillment of these requirements by some schools but not all. Students are responsible for monitoring the requirements of each school to which they intend to apply.

Generally, students with Advanced Placement credit are strongly advised to take further courses in the field in which they have received such credit.

In addition to medical school requirements, all medical schools currently require applicants to sit for the Medical College Admissions Test (MCAT). The recommended preparation for this exam is:

- One year of general chemistry and general chemistry lab
- One year of organic chemistry and organic chemistry lab
- One year of introductory biology and biology lab
- One semester of biochemistry
- One year of general physics and physics lab
- One semester of introductory psychology

As you prepare for this path, you should consult regularly with both your assigned adviser and one of the premedical advisers in the James H. Christine Turk Berick Center for Student Advising. These individuals will help to guide you in your course selection and planning, and introduce you to extracurricular and research opportunities related to your interests in health and medicine. Preprofessional Advising maintains an online list of many different clinical volunteer and research opportunities across New York City and beyond. Exploration of the career and sustained interactions with patients is viewed by many medical schools as essential preparation, and therefore students are strongly encouraged to spend time volunteering/working in clinical and research environments before applying to medical school.

Students must apply for admission to health professional schools more than one year in advance of the entry date. Students who are interested in going directly on to health professional schools following graduation should complete all prerequisite courses required for the MCAT by the end of the junior year. It is entirely acceptable (and most common) for students to take time between undergraduate and health professional school and thus delay application to these schools for one or more years. Students planning to apply to medical or dental school should be evaluated by the Premedical Advisory Committee prior to application. A Premedical Advisory Committee application is made available each

year in December. For more information regarding this process and other premedical-related questions, please consult with a premedical adviser in the Berick Center for Student Advising or peruse its website at cc-seas.columbia.edu/preprofessional/health.

Prelaw

Students fulfilling the School of Engineering and Applied Science's curriculum are well prepared to apply to and enter professional schools of law, which generally do not require any specific prelaw coursework. Schools of law encourage undergraduate students to complete a curriculum characterized by rigorous intellectual training involving relational, syntactical, and abstract thinking. While selecting courses, keep in mind the need to hone your writing skills, your communication skills, and your capacity for logical analysis.

While engineering students may find interests in many areas of the law, for intellectual property and patent law, a science and technology background will be greatly valued, if not essential.

Joint Programs

The 4-1 Program at Columbia College

Students who are admitted as first-year students to the School of Engineering and Applied Science and subsequently complete the four-year program for the Bachelor of Science degree have the opportunity to apply for admission to either Columbia College or Barnard College and, after one additional year of study, receive the Bachelor of Arts degree. The fifth year of study begins in the fall semester, and students are required to complete two full-time semesters in the College totaling at least 31 points.

The program is selective, and admission is based on the following factors: granting of the B.S. at Columbia Engineering at the end of the fourth year; completion of two semesters of either Literature Humanities or Contemporary Civilization by the end of the junior year; fulfillment of all College Core requirements by the end of the fourth year at the School; a minimum GPA of 3.0 in the College Core and other courses; and the successful completion of any prerequisites for the College major or concentration. Students apply at the end of their junior year at the School; to be admitted to the program, students need to have a plan in place to complete the College major or concentration by the end of their fifth year.

Interested students should contact their Advising Dean for further information.

Undergraduate Admissions

Undergraduate Admissions
212 Hamilton Hall, MC 2807
1130 Amsterdam Avenue
New York, NY 10027
212-854-2522
ugrad-ask@columbia.edu
undergrad.admissions.columbia.edu

For information about undergraduate admissions, please visit the Undergraduate Admissions website or contact the office by phone or email.

See the Graduate Admissions (p. 23)section for information about graduate admissions, including combined undergraduate/graduate programs.

Undergraduate Tuition, Fees, and Payments

The 2026–2027 tuition and fees are estimated. Tuition and fees are prescribed by statute and are subject to change at the discretion of the Trustees.

University charges such as tuition, fees, and residence hall and meal plans are billed in the first Student Account Statement of the term, which is sent out in July and December of each year for the upcoming term. This account is payable and due in full on or before the payment due date announced in the Statement, typically at the end of August or early January before the beginning of the billed term. Any student who does not receive the first Student Account Statement is expected to pay at registration.

If the University does not receive the full amount due for the term on or before the payment due date of the first Statement, a late payment charge of $150 will be assessed. An additional charge of 1.5 percent per billing cycle may be imposed on any amount past due thereafter.

Students with an overdue account balance may be prohibited from registering, changing programs, or obtaining a diploma or transcripts. In the case of persistently delinquent accounts, the University may utilize the services of an attorney and/or collection agent to collect any amount past due. If a student's account is referred for collection, the student may be charged an additional amount equal to the cost of collection, including reasonable attorney's fees and expenses incurred by the University.

Tuition

Undergraduate students enrolled in The Fu Foundation School of Engineering and Applied Science pay a flat tuition charge of $36,400 per term, regardless of the number of course credits taken. Postgraduate special students and degree candidates enrolled for a ninth term are billed according to the per-point system; the per-point cost is $2,342.

Fees

Mandatory Fees

Orientation fee:	$625 (one-time charge in the first term of registration)
Student Life fee:	$917 per term
Health and Related Services fee:	$723 per term
International Services charge:	$170 per term (international students only)
Document fee:	$105 (one-time charge)

Other Fees

Application for undergraduate admission:	$85
Application for undergraduate transfer admission:	$85

Late registration fee during late registration:	$50
After late registration:	$100

Books and course materials:	Depends upon course
Laboratory fees:	See course listings
Room and board (estimated):	$18,680 for first year students

Health Insurance and Other Expenses

Health Insurance

Columbia University offers the Student Medical Insurance Plan, which provides both Basic and Comprehensive levels of coverage. Full-time students are automatically enrolled in the Basic level of the Plan and billed for the insurance premium in addition to the Health Service fee. Visit the Columbia Health website at health.columbia.edu for detailed information about medical insurance coverage options and directions for making confirmation, enrollment, or waiver requests.

Personal Expenses

Students should expect to incur miscellaneous personal expenses for such items as clothing, linen, laundry, dry cleaning, and so forth. Students should also add to the above expenses the cost of two round trips between home and the University to cover travel during the summer and the month-long, midyear break.

The University advises students to open a local bank account upon arrival in New York City. Since it often takes as long as three weeks for the first deposit to clear, students should plan to cover immediate expenses using either a credit card, traveler's checks, or cash draft drawn on a local bank. Students are urged not to arrive in New York without sufficient start-up funds.

Laboratory Charges

Students may need to add another $100 to $300 for drafting materials or laboratory fees in certain courses. Each student taking laboratory courses must furnish, at their own expense, the necessary notebooks, blank forms, and similar supplies. In some laboratory courses, a fee is charged to cover expendable materials and equipment maintenance. Students engaged in special tests, investigations, theses, or research work are required to meet the costs of expendable materials as may be necessary for this work and in accordance with such arrangements as may be made between the student and the department immediately concerned.

Damages

All students will be charged for damage to instruments or apparatus caused by their carelessness. The amount of the charge will be the actual cost of repair, and, if the damage results in total loss of the apparatus, adjustment will be made in the charge for age or condition. To ensure that there may be no question as to the liability for damage, students should note whether the apparatus is in good condition before use and, in case of difficulty, request instruction in its proper operation. Where there is danger of costly damage, an instructor should be requested to inspect the apparatus. Liability for breakage will be decided by the instructor in charge of the course.

When the laboratory work is done by a group, charges for breakage will be divided among the members of the group. The students responsible for any damage will be notified that a charge is being made against them. The amount of the charge will be stated at that time or as soon as it can be determined.

Tuition and Fee Refunds

Students who make a complete withdrawal from a term are assessed a withdrawal fee of $75. Late fees, application fees, withdrawal fees, tuition deposits, special fees, computer fees, special examination fees, and transcript fees are not refundable.

The Health Service Fee, Health Insurance Premium, University facilities fees, and student activity fees are not refundable.

Students who withdraw within the first 60 percent of the academic period are subject to a refund calculation, which refunds a portion of tuition based on the percentage of the term remaining after the time of withdrawal. This calculation is made from the date the student's written notice of withdrawal is received by the Dean's Office.

Percentage Refund for Withdrawal during First Nine Weeks of Term

Prorated for calendars of a different duration:

Week	Percentage Refund
1st week	100%
2nd week	100%
3rd week	90%
4th week	80%
5th week	70%
6th week	60%
7th week	50%
8th week	40%
9th week and after	0%

For students receiving federal student aid, refunds will be made to the federal aid programs in accordance with Department of Education regulations. Refunds will be credited in the following order:

- Federal Unsubsidized Stafford Loans
- Federal Stafford Loans
- Federal Perkins Loans
- Federal PLUS Loans (when disbursed through the University)
- Federal Pell Grants
- Federal Supplemental Educational Opportunity Grants
- Other Title IV funds

Withdrawing students should be aware that they will not be entitled to any portion of a refund until all Title IV programs are credited and all outstanding charges have been paid.

Financial Aid for Undergraduate Study

Financial Aid and Educational Financing
618 Lerner Hall

2920 Broadway
Mailing: 100 Hamilton Hall, MC 2802
1130 Amsterdam Avenue
New York, NY 10027
Monday–Friday: 9:00 a.m.–5:00 p.m.

Phone: 212-854-3711
Fax: 212-854-5353
ugrad-finaid@columbia.edu
cc-seas.financialaid.columbia.edu

Columbia is committed to meeting the full demonstrated financial need for all applicants. Financial aid is available for all four undergraduate years, provided that students continue to demonstrate financial need.

All applicants who are citizens or permanent residents of the United States, who are granted refugee visas by the United States, or who are undocumented students in the United States are considered for admission in a need-blind manner.

International students who did not apply for financial aid in their first year are not eligible to apply for financial aid in any subsequent years. Foreign transfer candidates applying for aid must understand that such aid is awarded on an extremely limited basis. Columbia does not give any scholarships for academic, athletic, or artistic merit.

Please visit the Financial Aid website at cc-seas.financialaid.columbia.edu for more information on financial aid, including requirements and application instructions.

Satisfactory Academic Progress

Columbia University complies with federal SAP regulations. To be eligible for Federal Student Aid (Federal Pell Grant, Federal SEOG, Federal Work-Study, Federal Perkins Loan, Federal Direct/PLUS loan), an otherwise eligible student must meet or exceed the SAP standards set by their school or program at the time SAP is assessed. The SAP policy may be found online at sfs.columbia.edu/content/satisfactory-academic-progress.

Graduate Studies

- Graduate Programs (p. 18)
- Columbia Video Network (p. 21)
- Graduate Admissions (p. 23)
- Graduate Tuition, Fees, and Payments (p. 24)
- Financial Aid for Graduate Study (p. 26)

Graduate Programs

Graduate programs of study in The Fu Foundation School of Engineering and Applied Science are not formally prescribed, but are planned to meet the particular needs and interests of each individual student. Departmental requirements for each degree, which supplement the general requirements given below, appear in the sections on individual graduate programs.

Applicants for a graduate program are required to have completed an undergraduate degree and to provide an official transcript as part of the admissions application. Ordinarily, the candidate for a graduate degree will have completed an undergraduate course in the same field of engineering in which they seek a graduate degree. However, if the student's interests have changed, it may be necessary to make up such basic undergraduate courses as are essential to graduate study in their new field of interest.

A maximum of 15 points of credit of prior graduate-level coursework completed at Columbia University not used toward another degree may be counted toward the degree. Students registered in the School have a minimum requirement for each Columbia degree of 30 points of credit of coursework completed at Columbia University. The student must enroll for at least 15 of these points while registered as a matriculating student in a graduate degree program in the Engineering School. (See also the section Nondegree Students and the chapter Columbia Video Network.) Students wishing to change from the Ph.D. degree to the Eng.Sc.D. degree must therefore enroll for at least 15 points while registered in the School. For residence requirements for students registered in the Graduate School of Arts and Sciences or those wishing to change from the Eng.Sc.D. degree to the Ph.D. degree, see the policies of the Graduate School of Arts and Sciences.

Students admitted to graduate study are expected to enter upon the term for which they are admitted and continue their studies in each succeeding regular term of the academic year. Any student who fails to register for the following term will be withdrawn unless a leave of absence has been granted by the Office of Engineering Student Affairs.

While many candidates study on a full-time basis, it is possible to obtain all or a substantial part of the credit requirement for the master's or Eng.Sc.D. degrees through part-time study if the specific program of study allows.

Under special conditions, and with the prior approval of the department of their major interest and of the Office of Engineering Student Affairs, a student may be permitted to take a required subject at another school. However, credit for such courses will not reduce the 30-point minimum that must be taken at Columbia University.

For graduation, a candidate for any degree except a doctoral degree must file an Application for Degree or Certificate on the date specified on the Registrar's website. If the degree is not earned by the next regular time for the issuance of diplomas subsequent to the date of filing, the degree application may be considered for the following conferral date.

Candidates for a doctoral degree undergo a formal examination in which the student has the opportunity to discuss and defend the dissertation with respect to its sources, findings, interpretations, and conclusions before a committee of faculty knowledgeable in the student's field of research. Students must apply for this final examination, also referred to as the dissertation defense at least two weeks (but ideally four weeks) before the date of the defense.

Degrees are awarded three times a year—in October, February, and May.

Master of Science Degree

The Master of Science degree is offered in many fields of engineering and applied science upon the satisfactory completion of a minimum of 30 points of credit of approved graduate study extending over at least one academic year.

While a suitable Master of Science program will necessarily emphasize some specialization, the program should be well balanced, including basic subjects of broad importance as well as theory and applications. The history of modern economic, social, and political institutions is important in engineering, and this is recognized in the prescribed undergraduate program of the School. If the candidate's undergraduate

education has been largely confined to pure science and technology, a program of general studies, totaling from 6 to 8 points, may be required. Supplementary statements covering these special requirements are issued by the School's separate departments. An applicant who lacks essential training will be required to strengthen or supplement the undergraduate work by taking or repeating certain undergraduate courses before proceeding to graduate study. No graduate credit (that is, credit toward the minimum 30-point requirement for the Master of Science degree) will be allowed for such subjects. Accordingly, Master of Science programs may include from 35 to 45 points and may require three terms for completion. Doctoral research credits cannot be used toward M.S. degree requirements.

All degree requirements must be completed within five years of the beginning of graduate study. Under extraordinary circumstances, a written request for an extension of this time limit may be submitted to the student's department for approval by the department chair and the Office of Engineering Student Affairs (ESA). A minimum cumulative grade-point average of 2.5 is required for the M.S. degree. A student who, at the end of any term, has not attained the grade-point average required for the degree may be asked to withdraw.

An M.S. student may submit an application to apply and transfer to another academic program, but cannot transfer earlier than the first semester of enrollment. If the student is not successful with the application process, then they must make sure the requirements for the original academic program are completed.

Professional Development Leadership M.S. Requirement

(ENGI E4000 PROF DEVELOPMENT#LEADERSHIP)

The Professional Development and Leadership (PDL) program educates students to maximize performance and achieve their full potential to become engineering leaders. The core modules focus on the development of professional skills and perspectives needed to succeed in a fast-changing technical climate.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. This course is expected to be completed during the first two semesters of enrollment.

Professional Development Leadership Doctoral Requirement

(ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students)

The Professional Development and Leadership (PDL) program educates students to maximize performance and achieve their full potential during and after the doctoral program. The goal is to cultivate future scholars and leaders in their respective fields. The modules are tailored for each stage of the doctoral program, with a focus on the development of academic, research, and professional skills. Students will also have the opportunity to participate in small group communication workshops for doctoral students and individualized coaching tailored to their specific goals. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students , and should consult their program for specific PDL requirements.

The 4-2 Master of Science Program

The 4-2 Master of Science Program provides the opportunity for students holding bachelor's degrees from affiliated liberal arts colleges (see the listing under the heading The Combined Plan Program with Other Affiliate Colleges) with majors in mathematics, physics, chemistry, or certain other physical sciences to receive the M.S. degree after two years of study at Columbia in the following fields of engineering and applied science: biomedical, chemical, civil, earth and environmental, electrical, industrial, and mechanical engineering; applied physics; applied mathematics; computer science; engineering mechanics; operations research; and materials science.

Each applicant must produce evidence of an outstanding undergraduate record, including superior performance in physics and mathematics through differential equations. The program of study will be individually designed in consultation with a faculty adviser and will integrate undergraduate work with the field of engineering or applied science the student chooses to follow. During the first year, the program will consist primarily of basic undergraduate courses; during the second year, of graduate courses in the selected field. The student must complete at least 30 credits of graduate study to qualify for the degree.

A student whose background may require supplementary preparation in some specific area, or who has been out of school for a considerable period, will have to carry a heavier than normal course load or extend the program beyond two years.

Graduates of the 4-2 Master of Science program may not be eligible to take the Fundamentals of Engineering (FE) exam if their undergraduate degree is not in engineering or a related field. Students should also check with individual state boards to determine eligibility requirements for employment.

Please contact the Office of Engineering Student Affairs. You should also contact your home institution's Combined Plan liaison for program information. You may, in addition, email questions to seasgradmit@columbia.edu.

Dual Degree Program with Columbia Business School (MBAxMS)

Columbia Business School and Columbia Engineering offer a dual degree program leading to the degrees of Master of Business Administration and Master of Science in Engineering and Applied Science. (See Executive Master of Science in Engineering and Applied Science.)

Dual Degree Program in Computer Science with the School of Journalism

The School of Journalism and the Engineering School offer a dual degree program leading to the degrees of Master of Science in Journalism and the Master of Science in Computer Science. (See Computer Science.)

Dual Degree Program in Industrial Engineering with Columbia Business School

Columbia Business School and the Engineering School offer a joint program leading to the degrees of Master of Business Administration and

Master of Science in Industrial Engineering. (See Industrial Engineering and Operations Research.)

Master of Science Program in Management Science and Engineering

In collaboration with Columbia Business School's Decision, Risk and Operations Division, the Industrial Engineering and Operations Research department offers a master's degree program focused on management and engineering perspectives in solving problems of complex systems. (See Industrial Engineering and Operations Research.)

Master of Science Program in Business Analytics

In partnership with Columbia Business School's Decision, Risk and Operations Division and Marketing Division, the Industrial Engineering and Operations Research department offers a master's degree program designed for those who want to focus on learning the modeling techniques and data science tools that help businesses use data to make better decisions. (See Industrial Engineering and Operations Research.)

Office of Engineering Student Affairs

The Office of Engineering Student Affairs at The Fu Foundation School of Engineering and Applied Science is integral to the School's teaching, research, and service mission and works to enhance the educational opportunities available to students. This office provides leadership for the integration of educational programs and services that enhance recruitment, retention, and quality of campus life for students at Columbia Engineering. It strives to demonstrate sensitivity and concern in addressing the needs of the School's population. The office is dedicated to providing service to prospective, new, and continuing students pursuing an education in engineering or applied science.

Doctoral Degrees: Eng.Sc.D. and Ph.D.

Two doctoral degrees in engineering are offered by the University: the Doctor of Engineering Science, administered by The Fu Foundation School of Engineering and Applied Science, and the Doctor of Philosophy, administered by the Graduate School of Arts and Sciences. Both doctoral programs are subject to review by the Committee on Instruction of the School. Doctoral students may submit a petition to the Office of Engineering Student Affairs to change from the Eng.Sc.D. degree to the Ph.D. degree or from the Ph.D. degree to the Eng.Sc.D. degree. The petition must be submitted within the first year of enrollment in the doctoral program. Any petitions submitted after this period will not be considered. Doctoral degree status can be changed only once; students, therefore, must determine which doctoral degree program is most appropriate for their academic and professional endeavors.

Departmental requirements may include comprehensive written and oral qualifying examinations. A student must have a satisfactory grade-point average to be admitted to the doctoral qualifying examination. Thereafter, the student must write a dissertation embodying original research under the sponsorship of a member of their department and submit it to the department. If the department recommends the dissertation for defense, the student applies for final examination, which is held before an examining committee approved by the appropriate Dean's Office. This application must be made at least two weeks, with a strong preference for four weeks, before the date of the final examination.

The defense of the dissertation constitutes the final test of the candidate's qualifications. It must be demonstrated that the candidate has made a contribution to knowledge in a chosen area. In content, the dissertation should, therefore, be a distinctly original contribution in the selected field of study. In form, it must show the mastery of written English, which is expected of a university graduate.

For the Ph.D. Degree

A student must obtain the master's degree (M.S.) before enrolling as a candidate for the Ph.D. degree. Application for admission as a doctoral candidate may be made while a student is enrolled as a master's degree candidate. Candidates for the Ph.D. degree must register full time and complete six Residence Units. The minimum requirement in coursework for the doctoral degree is 60 points of credit beyond the bachelor's degree. A master's degree from an accredited institution may be accepted in the form of advanced standing as the equivalent of one year of residence (30 points of credit and two Residence Units). An application for advanced standing must be completed during the first semester of study. Ph.D. candidates will be required to complete a minimum of 30 additional points of credit in residence for a letter grade beyond the M.S.

Ph.D. candidates who have completed all six Residence Units can satisfy the continuous registration requirement and make use of various University facilities by registering for Matriculation & Facilities (M&F) for a maximum of two semesters if they are:

- completing a degree requirement such as a language examination or qualifying examination;
- preparing the dissertation proposal; or
- writing or distributing the dissertation.

If a Ph.D. student is registered in courses or holds a university teaching or research appointment, the student must register for either a full Residence Unit or Extended Residence.

Ph.D. students must be registered for the semester in which their distribution takes place. The term in which the dissertation distribution occurs is the last semester in which a Ph.D. student is permitted to register, even if the defense takes place in a subsequent term. Click here for more detailed information about final registration requirements. Students should also be aware that International Students with questions about their registration and remaining in visa compliance should contact the International Students and Scholars Office (ISSO).

Note: Full-time doctoral students who are supported on faculty grants through twelve-month research appointments should pay particular attention to the special conditions that are noted on the Registration and Application for PhD Defense page.

- Distribution deadlines can be found here.
- Dates for the fall and spring terms can be found on the Registrar's Academic Calendar.
- Dates for the summer term can be found on the School of Professional Studies website.
- Students covered under the Columbia Student Health Insurance Plan are strongly advised to review the information regarding the plan's coverage periods and important dates. Students with specific questions regarding their insurance coverage

should contact the Columbia Health Insurance Office at studentinsurance@columbia.edu.
- Similarly, students with active Columbia Residential leases should review the policy regarding dissertation defenses and housing eligibility.

Students should distribute final copies of the dissertation to defense committee members at least four weeks before the anticipated defense date to allow adequate time for committee members to review the dissertation thoroughly. The defense is expected to take place no later than two months after the distribution.

For the Eng.Sc.D. Degree

A student must obtain the master's degree (M.S.) before enrolling as a candidate for the Doctor of Engineering Science (DES) degree. The minimum requirement in coursework for the doctoral degree is 60 points of credit beyond the bachelor's degree. Eng.Sc.D. candidates will be required to complete a minimum of 30 additional points of credit in residence beyond the M.S. for a letter grade. A master's degree from an accredited institution may be accepted in the form of advanced standing as the equivalent of 30 points of credit. Candidates for the Eng.Sc.D. degree must, in addition to the 60-point requirement, accumulate 12 points of credit in the departmental course E9800: Doctoral research instruction (see below). The candidate for the degree of Doctor of Engineering Science must submit evidence that their dissertation has been filed in compliance with requirements set by the faculty of Engineering and Applied Science.

Doctoral Research Instruction

An Eng.Sc.D. candidate is required to complete 12 credits in the departmental course E9800: Doctoral research instruction in accordance with the following guidelines:

- After obtaining a master's degree or advanced standing, at which time the student begins doctoral research, the student is eligible to register for E9800 (3, 6, 9, or 12 points of credit per term).
- Registration for E9800 at a time other than that prescribed above is not permitted, except by written permission of the Office of Engineering Student Affairs (ESA).
- The 12 points of E9800 required for the Eng.Sc.D. degree do not count toward the minimum residence requirements, e.g., 30 points beyond the master's degree, so a student must complete at least 72 points in total for the DES.
- If a student is required to take coursework beyond the minimum residence requirements, the 12 points of doctoral research instruction must still be taken in addition to the required coursework.
- A student must register continuously through the fall and the spring terms. This requirement does not include the summer session.

Completion of Requirements

The requirements for the Eng.Sc.D. degree must be completed in no more than seven years. The seven-year time period begins at the time of enrollment and extends to the date on which the dissertation defense is held.

Extension of the time allowed for completion of the degree may be granted on recommendation of the student's sponsor and the department chair to the Office of Engineering Student Affairs when special circumstances warrant. Such extensions are initiated by submitting a statement of work in progress and a schedule for completion together with the sponsor's recommendation to the department chair.

Please contact the Office of Engineering Student Affairs for more information.

Nondegree Students

Qualified persons who are not interested in a degree program but who wish to take only certain courses may be permitted to register as nondegree students, provided course capacity allows and instructor permission is obtained.

Many graduate courses in The Fu Foundation School of Engineering and Applied Science are offered in the late afternoon and evening in order to make them available to working individuals who wish to further their knowledge in the areas of engineering and applied science. Individuals who find it difficult or impossible to attend classes on the Columbia campus may be able to receive instruction from the School through the Columbia Video Network. Individuals interested in this option should read the section describing the distance learning Columbia Video Network (CVN).

Nondegree students receive grades and must maintain satisfactory attendance and performance in classes or laboratories and will be subject to the same rules as degree candidates. Should a nondegree student decide to pursue a degree program, work completed as a nondegree student may be considered for advanced standing, but no more than 15 points of coursework completed as a nondegree student may be counted toward a graduate degree.

For additional information and regulations pertaining to nondegree students, see Graduate Admissions.

Columbia Video Network

Columbia Video Network
540 S. W. Mudd, MC 4719
500 West 120th Street
New York, NY 10027
212-854-6447
info@cvn.columbia.edu
cvn.columbia.edu

Background

Columbia University's Fu Foundation School of Engineering and Applied Science established the Columbia Video Network (CVN) in 1986 to meet a growing need within the engineering community for a graduate distance education program. More than 40 years later, our part-time, fully-online programs provide working professionals high quality graduate engineering education in a convenient and flexible format.

Program Benefits

At CVN, a top-ranked Best Graduate Online Engineering Program by the 2024 *U.S. News & World Report*, students can enroll in online courses and earn graduate engineering degrees without ever having to set foot on campus. CVN courses are taught by Columbia University faculty, offering students flexibility coupled with the high-caliber teaching, resources, and standards inherent in The Fu Foundation School of Engineering and Applied Science.

CVN students take graduate-level courses that are identical in curriculum and rigor to those offered to on-campus students. CVN courses are taught by the same faculty that teach on-campus courses. Students have access to online University resources and are a part of the Columbia community.

CVN graduates earn the same degrees as on-campus students. CVN's administrative staff is available to assist with registration procedures and technical queries. Students pursuing their M.S. and DES are assigned an academic adviser.

Programs of Study

CVN offers part-time, online graduate degrees, certificates, and nondegree courses. CVN students may enroll in select SEAS graduate courses in fall, spring, and summer terms. CVN administrators work closely with faculty members from each department to select courses that best fit the needs of our students.

Master of Science (M.S.) Degree Programs

The M.S. is a coursework-based master's, which requires 30 credits of online coursework. The M.S. must be completed within five years. Students are required to maintain continuous enrollment, which is a minimum of two classes per year, at least one in the fall and one in the spring semesters.

Fields of Study:

- Applied Mathematics
- Applied Physics
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Science
- Earth and Environmental Engineering
- Electrical Engineering
- Industrial Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Operations Research

M.S. Application

The M.S. application requires a minimum cumulative undergraduate GPA of 3.0, a resume/CV, a 250-word personal/professional statement, an unofficial transcript for each university attended, three letters of recommendation, self-reported GRE General Test scores (GRE scores are valid for five years), TOEFL/IELTS scores (if applicable), and an $85 application fee. Applications are reviewed on a rolling basis, but may be limited to departmental submission windows. Decisions are typically issued within ten weeks but may take longer during busy periods. Applications must be submitted via the application portal on cvn.columbia.edu.

Accepted students may request a deferral of their start term by a maximum of one semester after the term to which they were admitted to CVN.

Doctor of Engineering Science (DES) Degree Programs

The DES can be completed partially online. Students in the program can complete some of their courses online. Students also perform research on campus with a faculty adviser. Applicants must already have an M.S. in a related field prior to applying to the DES program. The DES must be completed within seven years. Applicants must have a potential faculty adviser selected and must have full funding commitment from their employer prior to submitting their applications.

Fields of Study:

- Earth and Environmental Engineering
- Electrical Engineering
- Mechanical Engineering

DES Application

The DES application requires a minimum cumulative undergraduate GPA of 3.0, an M.S. in a related field, a resume/CV, a 250-word personal/professional statement, an unofficial transcript for each university attended, three letters of recommendation, self-reported GRE General Test scores (GRE scores are valid for five years), TOEFL/IELTS scores (if applicable), an $85 application fee, and the name of a prospective faculty adviser. Applications must be submitted via the application portal on cvn.columbia.edu. Applications are reviewed on a rolling basis, but may be limited to departmental submission windows. Decisions are typically issued within 10 weeks, but may take longer during busy periods after submission.

Certification of Professional Achievement Programs

CVN offers 12-credit, four-course Certification of Professional Achievement programs in various fields for those who desire graduate-level coursework for professional advancement. Up to six credits earned in the Certification of Professional Achievement program can be applied toward an M.S. degree at CVN, as long as they are not applied toward the completion of a Certificate. Students enrolled in a certificate program must complete the program within two years and earn a GPA of 3.0 or higher. Completion of the certification does not guarantee acceptance into a degree program.

Fields of Study:

- Applied Mathematics
- Business and Technology
- Civil Engineering
- Construction Management
- Data Science
- Earth and Environmental Engineering
- Electrical Engineering
- Financial Engineering
- Industrial Engineering
- Information Systems
- Low Carbon and Efficiency Technology
- Manufacturing Engineering
- Materials Science
- Multimedia Networking
- Nanotechnology
- Networking and Systems
- New Media Engineering
- Operations Research
- Sustainable Energy
- Systems Engineering
- Telecommunications
- Wireless and Mobile Communications

Certification Application

The certification application requires a minimum cumulative undergraduate GPA of 3.0, a resume/CV, a 250-word personal/professional statement, an unofficial transcript for each university attended, three letters of recommendation, and an $85 application fee. Applications are reviewed on a rolling basis, and decisions are issued within two weeks of submission. Applications must be submitted via the application portal on cvn.columbia.edu.

Nondegree Courses

Students who have earned an undergraduate degree in engineering, mathematics, or a related field may earn up to six credits. Any of the CVN courses listed on the CVN website may be taken as a nondegree course, provided that the student has met the prerequisites for that course.

Up to six credits earned as a nondegree student may be applied toward the M.S. course requirements. Earning credit as a nondegree student does not guarantee acceptance into a degree program.

Nondegree Application

The application requires a minimum cumulative undergraduate GPA of 3.0, a resume/CV, a 250-word personal/professional statement, and unofficial transcripts from every university attended. There is no application fee. Applications are reviewed on a rolling basis, and decisions are issued within a week of submission. Applications must be submitted via the application portal on cvn.columbia.edu.

Graduate Admissions

Office of Graduate Admissions
1220 S. W. Mudd, MC 4708
500 West 120th Street
New York, NY 10027
212-854-4688
seasgradmit@columbia.edu
gradengineering.columbia.edu/admissions

The basic requirement for admission as a graduate student is a bachelor's degree received from an institution of acceptable standing. Ordinarily, the applicant will have majored in the field in which graduate study is intended, but in certain programs, preparation in a related field of engineering or science is acceptable. The applicant will be admitted only if the undergraduate record shows promise of productive and effective graduate work.

Students who hold an appropriate degree in engineering may apply for admission to study for the Ph.D. degree. However, students are required to obtain the master's degree first. Students currently enrolled in the School's M.S. program may apply for admission to the doctoral program after completing 15 points of coursework. Completion of a relevant master's degree is required prior to entry into the Ph.D. program.

Students may be admitted in one of the following five classifications:

- candidate for the M.S. degree,
- candidate for the M.S. degree leading to the Ph.D. degree,
- candidate for the Doctor of Engineering Science degree,
- candidate for the Doctor of Philosophy degree (see also the bulletin of the Graduate School of Arts and Sciences), or
- nondegree student (not a degree candidate).

Note: No more than 15 points of credit completed as a nondegree student may be counted toward a degree.

The applicant must submit all materials directly, not through an agent or third-party vendor, with the sole exception of submissions by the U.S. Department of State's Fulbright Program and its three partner agencies: IIE, LASPAU and AMIDEAST, and by the Danish-American Fulbright Commission (DAF), Deutscher Akademischer Austauschdienst (DAAD), and Vietnam Education Fund (VEF). In addition, the applicant will be required to attest to the accuracy and authenticity of all information and documents submitted to Columbia. If you have any questions about this requirement, please contact the admissions office at seasgradmit@columbia.edu.

Academic integrity is the cornerstone of a university education. Failure to submit complete, accurate, and authentic application documents consistent with these instructions may result in denial or revocation of admission, cancellation of academic credit, suspension, expulsion, or eventual revocation of degree. Applicants may be required to assist admissions staff and faculty involved in admission reviews in the verification of all documents and statements made in documents submitted by students as part of the application review process.

Application Requirements

Applicants can only apply to one degree program per admission term. Applicants must submit an online application and required supplemental materials, as described below. An official transcript from each postsecondary institution attended, personal statement, and resume or curriculum vitae must be submitted. Consideration for admission will be based not only on the completion of an earlier course of study, but also upon the quality of the record presented and upon such evidence as can be obtained concerning the applicant's personal fitness to pursue professional work.

Additionally, applicants must provide three letters of recommendation and the results of required standardized exams. If you have taken the Graduate Record Examination (GRE) and would like to provide your scores, you may, but it is not required as of July 2026. Students who do not submit scores will not be penalized in the graduate admissions review process. Students who do submit scores will be required to submit official test scores should they be admitted. Students applying to the Applied Physics Ph.D. or Applied Physics MS/Ph.D. Track program may supply GRE Physics subject test scores, although it is not required as of July 2026. GRE general and subject test scores are valid for five years from the test administration date according to the Educational Testing Service (ETS). English language test scores are required of all applicants who received their bachelor's degree in a country in which English is not the official and widely spoken language. The Test of English as a Foreign Language (TOEFL), International English Language Testing System (IELTS), Duolingo English Test (DET), or Pearson Test of English (PTE) scores satisfy the test requirement and are valid for two years according to the test organizations.

Applicants may be asked to participate in an interview as part of the application process.

English Proficiency

The Office of Engineering Student Affairs no longer requires students to demonstrate English proficiency as a graduation requirement at The Fu Foundation School of Engineering and Applied Science. Regardless of TOEFL, IELTS, DET, or PTE scores submitted for admission, students should continue to work on maintaining adequate verbal and/or written

abilities for successful integration within their classes and future professional endeavors. Students are highly encouraged to be proactive about addressing their English proficiency by utilizing the many resources available within Columbia University and throughout New York City.

Students have the option of enrolling in communication courses offered through Columbia Engineering's Professional Development and Leadership courses (noncredit, tuition-free). As a rule, ISSO will not permit students to drop courses or fall below full-time registration for language proficiency deficiencies.

Application Fee

The nonrefundable application fee for all graduate degree and nondegree programs is $85.

Graduate Admission Calendar

Applicants are admitted twice yearly, for the fall and spring semesters.

- Fall admission application deadlines: *December 15* for Ph.D., Eng.Sc.D., and M.S. leading to Ph.D. programs and *February 15* for most M.S. only and nondegree applicants. Please visit the Office of Graduate Admissions website for specific M.S. only program deadlines.
- Spring admission application deadline: *October 1* for all departments and degree levels.

Applicants who wish to be considered for scholarships, fellowships, and assistantships should file complete applications for fall admission.

Express Application

Columbia Engineering, Columbia College, General Studies, and Barnard seniors as well as alumni from the same schools, who have graduated within five years, may be eligible to apply to a master's program using the express application process. A minimum cumulative GPA of 3.3 in an approved undergraduate program is required to be eligible to submit an M.S. Express application. For more information about eligibility, visit the Office of Engineering Student Affairs website.

The M.S. Express online application, which waives the submission of GRE scores, letters of recommendation, and official transcripts, streamlines and simplifies the application process for graduate study. Contact your academic department or the Office of Engineering Student Affairs for further details.

BS/MS Application

The Integrated BS/MS Program is offered in Biomedical Engineering, Electrical Engineering, and Mechanical Engineering. The program is open only to Columbia University juniors with a cumulative GPA of 3.4. After earning the BS degree, students are able to seamlessly proceed toward earning their MS degree. Merging the BS and MS programs allows Columbia students to earn the MS degree in a very flexible and efficient manner.

Barnard 4+1 Pathway Application

The Barnard 4+1 Pathway is offered to current Barnard College juniors with a GPA of 3.5 or higher to apply to master's programs in Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Science, Electrical Engineering, Mechanical Engineering, and Industrial Engineering and Operations Research. Students should inquire with Beyond Barnard and plan on attending an introductory information session for the unique 4+1 Pathway they may be interested in pursuing. A maximum of 15 points of credit of graduate-level coursework, completed at Columbia University before the new program is approved and not used toward another degree, may be counted toward the master's degree. Students must enroll in the master's degree program for at least one semester and must enroll for at least 15 of these points while registered as a matriculating student in a degree program in the Engineering School.

One-Term Nondegree Student Status

Individuals who meet the eligibility requirements, who are U.S. citizens, U.S. permanent residents, or hold an appropriate visa, and who wish to take courses for enrichment, may secure faculty approval to take up to two graduate-level courses for one term only as a one-term nondegree student. This option is also appropriate for individuals who missed application deadlines. Applications for the one-term nondegree student status are available at the Office of Engineering Student Affairs and must be submitted during the first week of the fall or spring semester.

If a one-term nondegree student subsequently wishes either to continue taking classes the following term or to become a degree candidate, a formal application must be made through the Office of Engineering Student Affairs.

Transfer Applicants

Students who wish to change program of study, either within Columbia or another institution, would need to apply for admission to the program of interest. There is no transferring between programs. Previously completed graduate-level coursework must align with Columbia Engineering Advanced Standing Policy and the degree curriculum requirements.

Graduate Tuition, Fees, and Payments

The 2026–2027 tuition and fees are estimated. Tuition and fees are prescribed by statute and are subject to change at the discretion of the Trustees.

University charges such as tuition and fees are billed in the first Student Account Statement of the term, which is sent out in July and December of each year for the upcoming term. This account is payable and due in full on or before the payment due date announced in the Statement, typically at the end of August or early January before the beginning of the billed term. Any student who does not receive the first Student Account Statement is expected to pay at registration.

If the University does not receive the full amount due for the term on or before the payment due date of the first Statement, a late payment charge of $150 will be assessed. An additional charge of 1.5 percent per billing cycle may be imposed on any amount past due thereafter.

Students with an overdue account balance may be prohibited from registering, changing programs, or obtaining a diploma or transcripts. In the case of persistently delinquent accounts, the University may utilize the services of an attorney and/or collection agent to collect any amount past due. If a student's account is referred for collection, the student may be charged an additional amount equal to the cost of collection, including reasonable attorney's fees and expenses incurred by the University.

Tuition

Graduate students enrolled in M.S. and Eng.Sc.D. programs pay $2,822 per credit, except when a special fee is fixed. Graduate tuition for Ph.D. students is $29,272 per Residence Unit. The Residence Unit, full-time registration for one semester rather than for individual courses (whether or not the student is taking courses), provides the basis for tuition charges. Ph.D. students should consult the bulletin for the Graduate School of Arts and Sciences.

Fees

Comprehensive Fee/ Matriculation and Facilities

Eng.Sc.D.

Eng.Sc.D. candidates who have completed their twelve (12) credits of Doctoral Research Instruction (see Graduate Programs), and are at the "all but dissertation" stage are assessed a Comprehensive Fee of $2,806 per term by The Fu Foundation School of Engineering and Applied Science.

PhD

The Graduate School of Arts and Sciences will assess $2,806 tuition per term for the Matriculation and Facilities (M&F) registration. Students can only register for a maximum of two semesters of M&F (see Graduate Programs).

Mandatory Fees

University Services and Support Fee

Full-time master's programs:	$703 fall per term
Part-time master's programs:	$548 per term
All other full-time programs:	$645 per term
All other part-time programs:	$490 per term
Health and Related Services fee:	$759 per term
International Services charge:	$175 per term (international students only)
Document fee:	$105 (one-time charge)

Other Fees

Activities Fees for Master's Programs

First year full-time students (12 or more credits):	$480
Continuing full-time students (12 or more credits):	$460
First year part-time students (less than 12 credits):	$240
Continuing part-time students (less than 12 credits):	$230
All full-time and part-time M.S.-Ph.D. track and Ph.D. students shall be charged, per term, a student activities fee	$26

Application and Late Fees

Application for graduate admission:	$85
Late registration fee during late registration:	$50
Late registration fee after late registration:	$100
Books and course materials:	Depends upon course
Laboratory fees:	See course listings
IEOR master's program fee, Full-time master's program:	$1,144
IEOR master's program fee, Part-time master's program:	$572
Visiting Students program fee:	$572 per term
Dual MBA and Executive MS (BUEXMS) program fee:	$572 per term
MS in AI program fee, Full-time master's program:	$1,144
MS in AI program fee, Part-time master's program:	$572

Health Insurance and Other Expenses

Health Insurance

Columbia University offers the Student Medical Insurance Plan, which provides both Basic and Comprehensive levels of coverage. Full-time students are automatically enrolled in the Basic level of the Plan and billed for the insurance premium in addition to the Health Service fee. Visit the Columbia Health website at health.columbia.edu for detailed information about medical insurance coverage options and directions for making confirmation, enrollment, or waiver requests.

Personal Expenses

Students should expect to incur miscellaneous personal expenses for such items as food, clothing, linen, laundry, dry cleaning, and so forth.

The University advises students to open a local bank account upon arrival in New York City. Since it often takes as long as three weeks for the first deposit to clear, students should plan to cover immediate expenses using either a credit card, traveler's checks, or cash draft drawn on a local bank. Students are urged not to arrive in New York without sufficient start-up funds.

Laboratory Charges

Students may need to add another $100 to $300 for drafting materials or laboratory fees in certain courses. Each student taking laboratory courses must furnish, at their own expense, the necessary notebooks, blank forms, and similar supplies. In some laboratory courses, a fee is charged to cover expendable materials and equipment maintenance; the amount of the fee is shown with the descriptions in the course listings. Students engaged in special tests, investigations, theses, or research work are required to meet the costs of expendable materials as may be necessary for this work and in accordance with such arrangements as may be made between the student and the department immediately concerned.

Damages

All students will be charged for damage to instruments or apparatus caused by their carelessness. The amount of the charge will be the actual

cost of repair, and, if the damage results in total loss of the apparatus, adjustment will be made in the charge for age or condition. To ensure that there may be no question as to the liability for damage, students should note whether the apparatus is in good condition before use and, in case of difficulty, request instruction in its proper operation. Where there is danger of costly damage, an instructor should be requested to inspect the apparatus. Liability for breakage will be decided by the instructor in charge of the course.

When the laboratory work is done by a group, charges for breakage will be divided among the members of the group. The students responsible for any damage will be notified that a charge is being made against them. The amount of the charge will be stated at that time or as soon as it can be determined.

Tuition and Fee Refunds

Students who make a complete withdrawal from a term, including the summer, are assessed a withdrawal fee of $75. Late fees, application fees, withdrawal fees, tuition deposits, special fees, computer fees, special examination fees, and transcript fees are not refundable.

The Health Service Fee, Health Insurance Premium, University facilities fees, and student activity fees are not refundable.

Students who withdraw within the first 60 percent of the academic period are subject to a *pro rata* refund calculation, which refunds a portion of tuition based on the percentage of the term remaining after the time of withdrawal. This calculation is made from the date the student's written notice of withdrawal is received by the Office of Engineering Student Affairs.

Percentage Refund for Withdrawal during First Nine Weeks of Term

Prorated for calendars of a different duration, if the entire program is dropped:

Description	Charge Assessed
1st week	100%
2nd week	100%
3rd week	90%
4th week	80%
5th week	70%
6th week	60%
7th week	50%
8th week	40%
9th week and after	0%

Refund Policy When Dropping Individual Courses

Tuition for courses dropped by the last day of the Change-of-Program period is refunded in full. There is no refund of tuition for individual courses dropped after the last day of the Change-of-Program period. The Change-of-Program period is usually the first two weeks of the fall or spring semesters. For the Summer Change of Program period, please refer to the Summer semester academic calendar.

Please note: The prorated schedule above does not pertain to individual classes dropped (unless your entire schedule consists of only one class). The prorated schedule pertains to leave of absence and withdrawals.

For students receiving federal student aid, refunds will be made to the federal aid programs in accordance with Department of Education regulations. Refunds will be credited in the following order:

- Federal Unsubsidized Stafford Loans
- Federal Stafford Loans
- Federal Perkins Loans
- Federal PLUS Loans (when disbursed through the University)
- Federal Pell Grants
- Federal Supplemental Educational Opportunity Grants
- Other Title IV funds

Withdrawing students should be aware that they will not be entitled to any portion of a refund until all Title IV programs are credited and all outstanding charges have been paid.

Financial Aid for Graduate Study

Financing Graduate Education

The academic departments of Columbia Engineering and the Office of Student Financial Planning seek to ensure that all academically qualified students have enough financial support to enable them to work toward their degree. Possible forms of support for tuition, fees, books, and living expenses are: institutional grants, fellowships, teaching and research assistantships, on- or off-campus employment, and student loans. The Office of Student Financial Planning assists students with developing financing plans for completing a degree.

Columbia University graduate funds are administered by two separate branches of the University, and the application materials required by the two branches differ. Institutional grants, fellowships, and teaching and research assistantships are all departmentally administered. Questions regarding these awards should be directed to your academic department. Federal Student Loans (Unsubsidized and Graduate PLUS) and private student loans are administered by the Office of Student Financial Planning.

Questions about loans should be directed to the financial aid office via email at sfp@columbia.edu or phone at 212-854-7040.

Further information can be found at sfs.columbia.edu/sfp-grad-engin.

Instructions for Financial Aid Applicants

Deadlines

Apply for financial aid at the same time that you apply for admission. Your admissions application must be received by the December 15 deadline to be eligible for The Fu Foundation School of Engineering and Applied Science departmental funding (institutional grants, fellowships, and teaching and research assistantships). Spring admissions applicants will not be considered for departmental funding.

Incoming applicants and continuing students should complete the FAFSA at studentaid.gov/h/apply-for-aid/fafsa for fall enrollment.

Guidelines for continuing students are available from departmental advisers in advance of the established deadline. All continuing supported students must preregister for classes during the preregistration period.

Graduate School Departmental Funding

The graduate departments of Columbia Engineering offer an extensive array of funding. Funding decisions, based solely on merit, and

contingent upon making satisfactory academic progress, are made by the departments. All applicants for admission and continuing students maintaining satisfactory academic standing will be considered for departmental funds. Applicants should contact their department directly for information. Columbia Engineering prospective and continuing graduate students must complete their FAFSA in order to be considered for all forms of graduate financing. The application for admission to Columbia Engineering graduate programs is also used to apply for departmental funding. Outside scholarships for which you qualify must be reported to your department and the Office of Student Financial Planning. The School reserves the right to adjust your institutional award if you hold an outside scholarship, fellowship, or other outside funding.

Institutional Grants

Institutional grants are awarded to graduate students on the basis of academic merit. Recipients must maintain satisfactory academic standing.

Fellowships

Fellowships are financial and intellectual awards for academic merit that provide stipends to be used by fellows to further their research. If you are awarded a fellowship, you are expected to devote time to your own work, and you are not required to render any service to the University or donor. You may publish research produced by your fellowship work. As a fellow, you may not engage in remunerative employment without consent of the Dean. Applicants should contact the department directly for information.

Assistantships

Teaching and research assistantships, available to doctoral students in all departments, provide tuition exemption and a living stipend. Duties may include teaching, laboratory supervision, participation in faculty research, and other related activities. Teaching and research assistantships require up to 20 hours of work per week. If you are participating in faculty research that fulfills degree requirements, you may apply for a research assistantship. Assistantships are awarded on the basis of academic merit.

Alternative Funding Sources

External Awards

Because it is not possible to offer full grant and fellowship support to all graduate students and because of the prestige inherent in holding an award through open competition, applicants are encouraged to consider major national and international fellowship opportunities. It is important that prospective graduate students explore every available source of funding for graduate study.

In researching outside funding you may look to faculty advisers, career services offices, deans of students, and offices of financial aid where frequently you may find resource materials, books, and grant applications for a wide variety of funding sources. You must notify both your Columbia Engineering academic department and the Office of Student Financial Planning of any outside awards that you will be receiving.

Funding for International Students

To secure a visa, international students must demonstrate that they have sufficient funding to complete the degree. Many international students obtain support for their educational expenses from their government, a foundation, or a private agency.

International students who apply to doctoral programs of study by the December 15 deadline and are admitted to a Columbia Engineering doctoral program are automatically considered for departmental funding (institutional grants, fellowships, and teaching and research assistantships), upon completion of the required financial aid forms referred to above. Continuing international students must preregister for classes during the preregistration period and complete an enrollment status form to be considered for departmental funding.

Most private student loan programs are restricted to U.S. citizens and permanent residents. However, international students may be eligible to apply for these domestic loan programs with a creditworthy cosigner who is a citizen or permanent resident in the United States. Depending on the loan program, you may need a valid U.S. Social Security number.

Students who study at Columbia Engineering on temporary visas should fully understand the regulations concerning possible employment under those visas. Before making plans for employment in the United States, international students should consult with the International Students and Scholars Office (ISSO), located at 524 Riverside Drive, Suite 200; 212-854-3587. Its website is isso.columbia.edu.

Other Financial Aid—Federal and Private Programs

U.S. citizens and permanent residents enrolled at least half-time in a degree-granting program are eligible to apply for federal student loans. To apply for federal student loans, students should complete the Free Application for Federal Student Aid (FAFSA) using Columbia University's school code 002707 by May 5 for fall enrollment.

Several private student loan programs are available to both U.S. citizens and international students. These loans require that you have a good credit standing. International students may be eligible for a private loan with a creditworthy U.S. citizen or permanent resident cosigner.

Detailed information and application instructions for student loans may be found at the Office of Student Financial Planning website at sfs.columbia.edu/sfp-grad-engin.

Determination of your eligibility for financial aid is based in part on the number of courses for which you register. If you enroll in fewer courses than you initially reported on the loan request form, your loan eligibility may be reduced.

The FAFSA, planned enrollment form, and the loan request form must be completed each academic year, and you must maintain satisfactory academic progress as defined in the Graduate Programs (p. 18) section in order to remain eligible for federal student loans.

Veterans Benefits

The U.S. Department of Veterans Affairs, as well as state and local government, offers a number of educational assistance programs for veterans of the U.S. Armed Forces and their dependents. Based on the time and length of service, as well as current status, veterans can be eligible for one or more of these programs. Many benefits are available to advance the education and skills of veterans and service members. Spouses and family members may also be eligible for education and training assistance. Please visit Vets.gov to apply for education benefits.

To qualify for deferred tuition payments, please provide a copy of your Certificate of Eligibility and DD-214 (please note the DD-214 is not required for dependents) to the Columbia Office of Military & Veterans Affairs (OMVA).

- In person to 210 Kent Hall
- Scan and email to veterans@columbia.edu
- Fax to 212-854-2818

For assistance with utilizing your benefits as well as understanding the timeline of payments, please contact a School Certifying Official at 212-854-3161 or veterans@columbia.edu.

For questions related to the status of the VA application or entitlement eligibility, contact the Department of Veterans Affairs at 1-888-442-4551.

Additional resources and veterans news can be found at sfs.columbia.edu/departments/veterans-service.

Veterans Benefits and Transition Act of 2018

In accordance with Title 38 US Code 3679 subsection (e), this school adopts the following additional provisions for any students using U.S. Department of Veterans Affairs (VA) Post 9/11 G.I. Bill® (Ch. 33) or Vocational Rehabilitation and Employment (Ch. 31) benefits, while payment to the institution is pending from the VA. This school will not:

- Prevent or delay the student's enrollment;
- Assess a late penalty fee to the student;
- Require the student to secure alternative or additional funding;
- Deny the student access to any resources available to other students who have satisfied their tuition and fee bills to the institution, including, but not limited to, access to classes, libraries, or other institutional facilities.

However, to qualify for this provision, such students may be required to:

- Produce the Certificate of Eligibility by the first day of class;
- Provide written request to be certified;
- Provide additional information needed to properly certify the enrollment as described in other institutional policies.

Further information can be found at sfs.columbia.edu/content/information.

Employment

Students on fellowship support must obtain the permission of the Dean before accepting remunerative employment.

Students who study at Columbia Engineering on temporary visas should fully understand the regulations concerning possible employment under those visas. Before making plans for employment in the United States, international students should consult with the International Students and Scholars Office (ISSO) located at 524 Riverside Drive, Suite 200; 212-854-3587. Its website is isso.columbia.edu.

On-Campus Employment

The Graduate Career Placement Center maintains an extensive listing of student employment opportunities. Many resources are available to Columbia engineers and scientists in their job search and career exploration. For more information, visit: career.engineering.columbia.edu

Off-Campus Employment in New York City

One of the nation's largest urban areas, the city offers a wide variety of opportunities for part-time work. Many students gain significant experience in fields related to their research and study while they meet a portion of their educational expenses.

Gainful Employment Disclosures

Programs: Engineer of Mines and Metallurgical Engineer

These programs are designed to be completed in 32 weeks.

These programs will cost $71,998 if completed within the normal time. There may be additional costs for living expenses. These costs were accurate at the time of the posting but may have changed.

Fewer than 10 students completed this program within the normal time. This number has been withheld to preserve the confidentiality of the students.

The following states/territories do not have licensure requirements for this profession: Alabama, Alaska, American Samoa, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Federated States of Micronesia, Florida, Georgia, Guam, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Marshall Islands, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Northern Marianas, Ohio, Oklahoma, Oregon, Palau, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virgin Islands, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

For more information about graduation rates, loan repayment rates, and post-enrollment earnings about this institution and other postsecondary institutions, please read further on collegescorecard.ed.gov.

For the specific Columbia Gainful Employment Disclosures, please review them both at essential-policies.columbia.edu/files_facets/imce_shared/isclosure_CU_Template_2019_Engineer_of_Mines.pdf and essential-policies.columbia.edu/files_facets/imce_shared/sure_CU_Template_2019_Metallurgical_Engineer.pdf.

Contact Information

For questions about institutional grants, fellowships, and teaching and research assistantships, contact your academic department.

For questions about on- or off-campus non-need-based employment, contact:

Graduate Career Placement Center
Phone: 646-832-5941
seas-gcp@columbia.edu
career.engineering.columbia.edu.

For questions about student loans, contact:

Office of Student Financial Planning
210 Kent Hall, MC 9205
1140 Amsterdam Avenue
New York, NY 10027

Phone: 212-854-7040
Fax: 212-854-2818
sfp@columbia.edu
sfs.columbia.edu/sfp-grad-engin

Faculty & Administration

- Faculty (p. 29)
- Faculty Members-At-Large (p. 35)
- Emeriti and Retired Officers (Not in Residence) (p. 36)
- Administrative Officers and Staff (p. 37)

Faculty

Officers

Claire Shipman
Acting President of the University

Angela V. Olinto, Ph.D.
Provost of the University

Shih-Fu Chang, Ph.D.
Dean

Clifford Stein, Ph.D.
Secretary

Faculty

Adeyemi Adeleye
Assistant Professor of Earth and Environmental Engineering

Anish Agarwal
Assistant Professor of Industrial Engineering and Operations Research

Shipra Agrawal
Associate Professor of Industrial Engineering and Operations Research

Sunil K. Agrawal
Edwin Howard Armstrong Professor of Mechanical Engineering and Professor of Rehabilitation and Regenerative Medicine

Josh Alman
Associate Professor of Computer Science

Dimitris Anastassiou
Charles Batchelor Professor of Electrical Engineering and Professor of Systems Biology

James Anderson
Associate Professor of Electrical Engineering

Alexandr Andoni
Associate Professor of Computer Science

Treena L. Arinzeh
Professor of Biomedical Engineering

Gerard A. Ateshian
Andrew Walz Professor of Mechanical Engineering and Professor of Biomedical Engineering

Elham Azizi
Associate Professor of Biomedical Engineering and Herbert and Florence Irving Associate Professor of Cancer Data Research (in the Herbert and Florence Irving Institute for Cancer Dynamics and in the Herbert Irving Comprehensive Cancer Center)

William E. Bailey
Associate Professor of Materials Science and Engineering in the Department of Applied Physics and Applied Mathematics

Eric Balkanski
Assistant Professor of Industrial Engineering and Operations Research

Scott A. Banta
Professor of Chemical Engineering

Elias Bareinboim
Associate Professor of Computer Science

James Bartusek
Assistant Professor of Computer Science

Daniel Bauer
Senior Lecturer in the Discipline of Natural Language Processing, Computer Science

Homayoon Beigi
Professor of Professional Practice in the Department of Mechanical Engineering and of Electrical Engineering

Peter N. Belhumeur
Professor of Computer Science

Keren Bergman
Charles Batchelor Professor of Electrical Engineering

Raimondo Betti
Professor of Civil Engineering and Engineering Mechanics

Daniel Bienstock
Liu Family Professor of Industrial Engineering and Operations Research and Professor of Applied Physics and Applied Mathematics

Kyle J. M. Bishop
Professor of Chemical Engineering

Paul Blaer
Senior Lecturer in Computer Science

Adam Block
Assistant Professor of Computer Science

Allen H. Boozer
Professor of Applied Physics

Liliana Borcea
George P. Livanos Professor of Applied Physics and Applied Mathematics

Brian S. Borowski
Senior Lecturer in the Discipline of Computer Science

Christopher Boyce
Associate Professor of Chemical Engineering

Mary C. Boyce
Professor of Mechanical Engineering

Adrian Buganza Tepole
Associate Professor of Mechanical Engineering

Michael P. Burke
Associate Professor of Mechanical Engineering

Adam Cannon

Teaching Professor of Computer Science

Agostino Capponi
Professor of Industrial Engineering and Operations Research

Luca Carloni
Professor of Computer Science

Juliana Carneiro
Assistant Professor of Chemical Engineering

Augustin Chaintreau
Associate Professor of Computer Science

Siu-Wai Chan
Professor of Materials Science and Engineering (Henry Krumb School of Mines)

Kartik Chandran
Professor of Earth and Environmental Engineering (Henry Krumb School of Mines)

Julius Chang
Senior Lecturer in the Discipline of Construction Engineering and Management, Civil Engineering and Engineering Mechanics

Shih-Fu Chang
Morris A. and Alma Schapiro Professor and Professor of Electrical Engineering and Computer Science

Christopher Chen
Lecturer in the Discipline of Chemical Engineering

Jingguang G. Chen
Thayer Lindsley Professor of Chemical Engineering

Xi Chen
Professor of Computer Science

Ke Cheng
Alan L. Kaganov Professor of Biomedical Engineering

Lydia B. Chilton
Associate Professor of Computer Science

Pengbo Chu
Assistant Professor of Earth and Environmental Engineering

Asaf Cidon
Associate Professor of Electrical Engineering

Matei T. Ciocarlie
Associate Professor of Mechanical Engineering

Santiago Correa
Assistant Professor of Biomedical Engineering

Rachel Cummings
Associate Professor of Industrial Engineering and Operations Research

Tal Danino
Associate Professor of Biomedical Engineering

Gautam Dasgupta
Professor of Civil Engineering, Civil Engineering and Engineering Mechanics

Tony Dear
Senior Lecturer in Discipline of Computer Science

George Deodatis
Santiago and Robertina Calatrava Family Professor of Civil Engineering and Professor of Earth and Environmental Engineering Research

Aravind Devarakonda
Assistant Professor of Applied Physics and Applied Mathematics

Xuan Sharon Di
Associate Professor of Civil Engineering and Engineering Mechanics

Antonius Dieker
Professor of Industrial Engineering and Operations Research

Neil Dolinski
Assistant Professor of Chemical Engineering

Chaoqun Dong
Assistant Professor of Mechanical Engineering

Eleni Drinea
Senior Lecturer in the Discipline of Computer Science and in the Discipline of Industrial Engineering and Operations Research

Qiang Du
Fu Foundation Professor of Applied Mathematics

Christopher J. Durning
Professor of Chemical Engineering

Stephen A. Edwards
Associate Professor of Computer Science

Savannah Eisner
Assistant Professor of Electrical Engineering

Adam Elmachtoub
Associate Professor of Industrial Engineering and Operations Research

Daniel Esposito
Associate Professor of Chemical Engineering

Yuri Faenza
Associate Professor of Industrial Engineering and Operations Research

Raymond Farinato
Professor of Professional Practice in Earth and Environmental Engineering

Robert J. Farrauto
Professor of Professional Practice in Earth and Environmental Engineering

Steven K. Feiner
Wang Family Professor of Computer Science (in Dental Medicine)

Maria Q. Feng
Renwick Professor of Civil Engineering

Jacob Fish
Robert A. W. and Christine S. Carleton Professor of Civil Engineering

Greeshma Gadikota
Lenfest Earth Institute Professor of Climate Change and Professor of Earth and Environmental Engineering

Alexander Gaeta

David M. Rickey Professor of Applied Physics and Materials Science and Professor of Electrical Engineering

Oleg Gang
Professor of Chemical Engineering and Applied Physics and Material Science

Roxana Geambasu
Associate Professor of Computer Science

Pierre Gentine
Maurice Ewing and J. Lamar Worzel Professor of Geophysics in the Department of Earth and Environmental Engineering and Professor of Earth and Environmental Sciences and of Climate

Javad Ghaderi Dehkordi
Associate Professor of Electrical Engineering

Marco Giometto
Assistant Professor of Civil Engineering and Engineering Mechanics

Micah Goldblum
Assistant Professor of Electrical Engineering

Vineet Goyal
Professor of Industrial Engineering and Operations Research

Luis Gravano
Professor of Computer Science

Ronghui Gu
Tang Family Assistant Professor of Computer Science

X. Edward Guo
Stanley Dicker Professor of Biomedical Engineering and Professor of Medical Sciences (in Medicine)

Lauren Heckelman
Lecturer in the Discipline of Biomedical Engineering

Megan Heenan
Lecturer in the Discipline of Biomedical Engineering

Christine P. Hendon
Associate Professor of Electrical Engineering

Henry S. Hess
Professor of Biomedical Engineering

John Hewitt
Assistant Professor of Computer Science

Ali Hirsa
Professor of Professional Practice in Industrial Engineering and Operations Research

Julia B. Hirschberg
Percy K. and Vida L. W. Hudson Professor of Computer Science

Aleksander Hołyński
Assistant Professor of Computer Science

James C. Hone
Wang Fong-Jen Professor of Mechanical Engineering

Bianca Howard
Assistant Professor of Mechanical Engineering

Daniel J. Hsu
Associate Professor of Computer Science

Anran Hu
Assistant Professor of Industrial Engineering and Operations Research

Clark T. Hung
Professor of Biomedical Engineering and Orthopedic Sciences (in Orthopedic Surgery)

James S. Im
Professor of Materials Science in the Departments of Earth and Environmental Engineering and of Applied Physics and Applied Mathematics

Garud N. Iyengar
Professor of Industrial Engineering and Operations Research

Suman Jana
Associate Professor of Computer Science

Predrag R. Jelenkovic
Professor of Electrical Engineering

Xiaofan Fred Jiang
Associate Professor of Electrical Engineering

Hardeep V. Johar
Teaching Professor of Industrial Engineering and Operations Research and Business

Cedric Josz
Assistant Professor of Industrial Engineering and Operations Research

Jingyue Ju
Samuel Ruben–Peter G. Viele Professor of Engineering (Chemical Engineering)

Soulaymane Kachani
Professor of Professional Practice in Industrial Engineering and Operations Research

Kostis Kaffes
Assistant Professor of Computer Science

Gail E. Kaiser
Professor of Computer Science

Lance C. Kam
Professor of Biomedical Engineering and Medical Sciences (in Medicine)

Karen Kasza
Associate Professor of Mechanical Engineering

Ethan Katz-Bassett
Associate Professor of Electrical Engineering

Shiho Kawashima
Associate Professor of Civil Engineering and Engineering Mechanics

Yaren Kaya
Lecturer in the Discipline of Industrial Engineering and Operations Research

Shaina A. Kelly
Assistant Professor of Earth and Environmental Engineering

Tanvir Ahmed Khan

Assistant Professor of Electrical Engineering

Addis Kidane
Associate Professor of Civil Engineering and Engineering Mechanics

Martha A. Kim
Associate Professor of Computer Science

Peter R. Kinget
Bernard J. Lechner Professor of Electrical Engineering

David Knowles
Associate Professor of Computer Science

Elisa E. Konofagou
Robert and Margaret Hariri Professor of Biomedical Engineering and Professor of Radiology (Health Sciences)

Zoran Kostic
Professor of Professional Practice in Electrical Engineering

Ioannis A. Kougioumtzoglou
Associate Professor of Civil Engineering and Engineering Mechanics

Harish Krishnaswamy
Professor of Electrical Engineering

Christian Kroer
Associate Professor of Industrial Engineering and Operations Research

Sanat K. Kumar
Michael Bykhovsky and Charo Gonzalez-Bykhovsky Professor of Chemical Engineering

Ioannis Kymissis
Kenneth Brayer Professor of Electrical Engineering

Jeffrey W. Kysar
Professor of Mechanical Engineering and Otolaryngology/Head and Neck Surgery

Daniel Lacker
Associate Professor of Industrial Engineering and Operations Research

Andrew F. Laine
Percy K. and Vida L. W. Hudson Professor of Biomedical Engineering and Professor of Radiology (Health Sciences)

Kwai Hung Henry Lam
Associate Professor of Industrial Engineering and Operations Research

Aurel A. Lazar
Professor of Electrical Engineering

Fabrizio Lecci
Associate Professor of Professional Practice in Industrial Engineering and Operations Research

Jae Woo Lee
Senior Lecturer in the Discipline of Computer Science

Hyoseon Lee
Lecturer in the Discipline of Professional Development and Leadership in the Department of Industrial Engineering and Operations Research

Kam Leong
Samuel Y. Sheng Professor of Biomedical Engineering (in Systems Biology)

Xuenan Li
Ju Tang Chu and Wui Ping Chu Assistant Professor of Applied Mathematics

Qiao Lin
Professor of Mechanical Engineering

Tianyi Lin
Assistant Professor of Industrial Engineering and Operations Research

Hoe I. Ling
Professor of Civil Engineering and Engineering Mechanics

Yining Liu
Lecturer in the Discipline of Data Science in the Department of Computer Science

Hod Lipson
James and Sally Scapa Professor of Innovation in the Department of Mechanical Engineering

Michal Lipson
Higgins Professor of Electrical Engineering and Professor of Applied Physics

Helen H. Lu
Percy K. and Vida L.W. Hudson Professor of Biomedical Engineering and Professor of Dental and Craniofacial Engineering (in Dental Medicine)

Curtiss Lyman
Assistant Professor of Applied Physics and Applied Mathematics

Marianna Maiaru
Associate Professor of Civil Engineering and Engineering Mechanics

Tal Malkin
Professor of Computer Science

Lauren Marbella
Associate Professor of Chemical Engineering

Chris A. Marianetti
Professor of Materials Science and Applied Physics and Applied Mathematics in the Department of Applied Physics and Applied Mathematics

Mike Massimino
Professor of Professional Practice in Mechanical Engineering

José McFaline-Figueroa
Assistant Professor of Biomedical Engineering

Grace McIlvain
Assistant Professor of Biomedical Engineering

Kathleen McKeown
Henry and Gertrude Rothschild Professor of Computer Science

V. Faye McNeill
Professor of Chemical Engineering and Earth and Environmental Science (Arts and Sciences)

Xiang Meng
Associate Professor of Professional Practice in Electrical Engineering

Uday Menon
Lecturer in the Discipline of Industrial Engineering and Operations Research

Nima Mesgarani
Associate Professor of Electrical Engineering

Vishal Misra
RKS Professor of Computer Science

Vijay Modi
Professor of Mechanical Engineering and of Earth and Environmental Engineering

Barclay Morrison III
Professor of Biomedical Engineering

Chris Murphy
Senior Lecturer in the Discipline of Computer Science

Kristin M. Myers
Professor of Mechanical Engineering

D. R. Nagaraj
Henry Krumb Professor of Professional Practice of Mining in the Department of Earth and Environmental Engineering

Arvind Narayanaswamy
Associate Professor of Mechanical Engineering

Bento Natura
Assistant Professor of Industrial Engineering and Operations Research

Gerald A. Navratil
Thomas Alva Edison Professor of Applied Physics

Shree K. Nayar
T. C. Chang Professor of Computer Science

Nandan Nerurkar
Associate Professor of Biomedical Engineering

Jason Nieh
Professor of Computer Science

Oscar Nordness
Assistant Professor of Earth and Environmental Engineering

Ismail Cevdet Noyan
Professor of Materials Science and Engineering and of Earth and Environmental Engineering

Ben O'Shaughnessy
Professor of Chemical Engineering

Allie C. Obermeyer
Associate Professor of Chemical Engineering

Ibrahim S. Odeh
Senior Lecturer in the Discipline of Construction Management, Strategy and Business Development, Civil Engineering and Engineering Mechanics

Cody Paige
Assistant Professor of Mechanical Engineering

John Paisley
Associate Professor of Electrical Engineering

Thomas Panayotidi
Lecturer in the Discipline of Structural Engineering and Mechanics, Civil Engineering and Engineering Mechanics

Christos Papadimitriou
Donovan Family Professor of Computer Science

Elizabeth J. Paul
Assistant Professor of Applied Physics and Applied Mathematics

Carlos Paz-Soldan
Associate Professor of Applied Physics and Applied Mathematics

Itsik Pe'er
Professor of Computer Science and Systems Biology

Feniosky Peña-Mora
Edwin Howard Armstrong Professor of Civil Engineering and Engineering Mechanics and Professor of Earth and Environmental Engineering and of Computer Science

Toniann Pitassi
Jeffrey L. and Brenda Bleustein Professor of Engineering

Lorenzo M. Polvani
Maurice Ewing and J. Lamar Worzel Professor of Geophysics in the Department of Applied Physics and Applied Mathematics and Professor of Earth and Environmental Sciences

Matthias Preindl
Associate Professor of Electrical Engineering

Sakul Ratanalert
Senior Lecturer in the Discipline of Chemical Engineering

Baishakhi Ray
Associate Professor of Computer Science

Kui Ren
Professor of Applied Physics and Applied Mathematics

Kenneth A. Ross
Professor of Computer Science

Timothy Roughgarden
Professor of Computer Science

Dan Rubenstein
Professor of Computer Science

Nuttida Rungratsameetaweemana
Maa-Liao Assistant Professor of Biomedical Engineering

Paul Sajda
Vikram S. Pandit Professor of Biomedical Engineering; Professor of Radiology (Physics) and Electrical Engineering

Ansaf Salleb-Aouissi
Senior Lecturer in the Discipline of Computer Science

Markus S. Schlaepfer
Assistant Professor of Civil Engineering and Engineering Mechanics

P. James Schuck
Professor of Mechanical Engineering

Henning G. Schulzrinne

Julian Clarence Levi Professor of Mathematical Methods and Computer Science and Professor of Electrical Engineering

Silvia Sellán
Assistant Professor of Computer Science

Mingoo Seok
Associate Professor of Electrical Engineering

Rocco A. Servedio
Professor of Computer Science

Simha Sethumadhavan
Professor of Computer Science

Jay Sethuraman
Professor of Industrial Engineering and Operations Research

Kenneth L. Shepard
Lau Family Professor of Electrical Engineering and Professor of Biomedical Engineering

Samuel K. Sia
Professor of Biomedical Engineering

Karl Sigman
Professor of Industrial Engineering and Operations Research

Michele Simoncelli
Assistant Professor of Applied Physics and Applied Mathematics

Mijo Simunovic
Assistant Professor of Chemical Engineering

Brian Smith
Assistant Professor of Computer Science

Andrew W. Smyth
Robert A.W. and Christine S. Carleton Professor of Civil Engineering and Engineering Mechanics

Adam H. Sobel
Professor of Applied Physics and Applied Mathematics and of Environmental Sciences (Arts and Sciences)

Marc W. Spiegelman
Arthur D. Storke Memorial Professor of Earth and Environmental Sciences (Arts and Sciences) and Professor of Applied Physics and Applied Mathematics

Clifford Stein
Wai T. Chang Professor of Industrial Engineering and Operations Research and Professor of Computer Science

Daniel Steingart
Stanley-Thompson Professor of Chemical Metallurgy in the Department of Earth and Environmental Engineering and Professor of Chemical Engineering

Salvatore J. Stolfo
Morysa Engineering Professor for a Connected Humanity in the Department of Computer Science

Eric Stratman
Lecturer in the Discipline of Industrial Engineering and Operations Research

Bjarne Stroustrup
Professor of Computer Science

WaiChing Steve Sun
Associate Professor of Civil Engineering and Engineering Mechanics

Wenpin Tang
Tang Family Assistant Professor of Industrial Engineering and Operations Research

Adrian Buganza Tepole
Associate Professor of Mechanical Engineering

Michael K. Tippett
Associate Professor of Applied Physics and Applied Mathematics

Yannis P. Tsividis
Edwin Howard Armstrong Professor of Electrical Engineering

Alexander Urban-Artrith
Associate Professor of Chemical Engineering

David G. Vallancourt
Teaching Professor of Electrical Engineering

John T. Vaughan
Professor of Biomedical Engineering and Radiology (Physics) (in the Mortimer B. Zuckerman Mind Brain Behavior Institute)

Vijay Vedula
Assistant Professor of Mechanical Engineering

Latha Venkataraman
Lawrence Gussman Professor of Applied Physics and Professor of Chemistry

Venkat Venkatasubramanian
Samuel Ruben-Peter G. Viele Professor of Engineering

Nakul Verma
Senior Lecturer in the Discipline of Computer Science

Sanja Vickovic
Assistant Professor of Biomedical Engineering (in the Herbert and Florence Irving Institute for Cancer Dynamics)

Carl Vondrick
YM Associate Professor of Computer Science

Sinisa Vukelic
Senior Lecturer in the Discipline of Mechanics Laser Processing Characterization, Mechanical Engineering

Gordana Vunjak-Novakovic
University Professor and Mikati Foundation Professor of Biomedical Engineering

Haim Waisman
Professor of Civil Engineering and Engineering Mechanics

Kaizheng Wang
Assistant Professor of Industrial Engineering and Operations Research

Qi Wang
Associate Professor of Biomedical Engineering

Zhaoyou Wang
Assistant Professor of Electrical Engineering

Wen I. Wang
Thayer Lindsley Professor in the Faculty of Engineering and Applied Science (Electrical Engineering) and Professor of Applied Physics

Xiaodong Wang
Professor of Electrical Engineering

Michael I. Weinstein
Professor of Applied Mathematics and of Mathematics

Renata Maria Mattosinho Wentzcovitch
Professor of Materials Science and Applied Physics, and Earth and Environmental Science

Alan C. West
Samuel Ruben-Peter G. Viele Professor of Electrochemistry and Professor of Earth and Environmental Engineering

Harry West
Professor of Professional Practice in Industrial Engineering and Operations Research

Chris H. Wiggins
Associate Professor of Applied Mathematics and Systems Biology

Asher Williams
Assistant Professor of Chemical Engineering

Jeannette Wing
Professor of Computer Science

John Wright
Associate Professor of Electrical Engineering

Eugene Wu
Associate Professor of Computer Science

Bolun Xu
Assistant Professor of Earth and Environmental Engineering

Lily Xu
Sun-Wu Assistant Professor of Industrial Engineering and Operations Research

Junfeng Yang
Professor of Computer Science

Yuan Yang
Associate Professor of Materials Science and Engineering, Applied Physics and Applied Mathematics

Mihalis Yannakakis
Percy K. and Vida L. W. Hudson Professor of Computer Science

David Da-Wei Yao
Piyasombatkul Family Professor of Industrial Engineering and Operations Research

Yevgeniy Yesilevskiy
Senior Lecturer in the Discipline of Innovation and Design, Mechanical Engineering

Huiming Yin
Associate Professor of Civil Engineering and Engineering Mechanics

Ngai Yin Yip
LaVon Duddleson Krumb Assistant Professor of Earth and Environmental Engineering

Drew Youngren
Senior Lecturer in the Discipline of Applied Mathematics, Applied Physics and Applied Mathematics

Parisa Yousefpour
Assistant Professor of Biomedical Engineering

Nanfang Yu
Associate Professor of Applied Physics

Zhou Yu
Associate Professor of Computer Science

Henry Yuen
Srivani Family Associate Professor of Computer Science

Richard Zemel
Trianthe Dakolias Professor of Engineering and Applied Science and Professor of Computer Science

Xueyue (Sherry) Zhang
Assistant Professor of Applied Physics and Applied Mathematics

Zhuo Zhang
Assistant Professor of Computer Science

Yi Zhang
Senior Lecturer in the Discipline of Industrial Engineering and Operations Research

Changxi Zheng
Associate Professor of Computer Science

Xia Zhou
Associate Professor of Computer Science

Xunyu Zhou
Liu Family Professor of Industrial Engineering and Operations Research

Ben Zhu
Assistant Professor of Applied Physics and Applied Mathematics

Zhengbo Zou
Assistant Professor of Civil Engineering and Engineering Mechanics

Charles Zukowski
Professor of Electrical Engineering

Gil Zussman
Kenneth Brayer Professor of Electrical Engineering

Faculty Members-At-Large

Carlos J. Alonso
Dean, Graduate School of Arts and Sciences

Costis Maglaras
Dean, Columbia Business School

Josef Sorett
Dean, Columbia College

Dmitri N. Basov

Chair, Department of Physics

Brent Stockwell
Chair, Department of Biological Sciences

Chiu-Chu (Melissa) Liu
Chair, Department of Mathematics

Kevin Griffin
Chair, Department of Earth and Environmental Sciences

Professor David R. Reichman
Chair, Department of Chemistry

Emeriti and Retired Officers (Not in Residence)

Alfred V. Aho
Lawrence Gussman Professor Emeritus of Computer Science

Peter K. Allen
Professor Emeritus of Computer Science

Steven M. Bellovin
Percy K. and Vidda L. W. Hudson Professor Emeritus of Computer Science

Mark A. Cane
G. Unger Vetlesen Professor Emeritus of Earth and Climate Sciences and Professor Emeritus of Applied Physics and Applied Mathematics

Huk Yuk Cheh
Samuel Ruben-Peter G. Viele Professor Emeritus of Electrochemistry

Rene Chevray
Professor Emeritus of Mechanical Engineering

Edward G. Coffman
Professor Emeritus of Electrical Engineering and of Computer Science

Emanuel Derman
Professor Emeritus of Professional Practice in Industrial Engineering and Operations

Paul Diament
Professor Emeritus of Electrical Engineering

Zvi Galil
Julian Clarence Leu Professor Emeritus of Mathematical Methods and of Computer Science and Dean Emeritus

Donald Goldfarb
Alexander and Hermine Avanessians Professor Emeritus of Industrial Engineering and Operations Research

Jonathan L. Gross
Professor Emeritus of Computer Science

Irving P. Herman
Edwin Howard Armstrong Professor Emeritus of Applied Physics

John R. Kender
Professor Emeritus of Computer Science

Jeffrey T. Koberstein
Percy K. and Vida L. W. Hudson Professor Emeritus of Chemical Engineering

W. Michael Lai
Professor Emeritus of Mechanical Engineering and of Orthopedic Bioengineering (Orthopedic Surgery)

Eugene S. Machlin
Henry Marion Howe Professor Emeritus of Metallurgy

Michael Mauel
Professor Emeritus of Applied Physics

Henry E. Meadows Jr.
Professor Emeritus of Electrical Engineering

Van C. Mow
Stanley Dicker Professor Emeritus of Biomedical Engineering and Professor Emeritus of Orthopedic Engineering (Orthopedic Surgery)

Steven M. Nowick
Professor Emeritus of Computer Science and Electrical Engineering

Peter Schlosser
Maurice Ewing and J. Lamar Worzel Professor Emeritus of Geophysics and Professor Emeritus of Earth and Environmental Sciences

Christopher H. Scholz
Professor Emeritus of Earth and Environmental Sciences

Mischa Schwartz
Charles Batchelor Professor Emeritus of Electrical Engineering

Ponisseril Somasundaran
LaVon Duddleson Krumb Professor Emeritus of Mineral Engineering

Jordan L. Spencer
Professor Emeritus of Chemical Engineering

Thomas E. Stern
Dicker Professor Emeritus of Electrical Engineering

Horst Stormer
I. I. Rabi Professor Emeritus of Physics (Arts and Sciences) and Professor Emeritus of Applied Physics

Malvin Carl Teich
Professor Emeritus of Engineering Science

Rene B. Testa
Professor Emeritus of Civil Engineering and Engineering Mechanics

Nickolas J. Themelis
Professor Emeritus of Earth and Environmental Engineering

Rimas Vaicaitis
Renwick Professor Emeritus of Civil Engineering

Henryk Wozniakowski
Professor Emeritus of Computer Science

Edward S. Yang
Professor Emeritus of Electrical Engineering

Y. Lawrence Yao
Professor Emeritus of Mechanical Engineering

Tuncel M. Yegulalp

Professor Emeritus of Mining (Earth and Environmental Engineering, Henry Krumb School of Mines)

Yechiam Yemini
Professor Emeritus of Computer Science

Administrative Officers and Staff

Shih-Fu Chang
Dean

Wyatt Adams
Development Coordinator, Major Gifts

Adeola Anike Adegbola-White
Assistant Director, Graduate Student Wellness and Support Services

Shourav Ahsan
Academic Appointments Officer

Nicole Allende
Facilities Coordinator

Cassandra Armstrong
Administrative Assistant

Genesis Arroyo
Facilities Specialist

Kimberly Arroyo
Student Support Specialist

Rumana Ashraf
Director of Center-Scale Pre-Award Services

Carlotta Atkins
Talent Acquisition Manager

Ryan Atwell
Assistant Director of Professional Development

Nina L. Auslander-Padgham
Assistant Director, Alumni and Development Events

Dianna Austin
Assistant Director of Faculty Affairs and Faculty Development

Fernanda Ballester
Associate Director for Education and Community Programs

Nichole Barbe
Graduate Admissions Director

Mark Beer
Systems Engineer

Charlene A. Bernasko-Acquaye
Assistant Dean of Engineering Student Wellness and Success

Michelle Blaer
Program Coordinator

Siddharth Brahmbhatt
Institutional Research Analyst

Kristian Breton
Executive Director of Outreach and Community Engagement

Natiya Caldwell
Human Resources Project Specialist

Austin Cartagena
Assistant Director, Graduate Career Placement

Cecily Castle
Senior Director, Development for Leadership Giving and Annual Fund

Giovani Castro
Operations Specialist

Nancy Cedeno
Financial Analyst

Helen Cen
Director of Graduate Academic Programs

Andy Chae
Assistant Dean of Engineering Student Affairs

Lilian Chang
Assistant Director of Graduate Academic Advising

Paul Chang
Production Manager

Jimmy Chen
Systems Administrator

Qin Chen
Executive Director of Space Planning and Design

Ji Men Jenny Choy
Assistant Director of Strategic Partnership

Jaclyn Chu
Executive Director, Development and Strategic Initiatives

Jacquerlin Cruz
HR Leave and Operations Specialist

Grant Currin
Senior Science Writer

Francois Daigre
Space Planning and Design Manager

Ryan Day
Director of Professional Development and Leadership and Graduate Career Placement

Blair Dayton
Career Placement Officer, Biomedical Engineering

Whitney Delaney
Marketing Director

George Deodatis
Vice Dean of Research

Calinda Javonne Dickerson
Associate Director, Donor Relations and Stewardship

Yueming Dong

Employer Relations Specialist

Doreen Duffy
Senior Director of Alumni Engagement

Allison Elliott
Director, Executive Communications

Mohamed Abdelfattah
Director of Strategic Communications and Media Relations

Melanie Farmer
Director of ENG Communications

Jennifer Feliz
Manager, Academic Appointments

Danushi Fernando
Assistant Dean of Engagement and Strategic Programs

Rachel Fitzgerald
Facilities Specialist

Antonia Forika
Assistant Director of Event Planning and Logistics

Julian Fuchsberg
Assistant Director, Development and Strategic Initiatives

Gabrielle Gannon
Associate Dean of Graduate Admissions

Kimya Magen Gittens
Assistant Director of Academic Operations

Efrain Gonzalez Gomez
Director, Pre-Award Services

Richard Hagen
Assistant Director of Graduate Student Affairs

Irene Hahn
Associate Dean, Faculty Affairs

Michael A. Hammer
Human Resources Manager

Julie Han
Associate Director of Graduate Admissions Operations

John Harbison
Manager, Executive Education

Keely Henderson
Vice Dean of Development and Alumni Relations

Christine Hendon
Vice Dean of Engagement and Strategic Partnerships

Christian David Hernandez Melo
Graduate Student Life Manager

Brandon Hicks
Development Coordinator, Annual Giving

William W. Ho
Operations and Finance Manager

Michele Hoos
Executive Director of Communications

Lauren Hudak
Director of Institutional Reporting and Analytics

Ella C. Hungeling
Alumni Programs Coordinator

Kyle Hussey
Facilities Project Manager

Tasnia T. Islam
Research Center Program Manager

Liam Itgen
Major Gift Officer

Meaghan Jameyson
Associate Director of Graduate Admissions

Peter Janus
Graduate Admissions Coordinator

Angelie N. Jean-Brice
Special Projects Manager

Chen Jiang
Associate Director of International Graduate Student Services

Emily Johnson
Assistant Director, Annual Giving

Cassidy Keehan
Financial Aid and Fellowships Analyst

Kimberly Kefgen
Associate Director of Business Development

Karina Ko
Career Placement Officer, Business Analytics

Robert Kramer
Associate Director of Admissions and Academic Affairs

Jenna Kumabe
Career Placement Officer, Civil Engineering and Engineering Mechanics

Ioannis (John) Kymissis
Vice Dean of Infrastructure and Innovation

Tara Lanigan
Senior Director, Strategic Partnerships

Jackson Lau
System Administrator

Benjamin F. Laviana
Assistant Director, Graduate Admissions

Chae Rin Lee
Instructional Designer

Jennifer Lee
Director, Career Placement, Events & External Relations, Electrical Engineering

Johanna Levey

Outreach Program Manager

Alan Lin
Assistant Director of Budget and Finance

Ashley Liz
Business Operations Officer, Lasker

Molly Lopez
Managing Director, LEAP

Helen Lu
Senior Vice Dean of Faculty Affairs and Advancement

Cameron Maglio
Associate Director, Donor Relations and Stewardship

Lucy Mahbub
Director, Career Placement, Industrial Engineering and Operations Research

Jenny Mak
Senior Associate Dean of Undergraduate and Graduate Student Affairs

Eddie Mandhry
Director, Sports and AI Innovation Center

Liam Maserjian
Associate Director of AV and Multimedia

Janine Nadia Maslov
Assistant Director of Graduate Admissions

Angela Marie McClain
Director, Budget and Finance

Emily-Anne McCormack
Director of Career Placement, Civil Engineering and Applied Physics and Applied Mathematics

Joan McDowell
Executive Director of Human Resources

Theresa A. McKenzie
Chief Financial and Administrative Officer

Lena Ying Yee Mei
Outreach Program Manager

Chelsea Meyer
Associate Director for Development Marketing & Annual Giving

Beatrice Mhando
Communications Specialist

Vishal Misra
Vice Dean of Computing and Artificial Intelligence

Alexis Moore
Director of Enrollment and Operations

Conner Moore
Graduate Career Placement and Professional Development Operations Analyst

Olivia Moore
Managing Director, Center for Smart Streetscapes

Tiffany Moore
Program Manager

Barclay Morrison
Senior Vice Dean of Academic Programs

Stephon Moulterie
Career Placement Officer, Computer Science

Spyridon Mylonas
Managing Director, AI Research Center

Mahmoud Naghshineh
Executive Director of the Industry Solutions Launch Lab

Sarah Naumes
Director of Strategic Research Development

Alexis M. Newman
Director, Strategic Events and Programming

Kim Nguyen
Career Placement Advisor

Stephanie Nunez
Administrative Assistant

Quy O
Associate Director of Technology Services

Michael O'Malley
Manager of Operations and Systems

Janki Patel
Manager of Strategic Relations Initiatives

Anastasia Philippis
Director of Grants and Finance Services

Haley Planicka
Professional Development and Leadership Officer

Dmytro Pokhylko
Senior Director of Columbia Engineering Industry Innovation (CEII)

Benjamin Poleretzky
Production Specialist

Lilibeth Ramos Flores
Student Affairs Manager

Madeline Ramos
Manager of Faculty Affairs and Academic Appointments

Raina Ranaghan
Assistant Director of Career Placement, Chemical Engineering and Earth and Environmental Engineering

Adrieanna Reyes
Associate Director of Undergraduate Student Affairs

Paulo Ribeiro
Instructional Support Specialist

Marquis Rios
Senior Financial Analyst

Alexandra Romero

Production Coordinator

Stan Sakry
Executive Director of Facilities

Justin Saunders
Assistant Director of Operations & Support

Elisabeth Schapmann
Admissions Operations Officer

Deirdre Sullivan
Student Affairs Officer

Anthony Schmitt
Director, Pre-Award Services

Ivy Schultz
Senior Director of Entrepreneurship, Innovation, and Design

Esther Schwartz
Executive Assistant to the Dean

David Simpson
Administrative Assistant

Serena Sinckler
Assistant Director of Facilities

Targbe Somah
Finance Manager

Davey Souffront
Manager of Enrollment Services and Operations

Jennifer Stancek
Assistant Director, Academic Appointments

Natasha Stanislas
Assistant Director of Graduate Admissions Recruitment and Communications

Michelle R. Stevenson
Coordinator, Columbia Video Network

Elizabeth Strauss
Associate Dean, Engineering Student Affairs

Jessie Taft
Associate Director of Research Center Operations

Malcolm Thaxton
Senior Manager of Finance and Operations

Kyoko H. Thompson
Associate Director of Research Development

Randy Torres
Executive Director, Academic Appointments/Faculty Affairs

Dario Vasquez
Assistant Director of Entrepreneurship, Innovation, and Design

Tania Velimirovici
Academic Programs and Special Projects Officer

Alex J. Vervoort
Senior Associate Director of Alumni Relations

Xilin Wang
Course Operations Manager

Olivia Wenzel
Assistant Director of Annual Giving

Sean Wiggins
Executive Director of Online Learning

Emma Williams
Associate Director of Alumni Relations

Jack Wisniewski
Digital Content Strategist

Stephanie Brianne London-Wortel
Outreach Program Manager

Maryla Wozniak-Odomirok
Senior Analyst of Institutional Research Academic Programs

Ying Xu
Assistant Director of Graduate Admissions Recruitment and Communications

Sofia Yagaeva
Assistant Director, Columbia Video Network

Sara Yllescas
Career Placement Officer, Management Science and Engineering

Gordon Zhao
Finance Operations Analyst

Carlotta Atkins
Talent Acquisition Manager

Academic Departments and Programs

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Key to Course Listings

This section contains a description of the curriculum of each department in the School, along with information regarding undergraduate and graduate degree requirements, elective courses, and suggestions about

courses and programs in related fields. All courses are listed, whether or not they are being offered during the current year; if a course is not being given, that is indicated. Included as well are courses cross-listed with other departments and undergraduate divisions within the University.

Designators

Each course is preceded by a *four-letter designator*, which indicates the department or departments presenting the course.

Course Designator	Department Subject
AHIS	Art History
AHCE	Art History and Civil Engineering
AMCS	Applied Math and Computer Science
AMST	American Studies
ANTH	Anthropology
APAM	Applied Physics and Applied Math
APBM	Applied Physics and Biomedical Engineering
APCH	Applied Physics and Chemical Engineering
APMA	Applied Mathematics
APPH	Applied Physics
ARCH	Architecture
ASCE	Asian Civilization: East Asian
ASCM	Asian Civilization: Middle East
ASTR	Astronomy
BIOC	Biology and Chemistry
BIOL	Biology
BIST	Biostatistics
BMCH	Biomedical and Chemical Engineering
BMCS	Biomedical Engineering, Computer Science
BMEB	Biomedical Engineering, Electrical Engineering, and Biology
BMEE	Biomedical Engineering and Electrical Engineering
BMEN	Biomedical Engineering
BMME	Biomedical Engineering and Mechanical Engineering
BUSI	Business
CBMF	Computer Science, Biomedical Engineering and Medical Informatics
CEEM	Civil Engineering and Engineering Mechanics
CEOR	Civil Engineering and Operations Research
CHAP	Chemical Engineering and Applied Physics and Applied Math
CHBM	Chemical Engineering and Biomedical Engineering
CHCB	Chemistry, Biology and Computer Science
CHEE	Chemical Engineering and Earth and Environmental Engineering
CHEM	Chemistry
CHEN	Chemical Engineering
CHNS	Chinese
CIEE	Civil Engineering and Earth and Environmental Engineering
CIEN	Civil Engineering
CLPS	Comparative Literature and Society and Psychoanalytic Center
CMBS	Cellular, Molecular, and Biophysical Studies
COCI	Contemporary Civilization
COMS	Computer Science
COSA	Computer Science, Industrial Engineering and Operations Research, Statistics, and Applied Physics and Applied Mathematics
CSBS	Computer Science and Biological Science
CSEE	Computer Science and Electrical Engineering
CSEN	Computer Science and English
CSER	Center for Study of Ethnicity and Race
CSOR	Computer Science and Operations Research
DNCE	Dance
DRAN	Decision, Risk, and Operations
DROM	Decision, Risk, and Operations Management
EACE	Earth and Environmental Engineering and Civil Engineering
EACH	Earth and Environmental Engineering and Chemical Engineering
EAEE	Earth and Environmental Engineering
EAIA	Earth and Environmental Engineering and International and Public Affairs
ECBM	Electrical Engineering, Computer Science and Biomedical Engineering
ECIA	Earth and Environmental and Civil Engineering and International and Public Affairs
ECIE	Economics and Industrial Engineering
ECON	Economics
EEBM	Electrical Engineering and Biomedical Engineering
EECS	Electrical Engineering and Computer Science
EEEL	Earth and Environmental Engineering and Electrical Engineering
EEHS	Electrical Engineering and History
EEME	Electrical Engineering and Mechanical Engineering
EEOR	Electrical Engineering and Operations Research
EESC	Earth and Environmental Sciences
EHSC	Environmental Health Sciences
ELEN	Electrical Engineering
ENGI	Engineering
ENGL	English
EMME	Engineering Mechanics and Mechanical Engineering
ENME	Engineering Mechanics
FILM	Film
FINC	Finance
FREN	French
GERM	German
GRAP	Graphics
HIST	History
HSAM	History and Applied Mathematics
HUMA	Humanities
HUNG	Hungarian
IEME	Industrial Engineering and Mechanical Engineering
IEOR	Industrial Engineering and Operations Research
INAF	International Affairs

INTA	Earth and Environmental Engineering, Civil Engineering, and International and Public Affairs
LING	Linguistics
MATH	Mathematics
MEBM	Mechanical Engineering and Biomedical Engineering
MECE	Mechanical Engineering
MECH	Mechanical Engineering and Chemical Engineering
MECS	Mechanical Engineering and Computer Science
MEEM	Mechanical Engineering and Engineering Mechanics
MEIE	Mechanical Engineering and Industrial Engineering
MSAE	Materials Science and Engineering
MSIE	Management Science and Industrial Engineering and Operations Research
MUSI	Music
ORCA	Operations Research, Computer Science and Applied Mathematics
ORCS	Operations Research and Computer Science
PHED	Physical Education
PHIL	Philosophy
PHYS	Physics
PLAN	Planning
PLCE	Architecture Planning and Civil Engineering
POLS	Political Science
PSLG	Physiology
PSYC	Psychology
RELI	Religion
SCNC	Science
SIEO	Statistics and Industrial Engineering and Operations Research
SOCI	Sociology
SPAN	Spanish
STAT	Statistics
STCS	Statistics and Computer Science
URBS	Urban Studies
VIAR	Visual Arts

How Courses are Numbered

The course number that follows each designator consists of one or two *capital letters* followed by four digits. The capital letter indicates the University division or affiliate offering the course:

Letter(s)	University Division
B	Business
E	Engineering and Applied Science
P	Mailman School of Public Health
S	Summer Session
U	International and Public Affairs
W	Interfaculty course
Z	American Language Program

Arts and Sciences

Letter(s)	University Division
CC	Columbia College
UN	Undergraduate
GU	Undergraduate, Graduate
GR	Graduate Only

The *first digit* indicates the level of the course, as follows:

Digit	Level of Course
0	Course that cannot be credited toward any degree
1	Undergraduate course
2	Undergraduate course, intermediate
3	Undergraduate course, advanced
4	Graduate course that is open to qualified undergraduates
6	Graduate course
8	Graduate course, advanced
9	Graduate research course or seminar

An *x* following the course number means that the course meets in the fall semester; *y* indicates the spring semester.

Directory of Classes

Room assignments, days and hours, and course changes for all courses are available online at columbia.edu/cu/bulletin/uwb.

The School reserves the right to withdraw or modify the courses of instruction or to change the instructors at any time.

Applied Physics and Applied Mathematics

200 S. W. Mudd, MC 4701
212-854-4457
Applied Physics and Applied Mathematics: apam.columbia.edu
Materials Science and Engineering: matsci.apam.columbia.edu

The Department of Applied Physics and Applied Mathematics includes undergraduate and graduate studies in the fields of applied physics, applied mathematics, and materials science and engineering. The graduate program in applied physics includes plasma physics and controlled fusion; solid-state physics; optical and laser physics and medical physics. The graduate program in applied mathematics includes research in applied analysis, data science, and atmospheric, oceanic, and earth physics. The graduate programs in materials science and engineering are described here (p. 296).

Furthermore, the Department has a leadership role in development and support of Columbia Shared Computing resources and has access to multiple HPC clusters. In addition, the research of the Plasma Lab is supported by a dedicated data acquisition/data analysis system. Researchers in the department are using supercomputing facilities at the National Center for Atmospheric Research; the San Diego Supercomputing Center; the National Energy Research Supercomputer Center in Berkeley, California; the National Leadership Class Facility at Oak Ridge, Tennessee; various allocations via ACCESS; and others. The Amazon Elastic Compute Cloud (EC2) is also utilized to supplement computing resources in times of high demand.

Current Research Activities in the Department

Applied Physics

Plasma physics and fusion energy. In plasma physics, research is being conducted on:

1. equilibrium, stability, and transport in tokamak plasmas
2. modeling and optimization of stellarator plasmas
3. enabling technology of fusion such as superconducting magnets, blankets, and fuel cycle
4. the development of new plasma measurement techniques
5. fundamental plasma physics

The results from our fusion science experiments are used as a basis for collaboration with large national and international projects and support the growing commercial fusion startup sector. This program is closely coupled to the new Columbia Fusion Research Center which enables members to advance fundamental plasma physics, collaborate closely with industry, and broaden participation in this field.

Optical and laser physics. Active areas of research include quantum science and technology, flat optics, metasurfaces, silicon nanophotonics, superconducting circuits, nonlinear photonics, ultrafast optics, and photon integrated circuits.

Solid-state physics. Research in solid-state physics covers nanoscience and nanoparticles, electronic transport and inelastic light scattering in low-dimensional correlated electron systems, heterostructure physics and applications, grain boundaries and interfaces, nucleation in thin films, molecular electronics, nanostructure analysis, and electronic structure calculations.

Applied physics is part of the Columbia Quantum Initiative. Research opportunities also exist within the Columbia Nano Initiative (CNI), including the NSF Materials Research Science and Engineering Center, which focuses on low dimensional materials.

Applied and Computational Mathematics. The program in Applied Mathematics encompasses both methodological approaches in applied and computational math, which are fundamental to modern applications, and domain specific applied mathematics in classical and emergent new field of physics, engineering, bio-engineering, bio-physics, and social sciences. Current research encompasses analytical and numerical analysis of deterministic and stochastic partial differential equations, numerical analysis, large-scale scientific computation, fluid dynamics, dynamical systems and chaos, inverse problems, algorithms for data and machine learning, and their applications. Physical science applications include quantum and condensed-matter physics, materials science, electromagnetics, optics and photonics, plasma physics, medical imaging, and the earth sciences (atmospheric, oceanic, climate science, and solid earth geophysics).

Atmospheric, oceanic, and earth physics. Current research focuses on the dynamics of the atmosphere and the ocean, climate modeling, cloud physics, radiation transfer, remote sensing, geophysical/geological fluid dynamics, and geochemistry. Five faculty members share appointments with the Department of Earth and Environmental Sciences.

The Applied Mathematics Program has extensive connections (through joint and affiliated faculty, postdoctoral fellows and research scientists) in departments and centers at the School of Engineering and Applied Sciences (SEAS), Arts and Sciences, and the Columbia University Irving Medical Center (CUIMC) as well as in Columbia Institutes, such as the Data Science Institute (DSI), NASA Goddard Institute for Space Studies, Lamont-Doherty Earth Observatory. There are also extensive collaborations with national research centers, such as the Geophysical Fluid Dynamics Laboratory and the National Center for Atmospheric Research, and with national laboratories of the U.S. Department of Energy, custodians of the nation's most powerful supercomputers.

Laboratory and Computational Facilities in Applied Physics and Applied Mathematics

The Plasma Physics Laboratory, founded in 1961, is one of the leading university laboratories for the study of fusion and plasma physics in the United States. Within it, there are several experimental facilities. The Columbia High-Beta Tokamak (HBT-EP) supports the national program to develop controlled fusion energy. It utilizes high voltage, pulsed power systems, and laser and magnetic diagnostics to study the properties of high-performance plasmas and the use of advanced control schemes and is also being used to explore novel plasma configurations. The Columbia Stellarator Experiment (CSX) is developing high-temperature superconducting non-planar magnets and their application to the stellarator magnetic confinement concept. The Columbia University Tokamak for Education (CUTE) is a device targeting student engagement in developing and demonstrating tokamak pulse designs. The Pellets at Columbia (PAC) experiment is testing the science and technology of cryogenic material injection into high-temperature plasma. The Columbia plasma physics group also performs work at off-site Department of Energy user facilities, such as the DIII-D National Fusion Facilities in California and the National Spherical Torus Experiment Upgrade in New Jersey. The Plasma Physics Laboratory is an essential component of the Columbia Fusion Research Center. More information can be found at https://fusion.columbia.edu/.

Experimental research in solid-state physics and laser physics is conducted within the department and also in association with the Columbia Nano Initiative. Facilities include laser processing and spectroscopic apparatus, ultrahigh vacuum chambers for surface analysis, picosecond and femtosecond lasers, and a clean room that includes photo-lithography and thin film fabrication systems. Within this field, the Laser Diagnostics and Solid State Physics Laboratory conducts studies in laser spectroscopy of nanomaterials and semiconductor thin films, and laser diagnostics of thin film processing. The Laser Lab focuses on the study of laser surface chemical processing and new semiconductor structures. Research is also conducted in the shared characterization laboratories and clean room operated by CNI.

Current Research Activities and Laboratory Facilities in Materials Science and Engineering

See Current Research Activities and Laboratory Facilities in Materials Science and Engineering (p. 286).

Chair

Marc W. Spiegelman
208 S. W. Mudd

Department Administrator

Marri Davis

Professors

Daniel Bienstock, Industrial Engineering and Operations Research
Simon J. L. Billinge, Professor Emeritus
Allen H. Boozer
Liliana Borcea
Mark A. Cane, Professor Emeritus, Earth and Environmental Sciences
Siu-Wai Chan
Qiang Du
Alexander L. Gaeta
Oleg Gang, Chemical Engineering
Irving P. Herman, Professor Emeritus
James S. Im
Michal Lipson, Electrical Engineering
Chris A. Marianetti
Michael E. Mauel
Gerald A. Navratil
Ismail C. Noyan
Lorenzo M. Polvani, Earth and Environmental Sciences
Kui Ren
Christopher H. Scholz, Professor Emeritus, Earth and Environmental Sciences
Adam Sobel, Earth and Environmental Sciences
Marc W. Spiegelman, Earth and Environmental Sciences
Latha Venkataraman
Wen I. Wang, Electrical Engineering
Michael I. Weinstein, Mathematics
Renata M. Wentzcovitch, Earth and Environmental Sciences

Associate Professors

William E. Bailey
Carlos Paz-Soldan
Michael K. Tippett
Chris H. Wiggins, Systems Biology
Yuan Yang
Nanfang Yu

Assistant Professors

Aravind Devarakonda
Curtiss Lyman
Elizabeth Paul
Michele Simoncelli
Qiaho Ye
Xueyue (Sherry) Zhang
Ben Zhu

Lecturer in Discipline

Drew Youngren

Adjunct Associate Professors

Brian Cairns
Yuan He
Anastasia Romanou

Senior Research Scientists

Steven A. Sabbagh

Research Scientists

Jacek Chowdhary
Gregory Elsaesser
Igor Geogdzhayev
Christopher J. Hansen
Jeffrey Levesque
Nikolas C. Logan
Catherine Naud

Associate Research Scientists

Mikhail Alexandrov
Robert Field
Jeremy Hanson
Paul Lerner
Nils Leuthold
A. Oak Nelson
Ian G. Stewart
Veronika Zamkovska

Medical Physics Faculty

Zohaib Ahmad
Sean L. Berry
Peter F. Caracappa
C. Julian Chen
Perry S. Gerard
Monique C. Katz
Stephen L. Ostrow
Boyu Peng
Anna Rozenshtein
Cheng-Shie Wuu, Radiation Oncology
Marco Zaider
Pat Zanzonico

Course Descriptions

APAM E3899 Research Training. ***0.00 points*****.**
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

APAM E3999 UNDERGRADUATE FIELDWORK. *1.00-2.00 points*.
1-2 pts.

Prerequisites: Obtained internship and approval from faculty advisor. Restricted to ENAPMA, ENAPPH, ENMSAE.
May be repeated for credit, but no more than 3 total points may be used toward the 128credit degree requirement. Only for APAM undergraduate students who include relevant off-campus work experience as part of their approved program of study. Final report and letter of evaluation required. Fieldwork credits may not count toward any major core, technical, elective, and nontechnical requirements. May not be taken for pass/fail credit or audited.

Spring 2026: APAM E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 3999	001/18057		Yuan Yang	1.00-2.00	1/5
APAM 3999	002/20739		Lorenzo Polvani	1.00-2.00	0/1

Summer 2026: APAM E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 3999	001/11366		Lorenzo Polvani	1.00-2.00	5/5
APAM 3999	002/11367		Michael Tippett	1.00-2.00	2/5
APAM 3999	003/11864		Nanfang Yu	1.00-2.00	1/1
APAM 3999	004/11915		Alexander Gaeta	1.00-2.00	1/2
APAM 3999	005/11916		Kui Ren	1.00-2.00	1/5

APAM E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

APAM E4999 SUPERVISED INTERNSHIP. *1.00-3.00 points*.
1-3 pts.

Prerequisites: Obtained internship and approval from adviser.
Only for masters students in the Department of Applied Physics and Applied Mathematics who may need relevant work experience a part of their program of study. Final report required. May not be taken for pass/fail or audited

Spring 2026: APAM E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 4999	001/18048		Kui Ren	1.00-3.00	2/5
APAM 4999	002/19596		Klaus Hamacher	1.00-3.00	1/2

Summer 2026: APAM E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 4999	001/11138		Carlos Paz Soldan	1.00-3.00	1/5
APAM 4999	002/11469		Klaus Hamacher	1.00-3.00	2/5
APAM 4999	003/11470		Kui Ren	1.00-3.00	2/2
APAM 4999	004/12903		Kui Ren	1.00-3.00	1/1

Fall 2026: APAM E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 4999	001/19821		Michael Weinstein	1.00-3.00	0/5

APAM E6650 RESEARCH PROJECT. *1.00-6.00 points*.
Prerequisites: Written permission from instructor and approval from adviser.
May be repeated for credit. A special investigation of a problem in nuclear engineering, medical physics, applied mathematics, applied physics, and/or plasma physics consisting of independent work on the part of the student and embodied in a formal report

Spring 2026: APAM E6650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 6650	003/18132		Liliana Borcea	1.00-6.00	2/5
APAM 6650	013/18059		Carlos Paz Soldan	1.00-6.00	6/10
APAM 6650	015/17802		Kui Ren	1.00-6.00	0/8
APAM 6650	022/20161		Nanfang Yu	1.00-6.00	1/5
APAM 6650	023/20252		Ben Zhu	1.00-6.00	1/5
APAM 6650	024/20120		Klaus Hamacher	1.00-6.00	1/2

Fall 2026: APAM E6650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 6650	007/19984		Michele Simoncelli	1.00-6.00	0/10
APAM 6650	009/19986		Xueyue Zhang	1.00-6.00	0/10
APAM 6650	011/15046		Carlos Paz Soldan	1.00-6.00	2/10
APAM 6650	014/15639		Steven Sabbagh	1.00-6.00	3/5

APAM E9301 DOCTORAL RESEARCH. *0.00-15.00 points*.
0-15 pts.

Prerequisites: Qualifying examination for the doctorate.
Required of doctoral candidates

Spring 2026: APAM E9301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 9301	002/17800		Daniel Bienstock	0.00-15.00	1/5
APAM 9301	005/17752		Liliana Borcea	0.00-15.00	1/5
APAM 9301	006/17753		Aravind Devarakonda	0.00-15.00	3/5
APAM 9301	007/17754		Qiang Du	0.00-15.00	3/5
APAM 9301	008/17755		Alexander Gaeta	0.00-15.00	6/8
APAM 9301	011/17756		Michal Lipson	0.00-15.00	4/5
APAM 9301	012/17757		Chris Marianetti	0.00-15.00	1/5
APAM 9301	013/17758		Michael Mauel	0.00-15.00	4/5
APAM 9301	014/17759		Gerald Navratil	0.00-15.00	0/5
APAM 9301	015/17760		Elizabeth Paul	0.00-15.00	7/10
APAM 9301	016/17761		Carlos Paz Soldan	0.00-15.00	17/20
APAM 9301	018/17762		Lorenzo Polvani	0.00-15.00	3/5
APAM 9301	019/17763		Kui Ren	0.00-15.00	5/5
APAM 9301	020/17764		Steven Sabbagh	0.00-15.00	2/5
APAM 9301	021/17765		Adam Sobel	0.00-15.00	1/5
APAM 9301	022/17766		Marc Spiegelman	0.00-15.00	2/5
APAM 9301	025/17767		Michael Weinstein	0.00-15.00	3/5
APAM 9301	027/18215		Xueyue Zhang	0.00-15.00	1/5
APAM 9301	028/17768		Nanfang Yu	0.00-15.00	5/5
APAM 9301	029/17769		Michele Simoncelli	0.00-15.00	2/5

Fall 2026: APAM E9301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APAM 9301	001/15022		Daniel Bienstock	0.00-15.00	1/10
APAM 9301	003/15023		Liliana Borcea	0.00-15.00	1/10
APAM 9301	004/15024		Aravind Devarakonda	0.00-15.00	0/10
APAM 9301	005/15025		Qiang Du	0.00-15.00	1/10
APAM 9301	006/15026		Alexander Gaeta	0.00-15.00	4/10
APAM 9301	008/15027		Michal Lipson	0.00-15.00	2/10
APAM 9301	009/15028		Chris Marianetti	0.00-15.00	0/10
APAM 9301	010/15029		Elizabeth Paul	0.00-15.00	5/10
APAM 9301	011/15030		Carlos Paz Soldan	0.00-15.00	20/25
APAM 9301	012/15031		Lorenzo Polvani	0.00-15.00	2/10
APAM 9301	013/15032		Kui Ren	0.00-15.00	0/10
APAM 9301	014/15033		Steven Sabbagh	0.00-15.00	0/15
APAM 9301	015/15034		Michele Simoncelli	0.00-15.00	2/10
APAM 9301	016/15035		Adam Sobel	0.00-15.00	1/10
APAM 9301	019/15036		Michael Weinstein	0.00-15.00	0/10
APAM 9301	022/15037		Nanfang Yu	0.00-15.00	1/10
APAM 9301	023/15038		Xueyue Zhang	0.00-15.00	2/10

APBM E4650 ANATOMY FOR PHYSICISTS # ENGR. *3.00 points*.
Lect: 3.

Prerequisites: Engineering or physics background.
Systemic approach to the study of the human body from a medical imaging point of view: skeletal, respiratory, cardiovascular, digestive, and urinary systems, breast and womens issues, head and neck, and central nervous system. Lectures are reinforced by examples from clinical two- and three-dimensional and functional imaging (CT, MRI, PET, SPECT, U/S, etc.)

Fall 2026: APBM E4650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APBM 4650	001/10877	T Th 4:00pm - 5:20pm LI110 Hammer Hlth Sciences Center	Zohaib Ahmad, Perry Gerard, Anna Rozenshtein, Monique Katz	3.00	13/25

APCH E4080 SOFT CONDENSED MATTER. *3.00 points*.
Prerequisites: CHEE E3010 AND MSAE E3111; or equivalent.
Course is aimed at senior undergraduate and graduate students. Introduces fundamental ideas, concepts, and approaches in soft condensed matter with emphasis on biomolecular systems. Covers the broad range of molecular, nanoscale, and colloidal phenomena with revealing their mechanisms and physical foundations. The relationship between molecular architecture and interactions and macroscopic behavior are discussed for the broad range of soft and biological matter systems, from surfactants and liquid crystals to polymers, nanoparticles, and biomolecules. Modern characterization methods for soft materials, including X-ray scattering, molecular force probing, and electron microcopy are reviewed. Example problems, drawn from the recent scientific literature, link the studied materials to the actively developed research areas. Course grade based on midterm and final exams, weekly homework assignments, and final individual/team project

APMA E2000 MULTV. CALC. FOR ENGI # APP SCI. *4.00 points*.
Lect: 3.

Differential and integral calculus of multiple variables. Topics include partial differentiation; optimization of functions of several variables; line, area, volume, and surface integrals; vector functions and vector calculus; theorems of Green, Gauss, and Stokes; applications to selected problems in engineering and applied science

Spring 2026: APMA E2000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 2000	001/12897	T Th 8:40am - 9:55am 627 Seeley W. Mudd Building	Drew Youngren	4.00	46/52
APMA 2000	002/12898	T Th 1:10pm - 2:25pm 402 Chandler	Drew Youngren	4.00	120/126

Fall 2026: APMA E2000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 2000	001/14118	T Th 8:40am - 9:55am 313 Fayerweather	Curtiss Lyman	4.00	9/75
APMA 2000	002/14120	T Th 1:10pm - 2:25pm 428 Pupin Laboratories	Drew Youngren	4.00	48/135
APMA 2000	003/14121	T Th 5:40pm - 6:55pm 614 Schermerhorn Hall	Drew Youngren	4.00	42/120

APMA E2001 MULTV. CALC. FOR ENGI # APP SCI. *0.00 points*.
Required recitation session for students enrolled in APMA E2000

Spring 2026: APMA E2001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 2001	R01/12899	F 2:40pm - 3:30pm 302 Fayerweather	Baohua Yan	0.00	26/30
APMA 2001	R02/12900	Th 4:10pm - 5:00pm 407 Mathematics Building	Yinxi Pan	0.00	28/30
APMA 2001	R03/12902	F 10:10am - 11:00am 302 Fayerweather	Beiji Chen	0.00	29/30
APMA 2001	R04/12904	Th 4:10pm - 5:00pm C01 Knox Hall	Baohua Yan	0.00	26/30
APMA 2001	R05/12905	Th 5:10pm - 6:00pm 407 Mathematics Building	Yinxi Pan	0.00	28/30
APMA 2001	R06/12907	Th 11:40am - 12:30pm 307 Pupin Laboratories	Beiji Chen	0.00	29/30

APMA E2101 INTRO TO APPLIED MATHEMATICS. *3.00 points*.
Lect: 3.

Prerequisites: MATH V1201
A unified, single-semester introduction to differential equations and linear algebra with emphases on (1) elementary analytical and numerical technique and (2) discovering the analogs on the continuous and discrete sides of the mathematics of linear operators: superposition, diagonalization, fundamental solutions. Concepts are illustrated with applications using the language of engineering, the natural sciences, and the social sciences. Students execute scripts in Mathematica and MATLAB (or the like) to illustrate and visualize course concepts (programming not required)

Spring 2026: APMA E2101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 2101	001/12911	T Th 1:10pm - 2:25pm 207 Mathematics Building	Yuan He	3.00	121/152

Fall 2026: APMA E2101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 2101	001/14122	T Th 1:10pm - 2:25pm 517 Hamilton Hall	Yuan He	3.00	86/86

APMA E3101 APPLIED MATH I: LINEAR ALGEBRA. *3.00 points*.
Lect: 3.

Matrix algebra, elementary matrices, inverses, rank, determinants. Computational aspects of solving systems of linear equations: existence-uniqueness of solutions, Gaussian elimination, scaling, ill-conditioned systems, iterative techniques. Vector spaces, bases, dimension. Eigenvalue problems, diagonalization, inner products, unitary matrices

Fall 2026: APMA E3101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 3101	001/14123	T Th 10:10am - 11:25am 627 Seeley W. Mudd Building	Yuan He	3.00	41/52

APMA E3102 APPLIED MATHEMATICS II: PDE'S. *3.00 points*.
Lect: 3.

Prerequisites: (MATH UN2030) MATH V2030; or equivalent.
Introduction to partial differential equations; integral theorems of vector calculus. Partial differential equations of engineering in rectangular, cylindrical, and spherical coordinates. Separation of the variables. Characteristic-value problems. Bessel functions, Legendre polynomials, other orthogonal functions; their use in boundary value problems. Illustrative examples from the fields of electromagnetic theory, vibrations, heat flow, and fluid mechanics

Spring 2026: APMA E3102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 3102	001/12913	T Th 1:10pm - 2:25pm 825 Seeley W. Mudd Building	Michael Tippett	3.00	30/45

APMA E3900 UNDERGRAD RES IN APPLIED MATH. *0.00-4.00 points*.
0-4 pts.

Prerequisites: Written permission from instructor and approval from adviser.
This course may be repeated for credit, but no more than 6 points of this course may be counted toward the satisfaction of the B.S. degree requirements. Candidates for the B.S. degree may conduct an investigation in applied mathematics or carry out a special project under the supervision of the staff. Credit for the course is contingent upon the submission of an acceptable thesis or final report

Spring 2026: APMA E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 3900	001/20366		Curtiss Lyman	0.00-4.00	1/5
APMA 3900	002/20081		Marc Spiegelman	0.00-4.00	4/5

APMA E4007 APPLIED LINEAR ALGEBRA. *3.00 points*.
Prerequisites: Cannot be taken together with APMA E3101
Fundamentals of Linear Algebra including vector and Matrix algebra, solution of linear systems, existence and uniqueness, gaussian elimination, gauss-jordan elimination, the matrix inverse, elementary matrices and the LU factorization, computational cost of solutions. Vector spaces and subspaces, linear independence, basis and dimension. The 4 fundamental subspaces of a matrix. Orthogonal projection onto a subspace and solution of Linear Least Squares problems, unitary matrices, inner products, orthogonalization algorithms and the QR factorization, applications. Determinants and applications. Eigen problems including diagonalization, symmetric matrices, positive-definite systems, eigen factorization and applications to dynamical systems and iterative maps. Introduction to the singular value decomposition and its applications

Fall 2026: APMA E4007

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4007	001/14124	T Th 1:10pm - 2:25pm 702 Hamilton Hall	Marc Spiegelman	3.00	69/86
APMA 4007	C01/19917		Marc Spiegelman	3.00	1/99

APMA E4008 Advanced and Applied Linear Algebra. *3.00 points*.
Prerequisites: APMA E3101 AND APMA E4007; After the approval of APMA E4007, it could also serve as a pre-requisite to 4008.
Advanced topics in linear algebra with applications to data analysis, algorithms, dynamics and differential equations, and more. (1) General vector spaces, linear transformations, spaces isomorphisms; (2) spectral theory - normal matrices and their spectral properties, Rayleigh quotient, Courant-Fischer Theorem, Jordan forms, eigenvalue perturbations; (3) least squares problem and the Gauss-Markov Theorem; (4) singular value decomposition, its approximation properties, matrix norms, PCA and CCA

Spring 2026: APMA E4008

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4008	001/12917	T Th 10:10am - 11:25am 627 Seeley W. Mudd Building	Yuan He	3.00	40/52
APMA 4008	C01/20203		Yuan He	3.00	2/99
APMA 4008	V01/16787		Yuan He	3.00	9/99

APMA E4100 Applied Analysis. *3.00 points*.
Prerequisites: Strong background in multivariate calculus is required. Knowledge in elementary analysis such as the delta-epsilon definition of continuity, convergence of sequences of real numbers, topocontinuity of real-valued functions
Elementary introduction to fundamental concepts and techniques in classical analysis; applications of such techniques in different topics in applied mathematics. Brief review of essential concepts and techniques in elementary analysis; elementary properties of metric and normed spaces; completeness, compactness, and their consequences; continuous functions and their properties; Contracting Mapping Theorem and its applications; elementary properties of Hilbert and Banach spaces; bounded linear operators in Hilbert spaces; Fourier series and their applications.

Fall 2026: APMA E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4100	001/14125	M W 2:40pm - 3:55pm 545 Seeley W. Mudd Building	Liliana Borcea	3.00	35/35
APMA 4100	C01/19826		Liliana Borcea	3.00	0/99
APMA 4100	V01/18074		Liliana Borcea	3.00	7/99

APMA E4101 APPL MATH III:DYNAMICAL SYSTMS. *3.00 points*.
Lect: 3.

Prerequisites: or their equivalents, or instructor's permission.
An introduction to the analytic and geometric theory of dynamical systems; basic existence, uniqueness and parameter dependence of solutions to ordinary differential equations; constant coefficient and parametrically forced systems; Fundamental solutions; resonance; limit points, limit cycles and classification of flows in the plane (Poincare-Bendixson Therem); conservative and dissipative systems; linear and nonlinear stability analysis of equilibria and periodic solutions; stable and unstable manifolds; bifurcations, e.g. Andronov-Hopf; sensitive dependence and chaotic dynamics; selected applications.

Spring 2026: APMA E4101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4101	001/12919	M W 8:40am - 9:55am 313 Fayerweather	Xuenan Li	3.00	52/75
APMA 4101	V01/19798		Xuenan Li	3.00	1/99

APMA E4150 APPLIED FUNCTIONAL ANALYSIS. *3.00 points*.
Prerequisites: Advanced calculus and course in basic analysis, or instructor's permission.
Introduction to modern tools in functional analysis that are used in the analysis of deterministic and stochastic partial differential equations and in the analysis of numerical methods: metric and normed spaces. Banach space of continuous functions, measurable spaces, the contraction mapping theorem, Banach and Hilbert spaces bounded linear operators on Hilbert spaces and their spectral decomposition, and time permitting distributions and Fourier transforms

Spring 2026: APMA E4150

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4150	001/12921	M W 2:40pm - 3:55pm 825 Seeley W. Mudd Building	Michael Weinstein	3.00	6/30

APMA E4200 PARTIAL DIFFERENTIAL EQUATIONS. *3.00 points*.
Prerequisites: Course in ordinary differential equations.
Techniques of solution of partial differential equations. Separation of the variables. Orthogonality and characteristic functions, nonhomogeneous boundary value problems. Solutions in orthogonal curvilinear coordinate systems. Applications of Fourier integrals, Fourier and Laplace transforms. Problems from the fields of vibrations, heat conduction, electricity, fluid dynamics, and wave propagation are considered

Spring 2026: APMA E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4200	001/12923	T Th 1:10pm - 2:25pm 1127 Seeley W. Mudd Building	Curtiss Lyman	3.00	44/52
APMA 4200	V01/20047		Curtiss Lyman	3.00	6/99

Fall 2026: APMA E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4200	001/14128	M W 10:10am - 11:25am 1127 Seeley W. Mudd Building	Qiang Du	3.00	55/60
APMA 4200	V01/18075		Qiang Du	3.00	4/99

APMA E4204 FUNCTNS OF A COMPLEX VARIABLE. *3.00 points*.
Prerequisites: (MATH UN1202) MATH V1202; or equivalent.
Complex numbers, functions of a complex variable, differentiation and integration in the complex plane. Analytic functions, Cauchy integral theorem and formula, Taylor and Laurent series, poles and residues, branch points, evaluation of contour integrals. Conformal mapping, Schwarz-Christoffel transformation. Applications to physical problems

APMA E4300 COMPUT MATH:INTRO-NUMERCL METH. *3.00 points*.
Lect: 3.

Prerequisites: or their equivalents.
Corequisites: MECE E6104
Programming experience in Python extremely useful. Introduction to fundamental algorithms and analysis of numerical methods commonly used by scientists, mathematicians and engineers. Designed to give a fundamental understanding of the building blocks of scientific computing that will be used in more advanced courses in scientific computing and numerical methods for PDEs (e.g. APMA E4301, E4302). Topics include numerical solutions of algebraic systems, linear least-squares, eigenvalue problems, solution of non-linear systems, optimization, interpolation, numerical integration and differentiation, initial value problems and boundary value problems for systems of ODEs. All programming exercises will be in Python.

Spring 2026: APMA E4300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4300	001/12963	M W 1:10pm - 2:25pm 702 Hamilton Hall	Kui Ren	3.00	47/85
APMA 4300	C01/19988		Kui Ren	3.00	2/99
APMA 4300	V01/16598		Kui Ren	3.00	4/99

Fall 2026: APMA E4300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4300	001/14130	T Th 10:10am - 11:25am 833 Seeley W. Mudd Building	Qihao Ye	3.00	104/120

APMA E4301 NUMERICAL METHODS/PDE'S. *3.00 points*.
Lect: 3.

Prerequisites: (APMA E3102 and APMA E4200 and APMA E4300) or equivalents.
Numerical solution of differential equations, in particular partial differential equations arising in various fields of application. Presentation emphasizes finite difference approaches to present theory on stability, accuracy, and convergence with minimal coverage of alternate approaches (left for other courses). Method coverage includes explicit and implicit time-stepping methods, direct and iterative solvers for boundary-value problems.

Spring 2026: APMA E4301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4301	001/12953	T Th 10:10am - 11:25am 545 Seeley W. Mudd Building	Qiang Du	3.00	11/40
APMA 4301	C01/19793		Qiang Du	3.00	0/99
APMA 4301	V01/16631		Qiang Du	3.00	4/99

APMA E4302 METHODS IN COMPUTATIONAL SCI. *3.00 points*.
Lect: 3.

Prerequisites: (APMA E4300) and APMA E4300; and application and knowledge in C, Fortran or similar complied language.
Introduction to the key concepts and issues in computational science aimed at getting students to a basic level of understanding where they can run simulations on machines aimed at a range of applications and sizes from a single workstation to modern super-computer hardware. Topics include but are not limited to basic knowledge of UNIX shells, version control systems, reproducibility, Open MP, MPI, and many-core technologies. Applications will be used throughout to demonstrate the various use cases and pitfalls of using the latest computing hardware

Spring 2026: APMA E4302

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4302	001/16727	T Th 11:40am - 12:55pm 210 Seeley W. Mudd Building	Marc Spiegelman	3.00	13/12

APMA E4306 Applied Stochastic Analysis. *3.00 points*.
Prerequisites: Elementary probability theory IEOR E3658 or above, stochastic process the first part of IEOR E4106 or STAT G4264, knowledge on analysis MATH GU4601 or above, differential equations APMA E4200, numerical methods APMA E4300 & programming skills
Provides elementary introduction to fundamental ideas in stochastic analysis for applied mathematics. Core material includes: (i) review of probability theory (including limit theorems), and introduction to discrete Markov chains and Monte Carlo methods; (ii) elementary theory of stochastic process, Ito's stochastic calculus and stochastic differential equations; (iii) introductions to probabilistic representation of elliptic partial differential equations (the Fokker-Planck equation theory); (iv) stochastic approximation algorithms; and (v) asymptotic analysis of SDEs

Spring 2026: APMA E4306

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4306	001/12964	M W 10:10am - 11:25am 545 Seeley W. Mudd Building	Liliana Borcea	3.00	35/45
APMA 4306	C01/18311		Liliana Borcea	3.00	1/99
APMA 4306	V01/17539		Liliana Borcea	3.00	4/99

APMA E4901 SEM-PROBLEMS IN APPLIED MATH. *0.00 points*.
Lect: 1.

Required for, and can be taken only by, all applied mathematics majors in the junior year. Introductory seminars on problems and techniques in applied mathematics. Typical topics are nonlinear dynamics, scientific computation, economics, operation research, etc

Fall 2026: APMA E4901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4901	001/14135	M W 11:40am - 12:55pm 501 Schermerhorn Hall	Chris Wiggins	0.00	74/85

APMA E4903 SEM-PROBLEMS IN APPLIED MATH. *3.00-4.00 points*.
3-4 pts. Lect: 1

Required for all applied mathematics majors in the senior year. Term paper required. Examples of problem areas are nonlinear dynamics, asymptotics, approximation theory, numerical methods, etc. Approximately three problem areas are studied per term.

Fall 2026: APMA E4903

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4903	001/14137	M W 11:40am - 12:55pm 501 Schermerhorn Hall	Chris Wiggins	3.00-4.00	60/70

APMA E4990 SPEC TOPICS IN APPLIED MATH. *1.00-3.00 points*.
1-3 pts. Lect: 3.

Prerequisites: Advanced calculus and junior year applied mathematics, or their equivalents.
May be repeated for credit. Topics and instructors from the Applied Mathematics Committee and the staff change from year to year. For advanced undergraduate students and graduate students in engineering, physical sciences, biological sciences, and other fields. Examples of topics include multi-scale analysis and Applied Harmonic Analysis

Fall 2026: APMA E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 4990	001/16954	M 4:10pm - 5:25pm 222 Pupin Laboratories	Liliana Borcea, Josselin Garnier	1.00-3.00	3/25

APMA E6100 RESEARCH SEMINAR. *0.00 points*.
Lect: 3.

An M.S. degree requirement. Students attend at least three Applied Mathematics research seminars within the Department of Applied Physics and Applied Mathematics and submit reports on each.

Spring 2026: APMA E6100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 6100	D01/19995		Kui Ren	0.00	2/2

Fall 2026: APMA E6100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 6100	001/14142	T 2:45pm - 3:35pm 1024 Seeley W. Mudd Building	Qiang Du	0.00	37/50
APMA 6100	001/14142	T 4:10pm - 5:00pm 1024 Seeley W. Mudd Building	Qiang Du	0.00	37/50
APMA 6100	V01/19588		Qiang Du	0.00	4/99

APMA E6301 ANALYTIC METHODS FOR PDE'S. *3.00 points*.
Lect: 2.

Prerequisites: (APMA E3101) and (APMA E4200) APMA E3101 AND APMA E4200; or their equivalents. Advanced calculus, basic concepts in analysis, or instructor's permission.
Introduction to analytic theory of PDEs of fundamental and applied science; wave (hyperbolic), Laplace and Poisson equations (elliptic), heat (parabolic) and Schroedinger (dispersive) equations; fundamental solutions, Greens functions, weak/distribution solutions, maximum principle, energy estimates, variational methods, method of characteristics; elementary functional analysis and applications to PDEs; introduction to nonlinear PDEs, shocks; selected applications

Fall 2026: APMA E6301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APMA 6301	001/14145	T Th 1:10pm - 2:25pm 233 Seeley W. Mudd Building	Michael Weinstein	3.00	19/35

APMA E6302 NUMERICAL ANALYSIS OF PDE'S. *3.00 points*.
Lect: 2.

Prerequisites: (APMA E3102) or (APMA E4200) APMA E3102 OR APMA E4200
Numerical analysis of initial and boundary value problems for partial differential equations. Convergence and stability of the finite difference method, the spectral method, the finite element method and applications to elliptic, parabolic, and hyperbolic equations

APPH E3100 INTRO TO QUANTUM MECHANICS. *3.00 points*.
Lect: 3.

Prerequisites: (PHYS UN1403) or PHYS W1403; APMA E3101; or equivalent, and differential and integral calculus.
Corequisites: APMA E3101
Basic concepts and assumptions of quantum mechanics, Schrodinger's equation, solutions for one-dimensional problems including square wells, barriers and the harmonic oscillator, introduction to the hydrogen atom, atomic physics and X-rays, electron spin

Fall 2026: APPH E3100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 3100	001/14164	T Th 2:40pm - 3:55pm 328 Uris Hall	Aravind Devarakonda	3.00	13/35

APPH E3200 MECHANICS:FUND # APPLICATIONS. *3.00 points*.
Lect: 3

Prerequisites: (PHYS UN1402) and (MATH UN2030) or MATH V2030 AND PHYS C1402; or equivalent.
Basic non-Euclidean coordinate systems, Newtonian Mechanics, oscillations, Greens functions, Newtonian graviation, Lagrangian mechanics, central force motion, two-body collisions, noninertial reference frames, rigid body dynamics. Applications, including GPS and feedback control systems, are emphasized throughout

Fall 2026: APPH E3200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 3200	001/14165	M W 10:10am - 11:25am 616 Hamilton Hall	Elizabeth Paul	3.00	9/35

APPH E3300 APPLIED ELECTROMAGNETISM. *3.00 points*.
Lect: 3.

Prerequisites: APMA E3102
Corequisites: APMA E3102
Vector analysis, electrostatic fields, Laplaces equation, multipole expansions, electric fields in matter: dielectrics, magnetostatic fields, magnetic materials, and superconductors. Applications of electromagnetism to devices and research areas in applied physics

Spring 2026: APPH E3300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 3300	001/16707	M W 10:10am - 11:25am 337 Seeley W. Mudd Building	Xueyue Zhang	3.00	12/30

APPH E3900 UNDERGRAD RESRCH-APPLD PHYSICS. *0.00-4.00 points*.
0-4 pts.

Prerequisites: Written permission from instructor and approval from adviser.
This course may be repeated for credit, but no more than 6 points of this course may be counted toward the satisfaction of the B.S. degree requirements. Candidates for the B.S. degree may conduct an investigation in applied physics or carry out a special project under the supervision of the staff. Credit for the course is contingent upon the submission of an acceptable thesis or final report

Spring 2026: APPH E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 3900	006/20539		Xueyue Zhang	0.00-4.00	1/5
APPH 3900	010/18143		Elizabeth Paul	0.00-4.00	1/5
APPH 3900	011/18058		Carlos Paz Soldan	0.00-4.00	10/10
APPH 3900	012/20339		Michele Simoncelli	0.00-4.00	1/5
APPH 3900	013/20476		Nanfang Yu	0.00-4.00	1/5

Fall 2026: APPH E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 3900	008/15047		Carlos Paz Soldan	0.00-4.00	0/20

APPH E4010 INTRODUCTN TO NUCLEAR SCIENCE. *3.00 points*.
Prerequisites: APMA E2000 AND MATH V1202 AND MATH V2030 AND PHYS W1403; or equivalents.
Introductory course is for individuals with an interest in medical physics and other branches of radiation science. Topics include basic concepts, nuclear models, semi-empirical mass formula, interaction of radiation with matter, nuclear detectors, nuclear structure and instability, radioactive decay process and radiation, particle accelerators, and fission and fusion processes and technologies

Fall 2026: APPH E4010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4010	001/10876	T 6:30pm - 9:00pm 829 Seeley W. Mudd Building	Stephen Ostrow	3.00	24/30

APPH E4018 APPLIED PHYSICS LABORATORY. *3.00 points*.
Prerequisites: (ELEN E3401 and APPH E3300) or equivalent.
Typical experiments are in the areas of plasma physics, microwaves, laser applications, optical spectroscopy physics, and superconductivity.

Spring 2026: APPH E4018

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4018	001/12976		Aravind Devarakonda	3.00	20/25

APPH E4100 QUANTUM PHYSICS OF MATTER. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E3100)
Corequisites: APMA E3102
Basic theory of quantum mechanics, well and barrier problems, the harmonic oscillator, angular momentum identical particles, quantum statistics, perturbation theory and applications to the quantum physics of atoms, molecules, and solids.

Fall 2026: APPH E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4100	001/14166	T Th 10:10am - 11:25am 545 Seeley W. Mudd Building	Alexander Gaeta	3.00	25/35
APPH 4100	V01/18076		Alexander Gaeta	3.00	2/99

APPH E4110 MODERN OPTICS. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E3300) APPH E3300
Ray optics, matrix formulation, wave effects, interference, Gaussian beams, Fourier optics, diffraction, image formation, electromagnetic theory of light, polarization and crystal optics, coherence, guided wave and fiber optics, optical elements, photons, selected topics in nonlinear optics

Spring 2026: APPH E4110

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4110	001/12977	T Th 11:40am - 12:55pm 545 Seeley W. Mudd Building	Nanfang Yu	3.00	21/30
APPH 4110	V01/16672		Nanfang Yu	3.00	2/99

APPH E4112 LASER PHYSICS. *3.00 points*.
Lect: 3.

Prerequisites: Recommended but not required: APPH E3100 and APPH E3300 or their equivalents.
Optical resonators, interaction of radiation and atomic systems, theory of laser oscillation, specific laser systems, rate processes, modulation, detection, harmonic generation, and applications

APPH E4114 Quantum and Nonlinear Photonics. *3.00 points*.
Prerequisites: APPH E3300 AND PHYS W3008
Advanced senior-level/MS/PhD course covering interaction of laser light with matter in both classical and quantum domains. First half introduces microscopic origin of optical nonlinearities through formal derivation of nonlinear susceptibilities, emphasis on second- and third-order optical processes. Topics include Maxwell's wave equation, and nonlinear optical processes such as second-harmonic, difference frequency generation, four-wave mixing, and self-phase modulation, including various applications of processes such as frequency conversion, and optical parametric amplifiers and oscillators. Second half describes two-level atomic systems and quantization of electromagnetic field. Descriptions of coherent, Fock, and squeezed states of light discussed and techniques to generate such states outlined

Spring 2026: APPH E4114

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4114	001/12979	M W 10:10am - 11:25am 212a Lewisohn Hall	Alexander Gaeta	3.00	21/25

APPH E4130 SOLAR ENERGY & STORAGE. *3.00 points*.
Lect: 3.

Prerequisites: General physics PHYS C1401x, C1402y, C1403x, C1601x, and C1602y, freshman mathematics including ordinary differential equations MATH V1201 and MATH V1202, MATH E1210. Familiarity in thermodynamics, electromagnetism, quantum mechanics, solid-state Nature of solar radiation as electromagnetic waves and photons. Availability of solar radiation at different times and at various places in the world. Thermodynamics of solar energy. Elements of quantum mechanics for the understanding of solar cells, photosynthesis, and electrochemistry. Theory, design, manufacturing, and installation of solar cells. Lithium-ion rechargeable batteries and other energy-storage devices. Architecture of buildings to utilize solar energy

Fall 2026: APPH E4130

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4130	001/14167	M W 1:10pm - 2:25pm 524 Seeley W. Mudd Building	Julian Chen	3.00	17/35
APPH 4130	V01/18077		Julian Chen	3.00	1/99

APPH E4200 PHYSICS OF FLUIDS. *3.00 points*.
Lect: 3.

An introduction to the physical behavior of fluids for science and engineering students. Derivation of basic equations of fluid dynamics: conservation of mass, momentum, and energy. Dimensional analysis. Vorticity. Laminar boundary layers. Potential flow. Effects of compressibility, stratification, and rotation. Waves on a free surface; shallow water equations. Turbulence.

Fall 2026: APPH E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4200	001/14168	Th 4:10pm - 6:40pm 313 Pupin Laboratories	Lorenzo Polvani	3.00	26/35

APPH E4210 GEOPHYSICAL FLUID DYNAMICS. *3.00 points*.
Lect: 3.

Prerequisites: (APMA E3101) and (APMA E3102) and (APPH E4200) APMA E3101 AND APMA E3102 AND APPH E4200; or equivalents or instructor's permission.
Fundamental concepts in the dynamics of rotating, stratified flows. Geostrophic and hydrostatic balances, potential vorticity, f and beta plane approximations, gravity and Rossby waves, geostrophic adjustment and quasigeostrophy, baroclinic and barotropic instabilities, Sverdrup balance, boundary currents, Ekman layers

Spring 2026: APPH E4210

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4210	001/16974	T Th 8:40am - 9:55am 555 Ext Schermerhorn Hall	Dhruv Balwada	3.00	8/25

APPH E4300 APPLIED ELECTRODYNAMICS. *3.00 points*.
Prerequisites: APPH E3300
Overview of properties and interactions of static electric and magnetic fields. Study of phenomena of time dependent electric and magnetic fields including induction, waves, and radiation as well as special relativity. Applications are emphasized

APPH E4330 RADIOBIOLOGY FOR MED PHYS. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4010) APPH E4010; or equivalent.
Corequisites: APPH E4010
Interface between clinical practice and quantitative radiation biology. Microdosimetry, dose-rate effects and biological effectiveness thereof; radiation biology data, radiation action at the cellular and tissue level; radiation effects on human populations, carcinogenesis, genetic effects; radiation protection; tumor control, normal-tissue complication probabilities; treatment plan optimization

Fall 2026: APPH E4330

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4330	001/10971	Th 6:00pm - 8:00pm 1106b Seeley W. Mudd Building	Marco Zaider	3.00	7/13

APPH E4500 HEALTH PHYSICS. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4600) APPH E4600 OR APPH E6380
Corequisites: APPH E4600
Fundamental principles and objectives of health physics (radiation protection), the quantities of radiation dosimetry (the absorbed dose, equivalent dose, and effective dose) used to evaluate human radiation risks, elementary shielding calculations and protection measures for clinical environments, characterization and proper use of health physics instrumentation, and regulatory and administrative requirements of health physics programs in general and as applied to clinical activities

Spring 2026: APPH E4500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4500	001/10851	M 5:30pm - 8:00pm 252 Georgian (Nursing)	Peter Caracappa	3.00	13/13

APPH E4550 MEDICAL PHYSICS SEMINAR. *0.00 points*.
0 pts. Lect: 1.

Required for all graduate students in the Medical Physics Program. Practicing professionals and faculty in the field present selected topics in medical physics

Spring 2026: APPH E4550

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4550	001/10855	M 9:00am - 10:15am 214 Seeley W. Mudd Building	Cheng Wuu	0.00	8/10

APPH E4600 FUNDAMENTALS OF DOSIMETRY. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4010) or APPH E4010 OR APPH E4500; or equivalent.
Corequisites: APPH E4010
Basic radiation physics: radioactive decay, radiation producing devices, characteristics of the different types of radiation (photons, charged and uncharged particles) and mechanisms of their interactions with materials. Essentials of the determination, by measurement and calculation, of absorbed doses from ionizing radiation sources used in medical physics (clinical) situations and for health physics purposes

Fall 2026: APPH E4600

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4600	001/11008	W 4:00pm - 6:50pm 104 Knox Hall	Sean Berry	3.00	11/20

APPH E4710 RAD INSTRUMENT/MEASUREMENT LAB. *3.00 points*.
Lect: 1. Lab: 4.

Prerequisites: (APPH E4010) or APPH E4010
Corequisites: APPH E4010
Lab fee: $50. Theory and use of alpha, beta, gamma, and X-ray detectors and associated electronics for counting, energy spectroscopy, and dosimetry; radiation safety; counting statistics and error propagation; mechanisms of radiation emission and interaction. (Topic coverage may be revised.)

Fall 2026: APPH E4710

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4710	001/10875	T 10:30am - 12:30pm 112 Knox Hall	Marco Zaider, Stephen Ostrow	3.00	10/15
APPH 4710	001/10875	T 1:00pm - 3:00pm 112 Knox Hall	Marco Zaider, Stephen Ostrow	3.00	10/15
APPH 4710	001/10875	M 3:00pm - 5:00pm 214 Seeley W. Mudd Building	Marco Zaider, Stephen Ostrow	3.00	10/15

APPH E4901 SEM-PROBLMS IN APPLIED PHYSICS. *1.00 point*.
Lect: 1.

Required for, and can be taken only by, all applied physics majors and minors in the junior year. Discussion of specific and self-contained problems in areas such as applied electrodynamics, physics of solids, and plasma physics. Topics change yearly

Fall 2026: APPH E4901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4901	001/14170	M W 11:40am - 12:55pm 420 Pupin Laboratories	Elizabeth Paul, Aravind Devarakonda	1.00	7/35

APPH E4903 SEM-PROBLMS IN APPLIED PHYSICS. *2.00 points*.
Lect: 1. Tutorial:1.

Required for, and can be taken only by, all applied physics majors in the senior year. Discussion of specific and self-contained problems in areas such as applied electrodynamics, physics of solids, and plasma physics. Formal presentation of a term paper required. Topics change yearly

Fall 2026: APPH E4903

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4903	001/14171	M W 11:40am - 12:55pm 420 Pupin Laboratories	Aravind Devarakonda, Elizabeth Paul	2.00	13/35

APPH E4990 SPEC TOPICS IN APPLIED PHYSICS. *1.00-3.00 points*.
Prerequisites: Instructor's permission.
May be repeated for credit. Topics and instructors change from year to year. For advanced undergraduate students and graduate students in engineering, physical sciences, and other fields

Spring 2026: APPH E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 4990	001/12981	M W 11:40am - 12:55pm 829 Seeley W. Mudd Building	Michele Simoncelli	1.00-3.00	16/30

APPH E6081 SOLID STATE PHYSICS I. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E3100) APPH E3100; or the equivalent. Knowledge of statistical physics on the level of MSAE E3111 or PHYS GU4023 strongly recommended.
Crystal structure, reciprocal lattices, classification of solids, lattice dynamics, anharmonic effects in crystals, classical electron models of metals, electron band structure, and low-dimensional electron structures

APPH E6101 PLASMA PHYSICS I. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4300) APPH E4300
Debye screening. Motion of charged particles in space- and time-varying electromagnetic fields. Two-fluid description of plasmas. Linear electrostatic and electromagnetic waves in unmagnetized and magnetized plasmas. The magnetohydrodynamic (MHD) model, including MHD equilibrium, stability, and MHD waves in simple geometries

Fall 2026: APPH E6101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6101	001/14172	M W 1:10pm - 2:25pm 333 Uris Hall	Ben Zhu	3.00	14/35

APPH E6102 PLASMA PHYSICS II. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E6101) APPH E6101
Magnetic coordinates. Equilibrium, stability, and transport of torodial plasmas. Ballooning and tearing instabilities. Kinetic theory, including Vlasov equation, Fokker-Planck equation, Landau damping, kinetic transport theory. Drift instabilities

Spring 2026: APPH E6102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6102	001/12984	M W 1:10pm - 2:25pm 545 Seeley W. Mudd Building	Carlos Paz Soldan	3.00	10/25
APPH 6102	V01/16632		Carlos Paz Soldan	3.00	0/99

APPH E6319 CLIN NUCLEAR MEDICINE PHYSICS. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4010) APPH E4010; or equivalent.
Introduction to the instrumentation and physics used in clinical nuclear medicine and PET with an emphasis on detector systems, tomography and quality control. Problem sets, papers and term project

Spring 2026: APPH E6319

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6319	001/10852	T 5:30pm - 8:00pm 253 Engineering Terrace	Pat Zanzonico	3.00	9/10

APPH E6330 DIAGNOSTIC RADIOLOGY PHYSICS. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4600) APPH E4600
Physics of medical imaging. Imaging techniques: radiography, fluoroscopy, computed tomography, mammography, ultrasound, magnetic resonance. Includes conceptual, mathematical/theoretical, and practical clinical physics aspects

Spring 2026: APPH E6330

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6330	001/10853	W 5:30pm - 8:30pm 253 Engineering Terrace	Boyu Peng	3.00	10/10

APPH E6333 RADIATION THERAPY PHYS PRACT. *3.00 points*.
Prerequisites: APPH E6335; Grade of B+ or better in APPH E6335 and instructor's permission.
Students spend two to four days per week studying the clinical aspects of radiation therapy physics. Projects on the application of medical physics in cancer therapy within a hospital environment are assigned; each entails one or two weeks of work and requires a laboratory report. Two areas are emphasized: 1. computer-assisted treatment planning (design of typical treatment plans for various treatment sites including prostate, breast, head and neck, lung, brain, esophagus, and cervix) and 2. clinical dosimetry and calibrations (radiation measurements for both photon and electron beams, as well as daily, monthly, and part of annual QA)

Fall 2026: APPH E6333

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6333	001/11009		Cheng Wuu	3.00	7/12

APPH E6335 RADIATION THERAPY PHYSICS. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E4600) APPH E4600; APPH E4330 recommended.
Review of X-ray production and fundamentals of nuclear physics and radioactivity. Detailed analysis of radiation absorption and interactions in biological materials as specifically related to radiation therapy and radiation therapy dosimetry. Surveys of use of teletherapy isotopes and X-ray generators in radiation therapy plus the clinical use of interstitial and intracavitary isotopes. Principles of radiation therapy treatment planning and isodose calculations. Problem sets taken from actual clinical examples are assigned

Spring 2026: APPH E6335

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6335	001/10854	Th 5:00pm - 8:00pm LI108b Hammer Hlth Sciences Center	Cheng Wuu	3.00	10/10

APPH E6336 ADV TPCS IN RADIATION THERAPY. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E6335) APPH E6335
Advanced technology applications in radiation therapy physics, including intensity modulated, image guided, stereotactic, and hypofractionated radiation therapy. Emphasis on advanced technological, engineering, clinical, and quality assurance issues associated with high technology radiation therapy and the special role of the medical physicist in the safe clinical application of these tools

Fall 2026: APPH E6336

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6336	002/11013	Th 2:00pm - 5:00pm 1106b Seeley W. Mudd Building	Cheng Wuu	3.00	7/7

APPH E6340 DIAGNOSTIC RADIOL PRACTICUM. *3.00 points*.
Lab: 6.

Prerequisites: APPH6330; Grade of B+ or better in APPH E6330 and instructor's permission.
Practical applications of diagnostic radiology for various measurements and equipment assessments. Instruction and supervised practice in radiation safety procedures, image quality assessments, regulatory compliance, radiation dose evaluations and calibration of equipment. Students participate in clinical QC of the following imaging equipment: radiologic units (mobile and fixed), fluoroscopy units (mobile and fixed), angiography units, mammography units, CT scanners, MRI units and ultrasound units. The objective is familiarization in routine operation of test instrumentation and QC measurements utilized in diagnostic medical physics. Students are required to submit QC forms with data on three different types of radiology imaging equipment

Fall 2026: APPH E6340

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6340	001/11010		Boyu Peng	3.00	7/12

APPH E6365 NUCLEAR MEDICINE PRACTICUM. *3.00 points*.
Lab: 6.

Prerequisites: APPH E6319; Grade of B+ or better in APPH E6319 and instructor's permission.
Practical applications of nuclear medicine theory and application for processing and analysis of clinical images and radiation safety and quality assurance programs. Topics may include tomography, instrumentation, and functional imaging. Reports

Fall 2026: APPH E6365

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6365	001/11011		Klaus Hamacher	3.00	2/3

APPH E6380 HEALTH PHYSICS PRACTICUM. *3.00 points*.
Lab: 6.

Prerequisites: APPH E4500; Grade of B+ or better in APPH E4500 and instructor's permission.
Corequisites: APPH E4500
Radiation protection practices and procedures for clinical and biomedical research environments. Includes design, radiation safety surveys of diagnostic and therapeutic machine source facilities, the design and radiation protection protocols for facilities using unsealed sources of radioactivity – nuclear medicine suites and sealed sources – brachytherapy suites. Also includes radiation protection procedures for biomedical research facilities and the administration of programs for compliance to professional health physics standards and federal and state regulatory requirements for the possession and use of radioactive materials and machine sources of ionizing and non ionizing radiations in clinical situations. Individual topics are decided by the student and the collaborating Clinical Radiation Safety Officer

Fall 2026: APPH E6380

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 6380	001/11012		Peter Caracappa	3.00	2/10

APPH E9143 APPLIED PHYSICS SEMINAR. *3.00 points*.
Sem: 3.

May be repeated for credit. Selected topics in applied physics. Topics and instructors change from year to year.

APPH E9500 Plasma and Fusion Colloquium. *0.00 points*.
Plasma and Fusion Colloquium: All plasma and fusion graduate students are strongly encouraged to attend the department seminar as long as they are in residence. Interested undergraduates are also welcome. No degree credit is granted

Spring 2026: APPH E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 9500	001/18290	F 3:00pm - 5:00pm 233 Seeley W. Mudd Building	Carlos Paz Soldan	0.00	40/48

Fall 2026: APPH E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APPH 9500	001/15048	F 3:00pm - 5:00pm 627 Seeley W. Mudd Building	Carlos Paz Soldan	0.00	27/50

CHAP E4120 STATISTICAL MECHANICS AND COMP METHODS. *3.00 points*.
Lect: 3.

Prerequisites: Elementary statistics, thermodynamics, some familiarity with Python, or instructor's permission.
Boltzmann's entropy hypothesis and its restatement to calculate the Helmholtz and Gibbs free energies and the grand potential. Applications to interfaces, liquid crystal displays, polymeric materials, crystalline solids, heat capacity and electrical conductivity of crystalline materials, fuel cell solid electrolytes, rubbers, surfactants, molecular self assembly, ferroelectricity. Computational methods for molecular systems. Monte Carlo (MC) and molecular dynamics (MD) simulation methods. MC method applied to liquid-gas and ferromagnetic phase transitions. Deterministic MD simulations of isolated gases and liquids. Stochastic MD simulation methods.

Spring 2026: CHAP E4120

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHAP 4120	001/12993	Th 5:40pm - 8:25pm 1127 Seeley W. Mudd Building	Ben O'Shaughnessy, Kathy Marte-Garcia	3.00	27/60
CHAP 4120	V01/20169		Ben O'Shaughnessy	3.00	1/99

EESC UN3109 CLIMATE PHYSICS. *3.00 points*.
This is a calculus-based treatment of climate system physics and the mechanisms of anthropogenic climate change. By the end of this course, students will understand: how solar radiation and rotating fluid dynamics determine the basic climate state, mechanisms of natural variability and change in climate, why anthropogenic climate change is occurring, and which scientific uncertainties are most important to estimates of 21st century change. This course is designed for undergraduate students seeking a quantitative introduction to climate and climate change science. EESC V2100 (Climate Systems) is not a prerequisite, but can also be taken for credit if it is taken before this course

Spring 2026: EESC UN3109

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EESC 3109	001/12416	T Th 10:10am - 11:25am 555 Ext Schermerhorn Hall	Adam Sobel	3.00	9/25

HSAM UN2901 DATA:PAST, PRESENT AND FUTURE. *3.00 points*.
Lect: 1.5. Lab: 1.5.

Data-empowered algorithms are reshaping our professional, personal, and political realities, for good--and for bad. Data: Past, Present, and Future moves from the birth of statistics in the 18th century to the surveillance capitalism of the present day, covering racist eugenics, World War II cryptography, and creepy personalized advertising along the way. Rather than looking at ethics and history as separate from the science and engineering, the course integrates the teaching of algorithms and data manipulation with the political whirlwinds and ethical controversies from which those techniques emerged. We pair the introduction of technical developments with the shifting political and economic powers that encouraged and benefited from new capabilities. We couple primary and secondary readings on the history and ethics of data with computational work done largely with user-friendly Jupyter notebooks in Python

MSAE E3010 FOUNDATIONS OF MATERIALS SCIENCE. *3.00 points*.
Lect.: 3

Prerequisites: CHEM UN1404 and PHYS UN1011
Introduction to quantum mechanics: atoms, electron shells, bands, bonding; introduction to group theory: crystal structures, symmetry, crystallography; introduction to materials classes: metals, ceramics, polymers, liquid crystals, nanomaterials; introduction to polycrystals and disordered materials; noncrystalline and amorphous structures; grain boundary structures, diffusion; phase transformations; phase diagrams, time-temperature transformation diagrams; properties of single crystals: optical properties, electrical properties, magnetic properties, thermal properties, mechanical properties, and failure of polycrystalline and amorphous materials.

Fall 2026: MSAE E3010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3010	001/14148	T Th 10:10am - 11:25am 829 Seeley W. Mudd Building	Renata Wentzcovitch	3.00	14/30

MSAE E3012 LABORATORY IN MATERIALS SCI I. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3010) MSAE E3010
Lectures and hands-on experiments on the characterization of microstructure in crystalline and amorphous solids. Optical, scanning and transmission electron microscopy. Metallography, sample preparation and analysis. Stereology. Crystal structure determination with x-ray diffraction. Elemental analysis using energy-dispersive x-ray analysis. Atomic force microscopy

Fall 2026: MSAE E3012

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3012	001/14150	M 1:00pm - 5:00pm 214 Seeley W. Mudd Building	Yuan Yang	3.00	4/10

MSAE E3013 LABORATORY IN MATERIALS SCI II. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3011) MSAE E3012
Metallographic sample preparation, optical microscopy, quantitative metallography, hardness and tensile testing, plastic deformation, annealing, phase diagrams, brittle fracture of glass, temperature and strain-rate dependent deformation of polymers; written and oral reports. This is the second of a two-semester sequence materials laboratory course

Spring 2026: MSAE E3013

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3013	001/12989		Ismail Noyan	3.00	6/15

MSAE E3100 Crystallography. *3.00 points*.
Prerequisites: CHEM UN1403 or PHYS UN1403 or APMA E2101 Or equivalent
A first course in crystallography, crystal symmetry, Bravais lattices, point groups and space groups. Diffraction and diffracted intensities. Exposition of typical crystal structures in engineering materials, including metals, ceramics and semiconductors. Crystalline anisotropy.

Fall 2026: MSAE E3100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3100	001/14154	T Th 11:40am - 12:55pm 1024 Seeley W. Mudd Building	William Bailey	3.00	6/23

MSAE E3111 THERMO/KINETIC THRY/STAT MECH. *3.00 points*.
Lect: 3.

An introduction to the basic thermodynamics of systems, including concepts of equilibrium, entropy, thermodynamic functions, and phase changes. Basic kinetic theory and statistical mechanics, including diffusion processes, concept of phase space, classical and quantum statistics, and applications thereof

Fall 2026: MSAE E3111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3111	001/14153	T Th 4:10pm - 5:25pm 101 Knox Hall	Michele Simoncelli	3.00	19/35

MSAE E3156 DESIGN PROJECT. *3.00 points*.
Prerequisites: Senior standing. Written permission from instructor and approval from adviser.
E3156: a design problem in materials science or metallurgical engineering selected jointly by the student and a professor in the department. The project requires research by the student, directed reading, and regular conferences with the professor in charge. E3157: completion of the research, directed reading, and conferences, culminating in a written report and an oral presentation to the department

Fall 2026: MSAE E3156

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3156	001/14152		Yuan Yang	3.00	3/10

MSAE E3157 DESIGN PROJECT. *3.00 points*.
Prerequisites: Senior standing. Written permission from instructor and approval from adviser.
E3156: a design problem in materials science or metallurgical engineering selected jointly by the student and a professor in the department. The project requires research by the student, directed reading, and regular conferences with the professor in charge. E3157: completion of the research, directed reading, and conferences, culminating in a written report and an oral presentation to the department

Spring 2026: MSAE E3157

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3157	001/12992		Yuan Yang	3.00	6/10

MSAE E3201 Materials Thermodynamics and Phase Diagrams. *3.00 points*.
Prerequisites: MSAE E3010 Or equivalent or permission of the instructor
Review of laws of thermodynamics, thermodynamic variables and relations, free energies and equilibrium in thermodynamic systems. Unary, binary, and ternary phase diagrams, compounds and intermediate phases, solid solutions and Hume-Rothery rules, relationship between phase diagrams and metastability, defects in crystals. Thermodynamics of surfaces and interfaces, effect of particle size on phase equilibria, adsorption isotherms, grain boundaries, surface energy, electrochemistry.
Note: MSAE E4201 shares lectures and meeting times with E3201 and therefore, may not be taken in other semesters.

Spring 2026: MSAE E3201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3201	001/12997	T Th 11:40am - 12:55pm 627 Seeley W. Mudd Building	Renata Wentzcovitch	3.00	7/10

MSAE E3900 UNDERGRAD RES IN MATERIALS SCI. *0.00-4.00 points*.
0 to 4 pts.

Prerequisites: Written permission from instructor and approval from adviser.
May be repeated for credit, but no more than 6 points of this course may be counted toward the satisfaction of the B.S. degree requirements. Candidates for the B.S. degree may conduct an investigation in materials science or carry out a special project under the supervision of the staff. Credit for the course is contingent upon the submission of an acceptable thesis or final report

Spring 2026: MSAE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3900	004/20338		Siu-Wai Chan	0.00-4.00	1/5
MSAE 3900	007/18335		Michele Simoncelli	0.00-4.00	1/5
MSAE 3900	012/20394		Yuan Yang	0.00-4.00	1/5

Summer 2026: MSAE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3900	001/11370		Siu-Wai Chan	0.00-4.00	1/5
MSAE 3900	002/11476		Nanfang Yu	0.00-4.00	0/2

MSAE E4090 NANOTECHNOLOGY. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E3100) and (MSAE E3010) or their equivalents with instructor's permission.
The science and engineering of creating materials, functional structures and devices on the nanometer scale. Carbon nanotubes, nanocrystals, quantum dots, size dependent properties, self-assembly, nanostructured materials. Devices and applications, nanofabrication. Molecular engineering, bionanotechnology. Imaging and manipulating at the atomic scale. Nanotechnology in society and industry. Offered in alternate years.

Spring 2026: MSAE E4090

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4090	001/13006	M W 2:40pm - 3:55pm 415 Schapiro Cepser	Yuan Yang	3.00	33/42
MSAE 4090	V01/16667		Yuan Yang	3.00	3/99

MSAE E4100 CRYSTALLOGRAPHY. *3.00 points*.
Lect: 3

Prerequisites: (CHEM UN1403) and (PHYS UN1403) and (APMA E2101) or APMA E2101 AND CHEM W1403 AND PHYS W1403; or equivalent.
A first course on crystallography. Crystal symmetry, Bravais lattices, point groups, space groups. Diffraction and diffracted intensities. Exposition of typical crystal structures in engineering materials, including metals, ceramics, and semiconductors. Crystalline anisotropy

Fall 2026: MSAE E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4100	001/14155	T Th 11:40am - 12:55pm 1024 Seeley W. Mudd Building	William Bailey	3.00	16/28
MSAE 4100	V01/18132		William Bailey	3.00	1/99

MSAE E4102 SYNTHESIS # PROCESSING OF MATERIALS. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3010) or equivalent or instructors permission
A course on synthesis and processing of engineering materials. Established and novel methods to produce all types of materials (including metals, semiconductors, ceramics, polymers, and composites). Fundamental and applied topics relevant to optimizing the microstructure of the materials with desired properties. Synthesis and processing of bulk, thin-film, and nano materials for various mechanical and electronic applications.

Spring 2026: MSAE E4102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4102	001/13005	T Th 2:40pm - 3:55pm 1024 Seeley W. Mudd Building	Siu-Wai Chan	3.00	20/25
MSAE 4102	V01/18012		Siu-Wai Chan	3.00	1/99

MSAE E4105 Ceramic Nanomaterials. *3.00 points*.
Lect: 3.

Prerequisites: (CHEM UN1404) or or equivalent undergraduate thermodynamics.
Ceramic nanomaterials and nanostructures: synthesis, characterization, size-dependent properties, and applications; surface energy, surface tension and surface stress; effect of ligands, surfactants, adsorbents, isoelectric point, and surface charges; supersaturation and homogenous nucleation for monodispersity.

MSAE E4200 THEORY CRYSTALLIN MAT: PHONONS. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E4100) or MSAE E4100; or instructor's permission.
Phenomenological theoretical understanding of vibrational behavior of crystalline materials; introducing all key concepts at classical level before quantizing the Hamiltonian. Basic notions of Group Theory introduced and exploited: irreducible representations, Great Orthogonality Theorem, character tables, degeneration, product groups, selection rules, etc. Both translational and point symmetry employed to block diagonalize the Hamiltonian and compute observables related to vibrations/phonons. Topics include band structures, density of states, band gap formation, nonlinear (anharmonic) phenomena, elasticity, thermal conductivity, heat capacity, optical properties, ferroelectricty. Illustrated using both minimal model Hamiltonians in addition to accurate Hamiltonians for real materials (e.g., Graphene)

Fall 2026: MSAE E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4200	001/14158	T Th 1:10pm - 2:25pm 545 Seeley W. Mudd Building	Chris Marianetti	3.00	11/35
MSAE 4200	V01/18133		Chris Marianetti	3.00	1/99

MSAE E4201 MATERIALS THERMODYN/PHASE DIAG. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3010) or equivalent or instructor's permission.
Review of laws of thermodynamics, thermodynamic variables and relations, free energies and equilibrium in thermodynamic system. Statistical thermodynamics. Unary, binary, and ternary phase diagrams, compounds and intermediate phases, solid solutions and Hume-Rothery rules, relationship between phase diagrams and metastability, defects in crystals. Thermodynamics of surfaces and interfaces, effect of particle size on phase equilibria, adsorption isotherms, grain boundaries, surface energy, electrochemistry, statistical mechanics.

Spring 2026: MSAE E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4201	001/13001	T Th 11:40am - 12:55pm 627 Seeley W. Mudd Building	Renata Wentzcovitch	3.00	5/20
MSAE 4201	V01/16668		Renata Wentzcovitch	3.00	1/99

MSAE E4202 KINETICS OF TRANSFORMATIONS. *3.00 points*.
Lect: 3.

Prerequisites: (MSAE E4201) MSAE E4201
Review of thermodynamics, irreversible thermodynamics, diffusion in crystals and noncrystalline materials, phase transformations via nucleation and growth, overall transformation analysis and time-temperature-transformation (TTT) diagrams, precipitation, grain growth, solidification, spinodal and order-disorder transformations, martensitic transformation

Spring 2026: MSAE E4202

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4202	001/13009	W 4:10pm - 6:40pm 610 Martin Luther King Building	James Im	3.00	22/25
MSAE 4202	V01/16792		James Im	3.00	2/99

MSAE E4203 THEORY CRYSTALL MAT: ELECTRONS. *3.00 points*.
Prerequisites: MSAE E4200 Or instructor's permission
Phenomenological theoretical understanding of electrons in crystalline materials. Both translational and point symmetry employed to block diagonalize the Schrödinger equation and compute observables related to electrons. Topics include nearly free electrons, tight-binding, electron-electron interactions, transport, magnetism, optical properties, topological insulators, spin-orbit coupling, and superconductivity. Illustrated using both minimal model Hamiltonians in addition to accurate Hamiltonians for real materials.

Spring 2026: MSAE E4203

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4203	001/13013	T Th 1:10pm - 2:25pm 1024 Seeley W. Mudd Building	Chris Marianetti	3.00	18/25
MSAE 4203	V01/16795		Chris Marianetti	3.00	0/99

MSAE E4206 ELEC # MAGNETIC PROP OF SOLIDS. *3.00 points*.
Prerequisites: PHYS W1401 AND PHYS C1402 AND PHYS W1403; or equivalent.
A survey course on the electronic and magnetic properties of materials, oriented towards materials for solid state devices. Dielectric and magnetic properties, ferroelectrics and ferromagnets. Conductivity and superconductivity. Electronic band theory of solids: classification of metals, insulators, and semiconductors. Materials in devices: examples from semiconductor lasers, cellular telephones, integrated circuits, and magnetic storage devices. Topics from physics are introduced as necessary

MSAE E4208 Atomic Foundation Models. *3.00 points*.
Prerequisites: (APPH E3100 and MSAE E3111) or (CHEM BC3253 and CHEM GU4230) or (PHYS GU4021 and PHYS GU4023) or (MSAE E4200) or (MSAE E4203) or (MSAE E4206) Experience with a Unix interface (Linux/macOS), and Python programming are a plus. Or instructor's permission.
Machine-learning and foundation-model approaches for atomistic simulations of materials. Equivariant message-passing neural networks for interatomic forces and for electronic, dielectric, and magnetic degrees of freedom. Heat and charge transport in solids ranging from crystals to disordered and amorphous materials. Hands-on assignments: simulation workflows, data analysis, training, and fine-tuning of various machine-learning models for atomistic simulations of materials.

MSAE E4215 MECH BEHAVIOR OF MATERIALS. *3.00 points*.
Lect: 3.

Prerequisites: (MSAE E3010) Recommended preparation: a course in mechanics of materials.
Review of states of stress and strain and their relations in elastic, plastic, and viscous materials. Dislocation and elastic-plastic concepts introduced to explain work hardening, various materials-strengthening mechanisms, ductility, and toughness. Macroscopic and microstructural aspects of brittle and ductile fracture mechanics, creep and fatigue phenomena. Case studies used throughout, including flow and fracture of structural alloys, polymers, hybrid materials, composite materials, ceramics, and electronic materials devices. Materials reliability and fracture prevention emphasized.

Spring 2026: MSAE E4215

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4215	001/13016	M W 10:10am - 11:25am 1127 Seeley W. Mudd Building	William Bailey	3.00	16/35
MSAE 4215	V01/16670		William Bailey	3.00	1/99

Fall 2026: MSAE E4215

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4215	001/14159	M W 10:10am - 11:25am 1024 Seeley W. Mudd Building	Ismail Noyan	3.00	19/35
MSAE 4215	V01/18134		Ismail Noyan	3.00	1/99

MSAE E4250 CERAMICS # COMPOSITES. *3.00 points*.
Lect: 3.

Prerequisites: (MSAE E3010) and (MSAE E3013) Or instructor's permission.
Corequisites: MSAE E3013,MSAE E3010
Will cover some of the fundamental processes of atomic diffusion, sintering and microstructural evolution, defect chemistry, ionic transport, and electrical properties of ceramic materials. Following this, we will examine applications of ceramic materials, specifically, ceramic thick and thin film materials in the areas of sensors and energy conversion/storage devices such as fuel cells, and batteries. The coursework level assumes that the student has already taken basic courses in the thermodynamics of materials, diffusion in materials, and crystal structures of materials.

Fall 2026: MSAE E4250

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4250	001/14163	W 7:00pm - 9:30pm 644 Seeley W. Mudd Building		3.00	7/35

MSAE E4260 ELECTROCHEM MATLS # DEVS. *3.00 points*.
Lect: 3.

Prerequisites: (CHEM UN1403) and (MSAE E3010) or CHEM W1403 AND MSAE E3010; or equivalents or instructor's permission.
Overview of electrochemical processes and applications from perspectives of materials and devices. Thermodynamics and principles of electrochemistry, methods to characterize electrochemical processes, application of electrochemical materials and devices, including batteries, supercapacitors, fuel cells, electrochemical sensor, focus on link between material structure, composition, and properties with electrochemical performance.

Fall 2026: MSAE E4260

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4260	001/14160	M W 11:40am - 12:55pm 1024 Seeley W. Mudd Building	Yuan Yang	3.00	25/35
MSAE 4260	V01/18135		Yuan Yang	3.00	1/99

MSAE E4301 MATERIALS SCIENCE LABORATORY. *3.00 points*.
Prerequisites: Introductory materials course or equivalent or instructor's permission.
General experimental techniques in materials science, including X-ray diffraction, scanning electron microscopies, atomic force microscopy, materials synthesis and thermodynamics, characterization of material properties (mechanical, electrochemical, magnetic, electronic). Additional experiments at discretion of instructor

Fall 2026: MSAE E4301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4301	001/14161	M 1:00pm - 5:00pm 214 Seeley W. Mudd Building	Yuan Yang	3.00	9/20

MSAE E4990 SPEC TOPICS:MATERIAL SCI # ENGIN. *1.00-3.00 points*.
Prerequisites: Instructor's permission.
May be repeated for credit. Topics and instructors change from year to year. For advanced undergraduate students and graduate students in engineering, physical sciences, and other fields

MSAE E4999 SUPERVISED INTERNSHIP. *1.00-3.00 points*.
Prerequisites: Internship and approval from adviser must be obtained in advance.
Only for master's students in the Department of Applied Physics and Applied Mathematics who may need relevant work experience as part of their program of study. Final report required. May not be taken for pass/fail or audited

Summer 2026: MSAE E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4999	001/11471		Yuan Yang	1.00-3.00	2/5

MSAE E6085 COMP ELEC STRUCT-COMPLX MTRS. *3.00 points*.
Prerequisites: (APPH E3100) or APPH E3100; or equivalent.
Basics of density functional theory (DFT) and its application to complex materials. Computation of electronics and mechanical properties of materials. Group theory, numerical methods, basis sets, computing, and running open source DFT codes. Problem sets and a small project

MSAE E6100 TRANSMISSION ELEC MICROSCOPY. *3.00 points*.
Lect.: 3

Prerequisites: Instructor's permission.
Course Fee: $600. Theory and practice of transmission electron microscopy (TEM): principles of electron scattering, diffraction, and microscopy; analytical techniques used to determine local chemistry; introduction to sample preparation; laboratory and in-class remote access demonstrations, several hours of hands-on laboratory operation of the microscope; the use of simulation and analysis software; guest lectures on cryomicroscopy for life sciences and high resolution transmission electron microscopy for physical sciences; and, time permitting, a visit to the electron microscopy facility in the Center for Functional Nanomaterials (CFN) at the Brookhaven National Laboratory (BNL).

MSAE E6251 THIN FILMS AND LAYERS. *3.00 points*.
Lect: 3.

Vacuum basics, deposition methods, nucleation and growth, epitaxy, critical thickness, defects properties, effect of deposition procedure, mechanical properties, adhesion, interconnects, and electromigration

MSAE E6273 MATERIALS SCIENCE REPORTS. *0.00-6.00 points*.
0 to 6 pts.

Prerequisites: Written permission from instructor and approval from adviser.
Formal written reports and conferences with the appropriate member of the faculty on a subject of special interest to the student but not covered in the other course offerings

Spring 2026: MSAE E6273

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 6273	002/20080		William Bailey	0.00-6.00	1/5
MSAE 6273	008/20403		James Im	0.00-6.00	3/5
MSAE 6273	012/20095		Yuan Yang	0.00-6.00	4/8

Summer 2026: MSAE E6273

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 6273	001/11474		Siu-Wai Chan	0.00-6.00	1/5

Fall 2026: MSAE E6273

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 6273	008/19985		Michele Simoncelli	0.00-6.00	0/10

MSAE E8235 SELECTED TPCS IN MATERIALS SCI. *3.00 points*.
Lect: 3.

May be repeated for credit. Selected topics in materials science. Topics and instructors change from year to year. For students in engineering, physical sciences, biological sciences, and related fields

MSAE E9000 MATERIALS SCIENCE COLLOQUIUM. *0.00 points*.
0 pts.

Speakers from universities, national laboratories, and industry are invited to speak on the recent impact of materials science and engineering innovations

MSAE E9301 DOCTORAL RESEARCH. *0.00-15.00 points*.
0-15 pts.

Prerequisites: Qualifying examination for the doctorate.
Required of doctoral candidates

Spring 2026: MSAE E9301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 9301	001/17801		William Bailey	0.00-15.00	1/6
MSAE 9301	002/17770		James Hone, Katayun Barmak	0.00-15.00	4/5
MSAE 9301	003/17776		Aravind Devarakonda	0.00-15.00	1/5
MSAE 9301	008/17771		James Im	0.00-15.00	3/5
MSAE 9301	009/17772		Chris Marianetti	0.00-15.00	2/5
MSAE 9301	011/17773		Renata Wentzcovitch	0.00-15.00	0/5
MSAE 9301	012/17774		Yuan Yang	0.00-15.00	3/8
MSAE 9301	013/17775		Nanfang Yu	0.00-15.00	2/5

Fall 2026: MSAE E9301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 9301	001/15045		William Bailey	0.00-15.00	1/10
MSAE 9301	003/15040		Aravind Devarakonda	0.00-15.00	1/10
MSAE 9301	006/15041		James Im	0.00-15.00	0/10
MSAE 9301	007/15042		Chris Marianetti	0.00-15.00	1/10
MSAE 9301	009/15039		Renata Wentzcovitch	0.00-15.00	1/10
MSAE 9301	010/15043		Yuan Yang	0.00-15.00	2/10
MSAE 9301	011/15044		Nanfang Yu	0.00-15.00	0/10

ORCA E2500 FOUNDATIONS OF DATA SCIENCE. *3.00 points*.
Prerequisites: MATH UN1101 and MATH UN1102 MATH V1101 AND MATH V1102; Some familiarity with programming.
Designed to provide an introduction to data science for sophomore SEAS majors. Combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? Teaches critical concepts and skills in computer programming, statistical inference, and machine learning, in conjunction with hands-on analysis of real-world datasets such as economic data, document collections, geographical data, and social networks. At least one project will address a problem relevant to New York City

Spring 2026: ORCA E2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCA 2500	001/13321	F 10:10am - 12:40pm 329 Pupin Laboratories	Daniel Fernandez	3.00	69/75

Fall 2026: ORCA E2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCA 2500	001/14744	F 10:10am - 12:40pm 833 Seeley W. Mudd Building	Daniel Fernandez	3.00	73/90

ORCA E4500 FOUNDATIONS OF DATA SCIENCE. *3.00 points*.
Prerequisites: MATH V1101 AND MATH V1102; Some familiarity with programming
Designed to provide an introduction to data science for sophomore SEAS majors. Combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? Teaches critical concepts and skills in computer programming, statistical inference, and machine learning, in conjunction with hands-on analysis of real-world datasets such as economic data, document collections, geographical data, and social networks

PSAM UN3707 Persuasion at scale: causal inference, machine learning, and evidence-based understanding of the information environment. *3.00 points*.
By employing statistical and computational methods, including randomized controlled trials, natural experiments, and machine learning techniques, students will engage directly with real-world data to uncover the intricacies of persuasion across different sectors, including but not limited to quantifying the effects of partisan media, social media, and political campaigns. The course will also delve into the historical evolution of these persuasive techniques, providing students with a rich contextual background to better understand current trends and anticipate future developments. This course fulfills the quantitative methods requirement for the Political Science major

Spring 2026: PSAM UN3707

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
PSAM 3707	001/12687	M W 11:40am - 12:55pm 413 Kent Hall	Chris Wiggins, Eunji Kim	3.00	51/70

Undergraduate Programs

The Department of Applied Physics and Applied Mathematics offers three undergraduate programs: applied physics, applied mathematics, and materials science.

The applied physics and applied mathematics programs provide an excellent preparation for graduate study or for careers in which mathematical and technical sophistication are important. Using the large number of electives in these programs, students can tailor their programs to fit their personal and career interests. By focusing their technical electives, students can obtain a strong base of knowledge in a specialized area. In addition to formal minors, some elective specializations are available and are described in the Elective Specializations (p. 61) section. All technical electives are normally at the 3000 level or above.

See the Materials Science (p. 285) section for more information on the materials science program.

- Applied Physics (BS) (p. 63)
- Applied Mathematics (BS) (p. 66)
- Double Major in Applied Physics and Applied Mathematics (p. 68)
- Materials Science (BS) (p. 291)

Both applied physics and applied mathematics students can focus their technical electives and develop a strong base of knowledge in an elective specialization. There is no requirement to focus electives, so students may take as many or as few of the recommended courses in an elective specialization as is appropriate to their schedules and interests. Some specialties are given below, but this is not an exclusive list, and others can be worked out in coordination with the student's adviser. The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

Technical Electives

Application of Physics

Courses that will give a student a broad background in applications of physics:

ELEN E3000	x, J
MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE x
APPH E4010	INTRODUCTN TO NUCLEAR SCIENCE x
PHYS GU4018	SOLID STATE PHYSICS y
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS x
APPH E4110	MODERN OPTICS y
APPH E4112	LASER PHYSICS x
APPH E4200	PHYSICS OF FLUIDS x
APPH E4301	INTRO TO PLASMA PHYSICS y

x An x following the course number means that the course meets in the fall semester.

J The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

y A y following the course number means that the course meets in the spring semester.

Earth and Atmospheric Sciences

The earth sciences provide a wide range of problems of interest to physicists and mathematicians ranging from the dynamics of Earth's climate to earthquake physics to dynamics of Earth's deep interior. The Lamont-Doherty Earth Observatory, which is part of Columbia University, provides enormous resources for students interested in this area.

Atmosphere, Oceans, and Climate	
APAM E3109	
EESC GU4008	Introduction to Atmospheric Science
APPH E4200	PHYSICS OF FLUIDS
APPH E4210	GEOPHYSICAL FLUID DYNAMICS
EESC GU4925	INTRO TO PHYSICAL OCEANOGRAPHY
EESC GU4930	EARTH'S OCEANS # ATMOSPHERE
Solid Earth Geophysics	
EESC UN3201	SOLID EARTH DYNAMICS
EESC GU4085	GEODYNAMICS
EESC GU4113	Mineralogy and Mineral Resources
EESC GU4300	THE EARTH'S DEEP INTERIOR
EESC GU4701	Introduction to Igneous Petrology
EESC GU4949	Introduction to Seismology

(See also courses listed under Scientific Computation and Computer Science below.)

Basic Physics and Astrophysics

Fundamental physics and astrophysics can be emphasized. Not only is astrophysics providing a deeper understanding of the universe, but it is also testing the fundamental principle of physics.

PHYS UN3002	From Quarks To the Cosmos: Applications of Modern Physics y

ASTR UN3601	RELATVITY,BLACK HOLES,COSMOLGY [x, J]
ASTR UN3602	PHYSICAL COSMOLOGY [y,J]
ASTR GU4001	STELLAR STRUCTURE # EVOLUTION [y]
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS [x]

[x] An x following the course number means that the course meets in the fall semester.

[J] The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

[y] A y following the course number means that the course meets in the spring semester.

Business and Finance

The knowledge of physics and mathematics that is gained in the applied physics and applied mathematics programs is a strong base for a career in business or finance.

Economics	
ECON UN3211	INTERMEDIATE MICROECONOMICS [x,y,J]
ECON UN3213	INTERMEDIATE MACROECONOMICS [x,y,J]
Industrial Engineering and Operations Research	
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS [x]
IEOR E4201	[x]
IEOR E4202	[y]
Finance	
MATH GU4071	Introduction to the Mathematics of Finance [x]
IEOR E4106	STOCHASTIC MODELS [y,J]
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS [x,y,J]
ECON GU4280	CORPORATE FINANCE [x,y]
IEOR E4700	INTRO TO FINANCIAL ENGINEERING [x]

[x] An x following the course number means that the course meets in the fall semester.

[J] The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

[y] A y following the course number means that the course meets in the spring semester.

Mathematics Applicable to Physics

Applied physics students can specialize in the mathematics that is applicable to physics. This elective specialization is particularly useful for students interested in theoretical physics.

MATH UN3386	DIFFERENTIAL GEOMETRY [x]
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS [x]
APMA E4301	NUMERICAL METHODS/PDE'S [y]
APMA E4302	METHODS IN COMPUTATIONAL SCI [x]
PHYS GU4019	MATHEMATICL METHODS OF PHYSICS [y]

[x] An x following the course number means that the course meets in the fall semester.

[y] A y following the course number means that the course meets in the spring semester.

Fundamental Mathematics in Applied Mathematics

This specialization is intended for students who desire a more solid foundation in the mathematical methods and underlying theory. For example, this specialization could be followed by students with an interest in graduate work in applied mathematics.

MATH UN3386	DIFFERENTIAL GEOMETRY [x]
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS [x]
APMA E4150	APPLIED FUNCTIONAL ANALYSIS [x]
MATH GU4032	FOURIER ANALYSIS [x]
MATH GU4062	INTRO MODERN ANALYSIS II [y]
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS [x,y,J]
PHYS G4386	Geometrical Concepts In Physics
PHYS GU4387	[y]

[x] An x following the course number means that the course meets in the fall semester.

[J] The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

[y] A y following the course number means that the course meets in the spring semester.

Quantitative Biology

Traditionally biology was considered a descriptive science in contrast to the quantitative sciences that are based on mathematics, such as physics. This view no longer coincides with reality. Researchers from biology as well as from the physical sciences, applied mathematics, and computer science are rapidly building a quantitative base of biological knowledge. Students can acquire a strong base of knowledge in quantitative biology, both biophysics and computational biology, while completing the applied physics or applied mathematics programs.

Recommended	
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC [x]
BIOL UN2006	INTRO BIO II:CELL BIO,DEV/PHYS [y]
APPH E3400	PHYSICS OF THE HUMAN BODY [y]
APMA E4400	INTRO TO BIOPHYSICAL MODELING [y]

[x] An x following the course number means that the course meets in the fall semester.

[y] A y following the course number means that the course meets in the spring semester.

Other Technical Electives (a course in at least two areas recommended):

Biological Materials	
BIOL GU4070	The Biology and Physics of Single Molecules [x]
CHEN E4650	POLYMER PHYSICS [x]
Biomechanics	
BMEN E3320	FLUID BIOMECHANICS [y,J]
BMEN E4300	SOLID BIOMECHANICS [y,J]
Genomics and Bioinformatics	

BIOL W3037	Bioinformatics of Gene Expression
ECBM E3060	[x,J]
CBMF W4761	COMPUTATIONAL GENOMICS [y]
Neurobiology	
BIOL UN3004	NEUROBIO I:CELLULAR # MOLECULR [x,J]
BIOL UN3005	NEUROBIO II: DEVPT # SYSTEMS [y,J]
ELEN E4011	[x]

[x] An x following the course number means that the course meets in the fall semester.

[J] The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

[y] A y following the course number means that the course meets in the spring semester.

The second term of biology will be considered a technical elective if a student has credits from at least two other of the recommended courses in quantitative biology at the 3000 level or above.

Scientific Computation and Computer Science

Advanced computation has become a core tool in science, engineering, and mathematics and provides challenges for both physicists and mathematicians. Courses that build on both practical and theoretical aspects of computing and computation include:

MATH UN3020	NUMBER THEORY AND CRYPTOGRAPHY [x,J]
Select one of the following:	
COMS W3137	HONORS DATA STRUCTURES # ALGOL [x,y,J]
COMS W3139	[y,J]
COMS W3157	ADVANCED PROGRAMMING [x,y,J]
COMS W3203	DISCRETE MATHEMATICS [x,y,J]
COMS W4203	GRAPH THEORY [y]
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH [x]
APMA E4301	NUMERICAL METHODS/PDE'S [y]
APMA E4302	METHODS IN COMPUTATIONAL SCI [x]
COMS W4701	ARTIFICIAL INTELLIGENCE [x,y]
COMS W4771	MACHINE LEARNING [y]

[x] An x following the course number means that the course meets in the fall semester.

[J] The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

[y] A y following the course number means that the course meets in the spring semester.

Solid-State Physics

Much of modern technology is based on solid-state physics, the study of solids and liquids. Courses that will build a strong base for a career in this area are:

PHYS UN3083	ELECTRONICS LABORATORY [y,J]
MSAE E3110	[x]
ELEN E3106	SOLID STATE DEVICES-MATERIALS [x,J]
MSAE E4100	CRYSTALLOGRAPHY [x]
PHYS GU4018	SOLID STATE PHYSICS [y]
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS [x]

[x] An x following the course number means that the course meets in the fall semester.

[J] The courses that are often taken, or in some cases need to be taken, in the junior year are denoted with a "J."

[y] A y following the course number means that the course meets in the spring semester.

Applied Physics (BS)

Undergraduate Program in Applied Physics

The applied physics program stresses the basic physics that underlies most developments in engineering and the mathematical tools that are important to both physicists and engineers. Since the advances in most branches of technology lead to rapid changes in state-of-the-art techniques, the applied physics program provides the student with a broad base of fundamental science and mathematics while retaining the opportunity for specialization through technical electives.

Curriculum

The applied physics curriculum offers students the skills, experience, and preparation necessary for several career options, including opportunities to minor in economics and to take business-related courses. In recent years, applied physics graduates have entered graduate programs in many areas of applied physics or physics, enrolled in medical school, or been employed in various technical or financial areas immediately after receiving the B.S. degree.

Opportunities for undergraduate research exist in the many research programs in applied physics. These include fusion energy and plasma physics, optical and laser physics, and solid state and condensed matter physics. Undergraduate students can receive course credit for research or an independent project with a faculty member. Opportunities also exist for undergraduate students in the applied physics program to participate in this research through part-time employment during the academic year and full-time employment during the summer, either at Columbia or as part of nationwide NSF REU programs. Practical research experience is an important supplement to the formal course of instruction. Applied physics students participate in an informal undergraduate seminar to study current and practical problems in applied physics in both the junior and senior year. They also obtain hands-on experience in at least two advanced laboratory courses.

Majors are introduced to two areas of application of applied physics (AP) by a course in each of two areas. Approved areas and courses are:

Dynamical Systems: APMA E4101 APPL MATH III:DYNAMICAL SYSTMS or PHYS GU4003 ADVANCED MECHANICS

Optical or Laser Physics: APPH E4110 MODERN OPTICS or APPH E4112 LASER PHYSICS or APPH E4114 Quantum and Nonlinear Photonics

Nuclear Science: APPH E4010 INTRODUCTN TO NUCLEAR SCIENCE

Plasma Physics: APPH E4301 INTRO TO PLASMA PHYSICS or APPH E6101 PLASMA PHYSICS I

Physics of Fluids: APPH E4200 PHYSICS OF FLUIDS or MECE E3100 INTRO TO MECHANCIS OF FLUIDS or APPH E4210 GEOPHYSICAL FLUID DYNAMICS

Solid-State/Condensed Matter Physics: PHYS GU4018 SOLID STATE PHYSICS or MSAE E4200 THEORY CRYSTALLIN MAT: PHONONS

Biophysical Modeling: APMA E4400 INTRO TO BIOPHYSICAL MODELING

In addition to these courses, courses listed in the Elective Specializations in Applied Physics can be used to satisfy this requirement with preapproval of the applied physics adviser.

All students must take 30 points of electives in the third and fourth years, of which 17 points must be technical courses approved by the adviser. The 17 points include 2 points of an advanced laboratory in addition to APPH E4018 APPLIED PHYSICS LABORATORY. Technical electives must be at the 3000 level or above unless prior approval is obtained from the department. A number of approved technical electives are listed in the section on elective specializations. The remaining points of electives are intended primarily as an opportunity to complete the absolutely mandatory four-year, 27-point nontechnical requirement for the B.S. degree, but if this 27-point nontechnical requirement has been met already, then any type of coursework can satisfy these elective points.

Applied Physics Program

An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1101[1]	CALCULUS I
Choose one of the following Physics courses depending on sequence:	
PHYS UN1401 (Sequence I)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I
Choose one of the following Chemistry/Biology courses (taken Semester I or II):	
CHEM UN1403 (or higher)	GENERAL CHEMISTRY I-LECTURES
BIOL UN2001	ENVIRONMENTAL BIOLOGY I
BIOL UN2005 (or higher)	INTRO BIO I: BIOCHEM,GEN,MOLEC
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)	
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102[1]	CALCULUS II
Choose one of the following Physics courses depending on sequence:	
PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II
Choose one of the following Chemistry/Biology courses (taken Semester I or II):	
CHEM UN1403 (or higher)	GENERAL CHEMISTRY I-LECTURES
BIOL UN2001	ENVIRONMENTAL BIOLOGY I
BIOL UN2005 (or higher)	INTRO BIO I: BIOCHEM,GEN,MOLEC
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)	
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester I or II)[1]	MULTV. CALC. FOR ENGI # APP SCI
Choose one of the following Physics courses depending on sequence:	
PHYS UN1403 (Sequence 1)	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Sequence 2)	PHYSICS III:CLASS/QUANTUM WAVE
PHYS UN3081 (Sequence 3)	INTERMEDIATE LABORATORY WORK
Choose one of the following Required Nontechnical Electives:	
HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3-4)	
HUMA UN1121 or UN1123	Art Humanities
Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)	
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)[1]	MULTV. CALC. FOR ENGI # APP SCI
ODE[1,3]	
PHYS UN1494 (Sequences 1 and 2)	INTRO TO EXPERIMENTAL PHYS-LAB
Choose one of the following Required Nontechnical Electives:	
HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3-4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)	
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI

Third Year

Semester V

APPH E3200	MECHANICS:FUND # APPLICATIONS
MSAE E3111	THERMO/KINETIC THRY/STAT MECH
APMA E3101[6]	APPLIED MATH I: LINEAR ALGEBRA
APPH E4901	SEM-PROBLMS IN APPLIED PHYSICS
Tech Electives[4]	
Nontech or Tech Electives	

Semester VI

APPH E3100	INTRO TO QUANTUM MECHANICS
APPH E3300	APPLIED ELECTROMAGNETISM
APMA E3102[5]	APPLIED MATHEMATICS II: PDE'S
Tech Electives[4]	
Nontech or Tech Electives	

Fourth Year

Semester VII

APPH E4300	APPLIED ELECTRODYNAMICS
APPH E4100	QUANTUM PHYSICS OF MATTER
Course in first AP area	
APPH E4903	SEM-PROBLMS IN APPLIED PHYSICS
Tech Electives[4]	
Nontech or Tech Electives	

Semester VIII

Course in second AP area	
APPH E4018	APPLIED PHYSICS LABORATORY
Tech Electives[4]	
Nontech or Tech Electives	

[1] Students with advanced standing may start the calculus sequence at a higher level (see Advanced Placement Credit Chart (p. 8)), in which case students are suggested to add linear algebra in the first two years.

[2] With permission of faculty adviser, students demonstrating familiarity with computational mathematics using Python may waive course requirement and use 3 credits for another technical course.

[3] Applied physics majors should satisfy their ODE requirement with the Mathematics Department (ordinarily MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS). Students who take APMA E2101 INTRO TO APPLIED MATHEMATICS prior to declaring their major in applied physics may use this course to satisfy their ODE requirement with the permission of the faculty adviser.

[4] They must include at least 2 points of laboratory courses. If PHYS UN3081 INTERMEDIATE LABORATORY WORK is taken as part of the first two years of the program, these technical electives need not include laboratory courses. Technical electives must be at the 3000 level or above unless prior approval is obtained.

[5] MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS or APMA E4200 PARTIAL DIFFERENTIAL EQUATIONS may be substituted for APMA E3102 APPLIED MATHEMATICS II: PDE'S;

[6] MATH UN2010 LINEAR ALGEBRA may be used as a substitute for APMA E3101 APPLIED MATH I: LINEAR ALGEBRA

Applied Mathematics (BS)

Undergraduate Program in Applied Mathematics

The Applied Mathematics program is flexible and intensive. A student must take the required courses listed or prove equivalent standing. The student may elect the other courses from mathematics, computer science, physics, earth and environmental sciences, biophysics, economics, business and finance, or other application fields.

Each student tailors their own program in close collaboration with an adviser and should confer with their adviser on a regular basis to make sure they are on track for graduation. In particular, all required courses listed in the table must be taken to graduate. The specific sequence in which they are taken may depend somewhat on the student's elective specializations. In general, each student should always check with their adviser. Students are required to register for the Applied Mathematics Seminar during both the junior year (APMA E4901 for 0 point) and senior year (APMA E4903 for 3 or 4 points). During the junior year, the student attends the seminar lectures, and during the senior year, they attend the seminar lectures as well as tutorial problem sessions and present their research.

Students in the Applied Mathematics program go on to graduate programs in diverse fields or find employment directly in established industries and startups, government, education, etc.

Of the 27 points of elective content in the third and fourth years, at least 15 points of technical courses approved by the adviser must be taken. The remaining points of electives are intended primarily as an opportunity to complete the absolutely mandatory four-year, 27-point nontechnical requirement for the B.S. degree, but if this 27-point nontechnical requirement has been met already, then any type of coursework can satisfy these elective points.

Transfers into the Applied Mathematics program from other majors require a GPA of 3.0 or above, and the approval of the Applied Mathematics program committee.

Applied Mathematics Program

An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1101[1]	CALCULUS I

Choose one of the following Physics courses depending on sequence:

PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I

Choose one of the following Chemistry/Biology courses (taken Semester I or II):

CHEM UN1403 (or higher)	GENERAL CHEMISTRY I-LECTURES
BIOL UN2001	ENVIRONMENTAL BIOLOGY I
BIOL UN2005 (or higher)	INTRO BIO I: BIOCHEM,GEN,MOLEC
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING

Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)

ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102[1]	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

Choose one of the following Chemistry/Biology courses (taken Semester I or II):

CHEM UN1403 (or higher)	GENERAL CHEMISTRY I-LECTURES
BIOL UN2001	ENVIRONMENTAL BIOLOGY I
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING

Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)

ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)[1]	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on sequence:

PHYS UN1403 (Sequence 1) [2]	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Sequence 2)	PHYSICS III:CLASS/QUANTUM WAVE
PHYS UN3081 (Sequence 3)[3]	INTERMEDIATE LABORATORY WORK

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I

Global Core (3-4)	
HUMA UN1121 or UN1123	Art Humanities
Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)	
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)[1]	MULTV. CALC. FOR ENGI # APP SCI
ODE[1,4]	
PHYS UN1494 (Tracks 1 and 2)[3]	INTRO TO EXPERIMENTAL PHYS-LAB
Choose one of the following Required Nontechnical Electives:	
HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3-4)	
ECON UN1105 or UN1155	PRINCIPLES OF ECONOMICS
Complete Required Technical Electives (Student's choice) (taken Semester I, II, III, or IV)	
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Third Year

Semester V

APMA E3101[5]	APPLIED MATH I: LINEAR ALGEBRA
APMA E4204[5]	FUNCTNS OF A COMPLEX VARIABLE
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
APMA E4901	SEM-PROBLEMS IN APPLIED MATH
Tech Electives[6]	
Nontech Electives	

Semester VI

APMA E3102[5]	APPLIED MATHEMATICS II: PDE'S
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
Course from Group A[7]	
Tech Electives[6]	
Nontech Electives	

Fourth Year

Semester VII

MATH GU4061[5]	INTRO MODERN ANALYSIS I
APMA E4903	SEM-PROBLEMS IN APPLIED MATH
Course from Group B[7]	
Tech Electives[6]	
Nontech Electives	

Semester VIII

APMA E3900 (With an adviser's permission, an approved technical elective may be substituted)	UNDERGRAD RES IN APPLIED MATH
Courses designated MATH, APMA, or STAT	
Tech Electives[6]	
Nontech Electives	

1 Students with advanced standing may start the calculus sequence at a higher level (see Advanced Placement Credit Chart (p. 8), in which case students are suggested to add linear algebra in the first two years.

2 Transfer students who have not fulfilled the physics requirement prior to enrolling at Columbia may substitute this course with PHYS BC3001 CLASSICAL WAVES - LECTURE LAB.

3 Or a lab course in Astronomy, Astrophysics, Biology, or Chemistry.

4 Applied mathematics majors should satisfy their ODE requirement with the Mathematics Department (ordinarily MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS). Students who take APMA E2101 INTRO TO APPLIED MATHEMATICS prior to declaring their major in applied mathematics may use this course to satisfy their ODE requirement with the permission of the faculty adviser.

5 MATH UN2010 LINEAR ALGEBRA or COMS W3561 may be substituted for APMA E3101 APPLIED MATH I: LINEAR ALGEBRA; MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS or APMA E4200 PARTIAL DIFFERENTIAL EQUATIONS may be substituted for APMA E3102 APPLIED MATHEMATICS II: PDE'S; MATH UN3007 COMPLEX VARIABLES may be substituted for APMA E4204 FUNCTNS OF A COMPLEX VARIABLE; MATH UN2500 ANALYSIS AND OPTIMIZATION may be substituted for MATH GU4061 INTRO MODERN ANALYSIS I.

6 Any course in science, math, or engineering at the 3000 level or above qualifies as a technical elective, except for required or elective courses in the minor in entrepreneurship and innovation which do not count as technical electives unless authorized by an adviser. Elective courses may be chosen from other departments in SEAS and Arts and Sciences, e.g., the Departments of Mechanical Engineering, Electrical Engineering, Mathematics, and Statistics.

7 One course from Group A (p. 67) (Probability) and one course from Group B (p. 67) (Applied Probability/Statistics) required for graduation.

Group A - Probability

IEOR E3658	PROBABILITY FOR ENGINEERS	3.00
or IEOR E4150	INTRO-PROBABILITY # STATISTICS	
STAT GU4203	PROBABILITY THEORY	3.00
MATH GU4155	PROBABILITY THEORY	3.00

Group B - Applied Probability/Statistics

IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS	3.00
IEOR E4106	STOCHASTIC MODELS	3.00
STAT GU4204	STATISTICAL INFERENCE	3.00
STAT GU4207	ELEMENTARY STOCHASTIC PROCESS	3.00
COMS W4771	MACHINE LEARNING	3.00

Double Major in Applied Physics and Applied Mathematics

Students satisfy all requirements for both majors, except for the seminar requirements. They are required to take both senior seminars, APMA E4903 SEM-PROBLEMS IN APPLIED MATH and APPH E4903 SEM-PROBLMS IN APPLIED PHYSICS (taking one in the junior year and one in the senior year, due to timing conflicts), but not the junior seminars, APMA E4901 SEM-PROBLEMS IN APPLIED MATH and APPH E4901 SEM-PROBLMS IN APPLIED PHYSICS. A single foundational course may be used to fulfill a requirement in both majors. Students must maintain a GPA at or above 3.75, and must graduate with at least 143 points, 15 above the regular 128-point requirement. These extra 15 points should be technical electives appropriate for one or both majors.

To apply, a student first obtains the approval of both the general undergraduate Applied Physics adviser and the general undergraduate Applied Mathematics adviser, and then the approval of the Dean.

Graduate Programs

Financial aid is available for students pursuing a doctorate. Fellowships, scholarships, teaching assistantships, and graduate research assistantships are awarded on a competitive basis. The Aptitude Test of the Graduate Record Examination is required of candidates for admission to the department and for financial aid; the Advanced Tests are recommended.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program or specific PDL requirements.

Ethics training is required of all students pursuing a doctorate.

Ph.D. and Eng.Sc.D. Programs

After completing the M.S. program, doctoral candidates can select an elective specialization in one area of their programs. Some elective specializations have specific course requirements for the doctorate; elective courses are determined in consultation with the program adviser. Successful completion of an approved 30-point program of study is required in addition to successful completion of a written qualifying examination taken after two semesters of graduate study. An oral examination, taken within one year after the written qualifying examination, and a thesis proposal examination, taken within two years after the written qualifying examination, are required of all doctoral candidates, as is training in research and professional ethics.

- Applied Physics (MS) (p. 68)
- Applied Mathematics (MS) (p. 68)
- Medical Physics (MS) (p. 69)
- Medical Physics (Certification of Professional Achievement) (p. 70)
- Applied Mathematics (PhD, EngScD) (p. 70)
- Applied Physics (PhD, EngScD) (p. 71)
- Materials Science and Engineering (MS) (p. 296)
- Materials Science and Engineering (EngScD, PhD) (p. 297)

Applied Physics (MS)

M.S. Program in Applied Physics

This 30-point program of study leading to the degree of Master of Science, while emphasizing continued work in upper-level core physics, permits many options in several applied physics specialties. The program may be considered simply as additional education in areas beyond the bachelor's level, or as preparatory to doctoral studies in the applied physics fields of fusion and plasma physics, laser and optical physics, or solid-state physics.

Courses

Specific course requirements for the master's degree are determined in consultation with the faculty adviser, but students must complete at least four of the following courses or any other core course not listed below.

The core courses provide a student with a solid foundation in the fundamentals of applied physics. A core course is any 4000-level or above course with an APPH designator (excluding APPH E4901 and APPH E4903). The selection of core courses should be discussed with your faculty adviser.

APPH E4010	INTRODUCTN TO NUCLEAR SCIENCE
APPH E4018	APPLIED PHYSICS LABORATORY
APPH E4100	QUANTUM PHYSICS OF MATTER
APPH E4110	MODERN OPTICS
APPH E4112	LASER PHYSICS
APPH E4114	Quantum and Nonlinear Photonics
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
APPH E4130	SOLAR ENERGY & STORAGE
APPH E4200	PHYSICS OF FLUIDS
APPH E4210	GEOPHYSICAL FLUID DYNAMICS
APPH E4300	APPLIED ELECTRODYNAMICS
APPH E4990	SPEC TOPICS IN APPLIED PHYSICS
APPH E6101	PLASMA PHYSICS I
APPH E6102	PLASMA PHYSICS II

In addition to core courses, students must also select elective courses to complete the degree requirements. Approved elective courses include any APPH course not used to satisfy the core course requirement, all 4000-level and above courses in the Applied Mathematics (excluding APMA E4901 and APMA E4903) and Materials Science and Engineering Programs, and 4000-level and above courses from the following departments: Computer Science, Data Science, Earth and Environmental Engineering, Electrical Engineering, Mechanical Engineering, Physics, and Mathematics (excluding seminar courses). Additional courses from other departments not listed above may also be applied toward the elective requirements, subject to the approval of the faculty adviser.

Applied Mathematics (MS)

M.S. Program in Applied Mathematics

This 30-point program leads to a Master of Science degree. Students must complete five core courses and five electives. All degree requirements must be completed within five years. Students are required

to maintain at least a 2.5 grade point average. If a student is admitted to the terminal Applied Mathematics M.S. program, and is interested in the Ph.D. program*, the student must reapply for admission. The core courses provide a student with a foundation in the fundamentals of applied mathematics and contribute 15 points of graduate credit toward the degree.

*The Ph.D. program prepares the student to work either independently or collaboratively as a researcher through an emphasis on deep mastery of methods of mathematical modeling, analysis, and computation (more information on the Ph.D. program can be found here).

Courses

A core course is defined as any 4000-level or above course with an APMA designator (excluding APMA E4901 and APMA E4903). Students must complete five of the following courses or any other core course not listed below:

Required Courses	
Choose five of the following:	
APMA E4007	APPLIED LINEAR ALGEBRA
APMA E4008	Advanced and Applied Linear Algebra
APMA E4100	Applied Analysis
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
APMA E4150	APPLIED FUNCTIONAL ANALYSIS
APMA E4200	PARTIAL DIFFERENTIAL EQUATIONS
APMA E4204	FUNCTNS OF A COMPLEX VARIABLE
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
APMA E4301	NUMERICAL METHODS/PDE'S
APMA E4302	METHODS IN COMPUTATIONAL SCI
APMA E4306	Applied Stochastic Analysis
APMA E4990	SPEC TOPICS IN APPLIED MATH
APMA E6301	ANALYTIC METHODS FOR PDE'S
APMA E6302	NUMERICAL ANALYSIS OF PDE'S
APMA E6901	SPECIAL TOPICS IN APPLIED MATH
Research Seminar	
APMA E6100	RESEARCH SEMINAR
Elective Courses	
Choose five of the following (or any of those not used to satisfy the core requirements from the list above) for a total of 15 points of graduate credit: [1]	
Computer Science Elective Courses [2]	
COMS W4232	Advanced Algorithms
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4241	NUMERICL ALGORITHMS-COMPLEXITY
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
COMS W4281	INTRO TO QUANTUM COMPUTING
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4771	MACHINE LEARNING
Industrial Engineering/Operations Research Elective Courses [3]	
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS
IEOR E4004	OPTIMIZATION MODELS AND METHODS
IEOR E4007	OPT MODELS # METHODS FOR FE
IEOR E4106	STOCHASTIC MODELS
IEOR E4150	INTRO-PROBABILITY # STATISTICS
IEOR E4403	QUANTITATIVE CORPORATE FINANCE
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
Applied Physics, Physics, and Earth and Environmental Sciences Courses	
APPH E4100	QUANTUM PHYSICS OF MATTER
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
APPH E4200	PHYSICS OF FLUIDS
APPH E4210	GEOPHYSICAL FLUID DYNAMICS
APPH E4300	APPLIED ELECTRODYNAMICS
APPH E6101	PLASMA PHYSICS I
APPH E6102	PLASMA PHYSICS II
PHYS GU4003	ADVANCED MECHANICS
PHYS GU4019	MATHEMATICL METHODS OF PHYSICS
EESC GU4008	Introduction to Atmospheric Science
EESC GU4040	CLIM THERMODYN/ENERGY TRANSFER
EESC GU4925	INTRO TO PHYSICAL OCEANOGRAPHY
EESC GR6928	TROPICAL METEOROLOGY
4000-level and above Department of Mathematics Courses (excluding seminar courses)	
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
BINF GU4001	Introduction to Computational Biomedicine and Health
BMEN E4420	SIGNAL MODELING
ELEN E4815	RANDOM SIGNALS # NOISE
ELEN E4810	DIGITAL SIGNAL PROCESSING
EEME E6601	
NBHV GU4359	Mathematical Tools for Theoretical Neuroscience
STAT GU4606	ELEMENTRY STOCHASTIC PROCESSES

1 Courses from the Department of Economics, Business School, School of International and Public Affairs, or quantitative courses offered by the School of Professional Studies may not be counted as electives toward the degree.

2 Please check the Computer Science course registration policy for non-COMS students.

3 Please check the IEOR website for registration procedures required of non-IEOR students.

Other elective courses may be chosen from other departments in SEAS and Arts and Sciences, e.g., the Departments of Mechanical Engineering, Electrical Engineering, Mathematics, and Statistics.

Medical Physics (MS)

M.S. Program in Medical Physics

This CAMPEP-approved 36-point program in medical physics leads to the M.S. degree. It is administered by faculty from the School of Engineering and Applied Science in collaboration with faculty from the College of Physicians and Surgeons and the Mailman School of Public Health. It provides preparation toward certification by the American Board of Radiology.

The program consists of a core curriculum of medical and nuclear physics courses, anatomy, lab, seminar, a tutorial, one elective, and two practicums.

Required Courses	
APPH E4010	INTRODUCTN TO NUCLEAR SCIENCE
APPH E4330	RADIOBIOLOGY FOR MED PHYS
APPH E4710	RAD INSTRUMENT/MEASUREMENT LAB
APPH E4500	HEALTH PHYSICS
APPH E4550	MEDICAL PHYSICS SEMINAR
APPH E4600	FUNDAMENTALS OF DOSIMETRY
APPH E6319	CLIN NUCLEAR MEDICINE PHYSICS
APPH E6330	DIAGNOSTIC RADIOLOGY PHYSICS
APPH E6335	RADIATION THERAPY PHYSICS
APBM E4650	ANATOMY FOR PHYSICISTS # ENGR
Approved Electives	
APPH E6336	ADV TPCS IN RADIATION THERAPY
APAM E6650	RESEARCH PROJECT
APAM E4999	SUPERVISED INTERNSHIP
Third Practicum	

Up to 6 points of this 36-point program may be waived based on prior equivalent academic work. A student who enters the 36-point M.S. program in Medical Physics, having satisfactorily completed, prior to beginning the Program, a course determined by the faculty to be equivalent in content to a required course within the Program, may be considered to have satisfied that content requirement, may be allowed to have that requirement waived, and may be permitted to graduate from the M.S. Program in Medical Physics with fewer than 36 points, but not fewer than the 30-point minimum required by the School of Engineering and Applied Science. Evaluation of prior coursework may include review of syllabi, comparison of textbooks, consultation with instructors, and/or written or oral examination administered by Program faculty. A passing grade on a comprehensive examination is required for graduation. This examination, on subjects covered in the curriculum, is taken after two terms of study.

Medical Physics (Certification of Professional Achievement)

This graduate program of instruction leads to the Certification of Professional Achievement and requires satisfactory completion of six of the following courses:

APPH E4330	RADIOBIOLOGY FOR MED PHYS
APPH E4500	HEALTH PHYSICS
APPH E4600	FUNDAMENTALS OF DOSIMETRY
APBM E4650	ANATOMY FOR PHYSICISTS # ENGR
APPH E6330	DIAGNOSTIC RADIOLOGY PHYSICS
APPH E6335	RADIATION THERAPY PHYSICS

This is a part-time nondegree program. Students are admitted to the department as certificate-track students.

Applied Mathematics (PhD, EngScD)

Applied Mathematics

Applied and Computational Mathematics. The program in Applied Mathematics encompasses both methodological approaches in applied and computational math, which are fundamental to modern applications, and domain specific applied mathematics in classical and emergent new field of physics, engineering, bio-engineering, bio-physics, and social sciences. Current research encompasses analytical and numerical analysis of deterministic and stochastic partial differential equations, numerical analysis, large-scale scientific computation, fluid dynamics, dynamical systems and chaos, inverse problems, algorithms for data and machine learning, and their applications. Physical science applications include quantum and condensed-matter physics, materials science, electromagnetics, optics and photonics, plasma physics, medical imaging, and the earth sciences (atmospheric, oceanic, climate science, and solid earth geophysics).

Atmospheric, oceanic, and earth physics. Current research focuses on the dynamics of the atmosphere and the ocean, climate modeling, cloud physics, radiation transfer, remote sensing, geophysical/geological fluid dynamics, and geochemistry. Four faculty members share appointments with the Department of Earth and Environmental Sciences.

The **Ph.D. program** prepares the student to work either independently or collaboratively as a researcher through an emphasis on deep mastery of methods of mathematical modeling, analysis, and computation.

Courses

Courses	
APMA E4007	APPLIED LINEAR ALGEBRA
APMA E4008	Advanced and Applied Linear Algebra
APMA E4100	Applied Analysis
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
APMA E4150	APPLIED FUNCTIONAL ANALYSIS
APMA E4200	PARTIAL DIFFERENTIAL EQUATIONS
APMA E4204	FUNCTNS OF A COMPLEX VARIABLE
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
APMA E4301	NUMERICAL METHODS/PDE'S
APMA E4302	METHODS IN COMPUTATIONAL SCI
APMA E4306	Applied Stochastic Analysis
APMA E6301	ANALYTIC METHODS FOR PDE'S
APMA E6302	NUMERICAL ANALYSIS OF PDE'S
Related Courses of Specialization	
APPH E4200	PHYSICS OF FLUIDS
APPH E4210	GEOPHYSICAL FLUID DYNAMICS
COMS W4241	NUMERICL ALGORITHMS-COMPLEXITY
APMA E8308	
APMA E9815	
COMS W4232	Advanced Algorithms
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4241	NUMERICL ALGORITHMS-COMPLEXITY
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
COMS W4281	INTRO TO QUANTUM COMPUTING
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4771	MACHINE LEARNING
EESC GU4008	Introduction to Atmospheric Science
EESC GU4040	CLIM THERMODYN/ENERGY TRANSFER
EESC GU4925	INTRO TO PHYSICAL OCEANOGRAPHY
EESC GR6928	TROPICAL METEOROLOGY
PHYS GU4019	MATHEMATICL METHODS OF PHYSICS
MATH GU4032	FOURIER ANALYSIS
MATH GR6151	ANALYSIS # PROBABILITY I
MATH GR6152	ANALYSIS II
APMA E6901	SPECIAL TOPICS IN APPLIED MATH

Applied Physics (PhD, EngScD)

Applied Physics

This doctoral program has three specialties. APPH E4018 APPLIED PHYSICS LABORATORY is required for each of the three specialties in the first year of the doctoral program, in addition to any specific courses required of each specialty.

Plasma Physics

This graduate specialty is designed to emphasize preparation for professional careers in plasma research, controlled fusion, and space research. This includes basic training in relevant areas of applied physics, with emphasis on plasma physics and related areas leading to extensive experimental and theoretical research in the Columbia University Plasma Physics Laboratory and Columbia Fusion Research Center.

Required Courses *	
APPH E4018	APPLIED PHYSICS LABORATORY
APPH E4200	PHYSICS OF FLUIDS
APPH E4300	APPLIED ELECTRODYNAMICS
APPH E6101	PLASMA PHYSICS I
APPH E6102	PLASMA PHYSICS II

*Or equivalents taken at another university. Optional courses: APPH E9142 and APPH E9143 APPLIED PHYSICS SEMINAR,

Optical and Laser Physics

This graduate specialty involves a basic training in relevant areas of applied physics, with emphasis in quantum mechanics, quantum electronics, and related areas of specialization. Some active areas of research in which the student may concentrate are laser modification of surfaces, optical diagnostics of film processing, inelastic light scattering in nanomaterials, nonlinear optics, ultrafast optoelectronics photonic switching, optical physics of surfaces, and photon integrated circuits. Specific course requirements for the optical and laser physics doctoral specialization are set with the academic adviser.

Solid-State Physics

This graduate specialty encompasses the study of the electrical, optical, magnetic, thermal, high-pressure, and ultrafast dynamical properties of solids, with an aim to understanding them in terms of the atomic and electronic structure. The field emphasizes the formation, processing, and properties of thin films, low-dimensional structures—such as one- and two-dimensional electron gases, nanocrystals, surfaces of electronic and optoelectronic interest, and molecules. Facilities include a microelectronics laboratory, high-pressure diamond anvil cells, a molecular beam epitaxy machine, ultrahigh vacuum systems, lasers, equipment for the study of optical properties and transport on the nanoscale, and the instruments in the shared facilities overseen by the Columbia Nano Initiative (CNI). There are also significant resources for electrical and optical experimentation at low temperatures and high magnetic fields. Specific course requirements for the solid-state physics doctoral specialization are set with the academic adviser.

Biomedical Engineering

351 Engineering Terrace, MC 8904
212-854-4460
bme@columbia.edu
bme.columbia.edu

Biomedical engineering is an evolving discipline in engineering that draws on collaboration among engineers, physicians, and scientists to provide interdisciplinary insight into medical and biological problems. The field has developed its own knowledge base and principles that are the foundation for the academic programs designed by the Department of Biomedical Engineering at Columbia.

The programs in biomedical engineering at Columbia (B.S., M.S., Ph.D., Eng.Sc.D., and M.D./Ph.D.) prepare students to apply engineering and applied science to problems in biology, medicine, and the understanding of living systems and their behavior, and to develop biomedical systems and devices. Modern engineering encompasses sophisticated approaches to measurement, data acquisition and analysis, simulation, and systems identification. These approaches are useful in the study of individual cells, organs, entire organisms, and populations of organisms. The increasing value of mathematical models in the analysis of living systems is an important sign of the success of contemporary activity. The programs offered in the Department of Biomedical Engineering seek to emphasize the confluence of basic engineering science and applied engineering with the physical and biological sciences, particularly in the areas of biomechanics, cell and tissue engineering, and biosignals and biomedical imaging.

Programs in biomedical engineering are taught by its own faculty, members of other Engineering departments, and faculty from other University divisions who have strong interests and involvement in biomedical engineering. Several of the faculty hold joint appointments in Biomedical Engineering and other University departments.

Courses offered by the Department of Biomedical Engineering are complemented by courses offered by other departments in The Fu Foundation School of Engineering and Applied Science and by many departments in the Faculty of Medicine, the College of Dental Medicine, and the Mailman School of Public Health, as well as the science departments within the Graduate School of Arts and Sciences. The availability of these courses in a university that contains a large medical center and enjoys a basic commitment to interdisciplinary research is important to the quality and strength of the program.

Educational programs at all levels are based on engineering and biological fundamentals. From this basis, the program branches into concentrations of contemporary biomedical engineering fields. The intrinsic breadth of these concentrations, and a substantial elective content, prepare bachelor's and master's students to commence professional activity in any area of biomedical engineering or to go on to graduate school for further studies in related fields. The program also provides excellent preparation for the health sciences and the study of medicine. Graduates of the doctoral program are prepared for research activities at the highest level.

Areas of particular interest to Columbia faculty include biomechanics (Professors Ateshian, Guo, Hess, Morrison, and Nerurkar), cellular and tissue engineering (Professors Arinzeh, Correa, Danino, Hung, Kam, Leong, Lu, Morrison, Sia, and Vunjak-Novakovic), auditory biophysics (Professor Olson), biomaterials (Professors Arinzeh, Correa, Danino, Hess, Kam, Leong, Lu, Sia, and Vunjak-Novakovic), biosignals and biomedical imaging (Professors Guo, Hillman, Jacobs, Juchem, Konofagou, Laine, Sajda, Vaughan, and Wang), neuroengineering (Professors Hillman, Jacobs, Konofagou, Laine, Morrison, Sajda, and Wang) and machine learning (Azizi, Laine, Sajda, Vickovic).

Facilities

The Department of Biomedical Engineering has been supported by grants obtained from NIH, NSF, DoT, DoD, New York State, numerous research foundations, and University funding. The extensive facilities that are at the Medical Center, Manhattanville, and Morningside campuses include teaching and research laboratories that provide students with unusual access to contemporary research equipment specially selected for its relevance to biomedical engineering. Another addition is an undergraduate wet laboratory devoted to biomechanics and cell and tissue engineering, together with a biosignals and biomedical imaging and data processing laboratory. Each laboratory incorporates equipment normally reserved for advanced research and provides exceptional access to current practices in biomedical engineering and related sciences.

Research facilities of the Biomedical Engineering faculty include the Computational Cancer Biology Laboratory (Professor Azizi), the Synthetic Biological Systems Laboratory (Professor Danino), the Heffner Biomedical Imaging Laboratory (Professor Laine), the Laboratory for Intelligent Imaging and Neural Computing (Professor Sajda), the Bone Bioengineering Laboratory (Professor Guo), the Cellular Engineering Laboratory (Professor Hung), the Biomaterial and Interface Tissue Engineering Laboratory (Professor Lu), the Neurotrauma and Repair Laboratory (Professor Morrison), the Laboratory for Stem Cells and Tissue Engineering (Professor Vunjak-Novakovic), the Ultrasound and Elasticity Imaging Laboratory (Professor Konofagou), the Magnetic Resonance Scientific Engineering for Clinical Excellence Laboratory (Professor Juchem), the Microscale Biocomplexity Laboratory (Professor Kam), the Molecular and Microscale Bioengineering Laboratory (Professor Sia), the Laboratory for Functional Optical Imaging (Professor Hillman), the Cognitive Electrophysiology Laboratory (Professor J. Jacobs), the Nanobiotechnology and Synthetic Biology Laboratory (Professor Hess), the Laboratory for Neural Engineering and Control (Professor Wang), the Morphogenesis and Developmental Biomechanics Lab (Professor Nerurkar), and the Laboratory for Nanomedicine and Regenerative Medicine (Professor Leong). These laboratories are supplemented with core facilities, including a tissue culture facility, a histology facility, a confocal microscope, an atomic force microscope, a 2-photon microscope, epifluorescence microscopes, a freezer room, biomechanics facilities, a machine shop, and a specimen preparation room.

Chair

Paul Sajda

Vice Chair

Clark Hung

Chair of Undergraduate Studies

Lauren Heckelman

Chair of Graduate Studies

Lance Kam

Director of Finance and Administration

Alexander Schwarzer

Business Manager

Maria Leah Kim

Senior Manager of Academic and Student Affairs

Rosangely (Rosa) Gomez

Academic Financial Administrator

Rachel Kubi

Teaching Laboratory Engineer

Mira Roosth

Assistant Director of Strategic Programs and Communications

Camryn Hadley

Grants Manager

Farzana Begum

Grants Analyst

Aidan Michael Hogan

Financial Assistant

Michelle Cintron
Karen Evans

Professors

Treena L. Arinzeh
X. Edward Guo, Stanley Dicker Professor of Biomedical Engineering
Henry S. Hess
Clark T. Hung
Lance C. Kam
Elisa E. Konofagou, Robert and Margaret Hariri Professor of Biomedical Engineering and Radiology
Andrew F. Laine, Percy K. and Vida L. W. Hudson Professor of Biomedical Engineering
Helen H. Lu, Percy K. and Vida L. W. Hudson Professor of Biomedical Engineering
Kam W. Leong, Samuel Y. Sheng Professor of Biomedical Engineering
Barclay Morrison III
Paul Sajda, Vikram S. Pandit Professor of Biomedical Engineering
Samuel K. Sia
J. Thomas Vaughan
Gordana Vunjak-Novakovic, University Professor and the Mikati Foundation Professor of Biomedical Engineering

Associate Professors

Tal Danino
Qi Wang

Assistant Professors

Elham Azizi
Santiago Correa
Jose L. McFaline-Figueroa

Nandan Nerurkar
Sanja Vickovic

Lecturers

Lauren Heckelman
Megan Heenan

Joint Faculty

Gerard A. Ateshian, Andrew Walz Professor of Mechanical Engineering
Shunichi Homma, Margaret Miliken Hatch Professor of Medicine
Sachin Jambawalikar
Gerard Karsenty, Paul A. Marks Professor of Genetics and Development
Andrew Marks, Clyde '56 and Helen Wu Professor of Molecular Cardiology (in Medicine)
Elizabeth S. Olson
Li Qiang
Kenneth L. Shepard, Lau Family Professor of Electrical Engineering
Milan N. Stojanovic
Stavros Thomopoulos, Robert E. Carroll and Jane Chace Carroll Professor of Biomechanics
Harris Wang

Emeritus Faculty

Van C. Mow, Stanley Dicker Professor Emeritus of Biomedical Engineering

Adjunct Professors

Hariklia Deligianni
David Elad
Ernest Feleppa
Mark Gelfand
Howard Levin

Adjunct Associate Professor

Alayar Kangarlu

Adjunct Assistant Professors

Krista M. Durney
Chirag Sachar

Affiliates

Sunil Agrawal
Nadeen Chahine
Yasmine El-Shamayleh
Anthony Fitzpatrick
Jennifer Gelinas
Christine Hendon
Chi-Min Ho
Alice Huang
Elias Issa
Karen Kasza
Michael Lipton
Wei Min
Kristin Myers
Katharina Schultebrauck
Kaveri Thakoor
Raju Tomer
Stephen Tsang
Yvon Woappi
Binsheng Zhao

Course Descriptions

APBM E4650 ANATOMY FOR PHYSICISTS # ENGR. *3.00 points*.
Lect: 3.

Prerequisites: Engineering or physics background.
Systemic approach to the study of the human body from a medical imaging point of view: skeletal, respiratory, cardiovascular, digestive, and urinary systems, breast and womens issues, head and neck, and central nervous system. Lectures are reinforced by examples from clinical two- and three-dimensional and functional imaging (CT, MRI, PET, SPECT, U/S, etc.)

Fall 2026: APBM E4650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
APBM 4650	001/10877	T Th 4:00pm - 5:20pm LI110 Hammer Hlth Sciences Center	Zohaib Ahmad, Perry Gerard, Anna Rozenshtein, Monique Katz	3.00	13/25

BINF GU4001 Introduction to Computational Biomedicine and Health. *3.00 points*.
This course offers a comprehensive introduction to the core computational methods driving modern biomedical research and health data science. As biological and clinical datasets grow in scale and complexity—from genomic sequences and molecular profiles to electronic health records (EHRs) and consumer health data—this course equips students with the essential computational foundations to model, analyze, and interpret high-dimensional biomedical data. Organized around key algorithmic challenges spanning Clinical Informatics, Consumer Health Informatics, and Bioinformatics, the course focuses on the design and application of algorithms and statistical models to solve real-world biomedical problems. Lectures emphasize practical techniques and showcase their use across diverse biomedical data types. Designed for advanced undergraduates and graduate students in biomedical informatics, computer science, biomedical engineering, applied mathematics, and related fields, this course builds a rigorous understanding of computational biomedicine. It serves as a core requirement for the Biomedical Informatics PhD and master's programs and is cross-listed with Computer Science. Students interested in careers in bioinformatics, health data science, computational biology, or biomedical AI will find this course especially valuable. As biomedical data continue to expand in size, diversity, and impact, this course provides a critical foundation in the algorithmic, statistical, and computational tools needed to advance the future of research at the intersection of computation and human health

Fall 2026: BINF GU4001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BINF 4001	001/16864	M W 4:10pm - 5:25pm 327 Seeley W. Mudd Building	Harry Reyes	3.00	24/35

BMCS E4480 Statistical machine learning for genomics. *3.00 points*.
Prerequisites: Proficiency in Python/R programming, and background in probability/statistics. Recommended: COMS W4771.
Introduction to statistical machine learning methods using applications in genomic data and in particular high-dimensional single-cell data. Concepts of molecular biology relevant to genomic technologies, challenges of high-dimensional genomic data analysis, bioinformatics preprocessing pipelines, dimensionality reduction, unsupervised learning, clustering, probabilistic modeling, hidden Markov models, Gibbs sampling, deep neural networks, gene regulation. Programming assignments and final project will be required

Fall 2026: BMCS E4480

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMCS 4480	001/11501	Th 10:10am - 12:40pm 331 Uris Hall	Elham Azizi	3.00	19/50

BMCS E4575 High-dimensional statistics for biomedical data. *3.00 points*.
Prerequisites: (APMA E2000 and COMS W4771 and MATH UN2010) or (APMA E2101) Strong background in Python (or R) programming-Background in probability/statistics is recommended.
Statistical machine learning techniques and advanced mathematical concepts for analysis of high-dimensional biomedical data. Topics include optimal transport and probabilistic modeling for multi-modal genomic and imaging data integration and analysis of spatial and temporal dynamics. Programming assignments, problem sets, and a final project will be required.

Spring 2026: BMCS E4575

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMCS 4575	001/13326	Th 10:10am - 12:40pm 829 Seeley W. Mudd Building	Elham Azizi, Andrew Blumberg	3.00	20/40

BMEB W4020 Computational neuroscience: circuits in the brain. *3 points*.
Lect: 3.

Prerequisites: (ELEN E3801) or (BIOL UN3004) ELEN E3801 OR BIOL W3004
The biophysics of computation: modeling biological neurons, the Hodgkin-Huxley neuron, modeling channel conductances and synapses as memristive systems, bursting neurons and central pattern generators, I/O equivalence and spiking neuron models. Information representation and neural encoding: stimulus representation with time encoding machines, the geometry of time encoding, encoding with neural circuits with feedback, population time encoding machines. Dendritic computation: elements of spike processing and neural computation, synaptic plasticity and learning algorithms, unsupervised learning and spike time-dependent plasticity, basic dendritic integration. Projects in MATLAB.

Fall 2026: BMEB W4020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEB 4020	001/11269	T 7:00pm - 9:30pm 602 Hamilton Hall	Aurel Lazar	3	36/80

BMEE E4030 NEURAL CONTROL ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3801) ELEN E3801
Topics include basic cell biophysics, active conductance and the Hodgkin-Huxley model, simple neuron models, ion channel models and synaptic models, statistical models of spike generation, Wilson-Cowan model of cortex, large-scale electrohysiological recording methods, sensorimotor integration and optimal state estimation, operant conditioning of neural activity, nonlinear modelling of neural systems, sensory systems: visual pathway and somatosensory pathway, neural encoding model; spike triggered average (STA) and spike triggered covariance (STC) analysis, neuronal response to electrical micro-stimulation, DBS for Parkinson's disease treatment, motor neural prostheses, and sensory neural prostheses

BMEE E4740 BIOINSTRUMENTATION. *3.00 points*.
Lect: 1. Lab: 3.

Prerequisites: (ELEN E1201) and (COMS W1005) COMS W1005 AND ELEN E1201
Hands-on experience designing, building, and testing the various components of a benchtop cardiac pacemaker. Design instrumentation to measure biomedical signals as well as to actuate living tissues. Transducers, signal conditioning electronics, data acquisition boards, the Arduino microprocessor, and data acquisition and processing using MATLAB will be covered. Various devices will be discussed throughout the course, with laboratory work focusing on building an emulated version of a cardiac pacemaker

BMEN E2910 Introduction to Biomedical Engineering Design. *3.00 points*.
An introduction to prototyping techniques needed for medical device development, including computer-aided design (CAD), 3D printing, laser cutting, circuit design, and microcontrollers. Students will work collaboratively to design, fabricate, and evaluate a medical device, demonstrating competency in fabrication methods and iterative engineering design

BMEN E3010 BIOMEDICAL ENGINEERING I. *3.00 points*.
Lect: 3.

Prerequisites: (BIOL UN2005) and (BIOL UN2006) or BIOL C2005 AND BIOL C2006; BMEN E3810 AND BMEN E4001 OR BMEN E4001; or instructor's permission.
Corequisites: BMEN E3810,BMEN E4001
Various concepts within the field of biomedical engineering, foundational knowledge of engineering methodology applied to biological and/or medical problems through modules in biomechanics, biomaterials, and cell # tissue engineering

Fall 2026: BMEN E3010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3010	001/11503	M W 10:10am - 11:25am 303 Uris Hall	Qi Wang, Nandan Nerurkar, Santiago Correa	3.00	37/65

BMEN E3020 BIOMEDICAL ENGINEERING II. *3.00 points*.
Lect: 3.

Prerequisites: (BIOL UN2005) and (BIOL UN2006) or BIOL C2005 AND BIOL C2006; BMEN E3820 AND BMEN E4002 OR BMEN E4002; or instructor's permission.
Corequisites: BMEN E3820,BMEN E4002
Various concepts within the field of biomedical engineering, foundational knowledge of engineering methodology applied to biological and/or medical problems through modules in biomechanics, bioinstrumentation, and biomedical imaging

Spring 2026: BMEN E3020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3020	001/13327	M W 10:10am - 11:25am 633 Seeley W. Mudd Building	Grace McIlvain, Nandan Nerurkar, Clark Hung	3.00	53/65

BMEN E3810 BIOMEDICAL ENGINEERING LAB I. *3.00 points*.
Lab: 4.

Fundamental considerations of wave mechanics; design philosophies; reliability and risk concepts; basics of fluid mechanics; design of structures subjected to blast; elements of seismic design; elements of fire design; flood considerations; advanced analysis in support of structural design

Fall 2026: BMEN E3810

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3810	001/11506	W 1:10pm - 3:55pm 382 Engineering Terrace	Santiago Correa, Lauren Heckelman, Qi Wang	3.00	19/28
BMEN 3810	002/11516	Th 1:10pm - 3:55pm 382 Engineering Terrace	Lauren Heckelman, Santiago Correa, Qi Wang	3.00	19/28

BMEN E3820 BIOMEDICAL ENGINEERING LAB II. *3.00 points*.
Lab: 4.

Biomedical experimental design and hypothesis testing. Statistical analysis of experimental measurements. Analysis of experimental measurements. Analysis of variance, post hoc testing. Fluid shear and cell adhesion, neuro-electrophysiology, soft tissue biomechanics, biomecial imaging and ultrasound, characterization of excitable tissues, microfluidics

Spring 2026: BMEN E3820

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3820	001/13328	W 1:10pm - 3:45pm 382 Engineering Terrace	Grace McIlvain, Lauren Heckelman, Samuel Sia, Barclay Morrison, Clark Hung	3.00	23/27
BMEN 3820	002/13329	Th 1:10pm - 3:45pm 382 Engineering Terrace	Clark Hung, Barclay Morrison, Samuel Sia, Lauren Heckelman, Grace McIlvain	3.00	28/27

BMEN E3899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: BMEN E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3899	001/17300		Gerard Ateshian	0.00	0/100
BMEN 3899	002/17301		Tal Danino	0.00	1/100
BMEN 3899	003/17302		X. Edward Guo	0.00	0/100
BMEN 3899	004/17303		Henry Hess	0.00	0/100
BMEN 3899	006/17304		Clark Hung	0.00	0/100
BMEN 3899	009/17305		Lance Kam	0.00	0/100
BMEN 3899	010/17306		Elisa Konofagou	0.00	0/100
BMEN 3899	011/17307		Andrew Laine	0.00	0/100
BMEN 3899	012/17308		Kam Leong	0.00	0/100
BMEN 3899	013/17309		Helen Lu	0.00	1/100
BMEN 3899	014/17310		Barclay Morrison	0.00	2/100
BMEN 3899	015/17311		Elizabeth Olson	0.00	0/100
BMEN 3899	016/17312		Paul Sajda	0.00	0/100
BMEN 3899	017/17313		Kenneth Shepard	0.00	0/100
BMEN 3899	018/17314		Shunichi Homma	0.00	0/100
BMEN 3899	019/17316		Samuel Sia	0.00	0/100
BMEN 3899	020/16276		Milan Stojanovic	0.00	0/100
BMEN 3899	021/17315		Stavros Thomopoulos	0.00	0/100
BMEN 3899	022/16278		John Vaughan	0.00	0/100
BMEN 3899	023/16288		Gordana Vunjak-Novakovic	0.00	0/100
BMEN 3899	024/16289		Qi Wang	0.00	0/100
BMEN 3899	025/16290		Nandan Nerurkar	0.00	1/100
BMEN 3899	026/16291		Stephen Tsang	0.00	0/100
BMEN 3899	027/16294		Elham Azizi	0.00	0/100
BMEN 3899	028/16296		Jose McFaline-Figueroa	0.00	0/100
BMEN 3899	029/16297		Treena Arinzeh	0.00	0/100
BMEN 3899	030/17317		Sanja Vickovic	0.00	0/100
BMEN 3899	031/17318		Santiago Correa	0.00	0/100
BMEN 3899	032/16310		Kaveri Thakoor	0.00	0/100
BMEN 3899	033/16312		Yvon Woappi	0.00	0/100
BMEN 3899	034/16313		Yasmine El-Shamayleh	0.00	0/100
BMEN 3899	035/16315		Kaveri Thakoor	0.00	0/100
BMEN 3899	036/17970		Lauren Heckelman	0.00	0/100
BMEN 3899	037/20351		Grace McIlvain	0.00	3/100

Summer 2026: BMEN E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3899	001/11155		Gerard Ateshian	0.00	1/100
BMEN 3899	002/11156		Tal Danino	0.00	0/100
BMEN 3899	003/11157		X. Edward Guo	0.00	0/100
BMEN 3899	004/11158		Henry Hess	0.00	0/100
BMEN 3899	005/11159		Elizabeth Hillman	0.00	0/100
BMEN 3899	006/11160		Clark Hung	0.00	0/100
BMEN 3899	007/11161		Joshua Jacobs	0.00	0/100
BMEN 3899	008/11162		Christoph Juchem	0.00	0/100
BMEN 3899	009/11163		Lance Kam	0.00	0/100

BMEN E3910 BIOMEDICAL ENGINEERING DESIGN. *4.00 points*.
Lect: 1. Lab: 3.

A two-semester design sequence to be taken in the senior year. Elements of the design process, with specific applications to biomedical engineering: concept formulation, systems synthesis, design analysis, optimization, biocompatibility, impact on patient health and comfort, health care costs, regulatory issues, and medical ethics. Selection and execution of a project involving the design of an actual engineering device or system. Introduction to entrepreneurship, biomedical start-ups, and venture capital. Semester I: statistical analysis of detection/classification systems (receiver operation characteristic analysis, logistic regression), development of design prototype, need, approach, benefits and competition analysis. Semester II: spiral develop process and testing, iteration and refinement of the initial design/prototype and business plan development. A lab fee of $100 each is collected

Fall 2026: BMEN E3910

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3910	001/11570	T Th 10:10am - 11:25am 703 Hamilton Hall	Lauren Heckelman	4.00	46/54

BMEN E3920 BIOMEDICAL ENGIN DESIGN II. *4.00 points*.
Lect: 1. Lab: 3.

A two-semester design sequence to be taken in the senior year. Elements of the design process, with specific applications to biomedical engineering: concept formulation, systems synthesis, design analysis, optimization, biocompatibility, impact on patient health and comfort, health care costs, regulatory issues, and medical ethics. Selection and execution of a project involving the design of an actual engineering device or system. Introduction to entrepreneurship, biomedical start-ups, and venture capital. Semester I: statistical analysis of detection/classification systems (receiver operation characteristic analysis, logistic regression), development of design prototype, need, approach, benefits and competition analysis. Semester II: spiral develop process and testing, iteration and refinement of the initial design/prototype and business plan development. A lab fee of $100 each is collected

Spring 2026: BMEN E3920

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3920	001/13330	T Th 10:10am - 11:25am 750 Schapiro Cepser	Lauren Heckelman	4.00	37/55

BMEN E3998 PROJECTS IN BIOMEDICAL ENGIN. *1.00-3.00 points*.
Hours to be arranged.

Independent projects involving experimental, theoretical, computational, or engineering design work. May be repeated, but no more than 3 points of this or any other projects or research course may be counted toward the technical elective degree requirements as engineering technical electives

Spring 2026: BMEN E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3998	001/13331		Kaveri Thakoor	1.00-3.00	0/100
BMEN 3998	002/13332		Tal Danino	1.00-3.00	1/100
BMEN 3998	003/13333		X. Edward Guo	1.00-3.00	1/100
BMEN 3998	004/13334		Henry Hess	1.00-3.00	1/100
BMEN 3998	007/13336		Shunichi Homma	1.00-3.00	0/100
BMEN 3998	008/13337		Clark Hung	1.00-3.00	2/100
BMEN 3998	012/13340		Lance Kam	1.00-3.00	1/100
BMEN 3998	013/13341		Elisa Konofagou	1.00-3.00	1/100
BMEN 3998	015/13342		Andrew Laine	1.00-3.00	0/100
BMEN 3998	017/13343		Kam Leong	1.00-3.00	1/100
BMEN 3998	018/13344		Helen Lu	1.00-3.00	3/100
BMEN 3998	019/13345		Barclay Morrison	1.00-3.00	0/100
BMEN 3998	021/13346		Elizabeth Olson	1.00-3.00	0/100
BMEN 3998	023/13347		Paul Sajda	1.00-3.00	2/100
BMEN 3998	025/13348		Kenneth Shepard	1.00-3.00	0/100
BMEN 3998	026/13349		Samuel Sia	1.00-3.00	0/100
BMEN 3998	027/13350		Milan Stojanovic	1.00-3.00	0/100
BMEN 3998	028/13351		Stavros Thomopoulos	1.00-3.00	0/100
BMEN 3998	029/13352		John Vaughan	1.00-3.00	0/100
BMEN 3998	030/13353		Gordana Vunjak-Novakovic	1.00-3.00	2/100
BMEN 3998	031/13354		Qi Wang	1.00-3.00	0/100
BMEN 3998	032/13355		Nandan Nerurkar	1.00-3.00	1/100
BMEN 3998	033/13356		Stephen Tsang	1.00-3.00	1/100
BMEN 3998	034/13358		Elham Azizi	1.00-3.00	3/100
BMEN 3998	035/13357		Jose McFaline-Figueroa	1.00-3.00	3/100
BMEN 3998	036/13359		Treena Arinzeh	1.00-3.00	1/100
BMEN 3998	037/13360		Sanja Vickovic	1.00-3.00	1/100
BMEN 3998	038/13361		Santiago Correa	1.00-3.00	3/100
BMEN 3998	039/13362		Lauren Heckelman	1.00-3.00	5/100
BMEN 3998	040/13363		Grace McIlvain	1.00-3.00	3/100
BMEN 3998	041/13364		Ke Cheng	1.00-3.00	3/100
BMEN 3998	042/16010		Parisa Yousefpour	1.00-3.00	0/100
BMEN 3998	043/17319		Gerard Ateshian	1.00-3.00	1/100

Fall 2026: BMEN E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3998	001/11571		Lance Kam	1.00-3.00	0/100
BMEN 3998	002/11572		Tal Danino	1.00-3.00	0/50
BMEN 3998	003/11573		X. Edward Guo	1.00-3.00	0/50
BMEN 3998	004/11574		Henry Hess	1.00-3.00	0/50
BMEN 3998	007/11966		Clark Hung	1.00-3.00	0/50
BMEN 3998	011/11575		Lance Kam	1.00-3.00	0/50
BMEN 3998	012/11576		Elisa Konofagou	1.00-3.00	0/50
BMEN 3998	014/11577		Andrew Laine	1.00-3.00	0/50
BMEN 3998	016/11583		Kam Leong	1.00-3.00	2/50

BMEN E3999 UNDERGRADUATE FIELDWORK. *1.00-2.00 points*.
Prerequisites: Obtained internship and approval from faculty adviser. BMEN undergraduate students only.
May be repeated for credit, but no more than 3 total points may be used toward the 128-credit degree requirement. Only for BMEN undergraduate students who include relevant off-campus work experience as part of their approved program of study. Final report and letter of evaluation required. Fieldwork credits may not count toward any major core, technical, elective, and non-technical requirements. May not be taken for pass/fail credit or audited

Spring 2026: BMEN E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3999	001/13365		Lauren Heckelman	1.00-2.00	1/100

Summer 2026: BMEN E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3999	001/11188		Lauren Heckelman	1.00-2.00	4/100

Fall 2026: BMEN E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 3999	001/11681		Lauren Heckelman	1.00-2.00	0/100

BMEN E4000 SPECIAL TOPICS IN BIOMEDICAL ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: Instructors may impose prerequisites depending on the topic.
Current topics in biomedical engineering. Subject matter will vary by year

Spring 2026: BMEN E4000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4000	005/13367	W 4:10pm - 6:30pm 644 Seeley W. Mudd Building	Nuttida Rungratsameetaweemana	3.00	28/40
BMEN 4000	006/13368	Th 1:10pm - 3:40pm 401 Chandler	Tal Danino	3.00	18/25
BMEN 4000	007/13369	T 12:10pm - 2:40pm 517 3960 Broadway	Ke Cheng	3.00	24/24
BMEN 4000	008/13370	T 1:10pm - 3:40pm 253 Engineering Terrace	Parisa Yousefpour	3.00	20/24

Fall 2026: BMEN E4000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4000	002/11682	W 1:10pm - 3:40pm 516 Hamilton Hall	Millard Chan	3.00	14/30
BMEN 4000	006/11700	T 1:10pm - 3:40pm 401 Chandler	Tal Danino	3.00	15/25
BMEN 4000	007/13505	T 10:10am - 12:40pm 644 Seeley W. Mudd Building	Helen Lu	3.00	15/25
BMEN 4000	008/14989	T 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Parisa Yousefpour	3.00	7/24

BMEN E4001 QUANTITATIVE PHYSIOLOGY I. *3.00 points*.
Lect: 3.

Prerequisites: (BIOL UN2005) and (BIOL UN2006) BIOL C2005 AND BIOL C2006; BMEN E3010 AND BMEN E3810 OR BMEN E3010 OR BMEN E4490 OR BMEN E6505
Corequisites: BMEN E3010,BMEN E3810
Physiological systems at the cellular and molecular level are examined in a highly quantitative context. Topics include chemical kinetics, molecular binding and enzymatic processes, molecular motors, biological membranes, and muscles

Fall 2026: BMEN E4001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4001	001/11970	M W 8:40am - 9:55am 833 Seeley W. Mudd Building	Lance Kam	3.00	50/90
BMEN 4001	V01/18079		Lance Kam	3.00	1/99

BMEN E4002 QUANT PHYSIOLOGY II:ORGAN SYST. *3.00 points*.
Lect: 3.

Prerequisites: (BIOL UN2005) and (BIOL UN2006) BIOL C2005 AND BIOL C2006; BMEN E3020 AND BMEN E3820 OR BMEN E3020 OR BMEN E4490 OR BMEN E6505
Corequisites: BMEN E3020,BMEN E3820
Students are introduced to a quantitative, engineering approach to cellular biology and mammalian physiology. Beginning with biological issues related to the cell, the course progresses to considerations of the major physiological systems of the human body (nervous, circulatory, respiratory, renal)

Spring 2026: BMEN E4002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4002	001/13371	M W 8:40am - 9:55am 833 Seeley W. Mudd Building	Barclay Morrison	3.00	57/90

BMEN E4050 ELECTROPHYS OF HUM MEMORY * NAVIGATION. *3.00 points*.
Lect: 3.

Prerequisites: Instructor's permission.
Human memory, including working, episodic, and procedural memory. Electrophysiology of cognition, noninvasive and invasive recordings. Neural basis of spatial navigation, with links to spatial and episodic memory. Computational models of memory, brain stimulation, lesion studies.

BMEN E4110 BIOSTATISTICS FOR ENGINEERS. *4.00 points*.
Lect: 3.

Prerequisites: (APMA E2000 and APMA E2101 and MATH UN1202
Fundamental concepts of probability and statistics applied to biology and medicine. Probability distributions, hypothesis testing and inference, summarizing data and testing for trends. Signal detection theory and the receiver operator characteristic. Lectures accompanied by data analysis assignments using MATLAB as well as discussion of case studies in biomedicine.

Fall 2026: BMEN E4110

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4110	001/11865	T Th 11:40am - 12:55pm Room TBA	Nuttida Rungratsameetaweemana	4.00	120/120

BMEN E4210 DRIVING FORCES OF BIOLOGICAL SYSTEMS. *4.00 points*.
Lect: 4.

Prerequisites: (CHEM UN1404) and (MATH UN1202) BIOL C2005; or equivalent.
Corequisites: BIOL UN2005
Introduction to the statistical mechanics and thermodynamics of biological systems, with a focus on connecting microscopic molecular properties to macroscopic states. Both classical and statistical thermodynamics will be applied to biological systems; phase equilibria, chemical reactions, and colligative properties. Topics in modern biology, macromolecular behavior in solutions and interfaces, protein-ligand binding, and the hydrophobic effect

BMEN E4302 BIOMECHANICS OF MUSCULOSKELETAL SOFT TIS. *3.00 points*.
Lect.: 3.

Prerequisites: (ENME E3113) or ENME E3113; or equivalent. Restricted to seniors and graduate students.
Biomechanics of orthopaedic soft tissues (cartilage, tendon, ligament, meniscus, etc.). Basic and advanced viscoelasticity applied to the muscoskeletal system. Topics include mechanical properties, applied viscoelasticity theory, and biology of orthopaedic soft tissues

BMEN E4310 SOLID BIOMECHANICS. *3.00 points*.
Lect.: 3.

Prerequisites: (ENME E3105) and (ENME E3113) and ENME E3105 AND ENME E3113
Applications of continuum mechanics to the understanding of various biological tissues properties. The structure, function, and mechanical properties of various tissues in biolgical systems, such as blood vessels, muscle, skin, brain tissue, bone, tendon, cartilage, ligaments, etc. are examined. The establishment of basic governing mechanical principles and constitutive relations for each tissue. Experimental determination of various tissue properties. Medical and clinical implications of tissue mechanical behavior

Fall 2026: BMEN E4310

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4310	001/11866	T 4:10pm - 6:40pm 524 Seeley W. Mudd Building	X. Edward Guo	3.00	18/35
BMEN 4310	V01/18080		X. Edward Guo	3.00	0/99

BMEN E4330 Cellular Bioengineering # Therapeutics. *3.00 points*.
Prerequisites: General understanding of chemistry and biology.
Explores cutting-edge field of cellular bioengineering and applications of cell therapies. Comprehensive understanding of the principles, techniques, and ethical considerations involved in cells for medical applications studied.

Fall 2026: BMEN E4330

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4330	001/11867	W 1:10pm - 3:40pm 142 Uris Hall	Ke Cheng	3.00	100/100

BMEN E4350 Biomechanics of Developmental Biology. *3.00 points*.
Prerequisites: Undergraduate-level course in mechanics e.g., MECE E3113, BMEN E4310 and cell biology e.g., BIOL UN2005/6 or by instructor's permission.
Biophysical mechanisms of tissue organization during embryonic development: conservation laws, reaction-diffusion, finite elasticity, and fluid mechanics are reviewed and applied to a broad range of topics in developmental biology, from early development to later organogenesis of the central nervous, cardiovascular, musculoskeletal, respiratory, and gastrointestinal systems. Subdivided into modules on patterning (conversion of diffusible cues into cell fates) and morphogenesis (shaping of tissues), the course will include lectures, problem sets, reading of primary literature, and a final project

Spring 2026: BMEN E4350

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4350	001/13372	M W 1:10pm - 2:25pm 524 Seeley W. Mudd Building	Nandan Nerurkar	3.00	18/42
BMEN 4350	V01/16634		Nandan Nerurkar	3.00	1/99

BMEN E4410 PRIN OF ULTRASOUND IN MEDICINE. *3.00 points*.
Lect: 3.

Prerequisites: (MATH UN1202) and APMA E2000 or equivalent.
Fourier analysis. Physics of diagnostic ultrasound and principles of ultrasound imaging instrumentation. Propagation of plane waves in lossless medium; ultrasound propagation through biological tissues; single-element and array transducer design; pulse-echo and Doppler ultrasound instrumentation, performance evaluation of ultrasound imaging systems using tissue-mimicking phantoms, ultrasound tissue characterization; ultrasound nonlinearity and bubble activity; harmonic imaging; acoustic output of ultrasound systems; biological effects of ultrasound.

Spring 2026: BMEN E4410

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4410	001/13373	W 2:30pm - 5:00pm 545 Seeley W. Mudd Building	Elisa Konofagou	3.00	10/50
BMEN 4410	V01/16635		Elisa Konofagou	3.00	2/99

BMEN E4420 SIGNAL MODELING. *3.00 points*.
Lect: 3.

Prerequisites: or instructor's permission.
Fundamental concepts of signal processing in linear systems and stochastic processes. Estimation, detection and filtering methods applied to biomedical signals. Harmonic analysis, auto-regressive model, Wiener and Matched filters, linear discriminants, and independent components. Methods are developed to answer concrete questions on specific data sets in modalities such as ECG, EEG, MEG, Ultrasound. Lectures accompanied by data analysis assignments using MATLAB.

BMEN E4430 PRIN OF MAG RESONANCE IMAGING. *3.00 points*.
Lect: 3.

Prerequisites: (PHYS UN1403) and (APMA E2101) or APMA E2101 AND PHYS C1403; or instructor's permission.
Fundamental principles of Magnetic Resonance Imaging (MRI), including the underlying spin physics and mathematics of image formation with an emphasis on the application of MRI to neuroimaging, both anatomical and functional. The examines both theory and experimental design techniques

BMEN E4460 Deep Learning in Biomedical Imaging. *3.00 points*.
Prerequisites: APMA E2000 and APMA E2101 and MATH UN1202
Recommended: background in Python programming.
Introduction to methods in deep learning, with focus on applications to quantitative problems in biomedical imaging and Artificial Intelligence (AI) in medicine. Network models: Deep feedforward networks, convolutional neural networks and recurrent neural networks. Deep autoencoders for denoising. Segmentation and classification of biological tissues and biomarkers of disease. Theory and methods lectures will be accompanied with examples from biomedical image including analysis of neurological images of the brain (MRI), CT images of the lung for cancer and COPD, cardiac ultrasound. Programming assignments will use tensorflow / Pytorch and Jupyter Notebook. Examinations and a final project will also be required.

Spring 2026: BMEN E4460

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4460	001/13375	W 1:10pm - 3:40pm 517 Hamilton Hall	Andrew Laine	3.00	44/70

BMEN E4470 Deep Learning for Biomedical Signal Processing. *3.00 points*.
Prerequisites: Recommended: background in Python programming.
Introduction to methods in deep learning, focus on applications to biomedical signals and sequences. Review of traditional methods for analysis of signals and sequences. Temporal convolutional neural networks and recurrent neural networks. Long-short term memory (LSTM) models and deep state-space models. Theory and methods lectures accompanied with examples from biomedical signal and sequence analysis, including analysis of electroencephalogram (EEG), electrocardiogram (ECG/EKG), and genomics. Programming assignments use tensorflow/keras. Exams and final project required

Fall 2026: BMEN E4470

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4470	001/11868	M 4:10pm - 6:40pm 717 Hamilton Hall	Paul Sajda	3.00	55/80

BMEN E4480 Statistical machine learning for genomics. *3.00 points*.
Prerequisites: APMA E2101 and MATH UN1202 and MATH UN2010
Proficiency in Python/R programming, and background in probability/statistics. Recommended: COMS W4771.
Introduction to statistical machine learning methods using applications in genomic data and in particular high-dimensional single-cell data. Concepts of molecular biology relevant to genomic technologies, challenges of highdimensional genomic data analysis, bioinformatics preprocessing pipelines, dimensionality reduction, unsupervised learning, clustering, probabilistic modeling, hidden Markov models, Gibbs sampling, deep neural networks, gene regulation. Programming assignments and final project will be required.

BMEN E4490 Magnetic Resonance Spectroscopy: A Window to the Living Brain. *3.00 points*.
Prerequisites: BMEN E4001 OR BMEN E4002
Introduction to use of magnetic resonance spectroscopy (MRS) with focus on brain. Covers all aspects of in vivo MRS from theory to experiment, from data acquisition to the derivation of metabolic signatures, from study design to clinical interpretation. Includes theoretical concepts, hands-on training in MRS data literacy and direct experimental experience using a 3T MR scanner

Fall 2026: BMEN E4490

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4490	001/11870	F 3:10pm - 5:40pm 253 Engineering Terrace	Jia Guo	3.00	12/25

BMEN E4500 Functional Genomics: Methods and Applications. *3.00 points*.
Prerequisites: BIOL C2005 AND BIOL C2006
Introduces approaches for the functional genomic analysis of biological systems and their use to define genotype-phenotype relationships. Genetic variation, gene expression and regulation at the epigenome, chromatin organization level, and link between gene and protein expression covered. Case studies covered: study of cancer and cancer-associated processes, neuro-biology, and organismal development. The presented methods study these events at the genome, epigenome, transcriptome, and proteome levels.Approaches that increase the resolution of functional genomic assays to the level of individual cells, spatial profiling, integration with genetic and chemical screening methods, and their application to chemical genomic approaches also studied. Programming assignments and a final project required

Fall 2026: BMEN E4500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4500	001/11871	T 1:10pm - 3:40pm 633 Seeley W. Mudd Building	Jose McFaline-Figueroa	3.00	27/60

BMEN E4501 Biomaterials and Scaffold Design. *3.00 points*.
Lect: 3.

An introduction to the strategies and fundamental bioengineering design criteria in the development of biomaterials and tissue ngineered grafts. Materials structuralfunctional relationships, biocompatibility in terms of material and host responses. Through discussions, readings, and a group design project, students acquire an understanding of cell-material interactions and identify the arameters critical in the design and selection of biomaterials for biomedical applications.

BMEN E4510 TISSUE ENGINEERING. *3.00 points*.
Lect: 3

Prerequisites: (BIOL UN2005) and (BIOL UN2006) and (BMEN E4001) and (BMEN E4002) BIOL C2005 AND BIOL C2006 AND BMEN E4001 AND BMEN E4002
An introduction to the strategies and fundamental bioengineering design criteria behind the development of cell-based tissue substitutes. Topics include biocompatibility, biological grafts, gene therapy-transfer, and bioreactors

Fall 2026: BMEN E4510

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4510	001/11872	M W 11:40am - 12:55pm 303 Uris Hall	Clark Hung	3.00	38/67

BMEN E4520 SYNTHETIC BIOLOGY:PRIN GENETIC CIRCUITS. *3.00 points*.
Basic principles of synthetic biology and survey of the field. Fundamentals of biological circuits, including circuit design, modern techniques for DNA assembly, quantitative characterization of genetic circuits, and ODE modeling of biological circuits with MATLAB. Knowledge of biology, ordinary differential equations, and MATLAB will be assumed. Intended for advanced undergraduate and graduate students.

BMEN E4525 Advanced Cell and Tissue Engineering: From Concepts to Translation. *3.00 points*.
Prerequisites: Biology and Physiology
Covers advancements in the fields of cellular and developmental biology, molecular biology and materials science towards the development of "tissue engineered" therapies. Emphasis on tissue engineering therapies applied to musculoskeletal tissues, such as bone, cartilage, and skeletal muscle, and nervous tissues (central and peripheral nervous system). Design considerations and concepts in market analysis examined.

Spring 2026: BMEN E4525

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4525	001/13376	Th 4:10pm - 6:40pm 633 Seeley W. Mudd Building	Treena Arinzeh	3.00	21/30

BMEN E4530 DRUG AND GENE DELIVERY. *3.00 points*.
Prerequisites: BMEN E3010
Application of polymers and other materials in drug and gene delivery, with focus on recent advances in field. Basic polymer science, pharmacokinetics, and biomaterials, cell-substrate interactions, drug delivery system fabrication from nanoparticles to microparticles and electrospun fibrous membranes. Applications include cancer therapy, immunotherapy, gene therapy, tissue engineering, and regenerative medicine. Course readings include textbook chapters and journal papers. Homework assignments take format of assay responding to open-ended question. Term paper and 30-minute PowerPoint presentation required at end of semester

Fall 2026: BMEN E4530

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4530	001/11874	M 1:10pm - 3:40pm 303 Uris Hall	Kam Leong	3.00	52/67

BMEN E4535 Immunoengineering with Biomaterials and Nanotechnology. *3.00 points*.
Introduction to fundamental aspects of immunology and engineering strategies to modulate the immune system to improve human health. We will cover the innate and adaptive immune system and current methods to characterize the immune response. Applications focus on cancer, vaccines, and autoimmune disorders

Spring 2026: BMEN E4535

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4535	001/13377	M W 11:40am - 12:55pm 545 Seeley W. Mudd Building	Santiago Correa	3.00	49/50

BMEN E4545 Multimodal Neuroimaging. *0.00-3.00 points*.
Prerequisites: MATLAB and/or Python
Practical implementation of neuroimaging techniques, data types, processing methods and clinical findings on independent datasets across a variety of neurological and psychiatric conditions. Basics from anatomy to digital image analysis will be explored culminating in a final project

Spring 2026: BMEN E4545

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4545	001/16633	Th 4:10pm - 6:40pm 327 Seeley W. Mudd Building	Frank Provenzano	0.00-3.00	26/35

BMEN E4550 MICRO/NANO STRUCT CELL ENG. *3.00 points*.
Lect: 3.

Prerequisites: (BIOL UN2005) and (BIOL UN2006) or BIOL C2005 AND BIOL C2006; or equivalent.
Design, fabrication, and application of micro-/nanostructured systems for cell engineering. Recognition and response of cells to spatial aspects of their extracellular environment. Focus on neural, cardiac, coculture, and stem cell systems. Molecular complexes at the nanoscale.

Spring 2026: BMEN E4550

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4550	001/13378	M 2:10pm - 4:00pm 1024 Seeley W. Mudd Building	Lance Kam	3.00	39/45
BMEN 4550	V01/16636		Lance Kam	3.00	1/99

BMEN E4575 Biomolecular Engineering: Principles and Techniques. *3.00 points*.
Prerequisites: (BIOL UN2005 and BIOL UN2006)
This course provides an integrated lecture–laboratory introduction to modern biomolecular engineering and molecular biology techniques used in biotechnology and biomedical research. Students will gain a foundational understanding of how genetic information is stored, replicated, expressed, and engineered, as well as hands-on experience with core experimental techniques used in the field. Students are required to complete the required lab safety trainings prior to the first lab (instructions will be provided by the instructor), and attend all lab sessions. Lecture slides will be posted on CourseWorks; students are responsible for all material covered in class.

BMEN E4580 FOUND OF NANOBIOSCI/NANOBIOTECH. *3.00 points*.
Lect: 3.

Prerequisites: (BIOL UN2005) and (BIOL UN2006) and (BMEN E4001) and (BMEN E4002) or instructor's permission.
Fundamentals of nanobioscience and nanobiotechnology, scientific foundations, engineering principles, current and envisioned applications. Includes discussion of intermolecular forces and bonding, of kinetics and thermodynamics of self-assembly, of nanoscale transport processes arising from actions of biomolecular motors, computation and control in biomolecular systems, and of mitochondrium as an example of a nanoscale factory.

Spring 2026: BMEN E4580

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4580	001/13379	T Th 11:40am - 12:55pm 1024 Seeley W. Mudd Building	Henry Hess	3.00	35/55
BMEN 4580	V01/16638		Henry Hess	3.00	1/99

BMEN E4590 BIOMEMS:CELL/MOLECULAR APPLIC. *3.00 points*.
Lect: 3.

Prerequisites: or equivalent. Chemistry.
Topics include biomicroelectromechanical, microfluidic, and lab-on-a-chip systems in biomedical engineering, with a focus on cellular and molecular applications. Microfabrication techniques, biocompatibility, miniaturization of analytical and diagnostic devices, high-throughput cellular studies, microfabrication for tissue engineering, and in vivo devices.

Spring 2026: BMEN E4590

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4590	001/13380	T 4:10pm - 6:40pm 702 Hamilton Hall	Samuel Sia	3.00	27/80
BMEN 4590	V01/16640		Samuel Sia	3.00	1/99

BMEN E4583 Health from a Systems Perspective. *3.00 points*.
Prerequisites: (MATH E1210 and APMA E2101 and APMA E3102)
Prerequisites include ODE and PDE. Contact instructor if uncertain about background for course.
Health, disease, and death from a systems engineering perspective, introduction to control theory in a biomedical context.

Fall 2026: BMEN E4583

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4583	001/13507	W 10:00am - 12:40pm 829 Seeley W. Mudd Building	Henry Hess	3.00	36/36

BMEN E4585 Optical Microscopy for Biomedical Research. *3.00 points*.
Prerequisites: (BMEN E3010 and BMEN E3020 and BIOL UN2005 and BIOL UN2006)
Advanced optical microscopy techniques and their applications in biomedical research, scientific foundations, engineering principles, state-of-the-art techniques.

BMEN E4592 Lessons from Transformational Medical Advances. *3.00 points*.
Examines innovation systems and technology adoption in medical advances, with a focus on translational analysis across devices, diagnostics, and therapeutics. Case-based evaluation of diagnostic imaging (CT, MRI, ultrasound), minimally invasive surgical systems, cardiovascular devices, and drug development pipelines. Frameworks for R#D goal-setting, evaluation and testing protocols, regulatory constraints, technology diffusion, and multi-stakeholder development systems. For BMEN students, this course counts towards a technical elective, but not engineering content technical elective

Fall 2026: BMEN E4592

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4592	001/15345	W 4:10pm - 6:40pm 415 Schapiro Cepser	Samuel Sia	3.00	23/40

BMEN E4750 SOUND AND HEARING. *3.00 points*.
Lect: 3.

Prerequisites: (PHYS UN1401) and (MATH UN1201)
Introductory acoustics, basics of waves and discrete mechanical systems. The mechanics of hearing - how sound is transmitted through the external and middle ear to the inner ear, and the mechanical processing of sound within the inner ear.

Fall 2026: BMEN E4750

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4750	001/13497	M 4:10pm - 6:40pm 524 Seeley W. Mudd Building		3.00	6/50
BMEN 4750	V01/18081		Elizabeth Olson	3.00	1/99

BMEN E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: BMEN E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4899	001/16023		Gerard Ateshian	0.00	1/100
BMEN 4899	002/16024		Tal Danino	0.00	0/100
BMEN 4899	003/16025		X. Edward Guo	0.00	0/100
BMEN 4899	004/16026		Henry Hess	0.00	0/100
BMEN 4899	006/16027		Clark Hung	0.00	0/100
BMEN 4899	009/16028		Lance Kam	0.00	0/100
BMEN 4899	010/16029		Elisa Konofagou	0.00	0/100
BMEN 4899	011/16030		Andrew Laine	0.00	0/100
BMEN 4899	012/16031		Kam Leong	0.00	0/100
BMEN 4899	013/16032		Helen Lu	0.00	0/100
BMEN 4899	014/16033		Barclay Morrison	0.00	0/100
BMEN 4899	015/16034		Elizabeth Olson	0.00	1/100
BMEN 4899	016/16036		Paul Sajda	0.00	0/100
BMEN 4899	017/16037		Kenneth Shepard	0.00	0/100
BMEN 4899	018/16038		Shunichi Homma	0.00	0/100
BMEN 4899	019/16039		Samuel Sia	0.00	0/100
BMEN 4899	020/16040		Milan Stojanovic	0.00	0/100
BMEN 4899	021/16042		Stavros Thomopoulos	0.00	0/100
BMEN 4899	022/16043		John Vaughan	0.00	0/100
BMEN 4899	023/16046		Gordana Vunjak-Novakovic	0.00	1/100
BMEN 4899	024/16047		Qi Wang	0.00	0/100
BMEN 4899	025/16048		Nandan Nerurkar	0.00	0/100
BMEN 4899	026/16049		Stephen Tsang	0.00	0/100
BMEN 4899	027/16051		Elham Azizi	0.00	0/100
BMEN 4899	028/16052		Jose McFaline-Figueroa	0.00	0/100
BMEN 4899	029/16054		Treena Arinzeh	0.00	0/100
BMEN 4899	030/16055		Sanja Vickovic	0.00	0/100
BMEN 4899	031/16059		Santiago Correa	0.00	1/100
BMEN 4899	032/16060		Kaveri Thakoor	0.00	0/100
BMEN 4899	033/16061		Yvon Woappi	0.00	0/100
BMEN 4899	034/16063		Yasmine El-Shamayleh	0.00	0/100
BMEN 4899	035/16002		Parisa Yousefpour	0.00	0/100

Summer 2026: BMEN E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4899	001/11189		Gerard Ateshian	0.00	0/100
BMEN 4899	002/11190		Tal Danino	0.00	1/100
BMEN 4899	003/11191		X. Edward Guo	0.00	0/100
BMEN 4899	004/11192		Henry Hess	0.00	1/100
BMEN 4899	005/11193		Elizabeth Hillman	0.00	0/100
BMEN 4899	006/11194		Clark Hung	0.00	0/100
BMEN 4899	009/11196		Lance Kam	0.00	0/100
BMEN 4899	010/11197		Elisa Konofagou	0.00	0/100
BMEN 4899	011/11198		Andrew Laine	0.00	0/100
BMEN 4899	012/11199		Kam Leong	0.00	0/100
BMEN 4899	013/11200		Helen Lu	0.00	0/100
BMEN 4899	014/11201		Barclay Morrison	0.00	0/100

BMEN E4999 FIELDWORK. *1.00-2.00 points*.
Prerequisites: Obtained internship and approval from faculty advisor. BMEN graduate students only.
Only for BMEN graduate students who need relevant work experience as part of their program of study. Final reports required. May not be taken for pass/fail credit or audited

Spring 2026: BMEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4999	001/13381		Clark Hung	1.00-2.00	0/100

Summer 2026: BMEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4999	001/11215		Clark Hung	1.00-2.00	8/100

Fall 2026: BMEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 4999	001/11894		Clark Hung	1.00-2.00	2/100

BMEN E6000 Graduate Special Topic. *3 points*.
Lect: 3.

Prerequisites: Instructors may impose prerequisites depending on the topic.
Current topics in biomedical engineering. Subject matter will vary by year. Instructors may impose prerequisites depending on the topic.

Spring 2026: BMEN E6000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6000	001/13382	F 1:00pm - 3:00pm 227 Seeley W. Mudd Building	Sanja Vickovic	3	29/30

Fall 2026: BMEN E6000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6000	006/11896	M 10:10am - 12:40pm 382 Engineering Terrace	Megan Heenan	3	14/22

BMEN E6001 TOPICS IN BIOMED NANOTECHNOLOGY. *3.00 points*.
Prerequisites: Targeted toward graduate students; undergraduate student may participate with instructor's permission.
Review and critical discussion of recent literature in nanobiotechnology and synthetic biology. Experimental and theoretical techniques, critical advances. Quality judgments of scientific impact and technical accuracy. Styles of written and graphical communication, the peer review process

BMEN E6003 COMP MODELING-PHYSIOL SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (APMA E4200) and (BMEN E4001) and (BMEN E4002) or equivalent.
Advanced computational modeling and quantitative analysis of selected physiological systems from molecules to organs. Selected systems are analyzed in depth with an emphasis on modeling methods and quantitative analysis. Topics may include cell signaling, molecular transport, excitable membranes, respiratory physiology, nerve transmission, circulatory control, auditory signal processing, muscle physiology, data collection and analysis.

Spring 2026: BMEN E6003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6003	001/13383	M 4:10pm - 6:40pm 301 Pupin Laboratories	Elizabeth Olson, Elisa Konofagou, Kaveri Thakoor, Jose McFaline-Figueroa, Megan Heenan	3.00	136/180
BMEN 6003	V01/19642		Elizabeth Olson, Elisa Konofagou, Kaveri Thakoor, Jose McFaline-Figueroa, Megan Heenan	3.00	3/99

BMEN E6005 Biomedical Innovation I. *3 points*.
Lect: 3.

Prerequisites: Master's students only.
Project-based design experience for graduate students. Elements of design process, including need identification, concept generation, concept selection, and implementation. Development of design prototype and introduction to entrepreneurship and implementation strategies. Real-world training in biomedical design and innovation.

Spring 2026: BMEN E6005

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6005	001/13384	M W 2:10pm - 4:00pm 616 Martin Luther King Building	Megan Heenan	3	36/50

BMEN E6006 BIOMEDICAL DESIGN II. *3.00 points*.
Lect. 3.

Second semester of project-based design experience for graduate students. Elements of design process, with focus on skills development, prototype development and testing, and business planning. Real-world training in biomedical design, innovation, and entrepreneurship

Fall 2026: BMEN E6006

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6006	001/11898	M W 2:10pm - 4:00pm 627 Seeley W. Mudd Building	Megan Heenan	3.00	10/50

BMEN E6007 LAB-TO-MARKET. *3.00 points*.
Introduction to and application of commercialization of biomedical innovations. Topics include needs clarification, stakeholder analysis, market analysis, value proposition, business models, intellectual property, regulatory, and reimbursement. Development of path-to-market strategy and pitch techniques

Spring 2026: BMEN E6007

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6007	001/13385	T 4:10pm - 7:25pm 633 Seeley W. Mudd Building	Megan Heenan, Dennis Purcell	3.00	50/70

BMEN E6505 Advanced Biomaterials for Tissue Engineering. *3.00 points*.
Prerequisites: (BMEN E4501) or equivalent.
Corequisites: BMEN E4002,BMEN E4001
Advanced biomaterial selection and biomimetic scaffold design for tissue engineering and regenerative medicine. Formulation of bio-inspired design criteria, scaffold characterization and testing, and applications on forming complex tissues or organogenesis. Laboratory component includes basic scaffold fabrication, characterization and in vitro evaluation of biocompatibility. Group projects target the design of scaffolds for select tissue engineering applications.

BMEN E6510 STEM CELL, GENOME ENG # REGEN MED. *3.00 points*.
Lect: 3.

Prerequisites: (BMEN E4001) or (BMEN E4002) and Biology, Cell Biology.
General lectures on stem cell biology followed by student presentations and discussion of the primary literature. Themes presented include: basic stem cell concepts; basic cell and molecular biological characterization of endogenous stem cell populations; concepts related to reprogramming; directed differentiation of stem cell populations; use of stem cells in disease modeling or tissue replacement/repair; clinical translation of stem cell research.

Spring 2026: BMEN E6510

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6510	001/15993	T 9:00am - 11:00am LI205 Hammer Hlth Sciences Center	Stephen Tsang, Gordana Vunjak-Novakovic	3.00	34/70

BMEN E6520 Instructive Biomaterials. *3.00 points*.
Covers biomaterials that are instructive or have been designed or engineered to be instructive; structure-function-property relationships in natural and synthetic biomaterials. Advances in understanding of material properties emphasized; including electroactivity, chemical, mechanical, geometry/architecture, and the modification of material surfaces and context of their effect on biological function. Evolving field of smart biomaterials discussed. Exercises/demonstrations using materials characterization equipment conducted.

Fall 2026: BMEN E6520

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 6520	001/14460	W 1:10pm - 3:40pm 140 Uris Hall	Treena Arinzeh	3.00	9/30

BMEN E6700 Engineering in Genomics # AI. *3 points*.
Prerequisites: (BIOL UN2005 and BIOL UN2006 and BMEN E4110 and ENGI E1006)
Modern “omics” methods comprise a set of high-throughput techniques useful for the study of entire sets of biological molecules, such as genomes, transcripts, and proteins. These approaches strive to provide a comprehensive view of a living system, and are increasingly used to probe cellular diversity, trace the evolution and spread of pathology, and to directly connect molecules to functional changes at the level of the cell or organism. This course will survey the foundational technologies and ideas underpinning such work by building a clear, intuitive understanding of modern methods—sequencing chemistries (Illumina, PacBio HiFi, ONT), single-cell and spatial transcriptomics, single-cell and spatial DNA sequencing, in situ imaging-based sequencing, genome editing, and CRISPR-based perturbations—with computational themes like base-calling, normalization, cell-type classification, and interpretation of perturbation data. Familiarity with basic genomics methods and processing of biological data is helpful but not required.

BMEN E9100 MASTERS RESEARCH. *1.00-6.00 points*.
Candidates for the M.S. degree may conduct an investigation of some problem in biomedical engineering. No more than 6 points in this course may be counted for graduate credit

Spring 2026: BMEN E9100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9100	001/16013		Gerard Ateshian	1.00-6.00	1/100
BMEN 9100	002/16014		Tal Danino	1.00-6.00	0/100
BMEN 9100	003/16015		X. Edward Guo	1.00-6.00	0/100
BMEN 9100	004/16016		Henry Hess	1.00-6.00	1/100
BMEN 9100	008/16018		Clark Hung	1.00-6.00	7/100
BMEN 9100	012/13388		Lance Kam	1.00-6.00	0/100
BMEN 9100	013/13389		Elisa Konofagou	1.00-6.00	1/100
BMEN 9100	015/13390		Andrew Laine	1.00-6.00	5/100
BMEN 9100	017/13391		Kam Leong	1.00-6.00	2/100
BMEN 9100	018/13392		Helen Lu	1.00-6.00	2/100
BMEN 9100	019/13393		Barclay Morrison	1.00-6.00	0/100
BMEN 9100	021/13394		Elizabeth Olson	1.00-6.00	5/100
BMEN 9100	023/13395		Paul Sajda	1.00-6.00	3/100
BMEN 9100	025/13396		Kenneth Shepard	1.00-6.00	0/100
BMEN 9100	026/13397		Samuel Sia	1.00-6.00	0/100
BMEN 9100	027/13398		Milan Stojanovic	1.00-6.00	0/100
BMEN 9100	028/13399		Stavros Thomopoulos	1.00-6.00	1/100
BMEN 9100	029/13400		John Vaughan	1.00-6.00	0/100
BMEN 9100	030/13401		Gordana Vunjak-Novakovic	1.00-6.00	4/100
BMEN 9100	031/13402		Qi Wang	1.00-6.00	1/100
BMEN 9100	032/13403		Nandan Nerurkar	1.00-6.00	1/100
BMEN 9100	033/13404		Stephen Tsang	1.00-6.00	1/100
BMEN 9100	034/13405		Elham Azizi	1.00-6.00	0/100
BMEN 9100	035/13406		Jose McFaline-Figueroa	1.00-6.00	1/100
BMEN 9100	036/13407		Treena Arinzeh	1.00-6.00	0/100
BMEN 9100	037/13408		Sanja Vickovic	1.00-6.00	0/100
BMEN 9100	038/13409		Santiago Correa	1.00-6.00	4/100
BMEN 9100	039/13410		Kaveri Thakoor	1.00-6.00	0/100
BMEN 9100	040/13411		Yvon Woappi	1.00-6.00	2/100
BMEN 9100	041/13412		Yasmine El-Shamayleh	1.00-6.00	0/100
BMEN 9100	042/13413		Alice Huang	1.00-6.00	0/100
BMEN 9100	043/13414		Ke Cheng	1.00-6.00	0/100
BMEN 9100	044/13415		Grace McIlvain	1.00-6.00	2/100
BMEN 9100	045/13416		Despina Kontos	1.00-6.00	0/100
BMEN 9100	046/13417		Nadeen Chahine	1.00-6.00	0/100
BMEN 9100	047/16020		Parisa Yousefpour	1.00-6.00	4/100
BMEN 9100	048/17129		Iok In Chio	1.00-6.00	2/100
BMEN 9100	049/19891		Hasan Abaci	1.00-6.00	1/100

Summer 2026: BMEN E9100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9100	001/11224		Clark Hung	1.00-6.00	2/100
BMEN 9100	002/11220		Elizabeth Olson	1.00-6.00	2/100
BMEN 9100	009/11833		Gordana Vunjak-Novakovic	1.00-6.00	1/100

Fall 2026: BMEN E9100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment

BMEN E9200 Master's Thesis in BME. *0.00 points*.
This is a Pass/Fail zero credit course, "BME Master's Thesis" for MS students who are in the process of doing a thesis (BMEN E9100). It would be registered for before/during the final semester, the semester when the student will be defending the thesis. It must be approved by the faculty mentor

Spring 2026: BMEN E9200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9200	001/16498		Treena Arinzeh	0.00	0/100
BMEN 9200	002/16490		Elham Azizi	0.00	0/100
BMEN 9200	003/16491		Ke Cheng	0.00	0/100
BMEN 9200	004/16497		Santiago Correa	0.00	0/100
BMEN 9200	005/16500		Tal Danino	0.00	0/100
BMEN 9200	006/16503		X. Edward Guo	0.00	0/100
BMEN 9200	007/16504		Henry Hess	0.00	0/100
BMEN 9200	008/16506		Clark Hung	0.00	1/100
BMEN 9200	009/16509		Lance Kam	0.00	0/100
BMEN 9200	010/16511		Elisa Konofagou	0.00	0/100
BMEN 9200	011/16512		Andrew Laine	0.00	0/100
BMEN 9200	012/16513		Kam Leong	0.00	0/100
BMEN 9200	013/16514		Helen Lu	0.00	0/100
BMEN 9200	014/16515		Jose McFaline-Figueroa	0.00	0/100
BMEN 9200	015/16516		Grace McIlvain	0.00	0/100
BMEN 9200	016/16517		Barclay Morrison	0.00	0/100
BMEN 9200	017/16518		Nandan Nerurkar	0.00	0/100
BMEN 9200	018/16519		Elizabeth Olson	0.00	1/100
BMEN 9200	019/16520		Nuttida Rungratsameetaweemana	0.00	0/100
BMEN 9200	020/16521		Paul Sajda	0.00	0/100
BMEN 9200	021/16522		Samuel Sia	0.00	0/100
BMEN 9200	022/16523		John Vaughan	0.00	0/100
BMEN 9200	023/16524		Gordana Vunjak-Novakovic	0.00	0/100
BMEN 9200	024/16525		Qi Wang	0.00	0/100
BMEN 9200	025/16526		Megan Heenan	0.00	0/100
BMEN 9200	026/16527		Parisa Yousefpour	0.00	0/100

BMEN E9500 DOCTORAL RESEARCH. *1.00-6.00 points*.
Doctoral candidates are required to make an original investigation of a problem in biomedical engineering, the results of which are presented in the dissertation

Spring 2026: BMEN E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9500	001/13418		Gerard Ateshian	1.00-6.00	0/100
BMEN 9500	002/13419		Tal Danino	1.00-6.00	1/100
BMEN 9500	003/13420		X. Edward Guo	1.00-6.00	4/100
BMEN 9500	004/13421		Henry Hess	1.00-6.00	4/100
BMEN 9500	007/13422		Shunichi Homma	1.00-6.00	0/100
BMEN 9500	008/13423		Clark Hung	1.00-6.00	3/100
BMEN 9500	010/13424		Joshua Jacobs	1.00-6.00	0/100
BMEN 9500	012/13425		Lance Kam	1.00-6.00	0/100
BMEN 9500	013/13426		Elisa Konofagou	1.00-6.00	2/100
BMEN 9500	015/13427		Andrew Laine	1.00-6.00	3/100
BMEN 9500	017/13428		Kam Leong	1.00-6.00	3/100
BMEN 9500	018/13429		Helen Lu	1.00-6.00	1/100
BMEN 9500	019/13430		Barclay Morrison	1.00-6.00	1/100
BMEN 9500	021/13431		Elizabeth Olson	1.00-6.00	1/100
BMEN 9500	022/13432		Paul Sajda	1.00-6.00	1/100
BMEN 9500	024/13433		Kenneth Shepard	1.00-6.00	0/100
BMEN 9500	025/13434		Samuel Sia	1.00-6.00	2/100
BMEN 9500	026/13435		Milan Stojanovic	1.00-6.00	0/100
BMEN 9500	027/13436		Stavros Thomopoulos	1.00-6.00	2/100
BMEN 9500	028/13437		John Vaughan	1.00-6.00	0/100
BMEN 9500	029/13438		Gordana Vunjak-Novakovic	1.00-6.00	0/100
BMEN 9500	030/13439		Qi Wang	1.00-6.00	2/100
BMEN 9500	032/13440		Nandan Nerurkar	1.00-6.00	2/100
BMEN 9500	033/13441		Stephen Tsang	1.00-6.00	3/100
BMEN 9500	034/13442		Elham Azizi	1.00-6.00	3/100
BMEN 9500	035/13444		Jose McFaline-Figueroa	1.00-6.00	1/100
BMEN 9500	036/13447		Treena Arinzeh	1.00-6.00	5/100
BMEN 9500	037/13450		Sanja Vickovic	1.00-6.00	2/100
BMEN 9500	038/13452		Santiago Correa	1.00-6.00	3/100
BMEN 9500	039/13455		Kaveri Thakoor	1.00-6.00	1/100
BMEN 9500	040/13459		Yvon Woappi	1.00-6.00	0/100
BMEN 9500	041/13461		Yasmine El-Shamayleh	1.00-6.00	0/100
BMEN 9500	042/13464		Ke Cheng	1.00-6.00	5/100
BMEN 9500	043/13467		Grace McIlvain	1.00-6.00	5/100
BMEN 9500	044/13470		Despina Kontos	1.00-6.00	2/100
BMEN 9500	045/13473		Nadeen Chahine	1.00-6.00	1/100
BMEN 9500	046/13486		Alice Huang	1.00-6.00	1/100
BMEN 9500	047/13487		Nuttida Rungratsameetaweemana	1.00-6.00	1/100
BMEN 9500	048/16006		Parisa Yousefpour	1.00-6.00	0/100
BMEN 9500	049/16007		Harris Wang	1.00-6.00	1/100
BMEN 9500	050/18248		Iok In Chio	1.00-6.00	2/100
BMEN 9500	051/20315		Sunil Agrawal	1.00-6.00	1/100

Fall 2026: BMEN E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9500	002/14319		Tal Danino	1.00-6.00	6/50

BMEN E9700 BIOMEDICAL ENGINEERING SEMINAR. *0.00 points*.
0 pts. Sem: 1.

All matriculated graduate students are required to attend the seminar as long as they are in residence. No degree credit is granted. The seminar is the principal medium of communication among those with biomedical engineering interests within the University. Guest speakers from other institutions, Columbia faculty, and students within the Department who are advanced in their studies frequently offer sessions

Spring 2026: BMEN E9700

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9700	001/13488	Th 1:10pm - 2:25pm 301 Pupin Laboratories	Elizabeth Olson, Qi Wang	0.00	135/272

Fall 2026: BMEN E9700

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9700	001/14378	Th 1:10pm - 2:25pm 717 Hamilton Hall	Camryn Hadley, Qi Wang, Elizabeth Olson	0.00	112/225

BMEN E9800 DOCTORAL RESEARCH INSTRUCTION. *3.00-12.00 points*.
A candidate for the Eng.Sc.D. degree in biomedical engineering must register for 12 points of doctoral research instruction. Registration may not be used to satisfy the minimum residence requirement for the degree

Spring 2026: BMEN E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9800	001/13490		Gerard Ateshian	3.00-12.000	/100
BMEN 9800	002/13491		Tal Danino	3.00-12.000	/100
BMEN 9800	003/13492		X. Edward Guo	3.00-12.000	/100
BMEN 9800	004/13493		Henry Hess	3.00-12.000	/100
BMEN 9800	007/13494		Shunichi Homma	3.00-12.000	/100
BMEN 9800	008/13495		Clark Hung	3.00-12.000	/100
BMEN 9800	012/13496		Lance Kam	3.00-12.000	/100
BMEN 9800	015/13498		Andrew Laine	3.00-12.000	/100
BMEN 9800	017/13499		Kam Leong	3.00-12.000	/100
BMEN 9800	018/13500		Helen Lu	3.00-12.000	/100
BMEN 9800	019/13501		Barclay Morrison	3.00-12.000	/100
BMEN 9800	021/13502		Elizabeth Olson	3.00-12.000	/100
BMEN 9800	022/13503		Paul Sajda	3.00-12.000	/100
BMEN 9800	024/13504		Kenneth Shepard	3.00-12.000	/100
BMEN 9800	025/13505		Samuel Sia	3.00-12.000	/100
BMEN 9800	026/13506		Milan Stojanovic	3.00-12.000	/100
BMEN 9800	028/13508		John Vaughan	3.00-12.000	/100
BMEN 9800	029/13509		Gordana Vunjak-Novakovic	3.00-12.000	/100
BMEN 9800	030/13510		Qi Wang	3.00-12.000	/100
BMEN 9800	032/13511		Nandan Nerurkar	3.00-12.000	/100
BMEN 9800	034/13512		Stephen Tsang	3.00-12.000	/100
BMEN 9800	035/13513		Elham Azizi	3.00-12.000	/100
BMEN 9800	036/13514		Jose McFaline-Figueroa	3.00-12.000	/100
BMEN 9800	037/13515		Treena Arinzeh	3.00-12.000	/100
BMEN 9800	038/13516		Sanja Vickovic	3.00-12.000	/100
BMEN 9800	039/13517		Santiago Correa	3.00-12.000	/100
BMEN 9800	040/13518		Kaveri Thakoor	3.00-12.000	/100
BMEN 9800	041/13519		Ke Cheng	3.00-12.000	/100
BMEN 9800	042/13520		Grace McIlvain	3.00-12.000	/100
BMEN 9800	043/13521		Despina Kontos	3.00-12.000	/100
BMEN 9800	044/13522		Nadeen Chahine	3.00-12.000	/100
BMEN 9800	045/16008		Parisa Yousefpour	3.00-12.000	/100

Fall 2026: BMEN E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9800	002/14353		Tal Danino	3.00-12.000	/50
BMEN 9800	003/14354		X. Edward Guo	3.00-12.000	/50
BMEN 9800	004/14355		Henry Hess	3.00-12.000	/50
BMEN 9800	007/14356		Clark Hung	3.00-12.000	/50
BMEN 9800	011/14357		Lance Kam	3.00-12.000	/50
BMEN 9800	012/14358		Elisa Konofagou	3.00-12.000	/50
BMEN 9800	014/14359		Andrew Laine	3.00-12.000	/50
BMEN 9800	016/14360		Kam Leong	3.00-12.000	/50
BMEN 9800	017/14361		Helen Lu	3.00-12.000	/50
BMEN 9800	018/14362		Barclay Morrison	3.00-12.000	/50
BMEN 9800	019/14363		Nandan Nerurkar	3.00-12.000	/50
BMEN 9800	020/14364		Elizabeth Olson	3.00-12.000	/50

BMEN E9900 DOCTORAL DISSERTATION. *0.00 points*.
0 pts.

A candidate for the doctorate in biomedical engineering or applied biology may be required to register for this course in every term after the students course work has been completed and until the dissertation has been accepted

Spring 2026: BMEN E9900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEN 9900	001/13523		Gerard Ateshian	0.00	0/100
BMEN 9900	002/13524		Tal Danino	0.00	0/100
BMEN 9900	003/13525		X. Edward Guo	0.00	0/100
BMEN 9900	004/13526		Henry Hess	0.00	0/100
BMEN 9900	007/13527		Shunichi Homma	0.00	0/100
BMEN 9900	008/13528		Clark Hung	0.00	0/100
BMEN 9900	012/13531		Lance Kam	0.00	0/100
BMEN 9900	013/13533		Elisa Konofagou	0.00	0/100
BMEN 9900	015/13534		Andrew Laine	0.00	0/100
BMEN 9900	017/13535		Kam Leong	0.00	0/100
BMEN 9900	018/13536		Helen Lu	0.00	0/100
BMEN 9900	019/13537		Barclay Morrison	0.00	0/100
BMEN 9900	021/13538		Elizabeth Olson	0.00	0/100
BMEN 9900	022/13539		Paul Sajda	0.00	0/100
BMEN 9900	024/13540		Kenneth Shepard	0.00	0/100
BMEN 9900	025/13541		Samuel Sia	0.00	0/100
BMEN 9900	026/13542		Milan Stojanovic	0.00	0/100
BMEN 9900	027/13543		Stavros Thomopoulos	0.00	0/100
BMEN 9900	028/13544		John Vaughan	0.00	0/100
BMEN 9900	032/13545		Nandan Nerurkar	0.00	0/100
BMEN 9900	034/13546		Stephen Tsang	0.00	0/100
BMEN 9900	035/13547		Gordana Vunjak-Novakovic	0.00	0/100
BMEN 9900	036/13548		Qi Wang	0.00	0/100
BMEN 9900	037/13549		Elham Azizi	0.00	0/100
BMEN 9900	038/13550		Jose McFaline-Figueroa	0.00	0/100
BMEN 9900	039/13551		Treena Arinzeh	0.00	0/100
BMEN 9900	040/13552		Sanja Vickovic	0.00	0/100
BMEN 9900	041/13553		Santiago Correa	0.00	0/100
BMEN 9900	042/13554		Kaveri Thakoor	0.00	0/100
BMEN 9900	043/13555		Ke Cheng	0.00	0/100
BMEN 9900	044/13556		Grace McIlvain	0.00	0/100
BMEN 9900	045/13557		Despina Kontos	0.00	0/100
BMEN 9900	046/13558		Nadeen Chahine	0.00	0/100

CBMF W4761 COMPUTATIONAL GENOMICS. *3.00 points*.
Lect: 3.

Prerequisites: Working knowledge of at least one programming language, and some background in probability and statistics.
Computational techniques for analyzing genomic data including DNA, RNA, protein and gene expression data. Basic concepts in molecular biology relevant to these analyses. Emphasis on techniques from artificial intelligence and machine learning. String-matching algorithms, dynamic programming, hidden Markov models, expectation-maximization, neural networks, clustering algorithms, support vector machines. Students with life sciences backgrounds who satisfy the prerequisites are encouraged to enroll

Spring 2026: CBMF W4761

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CBMF 4761	001/12331	M W 5:40pm - 6:55pm 209 Havemeyer Hall	Cassandra Burdziak	3.00	47/60

ECBM E4040 NEURAL NETWRKS # DEEP LEARNING. *3.00 points*.
Lect: 3.

Prerequisites: (BMEB W4020) or (BMEE E4030) or (ECBM E4090) or (EECS E4750) or (COMS W4771) or BMEB W4020 OR BMEE E4030 OR ECBM E4090 OR EECS E4750 OR COMS W4771; or equivalent.
Developing features - internal representations of the world, artificial neural networks, classifying handwritten digits with logistics regression, feedforward deep networks, back propagation in multilayer perceptrons, regularization of deep or distributed models, optimization for training deep models, convolutional neural networks, recurrent and recursive neural networks, deep learning in speech and object recognition

Fall 2026: ECBM E4040

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4040	001/11220		Zoran Kostic	3.00	109/152

ECBM E4060 INTRO-GENOMIC INFO SCI # TECH. *3.00 points*.
Lect: 3.

Introduction to computational biology with emphasis on genomic data science tools and methodologies for analyzing data, such as genomic sequences, gene expression measurements and the presence of mutations. Applications of machine learning and exploratory data analysis for predicting drug response and disease progression. Latest technologies related to genomic information, such as single-cell sequencing and CRISPR, and the contributions of genomic data science to the drug development process

Fall 2026: ECBM E4060

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4060	001/11270	M 7:00pm - 9:30pm 717 Hamilton Hall	Tai-Hsien Ou Yang	3.00	21/80

ECBM E4070 Computing with Brain Circuits of Model Organisms. *3.00 points*.
Prerequisites: BIOL W3004 AND ELEN E3801; and Python programming experience, or instructor's permission.
Building the functional map of the fruit fly brain. Molecular transduction and spatio-temporal encoding in the early visual system. Predictive coding in the Drosophila retina. Canonical circuits in motion detection. Canonical navigation circuits in the central complex. Molecular transduction and combinatorial encoding in the early olfactory system. Predictive coding in the antennal lobe. The functional role of the mushroom body and the lateral horn. Canonical circuits for associative learning and innate memory. Projects in Python

Spring 2026: ECBM E4070

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4070	001/11503	M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building	Aurel Lazar	3.00	16/50
ECBM 4070	V01/16652		Aurel Lazar	3.00	1/99

ECBM E4090 BRAIN COMPUTER INTERFACES LAB. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (ELEN E3801) ELEN E3801
Hands-on experience with basic neural interface technologies. Recording EEG (electroencephalogram) signals using data acquisition systems (non-invasive, scalp recordings). Real-time analysis and monitoring of brain responses. Analysis of intention and perception of external visual and audio signals

ECBM E6070 TPC NEUROSCI # DEEP LEARN. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in neuroscience and deep learning. Content varies from year to year, and different topics rotate through the course numbers 6070 to 6079.

Spring 2026: ECBM E6070

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 6070	001/11516	M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building	Aurel Lazar	3.00	10/50
ECBM 6070	V01/16655		Aurel Lazar	3.00	1/99

EEBM E6090 TPCS:COMPUT NEUROSCI/NEUROENGI. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099

EEBM E6091 TPCS IN COMP NEUROSCI/ENGINEERING. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099. Topic: Devices and Analysis for Neural Circuits

EEBM E6095 TOPICS IN COMP NEUROSI # ENG. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090 to 6099

EEBM E6099 TPCS:COMPUT NEUROSCI/NEUROENGI. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neurscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099

MEBM E4439 MODELING # ID OF DYNAMIC SYST. *3.00 points*.
Prerequisites: (APMA E2101) and (ELEN E3801) or APMA E2101 AND ELEN E3801; EEME E3601; APMA E2101, ELEN E3801, or corequisite EEME E3601, or permission of instructor.
Corequisites: EEME E3601
Generalized dynamic system modeling and simulation. Fluid, thermal, mechanical, diffusive, electrical, and hybrid systems are considered. Nonlinear and high order systems. System identification problem and Linear Least Squares method. State-space and noise representation. Kalman filter. Parameter estimation via prediction-error and subspace approaches. Iterative and bootstrap methods. Fit criteria. Wide applicability: medical, energy, others. MATLAB and Simulink environments

MEBM E4710 MORPHOGENESIS:BIOL MAT SHP/STR. *3.00 points*.
Prerequisites: Courses in mechanics, thermodynamics, and ordinary differential equations at the undergraduate level or instructor's permission.
Introduction to how shape and structure are generated in biological materials using engineering approach emphasizing application of fundamental physical concepts to a diverse set of problems. Mechanisms of pattern formation, self-assembly, and self-organization in biological materials, including intracellular structures, cells, tissues, and developing embryos. Structure, mechanical properties, and dynamic behavior of these materials. Discussion of experimental approaches and modeling. Course uses textbook materials as well as collection of research papers

Undergraduate Programs

- Biomedical Engineering (BS) (p. 88)
- Integrated B.S./M.S. Program in Biomedical Engineering (p. 94)
- Biomedical Engineering Minor (p. 327)

Biomedical Engineering (BS)

The BS Biomedical Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Bioengineering and Biomedical and Similarly Named Engineering Programs. The Program Educational Objectives of the undergraduate program in biomedical engineering are as follows:

1. Professional employment in areas such as the medical device industry, engineering consulting, biomechanics, biomedical imaging, and biotechnology
2. Graduate studies in biomedical engineering or related fields;
3. Attendance at medical or dental school.

The undergraduate program in biomedical engineering will prepare graduates to achieve the following Student Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The undergraduate curriculum is designed to provide broad knowledge of the physical and engineering sciences and their application to the solution of biological and medical problems. Students are strongly encouraged to take courses in the order specified in the course tables; deviations must be discussed with a departmental adviser and approved by the department before registration. The first two years provide a strong grounding in the physical and chemical sciences, engineering fundamentals, mathematics, and modern biology. This background is used to provide a unique physical approach to the study of biological systems. The last two years of the undergraduate program provide substantial exposure to fundamentals in biomedical engineering with emphasis on the integration of principles of biomedical engineering, quantitative analysis of physiology, and experimental quantification and measurements of biomedical systems.

The common core biomedical engineering curriculum provides a broad yet solid foundation in biomedical engineering. The flexible choice of technical electives in the Department of Biomedical Engineering, other departments in the Engineering School, as well as in other departments in the arts and sciences allows students to broaden their biomedical engineering education to their individualized interests for a personalized curriculum. These qualities allow the faculty to prepare students for activity in all contemporary areas of biomedical engineering. Graduates of the program are equipped for employment in the large industrial sector devoted to health care, which includes pharmaceuticals, medical devices, artificial organs, prosthetics and sensory aids, diagnostics, medical instrumentation, and medical imaging. Graduates also accept employment in oversight organizations (FDA, NIH, OSHA, and others), medical centers, and research institutes. They are prepared for graduate study in biomedical engineering and several related areas of engineering and the health sciences. Students can meet entrance requirements for graduate training in the various allied health professions. No more than three additional courses are required to satisfy entrance requirements for most U.S. medical schools.

All biomedical engineering students are expected to register for nontechnical electives, both those specifically required by the School of Engineering and Applied Science and those needed to meet the 27-point total of nontechnical electives required for graduation.

First and Second Years

As outlined in this bulletin, in the first two years, all engineering students are expected to complete a sequence of courses in mathematics, physics, chemistry, computer science, engineering, modern biology, English composition, and physical education, as well as nontechnical electives including the humanities. For most of these sequences, the students may choose from two or more tracks. If there is a question regarding the acceptability of a course as a nontechnical elective, please consult the approved listing of courses in Liberal Arts Core for Columbia Engineering 27-Point Nontechnical Requirement (p. 8) or contact your advising dean for clarification.

Please see the charts in this section for a specific description of course requirements.

For students who are interested in the biomedical engineering major, they must take ELEN E1201 INTRO-ELECTRICAL ENGINEERING. For the computer science requirement, students must take ENGI E1006 INTRO TO COMP FOR ENG/APP SCI. They must take the two-semester BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC and BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS in the second year, which gives students a comprehensive overview of modern biology from molecular to organ system levels. In addition, all students must take APMA E2101 INTRO TO APPLIED MATHEMATICS and BMEN E2910 Introduction to Biomedical Engineering Design in their second year.

Third and Fourth Years

The biomedical engineering programs at Columbia are based on engineering and biological fundamentals. This is emphasized in our core requirements, which cannot be waived nor substituted. All students must take the two-semester introduction to biomedical engineering courses, BMEN E3010 BIOMEDICAL ENGINEERING I and BMEN E3020 BIOMEDICAL ENGINEERING II, which provide a broad yet solid foundation in the biomedical engineering discipline. In parallel, all students take the two-semester *Quantitative physiology, I* and *II* sequence (BMEN E4001 QUANTITATIVE PHYSIOLOGY I- BMEN E4002 QUANT PHYSIOLOGY II:ORGAN SYST), which is taught by biomedical engineering faculty and emphasizes quantitative applications of engineering principles in understanding biological systems and phenomena from molecular to organ system levels. In the fields of biomedical engineering, experimental techniques and principles are fundamental skills that good biomedical engineers must master. Beginning in junior year, all students take the two-semester sequence *Biomedical engineering laboratory, I & II* (BMEN E3810 BIOMEDICAL ENGINEERING LAB I, BMEN E3820 BIOMEDICAL ENGINEERING LAB II). In this two-semester series, students learn through hands-on experience the principles and methods of biomedical engineering experimentation, measurement techniques, quantitative theories of biomedical engineering, data analysis, and independent design of biomedical engineering experiments, in parallel to the *Biomedical engineering I & II* and *Quantitative physiology I & II* courses. In addition, all students must take BMEN E4110 BIOSTATISTICS FOR ENGINEERS. In the senior year, students are required to take a two-semester capstone design course, *Biomedical engineering design* (BMEN E3910 BIOMEDICAL ENGINEERING DESIGN and BMEN E3920 BIOMEDICAL ENGIN DESIGN II), in which students work within a team to tackle an open-ended design project in biomedical engineering. The underlying philosophy of these core requirements is to provide

our biomedical engineering students with a broad knowledge and understanding of topics in the field of biomedical engineering.

Parallel to these studies in core courses, students are required to take flexible technical elective courses, which are defined in the following section. The curriculum prepares students who wish to pursue careers in medicine by satisfying most requirements in the premedical programs with no more than three additional courses. Some of these additional courses may also be counted as nonengineering technical electives. Please see the course tables for schedules leading to a bachelor's degree in biomedical engineering.

It is strongly advised that students take required courses during the specific term that they are designated in the course tables, as scheduling conflicts may arise if courses are taken out of sequence.

Technical Elective Requirements

Technical electives provide in-depth understanding of a student's chosen interests. A technical elective is defined as a 3000-level or above course taught in SEAS or 3000-level or above course in biology, chemistry, biochemistry, or biotechnology. 2000-level organic chemistry and biochemistry courses may also count toward technical electives; please consult your adviser.

Students are required to take 18 points of technical electives. Of these, at least 12 points must be clearly engineering in nature (Engineering Content Technical Electives) as defined below. In addition, at least 6 points of the Engineering Content electives must be from courses in the Department of Biomedical Engineering.

1. Engineering Content Technical Electives provide sufficient engineering content to count toward the 48 units of engineering courses required for ABET accreditation and are defined as:
   a. All 3000-level or higher courses in the Department of Biomedical Engineering, except

BMEN E4010	
BMEN E4108	
BMEN E6510	STEM CELL, GENOME ENG # REGEN MED
BMEN E4000	SPECIAL TOPICS IN BIOMEDICAL ENGINEERING (fall 2019)

   (Note that only 3 points of BMEN E3998 PROJECTS IN BIOMEDICAL ENGIN may be counted toward technical elective degree requirements.)
   b. All 3000-level or higher courses in the Department of Mechanical Engineering, except MECE E4007 CREATIVE ENG # ENTREPRENEURSHP
   c. All 3000-level or higher courses in the Department of Chemical Engineering, except CHEN E4020 PROTECTN OF INDUST/INTELL PROP
   d. All 3000-level or higher courses in the Department of Electrical Engineering
   e. All 3000-level or higher courses in the Civil Engineering and Engineering Mechanics program, except

CIEN E4129	MANAGING ENG # CONST PROCESSES
CIEN E4130	DESIGN OF CONSTRUCTION SYSTEMS
CIEN E4131	PRIN OF CONSTRUCTN TECHNIQUES
CIEN E4132	PREV#RESOL OF CONSTR DISPUTES
CIEN E4133	CAPITAL FACILITY PLANNING/FIN
CIEN E4134	CONSTRUCTION INDUSTRY LAW
CIEN E4135	STRATEGIC MGT - ENG # CONSTR
CIEN E4136	Entrepreneurship in Engineering and Construction
CIEN E4138	REAL ESTATE FIN/CONST MANAG
CIEN E4140	ENVIR,HLTH,SAFETY CONC CONSTR

   f. All 3000-level or higher courses in the Earth and Environmental Engineering program
2. Courses from the following departments are not allowed to count toward the required 48 units of engineering courses:
   a. Department of Applied Physics and Applied Mathematics
   b. Department of Computer Science
   c. Department of Industrial Engineering and Operations Research
   d. Program of Materials Science and Engineering

Once 48 points of engineering content are satisfied, students may choose their remaining technical electives as defined at the beginning of this section.

If a 3000-level or greater course is cross listed between two departments, eligibility as an engineering content technical elective is determined by either of the listed departments in its designation, independent of order. At least one of the programs that are listed must be ABET-accredited to be considered engineering content. For example, APBM E4650 ANATOMY FOR PHYSICISTS # ENGR Anatomy for physicists & engineers and BMCH E4810 ARTIFICAL ORGANS are both engineering content technical electives. Finally, a cross-listed course that is greater than or equal to 3000 level and with BMEN in its call letters will qualify as a BME Engineering Technical Elective.

The accompanying charts describe the eight-semester degree program schedule of courses leading to the bachelor's degree in biomedical engineering.

The undergraduate Biomedical Engineering program is designed to provide a solid biomedical engineering curriculum through its core requirements while providing flexibility to meet the individualized interests of the students. All students are encouraged to design their own educational paths through technical electives. The following grouped courses provide a useful guide for students who wish to focus their studies in a particular Biomedical Engineering topic. The requirements for these elective concentrations are identical to those of the major's course requirements. To declare and earn this designation a student must take at least four of the courses listed for that concentration, and at least two of those must be biomedical engineering courses. It is not necessary to declare a concentration for the B.S. program.

To meet entrance requirements of most U.S. medical schools, students will need to take BIOC GU4501 BIOCHEM I-STRUCTURE/METABOLISM (4), CHEM UN2543 ORGANIC CHEMISTRY LABORATORY Organic chemistry laboratory (3), PHYS UN1494 INTRO TO EXPERIMENTAL PHYS-LAB (3), and PSYC UN1001 THE SCIENCE OF PSYCHOLOGY (3) as well.

Biomems and Nanotechnology

MECE E3100	INTRO TO MECHANCIS OF FLUIDS
MSAE E4090	NANOTECHNOLOGY
ENME E3113	MECHANICS OF SOLIDS

MECE E4212	MICROELECTROMECHANICAL SYSTEMS
BMEN E4550	MICRO/NANO STRUCT CELL ENG
BMEN E4580	FOUND OF NANOBIOSCI/NANOBIOTECH
BMEN E4590	BIOMEMS:CELL/MOLECULAR APPLIC
BMEN E4335	

Bioinformatics and Machine Learning

BIOL UN3041	CELL BIOLOGY
COMS W3101	PROGRAMMING LANGUAGES
COMS W3137	HONORS DATA STRUCTURES # ALGOL
BINF G4006	TRANSLATIONAL BIOINFORMATICS
BINF G4015	COMP SYS BIO:PROTEINS,NETWK,FUN
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
ECBM E4060	INTRO-GENOMIC INFO SCI # TECH
STAT GU4241	STATISTICAL MACHINE LEARNING
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
BMEN E4420	SIGNAL MODELING
BMEN E4460	Deep Learning in Biomedical Imaging
BMEN E4470	Deep Learning for Biomedical Signal Processing
COMS W4701	ARTIFICIAL INTELLIGENCE
CBMF W4761	COMPUTATIONAL GENOMICS
COMS W4771	MACHINE LEARNING
BMEN E4895	Analysis and Quantification of Medical Images

Biomaterials

MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE
BMEN E4501	Biomaterials and Scaffold Design
BMEN E4510	TISSUE ENGINEERING
BMEN E4520	SYNTHETIC BIOLOGY:PRIN GENETIC CIRCUITS
BMEN E4530	DRUG AND GENE DELIVERY
BMEN E4590	BIOMEMS:CELL/MOLECULAR APPLIC
MEBM E4710	MORPHOGENESIS:BIOL MAT SHP/STR
CHEN E4800	PROTEIN ENGINEERING
BMEN E4525	Advanced Cell and Tissue Engineering: From Concepts to Translation
BMEN E4335	

Biomechanics

MECE E3100	INTRO TO MECHANCIS OF FLUIDS
ENME E3105	MECHANICS
ENME E3105	MECHANICS
MECE E3301	THERMODYNAMICS
ENME E3113	MECHANICS OF SOLIDS
BMEN E4301	
BMEN E4302	BIOMECHANICS OF MUSCULOSKELETAL SOFT TIS
BMEN E4310	SOLID BIOMECHANICS
BMEN E4320	FLUID BIOMECHANICS
BMEN E4340	BIOMECHANICS OF CELLS
MEBM E4710	MORPHOGENESIS:BIOL MAT SHP/STR
BMEN E4750	SOUND AND HEARING

Biosignals and Biomedical Imaging

BMEN E4410	PRIN OF ULTRASOUND IN MEDICINE
ELEN E3801	SIGNALS AND SYSTEMS
BMEN E4420	SIGNAL MODELING
BMEN E4430	PRIN OF MAG RESONANCE IMAGING
BMEE E4740	BIOINSTRUMENTATION
ELEN E4810	DIGITAL SIGNAL PROCESSING
BMEN E4894	BIOMEDICAL IMAGING
BMEN E4898	BIOPHOTONICS
BMEN E4460	Deep Learning in Biomedical Imaging
BMEN E4470	Deep Learning for Biomedical Signal Processing

Cell and Tissue Engineering

CHEM UN2443	ORGANIC CHEMISTRY I-LECTURES
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES
BMEN E4210	DRIVING FORCES OF BIOLOGICAL SYSTEMS
BMEN E4310	SOLID BIOMECHANICS
BMEN E4501	Biomaterials and Scaffold Design
BMEN E4510	TISSUE ENGINEERING
BMEN E4550	MICRO/NANO STRUCT CELL ENG
BMEN E4330	Cellular Bioengineering # Therapeutics
BMEN E4335	
BMEN E4520	SYNTHETIC BIOLOGY:PRIN GENETIC CIRCUITS
BMEN E4525	Advanced Cell and Tissue Engineering: From Concepts to Translation

Design, Innovation, and Entrepreneurship

MECE E3408	COMPUTER GRAPHICS # DESIGN
ENGI W4100	RESEARCH TO REVENUE
BIOT GU4160	BIOTECHNOLOGY LAW
BIOT GU4161	ETHICS IN BIOPHARM PAT/REG LAW
BIOT GU4200	BIOPHARMACEUTICAL DEV # REG
BIOT GU4201	SEM-BIOTECH DEVPT # REGULATION
BMEE E4740	BIOINSTRUMENTATION
CHEN E4920	PHARMACEUTICAL INDUSTRY FOR ENGINEERS

Genomics and Systems Biology

CHBM E4321	The genome and the cell
APMA E4400	INTRO TO BIOPHYSICAL MODELING
BMEN E4420	SIGNAL MODELING
BMEN E4520	SYNTHETIC BIOLOGY:PRIN GENETIC CIRCUITS
BMEN E4530	DRUG AND GENE DELIVERY
BMEN E4590	BIOMEMS:CELL/MOLECULAR APPLIC
CHEN E4700	PRINCIPLES OF GENOMIC TECHNOL
CHEN E4760	
CHEN E4800	PROTEIN ENGINEERING
BMCS E4480	Statistical machine learning for genomics

Neural Engineering

BMEB W4020	Computational neuroscience: circuits in the brain
ELEN E3801	SIGNALS AND SYSTEMS
BMEE E4030	NEURAL CONTROL ENGINEERING
BMEN E4050	ELECTROPHYS OF HUM MEMORY * NAVIGATION

BMEN E4310	SOLID BIOMECHANICS
BMEN E4420	SIGNAL MODELING
BMEN E4430	PRIN OF MAG RESONANCE IMAGING
ELEN E4810	DIGITAL SIGNAL PROCESSING
BMEN E4894	BIOMEDICAL IMAGING
ECBM E4090	BRAIN COMPUTER INTERFACES LAB
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING

Premed and Pre-Health Professional

CHEM UN2443	ORGANIC CHEMISTRY I-LECTURES
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES
CHEM UN2493	ORGANIC CHEM. LAB I TECHNIQUES
CHEM UN2494	ORGANIC CHEM. LAB II SYNTHESIS
BIOC UN3300	BIOCHEMISTRY
BMEN E4320	FLUID BIOMECHANICS
BMEN E4410	PRIN OF ULTRASOUND IN MEDICINE
BMEN E4530	DRUG AND GENE DELIVERY

Robotics and Control of Biological Systems

MECE E3100	INTRO TO MECHANCIS OF FLUIDS
ENME E3105	MECHANICS
BMEE E4030	NEURAL CONTROL ENGINEERING
ENME E3113	MECHANICS OF SOLIDS
BMEN E4050	ELECTROPHYS OF HUM MEMORY * NAVIGATION
MEBM E4439	MODELING # ID OF DYNAMIC SYST
MECE E4602	INTRODUCTION TO ROBOTICS
BMEE E4740	BIOINSTRUMENTATION

Biomedical Engineering Program

An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I

Choose one of the following Chemistry courses depending on sequence:

CHEM UN1403 (Sequence 1)	GENERAL CHEMISTRY I-LECTURES
CHEM UN1500 (taken Semester I or II Sequence 1)	GENERAL CHEMISTRY LABORATORY
CHEM UN1604 (Sequence 2)	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045 (Sequence 3)	INTENSVE ORGANIC CHEMISTRY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (taken Semester I or II)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001[1]	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)[1]	THE ART OF ENGINEERING
HUMA UN1121 or UN1123 (taken Semester I or II)[1]	Art Humanities

Semester II

APMA E2000 (taken Semester II or III)	MULTV. CALC. FOR ENGI # APP SCI
APMA E2001 (taken Semester II or III)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

Choose one of the following Chemistry courses depending on sequence:

CHEM UN1404 (Sequence 1)	GENERAL CHEMISTRY II-LECTURES
CHEM UN1500 (taken Semester I or II Sequence 1)	GENERAL CHEMISTRY LABORATORY
CHEM UN1507 (Sequence 2)	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN2046 (Sequence 3)	INTENSVE ORG CHEM-FOR 1ST YEAR
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
PHED UN1002[1]	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)[1]	THE ART OF ENGINEERING
HUMA UN1121 or UN1123 (taken Semester I or II)[1]	Art Humanities

Second Year

Semester III

APMA E2000 (taken Semester II or III)	MULTV. CALC. FOR ENGI # APP SCI
APMA E2001 (taken Semester II or III)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on sequence:

PHYS UN1403 (Sequence 1)	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Sequence 2)	PHYSICS III:CLASS/QUANTUM WAVE

Choose one of the following Nontechnical Requirements:[1]

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3-4)	
ELEN E1201	INTRO-ELECTRICAL ENGINEERING
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC

Semester IV

Choose one of the following Nontechnical Requirements:[1]

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3-4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
APMA E2101	INTRO TO APPLIED MATHEMATICS
BIOL UN2006	INTRO BIO II:CELL BIO,DEV/PHYS
BMEN E2910	Introduction to Biomedical Engineering Design

Third Year

Semester V

BMEN E3010	BIOMEDICAL ENGINEERING I
BMEN E3810	BIOMEDICAL ENGINEERING LAB I
BMEN E4001	QUANTITATIVE PHYSIOLOGY I
BMEN E4110	BIOSTATISTICS FOR ENGINEERS

Nontech Elective (3 points)

Semester VI

BMEN E3020	BIOMEDICAL ENGINEERING II
BMEN E3820	BIOMEDICAL ENGINEERING LAB II
BMEN E4002	QUANT PHYSIOLOGY II:ORGAN SYST

Technical Elective (3 points)[2]

Nontech Elective (3 points)

Fourth Year

Semester VII

BMEN E3910	BIOMEDICAL ENGINEERING DESIGN

Technical Electives (9 points)[2]

Nontech Electives (3 points)

Semester VIII

BMEN E3920	BIOMEDICAL ENGIN DESIGN II

Technical Electives (6 points)[2]

[1] Students can mix these requirements according to what is available.

[2] Five of seven technical electives must have engineering content, and two of them must be from the Biomedical Engineering Department.

Integrated B.S./M.S. Program in Biomedical Engineering

The B.S./M.S. degree program is open to a select group of Columbia juniors and makes possible the earning of both the B.S. and M.S. degrees in an integrated fashion. Benefits of this program include the matching of graduate courses with the corresponding prerequisites, a greater ability to plan ahead for optimal course planning, and a simplified application process with no GRE required. Up to 6 points from the B.S. degree requirements, specifically BMEN E4001 QUANTITATIVE PHYSIOLOGY I and BMEN E4002 QUANT PHYSIOLOGY II:ORGAN SYST, will also count toward fulfilling the M.S. degree course requirements. To qualify for this program, students must have a cumulative GPA of at least 3.4 and should apply for the program by April 30 in their junior year. For more information on requirements and application process, please visit bme.columbia.edu.

Graduate Programs

The graduate curriculum in biomedical engineering is track-free. Initial graduate study in biomedical engineering is designed to expand the student's undergraduate preparation in the direction of the concentration of interest. In addition, sufficient knowledge is acquired in other areas to facilitate broad appreciation of problems and effective collaboration with specialists from other scientific, medical, and engineering disciplines. The Department of Biomedical Engineering offers a graduate program leading to the Master of Science degree (M.S.), the Doctor of Philosophy degree (Ph.D.), and the Doctor of Engineering Science degree (Eng.Sc.D.). Applicants who have a Master of Science degree or equivalent may apply directly to the doctoral degree program. All applicants are expected to have earned the bachelor's degree in engineering or in a cognate scientific program. The Graduate Record Examination (General Test only) is optional for all applicants. Students whose bachelor's degree was not earned in a country where English is the dominant spoken language are required to take the TOEFL, IELTS, PTE Academic, or Duolingo English Test.

Columbia Engineering does not admit students holding the bachelor's degree directly to doctoral studies; admission is offered either to the M.S. program or to the M.S. program/doctoral track. The Department of Biomedical Engineering also admits students into the 4-2 program, which provides the opportunity for students holding a bachelor's degree from certain physical sciences to receive the M.S. degree after two years of study at Columbia.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Biomedical Engineering (MS) (p. 94)
- Biomedical Engineering (PhD) (p. 96)
- Biomedical Engineering (MD/MS) (p. 96)

Biomedical Engineering (MS)

Master's Degree

In consultation with an appointed faculty adviser, M.S. students should select a program of 30 points of credit of graduate courses (4000-level or above) appropriate to their career goals. This program must include the course in computational modeling of physiological systems (BMEN E6003 COMP MODELING-PHYSIOL SYSTEMS); two semesters of BMEN E9700 BIOMEDICAL ENGINEERING SEMINAR; at least four other biomedical engineering courses where BM is in its call letters; and at least one graduate-level course (at least 3 credits) either in the departments of Applied Mathematics or Statistics or BMEN E4110 BIOSTATISTICS FOR ENGINEERS. Up to 6 credits of BMEN E9100 MASTERS RESEARCH may be taken to fulfill degree requirements. Up to 3 credits of coursework outside of SEAS may count toward the MS degree. Students with deficiency in physiology coursework are advised to take the BMEN E4001 QUANTITATIVE PHYSIOLOGY I-BMEN E4002 QUANT PHYSIOLOGY II:ORGAN SYST sequence before taking BMEN E6003 COMP MODELING-PHYSIOL SYSTEMS. Candidates must achieve a minimum grade-point average of 2.5. A thesis based on experimental, computational, or analytical research is optional. Students wishing to pursue the Master's Thesis option are required to complete 5-6 credits of BMEN E9100 MASTERS RESEARCH and consult with their BME faculty adviser **to register for BMEN E9200.**

MS concentrations are not required. The following grouped courses are a useful guide for students who wish to focus their studies in a particular Biomedical Engineering topic. If a student chooses to declare a concentration, the requirements for these elective concentrations are identical to those of the standard track (including BMEN E6003 COMP MODELING-PHYSIOL SYSTEMS, Applied Math / Statistics / BMEN E4110 BIOSTATISTICS FOR ENGINEERS, BMEN E9700 BIOMEDICAL ENGINEERING SEMINAR, four BMEN courses, and three or more SEAS courses, comprising at least 27 credits in SEAS out of a total 30 required credits), with one exception: students must take at least 12 credits from a list of track-specific courses.

Bioinformatics and Machine Learning

BINF G4006	TRANSLATIONAL BIOINFORMATICS
BINF G4015	COMP SYS BIO:PROTEINS,NETWK,FUN
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
STAT GU4241	STATISTICAL MACHINE LEARNING
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
BMEN E4420	SIGNAL MODELING
BMEN E4520	SYNTHETIC BIOLOGY:PRIN GENETIC CIRCUITS
BMEN E4460	Deep Learning in Biomedical Imaging
COMS W4701	ARTIFICIAL INTELLIGENCE
CBMF W4761	COMPUTATIONAL GENOMICS
COMS W4771	MACHINE LEARNING
COMS W4772/E6772	ADVANCED MACHINE LEARNING
BMEN E4895	Analysis and Quantification of Medical Images
BMEN E9100	MASTERS RESEARCH
BMCS E4480	Statistical machine learning for genomics
Any advanced course relevant to Bioinformatics and Machine Learning with advisor approval	

Biomaterials and Tissue Engineering

BMEN E4210	DRIVING FORCES OF BIOLOGICAL SYSTEMS
BMCH E4500	BIOL TRANSPORT # RATE PROCESS
BMEN E4501	Biomaterials and Scaffold Design
BMEN E4510	TISSUE ENGINEERING
BMEN E4530	DRUG AND GENE DELIVERY
BMEN E4550	MICRO/NANO STRUCT CELL ENG
BMEN E4580	FOUND OF NANOBIOSCI/NANOBIOTECH
BMEN E4590	BIOMEMS:CELL/MOLECULAR APPLIC
BMEN E6001	TOPICS IN BIOMED NANOTECHNOLOGY
BMEN E6500	TISSUE/MOLECULAR ENGI LAB
BMEN E6505	Advanced Biomaterials for Tissue Engineering
BMEN E9100	MASTERS RESEARCH
BMEN E4330	Cellular Bioengineering # Therapeutics
BMEN E4535	Immunoengineering with Biomaterials and Nanotechnology
BMEN E4520	SYNTHETIC BIOLOGY:PRIN GENETIC CIRCUITS
BMEN E4525	Advanced Cell and Tissue Engineering: From Concepts to Translation
Any advanced course relevant to Biomaterials and Tissue Engineering with advisor approval	

Biomechanics

MECE E4100	MECHANICS OF FLUIDS
BMEN E4301	
BMEN E4302	BIOMECHANICS OF MUSCULOSKELETAL SOFT TIS
BMEN E4310	SOLID BIOMECHANICS
MEBM E4703	MOLECULAR MECHANICS IN BIOLOGY
MEBM E4710	MORPHOGENESIS:BIOL MAT SHP/STR
BMEN E4750	SOUND AND HEARING
MECE E6100	ADVANCED MECHANICS OF FLUIDS
MEBM E6310 & MEBM E6311	MIXT THEORIES FOR BIOL TISSUES and MIXT THEORIES FOR BIOL TISSUES
MECE E6422 & MECE E6423	INTRO-THEORY OF ELASTICITY I and INTRO-THEORY OF ELASTICITY II
MECE E8501	ADVNCD CONTINUUM BIOMECHANICS
BMEN E9100	MASTERS RESEARCH
BMEN E4350	Biomechanics of Developmental Biology
Any advanced course relevant to Biomechanics with advisor approval	

Medical Imaging and Signals

BMEN E4410	PRIN OF ULTRASOUND IN MEDICINE
BMEN E4420	SIGNAL MODELING
BMEN E4430	PRIN OF MAG RESONANCE IMAGING
BMEE E4740	BIOINSTRUMENTATION
ELEN E4810	DIGITAL SIGNAL PROCESSING
BMEN E4840	FUNCTIONAL IMAGING BRAIN
BMEN E4894	BIOMEDICAL IMAGING
BMEN E4895	Analysis and Quantification of Medical Images
BMEN E4898	BIOPHOTONICS
BMEN E6410	Principles and Practices of In Vivo Magnetic Resonance Spectroscopy
BMEN E9100	MASTERS RESEARCH
BMEN E4460	Deep Learning in Biomedical Imaging
BMEN E4470	Deep Learning for Biomedical Signal Processing
Any advanced course relevant to Medical Imaging and Signals with advisor approval	

Neural Engineering

BMEB W4020	Computational neuroscience: circuits in the brain
BMEE E4030	NEURAL CONTROL ENGINEERING
BMEN E4050	ELECTROPHYS OF HUM MEMORY * NAVIGATION
BMEN E4420	SIGNAL MODELING
BMEN E4430	PRIN OF MAG RESONANCE IMAGING
ELEN E4810	DIGITAL SIGNAL PROCESSING
BMEN E4894	BIOMEDICAL IMAGING
BMEN E9100	MASTERS RESEARCH
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
ECBM E4090	BRAIN COMPUTER INTERFACES LAB
Any advanced course relevant to Neural Engineering with advisor approval	

Design, Innovation, and Entrepreneurship

ENGI W4100	RESEARCH TO REVENUE
BIOT GU4180	ENTREPRENEURSHIP IN BIOTECH
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEME E4310	MANUFACTURING ENTERPRISE
MECE E4604	PRODUCT DESIGN FOR MFG
MECE E4610	ADV MANUFACTURING PROCESSES
IEOR E4570	TOPICS IN OPERATIONS RESEARCH
BMEE E4740	BIOINSTRUMENTATION
BMEN E6005	Biomedical Innovation I
BMEN E6006	BIOMEDICAL DESIGN II
BMEN E6007	LAB-TO-MARKET
BIOT GU4200	BIOPHARMACEUTICAL DEV # REG
BMEN E9100	MASTERS RESEARCH
Any advanced course relevant to Design, Innovation, and Entrepreneurship with advisor approval	

Robotics and Control of Biological Systems

BMEE E4030	NEURAL CONTROL ENGINEERING
MECE E4058	MECHATRONICS # EMBEDDED MICRO
BMEN E4420	SIGNAL MODELING
MEBM E4439	MODELING # ID OF DYNAMIC SYST
EEME E4601	DISCRETE CONTROL SYSTEMS
MECE E4602	INTRODUCTION TO ROBOTICS
MECS E4603	APPLIED ROBOTICS: ALGORITHMS# SOFTWARE
MECE E4606	DIGITAL MANUFACTURING
BMEE E4740	BIOINSTRUMENTATION
MECE E6400	ADVANCED MACHINE DYNAMICS
EEME E6601	
EEME E6602	MODERN CONTROL THEORY
MECE E6614	ADV TPC:ROBOTICS/MECH SYNTHES
MECE E6615	ROBOTIC MANIPULATION
BMEN E9100	MASTERS RESEARCH

Any advanced course relevant to Robotics and Control of Biological Systems with advisor approval

Biomedical Engineering (PhD)

Doctoral Degree

Doctoral students must complete a program of 30 points of credit beyond the M.S. degree. The core course requirements (9 credits) for the doctoral program include the course in computational modeling of physiological systems (BMEN E6003 COMP MODELING-PHYSIOL SYSTEMS), plus at least two graduate-level courses (at least 6 credits) either in the departments of Applied Mathematics or Statistics or BMEN E4110 BIOSTATISTICS FOR ENGINEERS. If BMEN E6003 COMP MODELING-PHYSIOL SYSTEMS has already been taken for the master's degree, a technical elective can be used to complete the core course requirement. If one or both graduate-level applied mathematics courses have been taken for the master's degree, technical elective(s) can be used as a substitution. Students must register for BMEN E9700 BIOMEDICAL ENGINEERING SEMINAR and for research credits during the first two semesters of doctoral study. Remaining courses should be selected in consultation with the student's faculty adviser to prepare for the doctoral qualifying examination and to develop expertise in a clearly identified area of biomedical engineering. Students should not receive more than two "C" or below letter grades.

All graduate students admitted to the doctoral degree program must satisfy the equivalent of two semesters' experience in teaching (one semester for M.D./Ph.D. students). This may include supervising and assisting undergraduate students in laboratory experiments, grading, and preparing lecture materials to support the teaching mission of the department. The requirement must be completed by the 3rd year of graduate studies. The Department of Biomedical Engineering is the only engineering department that offers Ph.D. training to M.D./Ph.D. students. These candidates are expected to complete their Ph.D. program within 3.5 years, with otherwise the same requirements as those outlined for the Doctoral Degree program.

Doctoral Qualifying Examination

Doctoral candidates are required to pass a qualifying examination. This examination is given once a year, and it should be taken after the student has completed 30 points of graduate study. The qualifying examination consists of an oral exam during which the student presents an analysis of assigned scientific papers, as well as answers to questions in topics covering applied mathematics, quantitative biology and physiology, and material. The committee consists of the thesis adviser and two BME core faculty members approved by the graduate studies committee. A written analysis of the assigned scientific papers must be submitted prior to the oral exam. A minimum cumulative grade-point average of 3.2 without research credit grades is required to register for this examination.

Doctoral Committee and Thesis

Students who pass the qualifying examination must have a core BME faculty member who will serve as their primary research adviser or co-adviser. Each student is expected to submit a research proposal and present it to a committee that consists of three BME faculty members (two must be core BME faculty members, including research adviser) before the end of year 4. The committee considers the scope of the proposed research, its suitability for doctoral research and the appropriateness of the research plan. The committee may approve the proposal without reservation or may recommend modifications. In general, the student is expected to submit their research proposal after five semesters of doctoral studies. In accordance with regulations of the Graduate School of Arts and Sciences, each student is expected to submit a thesis and defend it before a committee of five faculty, one of whom holds primary appointment in another department or school or university. Every doctoral candidate is required to have had at least one first-author full-length paper accepted for publication in a peer-reviewed journal prior to recommendation for award of the degree.

Biomedical Engineering (MD/MS)

Dual Degree Program

M.D./M.S. Program in Biomedical Engineering

The Doctor of Medicine/Master of Science in Biomedical Engineering (M.D./M.S.) program is an integrated program offered between The Fu Foundation School of Engineering and Applied Science and the College of Physicians and Surgeons at Columbia University. The purpose of this program is to supplement the current training of medical students with world-class training in biomedical engineering at the graduate level. This interdisciplinary educational experience will prepare students to become innovative leaders in science, engineering, and medicine. Application to the program is restricted to enrolled Columbia medical students. It makes possible the earning of both the M.D. and M.S. degree in 5 years (4 years for the M.D. program, 1 year for the M.S. program). Six points from the M.D. degree, through completion of anatomy coursework, will also count toward the Master of Science degree. Students must first be admitted to the College of Physicians and Surgeons at Columbia University and then apply separately to the Department of Biomedical Engineering. For more information on requirements and application process, please visit bme.columbia.edu.

Chemical Engineering

801 S. W. Mudd, MC 4721
212-854-4453
cheme.columbia.edu

Chemical engineering is a highly interdisciplinary field, focused on the study and design of chemical systems from the molecular to the process, system, and global scales. Practicing chemical engineers are in charge of the development and production of diverse materials and processes in traditional chemical industries as well as many emerging new areas. Chemical engineers in industry guide the passage of the product from the laboratory to the marketplace, from ideas and prototypes to functioning articles and processes, from theory to reality. Chemical engineering research is broader still, applying the principles of chemical engineering to the study and design of systems in biochemistry or environmental science, energy, advanced materials, and more.

The expertise of chemical engineers is essential to production, marketing, and application in such areas as renewable energy, pharmaceuticals, high-performance materials in the aerospace and automotive industries, biotechnologies, semiconductors in the electronics industry, paints and plastics, synthetic fibers, artificial organs, biocompatible implants and prosthetics and numerous others. Increasingly, chemical engineers are involved in new technologies employing highly novel materials, whose unusual response at the molecular level endows them with unique properties. Examples include environmental technologies, emerging biotechnologies of major medical importance employing DNA- or protein-based chemical sensors, controlled-release drugs, new agricultural products, nanoparticle-based materials, bio-nanoparticle conjugates, and many others.

Driven by this diversity of applications, chemical engineering is perhaps the broadest of all engineering disciplines, drawing upon physics, chemistry, biology, mathematics and data science, and design. Some of the areas under active investigation are protein engineering, fundamentals and engineering of polymers, biopolymers, and other soft materials, colloidal machines, atmospheric chemistry and air quality, fundamentals and applications of electrochemistry for energy storage and manufacturing, multiphase flows, carbon capture and utilization, catalysis, and electrocatalysis, solar fuels, embryogenesis, the engineering and biochemistry of sequencing the human genome, emergent phenomena in complex and dynamical systems, the biophysics of cellular processes in living organisms, and DNA-guided assembly of inorganic and biological nanoscale objects. Diverse experimental approaches are employed, from NMR, to urban field measurements using sensor networks, to synchrotron techniques, and the theoretical work involves analytical mathematical physics, numerical simulations, and data science.

Interested students will have the opportunity to conduct research in these and other areas. The Department of Chemical Engineering at Columbia is committed to a leadership role in research and education in frontier areas of research and technology where progress derives from the conjunction of many different traditional research disciplines. Increasingly, new technologies and fundamental research questions demand this type of interdisciplinary approach.

The undergraduate program provides a chemical engineering degree that is a passport to many careers in directly related industries as diverse as biochemical engineering, environmental management, and pharmaceuticals. The degree is also used by many students as a springboard from which to launch careers in medicine, law, consulting, management, finance, and so on. For those interested in the fundamentals, a career of research and teaching is a natural continuation of their undergraduate studies. Whichever path the student may choose after graduation, the program offers a deep understanding of the physical and chemical nature of things and provides an insight into new technologies that are rapidly reshaping the society in which we live.

Facilities for Teaching and Research

The Department of Chemical Engineering provides access to state-of-the-art research instrumentation and computational facilities for its undergraduate and graduate students, postdoctoral associates, and faculty. The chemical engineering undergraduate laboratory features equipment including a Waters HPLC system, a SpectraMax spectrophotometer, a rotating disk electrode and potentiostat, a solar cell/electrolyzer/fuel cell apparatus, flow and temperature control equipment, an IR camera, two PhyMetrix Bench-top Moisture Analyzer units, and computer work stations.

State-of-the-art specialized research equipment are housed within individual faculty laboratories. Shared research laboratory facilities exist in the Columbia Electrochemical Energy Center, the Soft Materials laboratory, and the Columbia Genome Center.

Chemical engineering students, faculty, and research staff also have access to shared NMR, MRI, photochemical, spectroscopic, and mass spectrometry facilities in the Department of Chemistry.

Chair

Scott A. Banta

Vice Chair

V. Faye McNeill

Director of Finance and Administration

Kathy Marte-Garcia

Professors

Scott Banta
Kyle Bishop
Jingguang G. Chen, Thayer Lindsley Professor of Chemical Engineering
Christopher J. Durning
Oleg Gang
Jingyue Ju, Samuel Ruben–Peter G. Viele Professor of Engineering
Sanat K. Kumar, Bykhovsky Professor of Chemical Engineering
V. Faye McNeill
Ben O'Shaughnessy
Dan Steingart, Stanley-Thompson Professor of Chemical Metallurgy
Venkat Venkatasubramanian, Samuel Ruben–Peter G. Viele Professor of Engineering
Alan C. West, Samuel Ruben–Peter G. Viele Professor of Electrochemistry

Associate Professor

Christopher Boyce
Daniel Esposito
Lauren Marbella
Allie Obermeyer

Assistant Professors

Juliana Carneiro
Neil Dolinski
Mijo Simunovic
Alexander Urban
Asher Williams

Emeritus Faculty

Edward F. Leonard

Lecturer in Discipline

Christopher Chen

Senior Lecturer in Discipline

Sakul Ratanalert

Adjunct Professors

Elias Mattas
Kenneth Spall

Adjunct Associate Professors

Aghavni Bedrossian-Omer
Robert Bozic

Course Descriptions

Note: Check the department website for the most current course offerings and descriptions.

APCH E4080 SOFT CONDENSED MATTER. *3.00 points*.
Prerequisites: CHEE E3010 AND MSAE E3111; or equivalent.
Course is aimed at senior undergraduate and graduate students. Introduces fundamental ideas, concepts, and approaches in soft condensed matter with emphasis on biomolecular systems. Covers the broad range of molecular, nanoscale, and colloidal phenomena with revealing their mechanisms and physical foundations. The relationship between molecular architecture and interactions and macroscopic behavior are discussed for the broad range of soft and biological matter systems, from surfactants and liquid crystals to polymers, nanoparticles, and biomolecules. Modern characterization methods for soft materials, including X-ray scattering, molecular force probing, and electron microcopy are reviewed. Example problems, drawn from the recent scientific literature, link the studied materials to the actively developed research areas. Course grade based on midterm and final exams, weekly homework assignments, and final individual/team project

CHAP E4120 STATISTICAL MECHANICS AND COMP METHODS. *3.00 points*.
Lect: 3.

Prerequisites: Elementary statistics, thermodynamics, some familiarity with Python, or instructor's permission.
Boltzmann's entropy hypothesis and its restatement to calculate the Helmholtz and Gibbs free energies and the grand potential. Applications to interfaces, liquid crystal displays, polymeric materials, crystalline solids, heat capacity and electrical conductivity of crystalline materials, fuel cell solid electrolytes, rubbers, surfactants, molecular self assembly, ferroelectricity. Computational methods for molecular systems. Monte Carlo (MC) and molecular dynamics (MD) simulation methods. MC method applied to liquid-gas and ferromagnetic phase transitions. Deterministic MD simulations of isolated gases and liquids. Stochastic MD simulation methods.

Spring 2026: CHAP E4120

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHAP 4120	001/12993	Th 5:40pm - 8:25pm 1127 Seeley W. Mudd Building	Ben O'Shaughnessy, Kathy Marte-Garcia	3.00	27/60
CHAP 4120	V01/20169		Ben O'Shaughnessy	3.00	1/99

CHEE E3010 PRIN-CHEM ENGIN-THERMODYNAMICS. *3.00 points*.
Fundamentals are emphasized: the laws of thermodynamics are derived and their meaning explained and elucidated by applications to engineering problems. Pure systems are treated, with an emphasis on phase equilibrium

Fall 2026: CHEE E3010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEE 3010	001/11397	T Th 8:40am - 9:55am 627 Seeley W. Mudd Building	Mijo Simunovic	3.00	37/50

CHEE E4252 INTRO-SURFACE AND COLLOID SCI. *3.00 points*.
Lect: 3.

Prerequisites: Elemental physical chemistry.
The principles of surfaces and colloid chemistry critical to range of technologies indispensable to modern life. Surface and colloid chemistry has significance to life sciences, pharmaceuticals, agriculture, environmental remediation and waste management, earth resources recovery, electronics, advanced materials, enhanced oil recovery, and emerging extraterrestrial mining. Topics include: thermodynamics of surfaces, properties of surfactant solutions and surface films, electrokinetic phenomena at interfaces, principles of adsorption and mass transfer and modern experimental techniques. Leads to deeper understanding of interfacial engineering, particulate dispersions, emulsions, foams, aerosols, polymers in solution, and soft matter topics

Fall 2026: CHEE E4252

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEE 4252	001/14391	W 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Oscar Nordness	3.00	11/30

CHEE E6252 ADV SURFACE/COLLOID CHEMISTRY. *3.00 points*.
Lect:2. Lab:3.

Prerequisites: (CHEE E4252) CHEE E4252
Applications of surface chemistry principles to wetting, flocculation, flotation, separation techniques, catalysis, mass transfer, emulsions, foams, aerosols, membranes, biological surfactant systems, microbial surfaces, enhanced oil recovery, and pollution problems. Appropriate individual experiments and projects. Lab required

CHEN E1000 Chemical Engineering for Humanity. *1.00 point*.
Prerequisites: This course will be available for first semester first year students to take.
Introduction to the role of Chemical Engineering in addressing grand challenges facing humanity. Address challenges illustrating the important role that Chemical Engineers play in solving societal problems, including to those related to climate change, biotechnology and medicine, clean energy, and sustainable manufacturing of chemicals and materials

Fall 2026: CHEN E1000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 1000	001/11398	M 4:10pm - 5:25pm 825 Seeley W. Mudd Building	Scott Banta	1.00	20/40

CHEN E2100 Material and Energy Balances. *3.00 points*.
Lect: 2.5

Prerequisites: First-year chemistry and physics or equivalent.
Serves as an introduction to the chemical engineering profession. Students are exposed to concepts used in the analysis of chemical engineering problems. Rigorous analysis of material and energy balances on open and closed systems is emphasized. An introduction to important processes in the chemical and biochemical industries is provided

Fall 2026: CHEN E2100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 2100	001/11399	T Th 10:10am - 11:25am 140 Uris Hall	Christopher Vic Chen	3.00	34/50

CHEN E3020 ANALYSIS OF CHEM ENGIN PROBLMS. *3.00 points*.
Lect: 1 Lab: 1

Prerequisites: A Python course. ordinary differential equations.
Corequisites: CHEE E3010
Advance chemical-engineering problem-solving skills through the use of computational tools (primarily developed in Excel or Python). Examples are drawn from thermodynamics, transport phenomena, and chemical kinetics. The course is project based, emphasizing data analysis and report writing. Unstructured collaboration with peers is highly encouraged. Requisite numerical methods and Chemical Engineering concepts introduced

Spring 2026: CHEN E3020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3020	001/12748	M W 1:10pm - 2:25pm 227 Seeley W. Mudd Building	Alexander Urban	3.00	36/45

CHEN E3110 PRINCIPLES OF TRANSPORT PHENOMENA. *3.00 points*.
Lect: 3.

Prerequisites: Mechanics, Vector Calculus, Ordinary Differential Equations

Corequisites: CHEN E3020
A mechanistic and mathematical description of the engineering fundamentals of heat and mass transport and fluid mechanics based on mass, momentum and energy balances from the molecular to the continuum to the industrial device scale. Problems and applications will focus on energy, biological and chemical systems and processes

Fall 2026: CHEN E3110

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3110	001/11396	M W 10:10am - 11:25am 233 Seeley W. Mudd Building	Christopher Boyce	3.00	32/40

CHEN E3120 TRANSPORT PHENOMENA II. *3.00 points*.
Lec: 3.

Prerequisites: (CHEN E3110) CHEN E3110; CHEN E3220
Corequisites: CHEN E3220
Developments in Transport I are extended to handle turbulence. Topics include: Turbulent energy cascade, wall-bounded turbulent shear flow, time-averaging of the equations of change, Prandtls mixing length hypothesis for the Reynolds stress, the Reynolds analogy, continuum modeling of turbulent flows and heat transfer processes, friction factor, and Nusselt number correlations for turbulent conditions. Then macroscopic (system-level) mass, momentum, and energy balances for one-component systems are developed and applied to complex flows and heat exchange processes. The final part focuses on mass transport in mixtures of simple fluids: Molecular-level origins of diffusion phenomena, Ficks law and its multicomponent generalizations, continuum-level framework for mixtures and its application to diffusion dominated processes, diffusion with chemical reaction, and forced/free convection mass transport

CHEN E3210 CHEM ENGINEERNG THERMODYNAMICS. *3.00 points*.
Lect: 3.

Prerequisites: (CHEE E3010) and (CHEN E2100) CHEE E3010 AND CHEN E2100; CHEN E3220
Corequisites: CHEN E3220.
This course deals with fundamental and applied thermodynamic principles that form the basis of chemical engineering practice. Topics include phase equilibria, methods to treat ideal and non-ideal mixtures, and estimation of properties

CHEN E3230 REACTOR KINETICS/REACTOR DESIGN. *3.00 points*.
Prerequisites: CHEE E3010
Reaction kinetics, applications to the design of batch and continuous reactors. Multiple reactions, non-isothermal reactors. Analysis and modeling of reactor behavior.

Spring 2026: CHEN E3230

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3230	001/12759	T Th 11:40am - 12:55pm 227 Seeley W. Mudd Building	Asher Williams	3.00	26/45

CHEN E3810 CHEM ENG # APPLIED CHEM LAB. *3.00 points*.
Lab: 3.

Prerequisites: (CHEN E2100 and CHEN E3230 and CHEN E4300) or instructor's permission
Emphasizes active, experiment-based resolution of open-ended problems involving use, design, and optimization of equipment, products, or materials. Under faculty guidance students formulate, carry out, validate, and refine experimental procedures, and present results in oral and written form. Develops analytical, communications, and cooperative problem-solving skills in the context of problems that span from traditional, large scale separations and processing operations to molecular level design of materials or products. Sample projects include: scale up of apparatus, process control, chemical separations, microfluidics, surface engineering, molecular sensing, and alternative energy sources. Safety awareness is integrated.

Spring 2026: CHEN E3810

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3810	001/12739	M W 1:00pm - 5:00pm 703 Hamilton Hall	Aghavni Bedrossian, Neil Dolinski	3.00	33/40

CHEN E3899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: CHEN E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3899	001/16041		Scott Banta	0.00	0/5
CHEN 3899	002/16045		Kyle Bishop	0.00	0/5
CHEN 3899	003/16050		Christopher Boyce	0.00	0/5
CHEN 3899	004/16053		Juliana Silva Alves Carneiro	0.00	0/5
CHEN 3899	005/16058		Jingguang Chen	0.00	0/5
CHEN 3899	006/16062		Christopher Durning	0.00	0/5
CHEN 3899	007/16064		Daniel Esposito	0.00	0/5
CHEN 3899	008/16065		Oleg Gang	0.00	0/5
CHEN 3899	009/16067		Jingyue Ju	0.00	0/5
CHEN 3899	010/16070		Sanat Kumar	0.00	0/5
CHEN 3899	011/16071		Lauren Marbella	0.00	0/5
CHEN 3899	012/16072		Vivian McNeill	0.00	0/5
CHEN 3899	013/16073		Allie Obermeyer	0.00	0/5
CHEN 3899	014/16074		Ben O'Shaughnessy	0.00	0/5
CHEN 3899	015/16076		Neil Dolinski	0.00	0/5
CHEN 3899	016/16078		Mijo Simunovic	0.00	0/5
CHEN 3899	017/16079		Dan Steingart	0.00	0/5
CHEN 3899	018/16080		Alexander Urban	0.00	0/5
CHEN 3899	019/16082		Venkat Venkatasubramanian	0.00	0/5
CHEN 3899	020/16083		Alan West	0.00	0/5
CHEN 3899	021/16084		Asher Williams	0.00	0/5

CHEN E3900 UNDERGRADUATE RESEARCH PROJECT. *0.00-6.00 points*.
Candidates for the B.S. degree may conduct an investigation of some problem in chemical engineering or applied chemistry or carry out a special project under the supervision of the staff. Up to 6 points may be counted toward the technical elective content requirement. (Note that if more than 3 points of research are pursued, an undergraduate thesis is required.)

Spring 2026: CHEN E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3900	001/16095		Scott Banta	0.00-6.00	1/10
CHEN 3900	002/16096		Kyle Bishop	0.00-6.00	0/10
CHEN 3900	003/16098		Christopher Boyce	0.00-6.00	1/10
CHEN 3900	004/16099		Juliana Silva Alves Carneiro	0.00-6.00	3/10
CHEN 3900	005/16101		Jingguang Chen	0.00-6.00	1/10
CHEN 3900	006/16102		Christopher Durning	0.00-6.00	0/10
CHEN 3900	007/16104		Daniel Esposito	0.00-6.00	9/10
CHEN 3900	008/16105		Oleg Gang	0.00-6.00	2/10
CHEN 3900	009/16106		Jingyue Ju	0.00-6.00	0/10
CHEN 3900	010/16109		Sanat Kumar	0.00-6.00	1/10
CHEN 3900	011/16110		Lauren Marbella	0.00-6.00	0/10
CHEN 3900	012/16111		Vivian McNeill	0.00-6.00	0/10
CHEN 3900	013/16112		Allie Obermeyer	0.00-6.00	4/10
CHEN 3900	014/16113		Ben O'Shaughnessy	0.00-6.00	0/10
CHEN 3900	015/16143		Neil Dolinski	0.00-6.00	1/8
CHEN 3900	016/16144		Mijo Simunovic	0.00-6.00	0/10
CHEN 3900	017/16151		Dan Steingart	0.00-6.00	2/10
CHEN 3900	018/16153		Alexander Urban	0.00-6.00	3/10
CHEN 3900	019/16155		Venkat Venkatasubramanian	0.00-6.00	0/10
CHEN 3900	020/16156		Alan West	0.00-6.00	0/10
CHEN 3900	021/16157		Asher Williams	0.00-6.00	4/10

Summer 2026: CHEN E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3900	001/11775		Scott Banta	0.00-6.00	0/5
CHEN 3900	002/11776		Kyle Bishop	0.00-6.00	0/5
CHEN 3900	003/11777		Christopher Boyce	0.00-6.00	0/5
CHEN 3900	004/11778		Neil Dolinski	0.00-6.00	0/5
CHEN 3900	005/11779		Christopher Vic Chen	0.00-6.00	0/5
CHEN 3900	006/11780		Jingguang Chen	0.00-6.00	0/5
CHEN 3900	007/11781		Daniel Esposito	0.00-6.00	0/5
CHEN 3900	008/11782		Oleg Gang	0.00-6.00	0/5
CHEN 3900	009/11783		Jingyue Ju	0.00-6.00	0/5
CHEN 3900	010/11784		Sanat Kumar	0.00-6.00	1/5
CHEN 3900	011/11785		Lauren Marbella	0.00-6.00	0/5
CHEN 3900	012/11786		Vivian McNeill	0.00-6.00	0/5
CHEN 3900	013/11787		Allie Obermeyer	0.00-6.00	0/5
CHEN 3900	014/11788		Ben O'Shaughnessy	0.00-6.00	0/5
CHEN 3900	015/11789		Dan Steingart	0.00-6.00	0/5
CHEN 3900	016/11790		Mijo Simunovic	0.00-6.00	0/5
CHEN 3900	017/11791		Alexander Urban	0.00-6.00	0/5
CHEN 3900	018/11792		Venkat Venkatasubramanian	0.00-6.00	0/5

CHEN E3999 UNDERGRADUATE FIELDWORK. *1.00-2.00 points*.
Prerequisites: Restricted to Chemical Engineering undergraduate students.
Provides work experience on chemical engineering in relevant intern or fieldwork experience as part of their program of study as determined by the instructor. Written application must be made prior to registration outlining proposed internship/study program. A written report describing the experience and how it relates to the chemical engineering core curriculum is required. Employer feedback on student performance and the quality of the report are the basis of the grade. This course may not be taken for pass/fail or audited. May not be used as a technical or non-technical elective. May be repeated for credit, but no more than 3 points total of CHEN E3999 may be used for degree credit

Summer 2026: CHEN E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 3999	001/11889		Daniel Esposito	1.00-2.00	3/5

CHEN E4001 ESSENTIALS OF CHEM ENGIN A. *3.00 points*.
Lect: 3

Prerequisites: First-year chemistry and physics, vector calculus, ordinary differential equations, and the instructors permission.
Part of an accelerated consideration of the essential chemical engineering principles from the undergraduate program, including selected topics from Introduction to Chemical Engineering, Transport Phenomena I and II, and Chemical Engineering Control. While required for all M.S. students with Scientist to Engineer status, the credits from this course may not be applied toward any chemical engineering degree

Fall 2026: CHEN E4001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4001	001/11421	T Th 11:40am - 12:55pm 415 Schapiro Cepser	Christopher Vic Chen	3.00	9/40
CHEN 4001	R01/11422	F 10:00am - 11:15am 233 Seeley W. Mudd Building	Christopher Vic Chen	3.00	0/40

CHEN E4002 ESSENTIALS OF CHEM ENGIN B. *3.00 points*.
Lect: 3.

Prerequisites: First-year chemistry and physics, vector calculus, ordinary differential equations, and the instructors permission.
Part of an accelerated consideration of the essential chemical engineering principles from the undergraduate program, including topics from Reaction Kinetics and Reactor Design, Chemical Engineering Thermodynamics, I and II, and Chemical and Biochemical Separations. While required for all M.S. students with Scientist to Engineer status, the credits from this course may not be applied toward any chemical engineering degree

Fall 2026: CHEN E4002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4002	001/11423	T Th 1:10pm - 2:25pm 829 Seeley W. Mudd Building	Christopher Vic Chen	3.00	10/40
CHEN 4002	R01/11424	F 11:30am - 12:45pm 233 Seeley W. Mudd Building	Christopher Vic Chen	3.00	0/40

CHEN E4010 MATH METHODS IN CHEMICAL ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E3230) or equivalent, or instructors permission.
Mathematical description of chemical engineering problems and the application of selected methods for their solution. General modeling principles, including model hierarchies. Linear and nonlinear ordinary differential equations and their systems, including those with variable coefficients. Partial differential equations in Cartesian and curvilinear coordinates for the solution of chemical engineering problems.

Spring 2026: CHEN E4010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4010	001/12762	T Th 1:10pm - 2:25pm 545 Seeley W. Mudd Building	Vivian McNeill	3.00	21/45
CHEN 4010	V01/16641		Vivian McNeill	3.00	1/99

Fall 2026: CHEN E4010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4010	001/11425	M W 4:10pm - 5:25pm 233 Seeley W. Mudd Building	Vivian McNeill	3.00	40/40
CHEN 4010	D01/13771		Robert Bozic	3.00	3/99

CHEN E4020 PROTECTN OF INDUST/INTELL PROP. *3.00 points*.
Lect: 3.

Exposes scientists and engineers to the development, protection, and exploitation of intellectual property rights. Legal processes for obtaining and defending intellectual property rights are detailed. Best practices for innovation and commercialization are explored. Methods for valuation and monetization of intellectual property are illustrated through application of basic accounting and financial principles to case studies

Fall 2026: CHEN E4020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4020	001/11426	M 7:00pm - 9:30pm 545 Seeley W. Mudd Building	Kenneth Spall	3.00	17/40
CHEN 4020	V01/18082		Kenneth Spall	3.00	3/99

CHEN E4110 MECHANISMS OF TRANSPORT. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E3110) or the equivalent.
Continuum frame-work for modeling non-equilibrium phenomena in fluids with clear connections to the molecular/microscopic mechanisms for conductive transport. Continuum balances of mass and momentum; continuum-level development of conductive momentum flux (stress tensor) for simple fluids; applications of continuum framework for simple fluids (lubrication flows, creeping flows). Microscopic developments of the stress for simple and/or complex fluids; kinetic theory and/or liquid state models for transport coefficients in simple fluids; Langevin/Fokker-Plank/Smoluchowski framework for the stress in complex fluids; stress in active matter; applications for complex fluids.

Fall 2026: CHEN E4110

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4110	001/11427	T Th 11:40am - 12:55pm 545 Seeley W. Mudd Building	Christopher Durning	3.00	16/40
CHEN 4110	V01/18083		Christopher Durning	3.00	0/99

CHEN E4112 TRANSPORT IN FLUID MIXTURES. *3.00 points*.
Prerequisites: CHEE E3010 AND CHEN E3110; or the equivalent.
Develops and applies non-equilibrium thermodynamics for modeling of transport phenomena in fluids and their mixtures. Continuum balances of mass, energy and momentum for pure fluids; non-equilibrium thermodynamic development of Newtons law of viscosity and Fouriers law; applications (conduction dominated energy transport, forced and free convection energy transport in fluids); balance laws for fluid mixtures; non-equilibrium thermodynamic development of Ficks law; applications (diffusion-reaction problems, analogy between energy and mass transport processes, transport in electrolyte solutions, sedimentation)

Spring 2026: CHEN E4112

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4112	001/12745	M W 2:40pm - 3:55pm 524 Seeley W. Mudd Building	Christopher Durning	3.00	45/50
CHEN 4112	V01/17236		Christopher Durning	3.00	2/99

CHEN E4130 ADV CHEM ENGI THERMODYNAMICS. *3.00 points*.
Prerequisites: Successful completion of an undergraduate chemical engineering thermodynamics course.
The course provides a rigorous and advanced foundation in chemical engineering thermodynamics suitable for chemical engineering PhD students expected to undertake diverse research projects. Topics include Intermolecular interactions, non-ideal systems, mixtures, phase equilibria and phase transitions and interfacial thermodynamics

Fall 2026: CHEN E4130

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4130	001/11428	M W 2:40pm - 3:55pm 524 Seeley W. Mudd Building	Sanat Kumar	3.00	42/55
CHEN 4130	V01/19748		Sanat Kumar	3.00	1/99

CHEN E4140 ENGINEERING SEPARATIONS. *3.00 points*.
Prerequisites: (CHEE E3010 and CHEN E2100 and CHEN E3110) and or instructor's permission.
Design and analysis of unit operations employed in chemical engineering separations. Fundamental aspects of single and multistaged operations using both equilibrium and rate-based methods. Examples include distillation, absorption and stripping, extraction, membranes, crystallization, bioseparations, and environmental applications.

Spring 2026: CHEN E4140

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4140	001/12736	M W 11:40am - 12:55pm 227 Seeley W. Mudd Building	Daniel Esposito	3.00	29/45

CHEN E4150 COMPUTATIONAL FLUID DYNAMICS I. *3.00 points*.
Lect: 3.

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CHEN E4180 Machine Learning for Biomolecular and Cellular Applications. *3.00 points*.
Prerequisites: Some knowledge of Python, elementary statistics, thermodynamics
Introduction to machine learning techniques with applications to biological systems, emphasizing cell-biological molecular mechanisms and applications, and computational simulation. Overview of biology. Introduction to biological neurons and neural networks, learning and memory. Parallels between biological and artificial neural networks. Deep neural networks are introduced, hands-on computational experience for students. Big data from experiments or computational simulations: machine learning to extract mechanisms, dimensional reduction. Deep learning applications include drug discovery, protein structure prediction, molecular coarse-graining for simulations, and acceleration of molecular dynamics simulations

Fall 2026: CHEN E4180

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4180	001/11429	T 5:40pm - 8:25pm 415 Schapiro Cepser	Ben O'Shaughnessy	3.00	26/40

CHEN E4201 ENGIN APPL OF ELECTROCHEMISTRY. *3.00 points*.
Lect: 3.

Prerequisites: Physical chemistry and a course in transport phenomena.
Engineering analysis of electrochemical systems, including electrode kinetics, transport phenomena, mathematical modeling, and thermodynamics. Common experimental methods are discussed. Examples from common applications in energy conversion and metallization are presented

CHEN E4231 SOLAR FUELS. *3.00 points*.
Prerequisites: (CHEN E3230) or Or Graduate Standing or instructor's permission
Fundamentals and applications of solar energy conversion, especially technologies for conversion of sunlight into storable chemical energy or solar fuels. Topics include fundamentals of photoelectrochemistry, kinetics of solar fuels production, solar harvesting technologies, solar reactors, and solar thermal production of solar fuels. Applications include solar fuels technology for grid-scale energy storage, chemical industry, manufacturing, environmental remediation.

Fall 2026: CHEN E4231

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4231	001/11445	T Th 8:40am - 9:55am 415 Schapiro Cepser	Daniel Esposito	3.00	23/40

CHEN E4235 SURFACE REACTIONS # KINETICS. *3.00 points*.

Fall 2026: CHEN E4235

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4235	001/11430	T Th 1:10pm - 2:25pm 420 Pupin Laboratories	Jingguang Chen	3.00	50/50

CHEN E4300 CHEM PROC. CONTROL # SAFETY. *3.00 points*.
Lab: 2.

Prerequisites: Material and energy balances.
Ordinary differential equations including Laplace transforms. Reactor Design. An introduction to process control applied to chemical engineering through lecture and laboratory. Concepts include the dynamic behavior of chemical engineering systems, feedback control, controller tuning, and process stability

Fall 2026: CHEN E4300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4300	001/11431	T Th 1:10pm - 4:00pm 644 Seeley W. Mudd Building	Venkat Venkatasubramanian, Aghavni Bedrossian	3.00	25/40

CHEN E4320 MOLECULAR PHENOMENA-CHEM ENGI. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E3120) or CHEE E3010; or instructor's permission.
This course introduces a molecular level understanding of topics in modern chemical engineering. It builds upon and validates the concepts presented in the rest of the chemical engineering curriculum via a molecular perspective.

Fall 2026: CHEN E4320

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4320	001/11444	T Th 4:10pm - 5:25pm 233 Seeley W. Mudd Building	Kyle Bishop	3.00	7/30

CHEN E4325 BIOSEPARATIONS. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E2100 and CHEE E3010 and CHEN E3110 and CHEN E3230) or
The course focuses on design and analysis of the concentration, recovery, and isolation of biological molecules relevant in biotechnology. The unit operations used in recovery and purification of biological molecules will be presented in this course. Theory and design of filtration, microfiltration, centrifugation, cell disruption, extraction, adsorption, chromatography, precipitation, ultrafiltration, crystallization, and drying will be discussed. By the end of the course students will have an understanding of basic principles of downstream processing, design and operations of various unit operations used in recovery of biological products, examining traditional unit operations, as well as new concepts and emerging technologies that are likely to benefit biochemical product recovery in the future.

CHEN E4330 ADVANCED CHEMICAL KINETICS. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E3230) or Or instructor's permission
Complex reactive systems. Catalysis. Heterogeneous systems, with an emphasis on coupled chemical kinetics and transport phenomena. Reactions at interfaces (surfaces, aerosols, bubbles). Reactions in solution.

Spring 2026: CHEN E4330

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4330	001/12747	M W 4:10pm - 5:25pm 414 Schapiro Cepser	Juliana Silva Alves Carneiro	3.00	6/45
CHEN 4330	D01/18253		Robert Bozic	3.00	2/99

Fall 2026: CHEN E4330

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4330	D01/13779		Robert Bozic	3.00	1/99

CHEN E4380 Green Chemical Engineering # Innovation. *3.00 points*.
Prerequisites: CHEM W1404 AND CHEM S2444 AND CHEN E2100
Approaches used in chemistry and chemical engineering to design green, sustainable products and processes; focus of using the tenets of green chemistry as a means for chemical innovation. Technical and design practice and measuring the impacts of green and conventional approaches emphasized. Themes of business, regulatory, ethical, and social considerations relevant to chemical engineering practice

Spring 2026: CHEN E4380

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4380	001/12757	T Th 10:10am - 11:25am 1127 Seeley W. Mudd Building	Christopher Vic Chen	3.00	27/45
CHEN 4380	V01/17133		Christopher Vic Chen	3.00	4/99

CHEN E4400 Pharmaceutical Process Development. *3.00 points*.
Lect: 3.

Prerequisites: CHEN E2100 or Or equivalent or instructor's permission
Chemical engineering fundamentals as applied to process research, development, and manufacturing of pharmaceutical products. Course topics include: comprehensive overview of the biopharmaceutical business (therapeutic areas, markets, drug discovery, clinical development, commercialization), process research, creation, development, optimization, sustainability, green chemistry and engineering, safety (patient, process, and personnel), unit operations and associated calculations relevant to pharmaceutical processes, process scale-up, implementation, assessment, technology transfer, new technologies, economic analysis, drug product formulation and manufacturing, and regulatory considerations. Case studies and real-life examples are presented throughout the course

Fall 2026: CHEN E4400

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4400	001/11433	W 7:00pm - 9:30pm 415 Schapiro Cepser	Elias Mattas	3.00	30/40

CHEN E4444 Climate Technology. *3.00 points*.
Scientific and economic analysis of real-world technologies for climate change mitigation and adaptation. Partner with students from the business school to assess and assigned technology based on technical viability, commercial opportunity, and impact on mitigating or adapting to climate change. Assigned technologies provided by the investment community to teams of four, with expectations for independent research on the technologies, with deliverables of written and oral presentations

Spring 2026: CHEN E4444

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4444	001/12789	W 9:00am - 12:00pm 570 Geffen Hall	Alan West	3.00	14/15

CHEN E4500 PROCESS # PRODUCT DESIGN I. *4.00 points*.
Lect: 4.

Prerequisites: (CHEN E2100) and (CHEN E4140) CHEN E2100 AND CHEN E4140
The practical application of chemical engineering principles for the design and economic evaluation of chemical processes and plants. Use of ASPEN Plus for complex material and energy balances of real processes. Students are expected to build on previous coursework to identify creative solutions to two design projects of increasing complexity. Each design project culminates in an oral presentation, and in the case of the second project, a written report

Fall 2026: CHEN E4500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4500	001/11441	W 1:10pm - 2:25pm 1224 Seeley W. Mudd Building	Sakul Ratanalert	4.00	25/40
CHEN 4500	001/11441	M 1:10pm - 3:55pm 1224 Seeley W. Mudd Building	Sakul Ratanalert	4.00	25/40

CHEN E4501 PROCESS SAFETY. *3.00 points*.
Aimed at seniors and graduate students. Provides classroom experience on chemical engineering process safety as well as Safety in Chemical Engineering certification. Process safety and process control emphasized. Application of basic chemical engineering concepts to chemical reactivity hazards, industrial hygiene, risk assessment, inherently safer design, hazard operability analysis, and engineering ethics. Application of safety to full spectrum of chemical engineering operations

Spring 2026: CHEN E4501

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4501	001/12780	T Th 11:40am - 12:55pm 524 Seeley W. Mudd Building	Robert Bozic	3.00	12/45
CHEN 4501	D01/18266		Robert Bozic	3.00	2/99

Fall 2026: CHEN E4501

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4501	001/11442	M W 1:10pm - 2:25pm 829 Seeley W. Mudd Building	Robert Bozic	3.00	7/40
CHEN 4501	D01/13785		Robert Bozic	3.00	1/99

CHEN E4510 PROCESS # PRODUCT DESIGN II. *3.00 points*.
Prerequisites: CHEN E4500 or (CHEN E4001 and CHEN E4002)
Students carry out a semester-long process or product design project. The project culminates with a formal written design report and a public presentation.

Spring 2026: CHEN E4510

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4510	001/12753	M W 5:40pm - 6:55pm 1224 Seeley W. Mudd Building	Sakul Ratanalert	3.00	11/30

CHEN E4580 ARTIFICIAL INTELLIGENCE IN CHEMICAL ENGINEERING. *3.00 points*.

CHEN E4600 AEROSOLS. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E3110) or Instructor's Permission
Corequisites: CHEN E3230
Aerosol impacts on indoor and outdoor air quality, health, and climate. Major topics include aerosol sources, physics, and chemistry; field and laboratory techniques for aerosol characterization; aerosol direct and indirect effects on climate; aerosols in biogeochemical cycles and climate engineering; health impacts including exposure to ambient aerosols and transmission of respiratory disease.

CHEN E4620 INTRO-POLYMERS/SOFT MATERIALS. *3.00 points*.
Lect: 3.

An introduction to the chemistry and physics of soft material systems (polymers, colloids, organized surfactant systems and others), emphasizing the connection between microscopic structure and macroscopic physical properties. To develop an understanding of each system, illustrative experimental studies are discussed along with basic theoretical treatments. High molecular weight organic polymers are discussed first (basic notions, synthesis, properties of single polymer molecules, polymer solution and blend thermodynamics, rubber and gels). Colloidal systems are treated next (dominant forces in colloidal systems, flocculation, preparation and manipulation of colloidal systems) followed by a discussion of self-organizing surfactant systems (architecture of surfactants, miceles and surfactant membranes, phase behavior).

Fall 2026: CHEN E4620

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4620	001/11443	M W 10:10am - 11:25am 644 Seeley W. Mudd Building	Christopher Durning	3.00	19/40
CHEN 4620	V01/18084		Christopher Durning	3.00	2/99

CHEN E4630 TOPICS IN SOFT MATERIALS. *3.00 points*.
Prerequisites: Physical chemistry or instructor's permission.
Self-contained treatments of selected topics in soft materials (e.g. polymers, colloids, amphiphiles, liquid crystals, glasses, powders). Topics and instructor may change from year to year. Intended for junior/senior level undergraduates and graduate students in engineering and the physical sciences

Spring 2026: CHEN E4630

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4630	001/12734	M W 10:10am - 11:25am 524 Seeley W. Mudd Building	Christopher Durning	3.00	21/45
CHEN 4630	V01/17237		Christopher Durning	3.00	2/99

CHEN E4650 POLYMER PHYSICS. *3.00 points*.
Prerequisites: (CHEN E3110) and (CHEN E4620)
Senior undergraduate/first-year graduate course on the physics of polymer systems. Topics include scaling behavior of chains under different conditions, mixing thermodynamics, networks and geation, polymer dynamics, including retation and entanglements. Special topics: nanocomposites.

CHEN E4655 Polymers for Sustainability. *3.00 points*.
Focuses on sustainability aspects of polymers. Emphasizes polymers at end of life, including recycling processes. Examines how polymers generate micro- and nanoplastics during use and after environmental disposal. Highlights the role of data science and ML in understanding and addressing these issues. Focuses on polymer life cycle with emphasis on underlying scientific principles

Fall 2026: CHEN E4655

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4655	001/19502	M W 4:10pm - 5:25pm 829 Seeley W. Mudd Building	Sanat Kumar	3.00	3/30

CHEN E4660 BIOCHEMICAL ENGINEERING. *3.00 points*.
Lect: 3

Prerequisites: (CHEN E3230) or Or instructor's permission
Engineering of biochemical and microbiological reaction systems. Kinetics, reactor analysis, and design of batch and continuous fermentation and enzyme processes. Recovery and separations in biochemical engineering systems.

Spring 2026: CHEN E4660

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4660	001/16363	F 1:10pm - 3:55pm 140 Uris Hall	Scott Banta, Mallori Herishko	3.00	6/45

CHEN E4670 CHEMICAL ENGINEERING DATA ANALYSIS. *3.00 points*.
Prerequisites: CHEN E3230; CHEN E3230 or instructor's permission.
Course is aimed at senior undergraduate and graduate students. Introduces fundamental concepts of Bayesian data analysis as applied to chemical engineering problems. Covers basic elements of probability theory, parameter estimation, model selection, and experimental design. Advanced topics such as nonparametric estimation and Markov chain Monte Carlo (MEME) techniques are introduced. Example problems and case studies drawn from chemical engineering practice are used to highlight the practical relevance of the material. Theory reduced to practice through programming in Mathematica. Course grade based on midterm and final exams, biweekly homework assignments, and final team project.

Spring 2026: CHEN E4670

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4670	001/12741	M W 1:10pm - 2:25pm 1127 Seeley W. Mudd Building	Kyle Bishop	3.00	10/50
CHEN 4670	V01/16643		Kyle Bishop	3.00	1/99

CHEN E4700 PRINCIPLES OF GENOMIC TECHNOL. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate-level biology, organic chemistry and instructor's permission.
Chemical and physical aspects of genome structure and organization, genetic information flow from DNA to RNA to Protein. Nucleic acid hybridization and sequence complexity of DNA and RNA. Genome mapping and sequencing methods. The engineering of DNA polymerase for DNA sequencing and polymerase chain reaction. Fluorescent DNA sequencing and high-throughput DNA sequencer development. Construction of gene chip and micro array for gene expression analysis. Technology and biochemical approach for functional genomics analysis. Gene discovery and genetics database search method. The application of genetic database for new therapeutics discovery

Fall 2026: CHEN E4700

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4700	001/11447	M 5:40pm - 8:25pm 327 Seeley W. Mudd Building	Jingyue Ju	3.00	25/30

CHEN E4720 Pharmacokinetics for Engineers. *3.00 points*.
Prerequisites: (CHEN E3230) or (CHEN E4001 and CHEN E4002)
Develop process models of the human body to predict pharmaceutical effects as a function of time and organ (or cell) type to work for a wide variety of pharmaceuticals, including small molecules, biologics, and chemotherapy agents. Computer models of pharmacokinetic behavior will be developed and then used to analyze and design drug delivery regimens. Covers: spectrum of factors affecting pharmaceutical effects on physiology, including drug formulation, mode of dosing and dosing rate, metabolism and metabolic cascades, storage in fatty tissues, and diffusional limitations.

Spring 2026: CHEN E4720

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4720	001/17193	M W 4:10pm - 5:25pm 524 Seeley W. Mudd Building	Sakul Ratanalert	3.00	24/30
CHEN 4720	V01/17325		Sakul Ratanalert	3.00	2/99

CHEN E4780 QUANT METHODS IN CELL BIOLOGY. *3.00 points*.
Lect: 3.

Quantitative statistical analysis and mathematical modeling in cell biology for an audience with diverse backgrounds. The course presents quantitative methods needed to analyze complex cell biological experimental data and to interpret the analysis in terms of the underlying cellular mechanisms. Optical and electrical experimental methods to study cells and basic image analysis techniques are described. Methods of statistical analysis of experimental data and techniques to test and compare mathematical models against measured statistical properties will be introduced. Concepts and techniques of mathematical modeling will be illustrated by applications to mechanosensing in cells, the mechanics of cytokinesis during cell division and synaptic transmission in the nervous system. Image analysis, statistical analysis, and model assessment will be illustrated for these systems.

CHEN E4800 PROTEIN ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: (CHEN E3230)
Fundamental tools and techniques currently used to engineer protein molecules. Methods used to analyze the impact of these alterations on different protein functions with specific emphasis on enzymatic catalysis. Case studies reinforce concepts covered, and demonstrate the wide impact of protein engineering research. Application of basic concepts in the chemical engineering curriculum (reaction kinetics, mathematical modeling, thermodynamics) to specific approaches utilized in protein engineering.

CHEN E4860 NMR BIOSOFTENG. *3.00 points*.
Prerequisites: PHYS W1401 OR CHEE E3010; Or instructors approval
This course is for junior/senior undergraduates and graduate (MS) students. The course focuses on the fundamentals of nuclear magnetic resonance (NMR) spectroscopy and imaging in fields ranging from biomedical engineering to electrochemical energy storage. Course material covers basic NMR theory, instrumentation (including in situ/operando setup), data interpretation, and experimental design to couple with other materials characterization strategies. Course grade based on problem sets, quizzes, and final project presentation

CHEN E4870 Synthetic Organogenesis. *3.00 points*.
Prerequisites: Any quantitative undergraduate course with elements of biology, such as Chemistry, Biochemical Engineering/Biochemistry, Biophysics, but also at the instructor's permission.
The goal of synthetic organogenesis is to use stem cells to reconstitute aspects of embryo development and organ formation in vitro. Examines the molecular basis of human embryogenesis. Introduces synthetic organogenesis as an interdisciplinary field. Students learn to recognize generic molecular mechanisms behind signaling and cell lineage specification. Covers recent advances in applying engineering and contemporary biology to creating organoids and organs on chips using human stem cells.

Spring 2026: CHEN E4870

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4870	001/12787	T 4:10pm - 6:55pm 227 Seeley W. Mudd Building	Mijo Simunovic	3.00	31/45

CHEN E4880 ATOMISTIC SIMULATIONS FOR SCIENCE AND EN. *3.00 points*.
Prerequisites: A course in statistical mechanics or thermodynamics or instructors permission
Many materials properties and chemical processes are governed by atomic-scale phenomena such as phase transformations, atomic/ionic transport, and chemical reactions. Thanks to progress in computer technology and methodological development, now there exist atomistic simulation approaches for the realistic modeling and quantitative prediction of such properties. Atomistic simulations are therefore becoming increasingly important as a complement for experimental characterization, to provide parameters for meso- and macroscale models, and for the in-silico discovery of entirely new materials. This course aims at providing a comprehensive overview of cutting-edge atomistic modeling techniques that are frequently used both in academic and industrial research and engineering. Participants will develop the ability to interpret results from atomistic simulations and to judge whether a problem can be reliably addressed with simulations. The students will also obtain basic working knowledge in standard simulation software

Spring 2026: CHEN E4880

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4880	001/12776	T Th 4:10pm - 5:25pm 545 Seeley W. Mudd Building	Alexander Urban	3.00	41/45
CHEN 4880	V01/16644		Alexander Urban	3.00	2/99

CHEN E4890 BIOPHARMACEUTICALS PRODUCT DEV. *3.00 points*.
Aimed at graduate students of Chemical Engineering. Examines the application of Chemical Engineering fundamentals and entrepreneurship in starting up a biopharmaceutical company and in developing a biopharmaceutical product. Serves as a description of the major stages of developing a biopharmaceutical product. Topics presented will include drug discovery, preclinical and clinical development, IP, manufacturing, and regulatory process. In addition, implementation of the lean startup methodology, business valuation, and financial considerations for a biopharmaceutical startup will be offered. Basic topics in the chemical engineering curriculum (reaction kinetics, mathematical modeling, unit operations, thermodynamics), as well as specific topics in developing biopharmaceuticals will be discussed in this course

CHEN E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: CHEN E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4899	001/20402		Scott Banta	0.00	0/5
CHEN 4899	008/20482		Daniel Esposito	0.00	0/1

Fall 2026: CHEN E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4899	001/11452		Christopher Vic Chen	0.00	0/10

CHEN E4900 TOPICS IN CHEMICAL ENGINEERING. *3.00 points*.
Lect: 3.

Additional current topics in chemical engineering taught by regular or visiting faculty. Special topics arranged as the need and availability arise. Topics usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit.

Spring 2026: CHEN E4900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4900	001/12731	M W 8:40am - 9:55am 644 Seeley W. Mudd Building	Sanat Kumar	3.00	6/20
CHEN 4900	003/12784	T 4:10pm - 6:55pm 503 Hamilton Hall	Jingguang Chen	3.00	17/45
CHEN 4900	004/12998	F 10:10am - 12:50pm 227 Seeley W. Mudd Building	Lauren Marbella	3.00	13/45

CHEN E4910 SOLID STATE CHEMISTRY IN PHARMACEUTICAL. *3.00 points*.
Prerequisites: Thermodynamics any, or General Chemistry Students. Must be engineering juniors or seniors, engineering graduate students, or PhD and undergraduate students in the sciences, e.g. chemistry or biology.
Prerequisites: Pre-requisites: Thermodynamics (any), or General Chemistry Students must be engineering juniors or seniors, engineering graduate students, or PhD and undergraduate students in the sciences, e.g. chemistry or biology

CHEN E4920 PHARMACEUTICAL INDUSTRY FOR ENGINEERS. *3.00 points*.
This course provides students an overview of biopharmaceutical design, development, manufacturing, and regulatory requirements from an engineering perspective. The unit operations, equipment selection, and process development associated with small molecule, biologics, and vaccine manufacturing are all illustrated through examples, and quantitative engineering approaches are applied as appropriate. Small molecules, biologics, vaccines, solid oral formulations, sterile processing, and design of experiments (DoE) are treated along with a module on regulatory requirements.

CHEN E4930 Biopharmaceutical Process Laboratory. *3.00 points*.
Prerequisites: Organic Chemistry Lab I, Undergraduate Organic Chemistry.

Prerequisites: see notes re: points Organic Chemistry Lab 1, Organic Chemistry
Intended for junior and senior undergraduate and graduate students interested in gaining hands-on experience in biopharmaceutical processing. Processes and unit operations applied widely in the biopharmaceutical industry, including tableting, dissolution, disintegration, fermentation, chromatography, tangential flow filtration, mixing, and crystallization. Process parameters, chemical and molecular properties, process performance, and product attributes. Includes a combination of lectures (given during lab time), experiments, and report writing

CHEN E4949 Chemical Engineering of Wine Making. *3.00 points*.
Prerequisites: CHEN E3230
Course aimed at seniors and graduate students. Provides classroom experience on wine making. Wine making chemistry, design, safety, and process control are emphasized in classroom instruction. Applies basic chemical engineering concepts to chemical reactivity in wine making. Written and oral reports required. Wine making can be used anywhere in the world and the principles of the fermentation extend into other industries. Academic and industry contributions to the content of chemical engineering concepts in wine making include chemical reactivity hazards, industrial hygiene, risk assessment, inherently safer design, and hazard operability analysis. With the ultimate aim of leaning a skill set and safer operations in the chemical engineering profession, the applications of wine making will be emphasized.

Spring 2026: CHEN E4949

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4949	001/12996	Th 2:40pm - 5:25pm 829 Seeley W. Mudd Building	Robert Bozic	3.00	8/30

CHEN E4960 Soft and BioNano Materials. *3.00 points*.
Prerequisites: Undergraduate Thermodynamics (or Equivalent)
Focuses on fundamental concepts in soft condensed matter with emphasis on biomolecular and nanoscale systems. Integrates principles from biochemistry, materials science, physics, and nanotechnology to develop a unified view of soft and biological matter. Covers structure, properties, and functions of key biomolecules, along with biomolecular design and self-assembly, including DNA/RNA-based nanotechnology and molecular programming. Examines diverse soft matter systems such as polymers, surfactants, liquid crystals, and nanoparticles, highlighting how molecular interactions determine macroscopic behavior and underlying physical principles. Introduces modern experimental and computational methods, connecting core concepts to current research in the field.

Fall 2026: CHEN E4960

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4960	001/19503	Th 5:40pm - 8:25pm 337 Seeley W. Mudd Building	Oleg Gang	3.00	6/30

CHEN E4999 FIELDWORK. *1.00-3.00 points*.

Spring 2026: CHEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4999	001/17537		Christopher Vic Chen, Sakul Ratanalert	1.00-3.00	1/10

Summer 2026: CHEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4999	001/11444		Christopher Vic Chen	1.00-3.00	13/20

Fall 2026: CHEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 4999	001/11451		Christopher Vic Chen	1.00-3.00	1/25

CHEN E6543 CHEMICAL ENGIN RES METHODOLOGY. *1.00 point*.

Fall 2026: CHEN E6543

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 6543	001/11453	T 11:40am - 12:55pm 826 Seeley W. Mudd Building	Scott Banta	1.00	1/25

CHEN E8100 TOPICS IN BIOLOGY. *3.00 points*.

Lect: 3.

Prerequisites: Instructors permission

This research seminar introduces topics at the forefront of biological research in a format and language accessible to quantitative scientists and engineers lacking biological training. Conceptual and technical frameworks from both biological and physical science disciplines are utilized. The objective is to reveal to graduate students where potential lies to apply techniques from their own disciplines to address pertinent biological questions in their research. Classes entail reading, criticism and group discussion of research papers and textbook materials providing overviews to various biological areas including: evolution, immune system, development and cell specialization, the cytoskeleton and cell motility, DNA transcription in gene circuits, protein networks, recombinant DNA technology, aging, and gene therapy

CHEN E9000 CHEMICL ENGINEERING COLLOQUIUM. *0.00 points*.

0 pts. Col: 1.

All graduate students are required to attend the department colloquium as long as they are in residence. No degree credit is granted

Spring 2026: CHEN E9000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9000	001/12772	T 3:00pm - 4:00pm 750 Schapiro Cepser	Mijo Simunovic	0.00	41/50

Fall 2026: CHEN E9000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9000	001/11454	T 3:00pm - 4:00pm 601 Fairchild Life Sciences Bldg	Neil Dolinski	0.00	43/71

CHEN E9001 MASTER'S COLLOQUIUM. *0.00 points*.

Required for all M.S. students in residence in their first semester. Topics related to professional development and the practice of chemical engineering. No degree credits granted. Intended for M.S students only; and not for M.S./Ph.D. track, Ph.D. or D.E.S. students

Fall 2026: CHEN E9001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9001	001/11455	Th 2:40pm - 3:55pm 633 Seeley W. Mudd Building	Christopher Vic Chen	0.00	21/70

CHEN E9400 MASTERS RESEARCH. *1.00-6.00 points*.

Prescribed for M.S. candidates; elective for others with the approval of the Department. Degree candidates are to conduct an investigation of some problem in chemical engineering. No more than 6 points in this course may be counted for graduate credit

Spring 2026: CHEN E9400

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9400	001/16161		Scott Banta	1.00-6.00	2/10
CHEN 9400	002/16175		Kyle Bishop	1.00-6.00	0/10
CHEN 9400	003/16176		Christopher Boyce	1.00-6.00	2/10
CHEN 9400	004/16177		Juliana Silva Alves Carneiro	1.00-6.00	1/10
CHEN 9400	005/16179		Christopher Vic Chen	1.00-6.00	0/10
CHEN 9400	006/16181		Jingguang Chen	1.00-6.00	0/10
CHEN 9400	007/16182		Christopher Durning	1.00-6.00	0/10
CHEN 9400	008/16183		Daniel Esposito	1.00-6.00	2/10
CHEN 9400	009/16184		Oleg Gang	1.00-6.00	3/10
CHEN 9400	010/16185		Jingyue Ju	1.00-6.00	5/10
CHEN 9400	011/16187		Sanat Kumar	1.00-6.00	2/10
CHEN 9400	012/16188		Lauren Marbella	1.00-6.00	3/10
CHEN 9400	013/16189		Vivian McNeill	1.00-6.00	0/10
CHEN 9400	014/16191		Allie Obermeyer	1.00-6.00	0/10
CHEN 9400	015/16192		Ben O'Shaughnessy	1.00-6.00	1/10
CHEN 9400	018/16193		Dan Steingart	1.00-6.00	2/10
CHEN 9400	019/16194		Alexander Urban	1.00-6.00	2/10
CHEN 9400	020/16195		Venkat Venkatasubramanian	1.00-6.00	2/10
CHEN 9400	021/16198		Alan West	1.00-6.00	2/10
CHEN 9400	022/16199		Asher Williams	1.00-6.00	3/10
CHEN 9400	023/16200		Neil Dolinski	1.00-6.00	4/10

Summer 2026: CHEN E9400

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9400	001/11599		Scott Banta	1.00-6.00	0/5
CHEN 9400	002/11600		Kyle Bishop	1.00-6.00	0/5
CHEN 9400	003/11601		Christopher Boyce	1.00-6.00	0/5
CHEN 9400	004/11602		Neil Dolinski	1.00-6.00	2/5
CHEN 9400	005/11603		Jingguang Chen	1.00-6.00	0/5
CHEN 9400	006/11604		Daniel Esposito	1.00-6.00	0/5
CHEN 9400	007/11605		Jingyue Ju	1.00-6.00	4/5
CHEN 9400	008/11606		Sanat Kumar	1.00-6.00	0/5
CHEN 9400	009/11607		Oleg Gang	1.00-6.00	1/5
CHEN 9400	010/11608		Lauren Marbella	1.00-6.00	0/5
CHEN 9400	011/11609		Vivian McNeill	1.00-6.00	0/5
CHEN 9400	012/11610		Allie Obermeyer	1.00-6.00	0/5
CHEN 9400	013/11611		Ben O'Shaughnessy	1.00-6.00	1/5
CHEN 9400	014/11612		Dan Steingart	1.00-6.00	0/5
CHEN 9400	015/11613		Mijo Simunovic	1.00-6.00	0/5
CHEN 9400	016/11614		Alexander Urban	1.00-6.00	0/5
CHEN 9400	017/11615		Venkat Venkatasubramanian	1.00-6.00	1/5
CHEN 9400	018/11616		Alan West	1.00-6.00	1/5
CHEN 9400	019/11617		Juliana Silva Alves Carneiro	1.00-6.00	0/5
CHEN 9400	020/11618		Asher Williams	1.00-6.00	0/5

CHEN E9500 DOCTORAL RESEARCH. *1.00-15.00 points*.
Prerequisites: The qualifying examinations for the doctorate
Open only to certified candidates for the Ph.D. and Eng.Sc.D. degrees. Doctoral candidates in chemical engineering are required to make an original investigation of a problem in chemical engineering or applied chemistry, the results of which are presented in their dissertations. No more than 15 points of credit toward the degree may be granted when the dissertation is accepted by the department

Spring 2026: CHEN E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9500	001/16309		Scott Banta	1.00-15.00	5/10
CHEN 9500	002/16332		Kyle Bishop	1.00-15.00	3/10
CHEN 9500	003/16391		Christopher Boyce	1.00-15.00	2/10
CHEN 9500	004/16395		Juliana Silva Alves Carneiro	1.00-15.00	2/10
CHEN 9500	005/16398		Jingguang Chen	1.00-15.00	7/10
CHEN 9500	006/16401		Christopher Durning	1.00-15.00	0/10
CHEN 9500	007/16405		Daniel Esposito	1.00-15.00	5/10
CHEN 9500	008/16414		Oleg Gang	1.00-15.00	8/10
CHEN 9500	009/16415		Jingyue Ju	1.00-15.00	2/10
CHEN 9500	010/16416		Sanat Kumar	1.00-15.00	5/12
CHEN 9500	011/16419		Lauren Marbella	1.00-15.00	5/10
CHEN 9500	012/16420		Vivian McNeill	1.00-15.00	1/10
CHEN 9500	013/16422		Allie Obermeyer	1.00-15.00	5/10
CHEN 9500	014/16423		Ben O'Shaughnessy	1.00-15.00	3/10
CHEN 9500	016/16424		Mijo Simunovic	1.00-15.00	5/10
CHEN 9500	017/16425		Dan Steingart	1.00-15.00	4/10
CHEN 9500	018/16426		Alexander Urban	1.00-15.00	2/10
CHEN 9500	019/16428		Venkat Venkatasubramanian	1.00-15.00	4/10
CHEN 9500	020/16429		Alan West	1.00-15.00	5/10
CHEN 9500	021/16430		Asher Williams	1.00-15.00	2/10
CHEN 9500	022/16431		Neil Dolinski	1.00-15.00	2/10

Fall 2026: CHEN E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9500	001/11477		Scott Banta	1.00-15.00	5/15
CHEN 9500	002/11478		Kyle Bishop	1.00-15.00	2/15
CHEN 9500	003/11479		Christopher Boyce	1.00-15.00	0/15
CHEN 9500	004/11480		Juliana Silva Alves Carneiro	1.00-15.00	2/15
CHEN 9500	005/11481		Jingguang Chen	1.00-15.00	5/15
CHEN 9500	006/11482		Neil Dolinski	1.00-15.00	2/15
CHEN 9500	007/11483		Daniel Esposito	1.00-15.00	6/15
CHEN 9500	008/11484		Oleg Gang	1.00-15.00	6/15
CHEN 9500	009/11485		Jingyue Ju	1.00-15.00	0/15
CHEN 9500	010/11486		Sanat Kumar	1.00-15.00	4/15
CHEN 9500	011/11487		Lauren Marbella	1.00-15.00	5/15
CHEN 9500	012/11488		Vivian McNeill	1.00-15.00	1/15
CHEN 9500	013/11489		Ben O'Shaughnessy	1.00-15.00	2/15
CHEN 9500	014/11490		Allie Obermeyer	1.00-15.00	4/15
CHEN 9500	015/11491		Mijo Simunovic	1.00-15.00	4/15
CHEN 9500	016/11492		Dan Steingart	1.00-15.00	4/15
CHEN 9500	017/11493		Alexander Urban	1.00-15.00	2/15
CHEN 9500	018/11494		Venkat	1.00-15.00	4/15

CHEN E9800 DOCTORAL RESEARCH INSTRUCTION. *3.00-12.00 points*.
3, 6, 9 or 12 pts.

A candidate for the Eng.Sc.D. degree in chemical engineering must register for 12 points of doctoral research instruction. Registration in CHEN E9800 may not be used to satisfy the minimum residence requirement for the degree.

Spring 2026: CHEN E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9800	001/16308		Allie Obermeyer	3.00-12.00	1/1

Fall 2026: CHEN E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEN 9800	001/11497		Allie Obermeyer	3.00-12.00	0/1

MECH E4320 INTRO TO COMBUSTION. *3.00 points*.
Prerequisites: Introductory thermodynamics, fluid dynamics, and heat transfer at the undergraduate level or instructor's permission. Thermodynamics and kinetics of reacting flows; chemical kinetic mechanisms for fuel oxidation and pollutant formation; transport phenomena; conservation equations for reacting flows; laminar nonpremixed flames (including droplet vaporization and burning); laminar premixed flames; flame stabilization, quenching, ignition, extinction, and other limit phenomena; detonations; flame aerodynamics and turbulent flames

Undergraduate Programs

- Chemical Engineering (BS) (p. 109)
- Chemical Engineering Minor (p. 327)

Chemical Engineering (BS)

The Chemical Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Chemical, Biochemical, Biomolecular and similarly named engineering programs.

The Program Educational Objectives, expectations of what graduates are expected to attain within a few years of graduation, are:

1. Careers in industries that require technical expertise in chemical engineering.
2. Leadership positions in industries that require technical expertise in chemical engineering.
3. Graduate-level studies in chemical engineering and related technical or scientific fields (e.g. biomedical or environmental engineering, materials science).
4. Careers outside of engineering that take advantage of an engineering education, such as business, management, finance, law, medicine, or education.
5. A commitment to life-long learning and service within their chosen profession.

Upon graduation, we expect our students to achieve the following Student Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The first and sophomore years of study introduce general principles of science and engineering and include a broad range of subjects in the humanities and social sciences. Although the program for all engineering students in these first two years is to some extent similar, there are a few important differences for chemical engineering majors. Those wishing to learn about, or major in, chemical engineering should take the professional elective CHEN E1000 Chemical Engineering for Humanity in term I, taught by the Chemical Engineering Department. This course provides a broad overview of modern chemical engineering. Those wishing to major in chemical engineering should also take ENGI E1006 INTRO TO COMP FOR ENG/APP SCI in term II. Chemical engineering majors receive additional instruction in CHEN E3020 ANALYSIS OF CHEM ENGIN PROBLMS, and throughout the major core curriculum, on the use of computational methods to solve chemical engineering problems.

The Degree Track table (p. 112) spells out the core course requirements, which are split between courses emphasizing engineering science and those emphasizing practical and/or professional aspects of the discipline. Throughout, skills required of practicing engineers are developed (e.g., writing and presentation skills, competency with computers).

The Degree Track table also shows that a significant fraction of the junior-senior program is reserved for electives, both technical and nontechnical. Twenty-one points (7 courses) of technical electives are included in the junior and senior year requirements. Technical electives are science and/or technology based and feature quantitative analysis. Generally, technical electives must be 3000 level or above but there are a few exceptions including:

PHYS UN1403	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601	PHYSICS III:CLASS/QUANTUM WAVE
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC
BIOL UN2006	INTRO BIO II:CELL BIO,DEV/PHYS
BIOL UN2501	CONTEMPORARY BIOLOGY LAB
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES

A full list of approved technical elective courses in each category can be found on the departmental website or obtained from the departmental advisers. The technical electives are subject to the following constraints:

- **1 Thermodynamics Elective:** One technical elective must fall within the category “thermodynamics electives”: Chemical engineering courses with 50% or more content related to thermodynamics. Examples include:

CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
CHEN E4650	POLYMER PHYSICS
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN

- **1 Transport Elective:** One technical elective must fall within the category “transport electives”: Chemical engineering courses with 50% or more content related to transport phenomena (fluid mechanics, heat transfer, or mass transfer). Examples include:

CHEN E4150	COMPUTATIONAL FLUID DYNAMICS I
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
CHEN E4600	AEROSOLS
CHEN E4630	TOPICS IN SOFT MATERIALS

- **3 Engineering Technical Electives**: Three upper-level SEAS technical courses having significant engineering content. At least one of these three tech electives must have the designators BMCH, CHEN, CHEE, CHAP, or MECH. Qualifying courses are determined by Chemical Engineering advisors.
- **2 STEM Technical Electives:** The remaining two technical elective courses must comprise "advanced STEM" coursework, which includes the natural sciences, mathematically-oriented SEAS classes, and certain courses based on engineering topics. Qualifying courses are determined by Chemical Engineering department advisors. For a course to count towards this category, these STEM courses must be sufficiently advanced/technical (generally 3000 level or above), but do not necessarily contain engineering content. A limited number of natural science courses (e.g. Chemistry, Physics, Biology) with course number less than 3000 level are approved for this category.

The junior-senior technical electives provide the opportunity to explore new, interesting areas beyond the core requirements of the degree. Often, students satisfy the technical electives by taking courses from another SEAS department in order to obtain a minor from that department. Alternately, you may wish to take courses in several new areas, or perhaps to explore familiar subjects in greater depth, or you may wish to gain experience in actual laboratory research. Up to 6 points of CHEN E3900 UNDERGRADUATE RESEARCH PROJECT may be counted toward the technical elective content. (Note that if more than 3 points of research are pursued, an undergraduate thesis is required.)

The undergraduate elective specializations are a way for students to explore a subject area in modern chemical engineering in depth through their selection of technical elective courses. To fulfill an elective specialization, the student must complete any combination of four courses (12 points total) from the list of suggested courses in that subject area. Elective specialization areas are: Climate, Environment, and Energy Solutions; Biotechnology and Biopharmaceuticals; Data and Computational Science; and Advanced Materials. More information on courses satisfying the requirements for each elective specialization can be found on the departmental website.

The program details discussed above apply to undergraduates who are enrolled at Columbia as first-years and declare the chemical engineering major in the sophomore year. However, the chemical engineering program is designed to be readily accessible to participants in any of Columbia’s Combined Plans and to transfer students. In such cases, the guidance of one of the departmental advisers in planning your program is required

(contact information for the departmental UG advisers is listed on the department's website: cheme.columbia.edu).

Elective Specializations

Undergraduate elective specializations allow chemical engineering students to carry out in- depth exploration of a subject area in modern chemical engineering. To fulfill a specialization, the student must complete any combination of four courses (12 points total) from a list of technical elective courses that have been approved by the department to count towards that specialization. Courses taken P/F do not count towards specializations. Four specializations are offered: (i) Advanced Materials, (ii) Biotechnology and Biopharmaceuticals, (iii) Climate, Environment, and Energy Solutions, and (iv.) Data and Computational Science.

Advanced Materials

The coursework for a concentration in Advanced Materials provides an understanding of the fundamentals and technological challenges associated with the design of new materials, including soft materials, materials for electrochemical energy storage, and biomaterials.

Any combination of four courses (12 points total) satisfies the Advanced Materials Specialization Requirement.

CHEN E3900	UNDERGRADUATE RESEARCH PROJECT
APCH E4080	SOFT CONDENSED MATTER
CHEN E4620	INTRO-POLYMERS/SOFT MATERIALS
CHEN E4630	TOPICS IN SOFT MATERIALS
CHEN E4650	POLYMER PHYSICS
CHEN E4860	NMR BIOSOFTENG
CHEN E4665	Polymer Chemistry for Sustainable Solutions
CHEN E4870	Synthetic Organogenesis
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN
CHEN E4910	SOLID STATE CHEMISTRY IN PHARMACEUTICAL
CHEN XXXX [1]	
MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE
MSAE E4090	NANOTECHNOLOGY
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS
MSAE E4260	ELECTROCHEM MATLS # DEVS

[1] Polymer Science for Sustainability (taught as a CHEN E4900 Topics in Chemical Engineering course in Spring 2025; it will be given its own course number in future semesters)

Biotechnology and Biopharmaceuticals

Manufacturing and discovery in biotechnology and biopharmaceuticals continue to advance at a rapid pace, creating opportunities for engineers to contribute to interdisciplinary areas and apply their core skills to advancing technology. This concentration engages students with recent developments within biotechnology and biopharmaceuticals, focusing on engineering applications and approaches.

Any combination of four courses (12 points total) satisfies the Biotechnology and Biopharmaceuticals Specialization Requirement.

CHEN E3900	UNDERGRADUATE RESEARCH PROJECT
CHEN E4180	Machine Learning for Biomolecular and Cellular Applications
CHEN E4325	BIOSEPARATIONS
CHEN E4400	Pharmaceutical Process Development
CHEN E4660	BIOCHEMICAL ENGINEERING
CHEN E4700	PRINCIPLES OF GENOMIC TECHNOL
CHEN E4725	Therapeutic Systems Design: Biomolecules and Immune Interfaces
CHEN E4800	PROTEIN ENGINEERING
CHEN E4870	Synthetic Organogenesis
CHEN E4890	BIOPHARMACEUTICALS PRODUCT DEV
CHEN E4910	SOLID STATE CHEMISTRY IN PHARMACEUTICAL
CHEN E4920	PHARMACEUTICAL INDUSTRY FOR ENGINEERS
CHEN E4930	Biopharmaceutical Process Laboratory
CHEN E8100	TOPICS IN BIOLOGY
CHEN XXXX [1]	
BMEN E4110	BIOSTATISTICS FOR ENGINEERS
BMEN E6500	TISSUE/MOLECULAR ENGI LAB
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC
BIOL UN2006	INTRO BIO II:CELL BIO,DEV/PHYS
BIOL UN2501	CONTEMPORARY BIOLOGY LAB
BIOC UN3300	BIOCHEMISTRY

[1] Sustainable Process Engineering (taught as a CHEN 4900 Topics in Chemical Engineering course in Spring 2025; it will be given its own course number in future semesters)

Climate, Environment, and Energy Solutions

The coursework for a specialization in Climate, Environment, and Energy Solutions provides the student with an understanding of the fundamentals and technological challenges associated with solutions to the challenges of climate change and environmental pollution, including clean energy and storage, geoengineering, pollution control, and their environmental context. Furthermore, students may choose to learn about electrochemical processes that will continue to rise in importance as sustainable routes to leverage renewable energy for the production of chemicals, fuels, and materials.

Any combination of four courses (12 points total) satisfies the Climate Solutions Specialization Requirement.

CHEN E3900	UNDERGRADUATE RESEARCH PROJECT
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
CHEN E4231	SOLAR FUELS
CHEN E4331	Catalysis and Kinetics of Sustainable CO2 Conversion
CHEN E4600	AEROSOLS
CHEN E4410	
CHEN XXXX [1]	
EAEE E3103	ENERGY,MINERALS,MATERIALS SYST
EAEE E4002	ALTERNATIVE ENERGY RESOURCES
EAEE E4003	AQUATIC CHEMISTRY
EAEE E4011	Industrial ecology for manufacturing
EAEE E4163	
EAEE E4180	ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

EAEE E4300	INTRO TO CARBON MANAGEMENT
EAEE E4301	CARBON STORAGE
EAEE E4305	CO2 UTILIZATION AND CONVERSION
CIEE E3255	
CIEE E3250	
CIEE E4252	
MECE E4211	ENERGY SOURCES AND CONVERSION
MSAE E4260	ELECTROCHEM MATLS # DEVS
EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST
EESC UN3101	Geochemistry for a Habitable Planet
EESC GU4008	Introduction to Atmospheric Science
EESC W4020	Humans and the Carbon Cycle
EESC GU4924	INTRO TO ATMOSPHERIC CHEMISTRY

[1] Sustainable Process Engineering (taught as a CHEN 4900 Topics in Chemical Engineering course in Spring 2025; it will be given its own course number in future semesters)

Data and Computational Science

The coursework for a concentration in Data and Computational Science provides an understanding of data science tools and computational modeling methods relevant to modern chemical engineering practice. These tools include methods of data curation, statistical data analysis, predictive modeling, and experimental design that integrate advances in machine learning and artificial intelligence into the chemical engineering domain.

Any combination of four courses (12 points total) satisfies the Data and Computational Science Specialization Requirement.

CHEN E3900	UNDERGRADUATE RESEARCH PROJECT
CHEN E4010	MATH METHODS IN CHEMICAL ENGIN
CHEN E4180	Machine Learning for Biomolecular and Cellular Applications
CHEN E4670	CHEMICAL ENGINEERING DATA ANALYSIS
CHEN E4580	ARTIFICIAL INTELLIGENCE IN CHEMICAL ENGINEERING
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
CHEN E4150	COMPUTATIONAL FLUID DYNAMICS I
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN
ORCA E2500	FOUNDATIONS OF DATA SCIENCE [1]
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
COMS W4721	MACHINE LEARNING FOR DATA SCI
COMS W4771	MACHINE LEARNING

[1] These courses cannot be counted as technical electives, but they may be used for the **math elective**.

Chemical Engineering Program

An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1101	CALCULUS I

Choose one of the following Physics courses depending on sequence:

PHYS UN1401 (Sequence1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I

Choose one of the following Chemistry courses depending on sequence:

CHEM UN1403 & CHEM UN1500 (Sequence 1)	GENERAL CHEMISTRY I-LECTURES
CHEM UN1604 (Sequence 2)	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045 (Sequence 3)	INTENSVE ORGANIC CHEMISTRY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
CHEN E1000	Chemical Engineering for Humanity
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

Choose one of the following Chemistry courses depending on sequence:

CHEM UN1404 (Sequence 1)	GENERAL CHEMISTRY II-LECTURES
CHEM UN1507 (Sequence 2)	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN2046 & CHEM UN1507 (Sequence 3)	INTENSVE ORG CHEM-FOR 1ST YEAR
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on sequence:

PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081	INTERMEDIATE LABORATORY WORK
CHEM UN2443 (Sequences 1 and 2)	ORGANIC CHEMISTRY I-LECTURES
One core humanities elective (3-4)[1]	
CHEN E2100	Material and Energy Balances

Semester IV

MATH UN2030 or APMA E2101	ORDINARY DIFFERENTIAL EQUATIONS
Three core humanities electives (11)	
CHEN E3020	ANALYSIS OF CHEM ENGIN PROBLMS

Third Year

Semester V

CHEN E3110	PRINCIPLES OF TRANSPORT PHENOMENA
CHEE E3010	PRIN-CHEM ENGIN-THERMODYNAMICS
Adv Natural Science Lab[2]	
Complete Required Nontech Elective	
Complete Required Tech Elective[3]	

Semester VI

Math Elective[4]	
PHED UN1001 (may be taken any Semester)	PHYSICAL EDUCATION ACTIVITIES
CHEN E3230	REACTOR KINETICS/REACTOR DESIGN
CHEN E4140	ENGINEERING SEPARATIONS
Complete Required Nontech Electives	
Complete Required Tech Electives[3]	

Fourth Year

Semester VII

CHEN E4500	PROCESS # PRODUCT DESIGN I
CHEN E4300	CHEM PROC. CONTROL # SAFETY
Complete Required Nontech Elective	
Complete Required Tech Electives[3]	

Semester VIII

PHED UN1002 (may be taken any Semester)	PHYSICAL EDUCATION ACTIVITIES
CHEN E3810	CHEM ENG # APPLIED CHEM LAB
Complete Required Tech Electives[3]	

1 Four core humanities electives should be taken as follows: In Semester III, HUMA CC1001 Literature Humanities I or COCI CC1101 CONTEMP WESTERN CIVILIZATION I (4) or any initial course in one of the Global Core sequences offered by the College (3–4); in Semester IV, HUMA CC1002 Literature Humanities II or COCI CC1102 CONTEMP WESTRN CIVILIZATION II (4) or ASCM UN2002 INTRO MAJOR TOPICS: EAST ASIAN or the second course in the Global Core sequence elected in Semester III (3–4); also in Semester IV, ECON UN1105 PRINCIPLES OF ECONOMICS (4) with ECON UN1155 PRINCIPLES OF ECONOMICS-DISC recitation (0) and either HUMA UN1121 Art Humanities or HUMA UN1123 Music Humanities (3).

2 Total of 3 points required. Choose from CHEM UN2493 ORGANIC CHEM. LAB I TECHNIQUES (1.5), CHEM UN2496 ORGANIC CHEM. LABORATORY II (1.5), CHEM UN2543 ORGANIC CHEMISTRY LABORATORY (3), CHEM UN2545 INTENSIVE ORGANIC CHEM LAB (3), CHEM UN3085 PHYSICL-ANALYTICL LABORATORY I (3), BIOL 2501 (3), EEEB 3015 (3), or another course approved by the major adviser.

3 See the bulletin text for technical elective requirements.

4 Math elective options include APMA E3101 APPLIED MATH I: LINEAR ALGEBRA, MATH UN2010 LINEAR ALGEBRA, APMA E3102 APPLIED MATHEMATICS II: PDE'S, APMA E4150 APPLIED FUNCTIONAL ANALYSIS, APMA E4300 COMPUT MATH:INTRO-NUMERCL METH, STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS, or another course approved by the major adviser.

Graduate Programs

The graduate program in chemical engineering, with its large proportion of elective courses and independent research, offers experience in any of the fields of departmental activity mentioned in previous sections. For both chemical engineers and those with undergraduate educations in other related fields such as physics, chemistry, and biochemistry, the Ph.D. program provides the opportunity to become expert in research fields central to modern technology and science.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Chemical Engineering (MS) (p. 114)
- Chemical Engineering (PhD/DES) (p. 116)

Chemical Engineering (MS)

M.S. Degree

The requirements are:

1. The core courses:
   a. Math core: Mathematical methods in chemical engineering (CHEN E4010 MATH METHODS IN CHEMICAL ENGIN),
   b. Transport core: Transport phenomena, III (CHEN E4110 MECHANISMS OF TRANSPORT) or Transport in fluid mixtures (CHEN E4112 TRANSPORT IN FLUID MIXTURES),
   c. Kinetics core: Advanced chemical kinetics (CHEN E4130 ADV CHEM ENGI THERMODYNAMICS) or Surface reactions and kinetics (CHEN E4235 SURFACE REACTIONS # KINETICS), and
   d. Thermo core: Advanced chemical engineering thermodynamics (CHEN E4130 ADV CHEM ENGI THERMODYNAMICS)* or Statistical mechanics (CHAP E4120 STATISTICAL MECHANICS AND COMP METHODS); and
2. 18 points of 4000-level or higher courses, approved by the graduate coordinator or research adviser, of which up to 6 may be Master's research (CHEN E9400 MASTERS RESEARCH). Students with undergraduate preparation in physics, chemistry, biochemistry, pharmacy, and related fields may enroll in the scientist-to-engineer (S2E) program that leads to the master's degree in chemical engineering. This program requires an extra 6 credits associated with two mandatory Essentials classes (CHEN E4001 ESSENTIALS OF CHEM ENGIN A and CHEN E4002 ESSENTIALS OF CHEM ENGIN B) that are used to ease the transition into chemical engineering.

Specializations

Graduate elective specializations allow chemical engineering students to carry out in-depth exploration of a subject area in modern chemical engineering. To fulfill a specialization, the student must complete any combination of four courses (12 points total) from a list of technical elective courses that have been approved by the department to count towards that specialization. Courses taken P/F do not count towards specializations. Five specializations are offered: (i) Biotechnology; (ii) Climate Solutions; (iii) Data and Computational Science; (iv) Electrochemical Energy; and (v) Soft and Sustainable Materials.

Biotechnology

Manufacturing and discovery in biotechnology and biopharmaceuticals continue to advance at a rapid pace, creating opportunities for engineers to contribute to interdisciplinary areas and apply their core skills to advancing technology. This MS program engages students with recent developments within biotechnology and biopharmaceuticals, focusing on engineering applications and approaches.

There is an established robust biopharmaceutical, fine chemical, and cosmetic industry located in the region (J&J, Merck, BMS, Regeneron, Celgene, Pfizer, L'Oreal, IFF) that can support student internships, research projects, as well as offer employment opportunities to graduates. In addition to these large companies, the metropolitan New York / New Jersey region also is home to many smaller start-up companies in this space and this is expected to grow in the future. The program features a selection of lecture-based courses, opportunities for research with faculty members, and potential industrial internships. In addition, students can gain laboratory experience within teaching laboratories, for example Biotechnology and Biopharmaceutical Lab and Tissue and Molecular Engineering Lab.

To satisfy the requirements for the Specialization in Biotechnology and Biopharmaceuticals, you must take 12 points (likely four courses) from the following list:

CHEN E9400	MASTERS RESEARCH
CHEN E4180	Machine Learning for Biomolecular and Cellular Applications
CHEN E4325	BIOSEPARATIONS
CHEN E4400	Pharmaceutical Process Development
CHEN E4660	BIOCHEMICAL ENGINEERING
CHEN E4700	PRINCIPLES OF GENOMIC TECHNOL
CHEN E4720	Pharmacokinetics for Engineers
CHEN E4800	PROTEIN ENGINEERING
CHEN E4860	NMR BIOSOFTENG
CHEN E4870	Synthetic Organogenesis
CHEN E4890	BIOPHARMACEUTICALS PRODUCT DEV
CHEN E4910	SOLID STATE CHEMISTRY IN PHARMACEUTICAL
CHEN E4920	PHARMACEUTICAL INDUSTRY FOR ENGINEERS
CHEN E4930	Biopharmaceutical Process Laboratory
CHEN E8100	TOPICS IN BIOLOGY
BIOL G4310	Intensive Lab in Biotechnology
BMEN E4001	QUANTITATIVE PHYSIOLOGY I
BMEN E4002	QUANT PHYSIOLOGY II:ORGAN SYST
BMEN E4110	BIOSTATISTICS FOR ENGINEERS
BMEN E4330	Cellular Bioengineering # Therapeutics
BMEN E4430	PRIN OF MAG RESONANCE IMAGING
BMEN E4500	Functional Genomics: Methods and Applications
BMEN E4510	TISSUE ENGINEERING
BMEN E4550	MICRO/NANO STRUCT CELL ENG
BMEN E4580	FOUND OF NANOBIOSCI/NANOBIOTECH
BMEN E6007	LAB-TO-MARKET
BMEN E6500	TISSUE/MOLECULAR ENGI LAB
PHAR G8001	Principles of Systems Pharmacology

Please consult Prof. Sakul Ratanalert for questions about this specialization and its courses.

Climate Solutions

The coursework for a specialization in Climate Solutions provides the MS candidate with an understanding of the fundamentals and technological challenges associated with climate solutions including clean energy and storage, geoengineering and their environmental context. Furthermore, students may choose to learn about electrochemical processes that will continue to rise in importance as sustainable routes to leverage renewable energy for the production of chemicals, fuels, and materials.

Through the S2E program, the specialization is also appropriate for students with undergraduate degrees in chemistry, materials science, mechanical engineering and related disciplines.

To satisfy the requirements for the Specialization in Climate Solutions, you must take 12 points (likely four courses) from the following list:

CHEN E9400	MASTERS RESEARCH
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
CHEN E4231	SOLAR FUELS
CHEN E4444	Climate Technology
CHEN E4600	AEROSOLS
CHEN E4860	NMR BIOSOFTENG
CHEN E4180	Machine Learning for Biomolecular and Cellular Applications
CHEN E4305	
CHEN E4550	Climate Engineering
EESC GU4008	Introduction to Atmospheric Science
EESC W4403	Managing and adapting to climate change
EESC GR6922	ATMOSPHERIC RADIATION
MECE E4211	ENERGY SOURCES AND CONVERSION
MECE E4320	INTRO TO COMBUSTION

Please consult Prof. Chris Chen for question about this specialization and its courses.

Data and Computational Science

The coursework for a specialization in Data and Computational Science provides the MS candidate with an understanding of data science tools and computational modeling methods relevant to modern chemical engineering practice. These tools include methods of data curation, statistical data analysis, predictive modeling, and experimental design that integrate advances in machine learning and artificial intelligence into the chemical engineering domain. Hack-a-thons planned throughout the MS program provide students with the opportunity to apply the tools they learn to solve real-world problems.

Through the S2E program, the specialization is also appropriate for students with undergraduate degrees in chemistry, materials science, mechanical engineering and related disciplines.

To satisfy the requirements for the Specialization in Data and Computational Science, you must take 12 points (likely four courses) from the following list:

CHEN E9400	MASTERS RESEARCH
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
CHEN E4180	Machine Learning for Biomolecular and Cellular Applications
CHEN E4670	CHEMICAL ENGINEERING DATA ANALYSIS
CHEN E4580	ARTIFICIAL INTELLIGENCE IN CHEMICAL ENGINEERING
CHEN E4150	COMPUTATIONAL FLUID DYNAMICS I
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN
EAEE E4000	Machine learning for environmental engineering and science
IEOR E4212	Data Analytics # Machine Learning for OR
IEOR E4540	DATA MINING
MECE E4520	DATA SCIENCE FOR MECHANICAL SYSTEMS

Please consult Prof. Alex Urban for questions about this specialization and its courses.

Electrochemical Energy

The coursework for a specialization in Electrochemical Energy provides the MS candidate with an understanding of the fundamentals and technological challenges associated with batteries and fuel cells. Furthermore, students may choose to learn about electrochemical processes that will continue to rise in importance as sustainable routes to leverage renewable energy for the production of chemicals, fuels, and materials.

To satisfy the requirements for the Electrochemical Energy, you must take 12 points (likely four courses) from the following list:

CHEN E9400	MASTERS RESEARCH
CHEN E4235	SURFACE REACTIONS # KINETICS
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
CHEN E4231	SOLAR FUELS
CHEN E4444	Climate Technology
CHEN E4860	NMR BIOSOFTENG
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN
CHEN E4900	TOPICS IN CHEMICAL ENGINEERING
EAEE E4180	ELECTROCHEMICAL ENERGY STORAGE SYSTEMS
MECE E4211	ENERGY SOURCES AND CONVERSION
APAM E4260	
ELEN E4361	POWER ELECTRONICS

Please consult Prof. lauren Marbella for questions about this specialization and its courses.

Soft and Sustainable Materials

The coursework for a specialization in Soft and Sustainable Materials provides the MS candidate with an understanding of the fundamental and technological challenges associated with producing materials that can be more easily repaired, reprocessed, or otherwise degraded at end-of-life. In particular, many of the courses in this concentration focus on polymers, plastics, and other soft materials; covering synthesis, processing, underlying physics, and eventual degradation (either industrial or environmental). A detailed understanding of each of these areas is essential for establishing the next-generation of sustainable materials.

Through the S2E program, this specialization is also appropriate for students with undergraduate degrees in chemistry, materials science, mechanical engineering, or other related disciplines.

CHEN E9400	MASTERS RESEARCH
APCH E4080	SOFT CONDENSED MATTER
CHEN E4380	Green Chemical Engineering # Innovation
CHEN E4620	INTRO-POLYMERS/SOFT MATERIALS
CHEN E4630	TOPICS IN SOFT MATERIALS
CHEN E4650	POLYMER PHYSICS
CHEN E4665	Polymer Chemistry for Sustainable Solutions
CHEN E4860	NMR BIOSOFTENG
CHEN E4870	Synthetic Organogenesis
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN
CHEN E4900	TOPICS IN CHEMICAL ENGINEERING
CHEN E4910	SOLID STATE CHEMISTRY IN PHARMACEUTICAL
MSAE E4090	NANOTECHNOLOGY
MSAE E4260	ELECTROCHEM MATLS # DEVS

Please consult Prof. Neil Dolinski for questions about this specialization and its courses.

Chemical Engineering (PhD/DES)

Doctoral Degrees

The Ph.D. and DES degrees have essentially the same requirements. All students in a doctoral program must

1. **Only for students who have not yet earned an MS before their time in our program**: Earn satisfactory grades in the four core courses (CHEN E4010 MATH METHODS IN CHEMICAL ENGIN, CHEN E4110 MECHANISMS OF TRANSPORT, CHEN E4330 ADVANCED CHEMICAL KINETICS, CHEN E4130 ADV CHEM ENGI THERMODYNAMICS/CHAP E4120 STATISTICAL MECHANICS AND COMP METHODS);
2. pass a Qualifying Examination;
3. pass a Proposal Examination within 12 months of passing the Qualifying Examination;
4. pass a Dissertation Defense; and
5. satisfy course requirements beyond the four core courses.

For detailed requirements, please consult the departmental office or graduate coordinator. Students with degrees in related fields such as physics, chemistry, biochemistry, and others are encouraged to apply to this highly interdisciplinary program.

Civil Engineering and Engineering Mechanics

600 S. W. Mudd, MC 4709
212-854-3143
civil.columbia.edu

The Department of Civil Engineering and Engineering Mechanics focuses on two broad areas of instruction and research. The first, the classical field of civil engineering, deals with the planning, design, construction, and maintenance of the built environment. This includes buildings, foundations, bridges, transportation facilities, nuclear and conventional power plants, hydraulic structures, and other facilities essential to society. The second is the science of mechanics and its applications to various engineering disciplines. Frequently referred to as applied mechanics, it includes the study of the mechanical and other properties of materials, stress analysis of stationary and movable structures, the dynamics and vibrations of complex structures, aero- and hydrodynamics, and the mechanics of biological systems.

Mission

The department aims to provide students with a technical foundation anchored in theory together with the breadth needed to follow diverse career paths, whether in the profession via advanced study or apprenticeship, or as a base for other pursuits.

Current Research Activities

Current research activities in the Department of Civil Engineering and Engineering Mechanics are centered in the areas outlined below. A number of these activities impact directly on problems of societal importance, such as rehabilitation of the infrastructure, mitigation of natural or man-made disasters, and environmental concerns.

Solid mechanics: mechanical properties of new and exotic materials, constitutive equations for geologic materials, failure of materials and components, properties of fiber-reinforced cement composites, damage mechanics.

Multihazard risk assessment and mitigation: integrated risk studies of the civil infrastructure form a multihazard perspective, including earthquake, wind, flooding, fire, blast, and terrorism. The engineering, social, financial, and decision-making perspectives of the problem are examined in an integrated manner.

Probabilistic mechanics: random processes and fields to model uncertain loads and material/soil properties, nonlinear random vibrations, reliability and safety of structural systems, computational stochastic mechanics, stochastic finite element and boundary element techniques, Monte Carlo simulation techniques, random micromechanics.

Structural control and health monitoring: topics of research in this highly cross-disciplinary field include the development of “smart” systems for the mitigation and reduction of structural vibrations, assessment of the health of structural systems based on their vibration response signatures, and the modeling of nonlinear systems based on measured dynamic behavior.

Fluid mechanics: numerical and theoretical study of fluid flow and transport processes, nonequilibrium fluid dynamics and thermodynamics, turbulence and turbulent mixing, boundary-layer flow, urban and vegetation canopy flow, particle-laden flow, wind loading, flow through porous media, and flow and transport in fractured rock.

Environmental engineering/water resources: modeling of flow and pollutant transport in surface and subsurface waters, unsaturated zone hydrology, geoenvironmental containment systems, analysis of watershed flows including reservoir simulation.

Structures: dynamics, stability, and design of structures, structural failure and damage detection, fluid and soil structure interaction, ocean structures subjected to wind-induced waves, inelastic dynamic response of reinforced concrete structures, earthquake-resistant design of structures.

Geotechnical engineering: soil behavior, constitutive modeling, reinforced soil structures, geotechnical earthquake engineering, liquefaction and numerical analysis of geotechnical systems.

Structural materials: cement-based materials, micro- and macromodels of fiber-reinforced cement composites, utilization of industrial by-products and waste materials, beneficiation of dredged material.

Earthquake engineering: response of structures to seismic loading, seismic risk analysis, active and passive control of structures subject to earthquake excitation, seismic analysis of long-span cable-supported bridges.

Flight structures: composite materials, smart and multifunctional structures, multiscale and failure analysis, vibration control, computational mechanics and finite element analysis, fluid-structure interaction, aeroelasticity, optimal design, and environmental degradation of structures.

Advanced materials: multifunctional engineering materials, advanced energy materials, durable infrastructure materials, new concretes/composites using nanotubes, nanoparticles, and other additives with alternative binders, sustainable manufacturing technologies, rheological characterization for advanced cement/concrete placement processes.

Computational mechanics: aimed at understanding and solving problems in science and engineering, topics include multiscale methods in space and time (e.g., homogenization and multigrid methods); multiphysics modeling; material and geometric nonlinearities; strong and weak discontinuities (e.g., cracks and inclusions); discretization techniques (e.g., extended finite element methods and mixed formulations); verification and validation (e.g., error analysis); software development and parallel computing.

Multiscale mechanics: solving various engineering problems that have important features at multiple spatial and temporal scales, such as predicting material properties or system behavior based on information from finer scales; focus on information reduction methods that provide balance between computational feasibility and accuracy.

Transportation engineering: understanding and modeling transportation systems that are radically evolving due to emerging communication and sensing technologies; leveraging large data collected from various traffic sensors to understand transformation in travel behavior patterns; modeling travel behavior using a game theory approach to help decision-makers understand upcoming changes and prepare for effective planning and management of next generation transportation systems.

Construction engineering and management: contracting strategies; alternative project delivery systems; minimizing project delays and disputes; advanced technologies to enhance productivity and efficiency; strategic decisions in global engineering and construction markets; industry trends and challenges.

Infrastructure delivery and management: decision support systems for infrastructure asset management; assessing and managing infrastructure assets and systems; capital budgeting processes and decisions; innovative financing methods; procurement strategies and processes; data management practices and systems; indicators of infrastructure performance and service; market analysis.

Construction robotics: an emerging field that integrates robotics, AI, and civil engineering to automate or augment construction tasks; addresses challenges such as perception, decision making, navigation, and manipulation in cluttered and dynamic environments, worker safety during human-robot collaboration, and integration with existing technology such as digital twins; aims to improve productivity, safety, and sustainability in the construction industry.

Integrated Computational Materials Engineering (ICME): multiscale process modeling and computational mechanics for accelerated design and performance optimization applied to advanced composites for aerospace, automotive, and energy-efficient structures.

Facilities

The offices and laboratories of the department are in the S. W. Mudd Building and the Engineering Terrace.

Computing

The department manages a substantial computing facility of its own in addition to being networked to all the systems operated by the University. The department facility enables its users to perform symbolic and numeric computation, three-dimensional graphics, and expert systems development. Connections to wide-area networks allow the facility's users to communicate with centers throughout the world. All faculty and student offices and department laboratories are hardwired to the computing facility, which is also accessible remotely to users. Numerous personal computers and graphics terminals exist throughout the department, and a PC lab is available to students in the department in addition to the larger school-wide facility.

Laboratories

Robert A. W. Carleton Strength of Materials Laboratory

The Carleton Laboratory serves as the central laboratory for all experimental work performed in the Department of Civil Engineering and Engineering Mechanics. It is the largest laboratory at Columbia University's Morningside campus and is equipped for teaching and research in all types of engineering materials and structural elements, as well as damage detection, fatigue, vibrations, and sensor networks. The Laboratory has a full-time staff who provide assistance in teaching and research. The Laboratory is equipped with a strong floor that allows for the testing of full-scale structural components such as bridge decks, beams, and columns. Furthermore, it is equipped with universal testing machines ranging in capacity from 150 kN (30,000 lbs.) to 3 MN (600,000 lbs.). The seamless integration of both research and teaching in the same shared space allows civil engineering students of all degree tracks to gain a unique appreciation of modern experimental approaches to material science and engineering mechanics.

The Carleton Laboratory serves as the hub of instruction for classes offered by the Department of Civil Engineering and Engineering Mechanics, most prominently ENME E3114 EXPERIMENTAL MECH OF MATERIALS, ENME E3106 DYNAMICS AND VIBRATIONS, and CIEN E3141 SOIL MECHANICS. The Laboratory also hosts and advises the AISC Steel Bridge Team in the design, fabrication, and construction phases of their bridge, which goes to regional and national competition annually.

Additionally, the Carleton Laboratory has a fully outfitted machine shop capable of machining parts, fittings, and testing enclosures in steel, nonferrous metals, acrylic, and wood. The Carleton Machine Shop's machine tool pool is state-of-the-art, either of the latest generation or recently rebuilt and modernized. The machine shop is open for use by undergraduate students performing independent research and is supported by the Lab's senior lab technician.

The Donald M. Burmister Soil Mechanics Laboratory
The Burmister Laboratory contains equipment and workspace to carry out all basic soil mechanics testing for our undergraduate and graduate programs. Several unique apparatuses have been acquired or fabricated for advanced soil testing and research: automated plain strain/triaxial apparatus for stress path testing at both drained and undrained conditions, direct sheer device for minimum compliance, and a unique sand hopper which prepares foundations and slopes for small scale model testing. The Laboratory has established a link and cooperation for large-scale testing for earthquake and geosynthetic applications with NRIAE, the centrifuge facilities at the Rensselaer Polytechnic Institute and the Tokyo Institute of Technology.

The Heffner Hydrologic Research Laboratory
The Heffner Laboratory is a facility for both undergraduate instruction and research in aspects of fluid mechanics, environmental applications, and water resources. The Heffner Laboratory houses the facilities for teaching the laboratory component of the ENME E3161 FLUID MECHANICS course and includes multiple hydraulic benches with a full array of experimental modules.

The Eugene Mindlin Laboratory for Structural Deterioration Research
The Mindlin Laboratory has been developed for teaching and research dedicated to all facets of the assessment of structures, deterioration of structural performance and surface coatings, dynamic testing for earthquakes, and other applications. The commissioning of a state-of-the-art 150 kN Instron universal testing machine, a QUV ultraviolet salt spray corrosion system, a freeze-thaw tester, a Keyence optical microscope and surface analyzer have further expanded the Mindlin Laboratory's capabilities in material testing and characterization. The Mindlin Laboratory also serves as a state-of-the-art medium scale nondestructive structural health monitoring facility, allowing the conduct of research in the assessment of our nation's degrading civil infrastructure.

The Institute of Flight Structures
The Institute of Flight Structures was established within the department through a grant by the Daniel and Florence Guggenheim Foundation. It provides a base for graduate training in aerospace and aeronautical related applications of structural analysis and design.

Chair
Andrew Smyth

Director of Finance and Administration
Ann Madigan

Manager of Graduate Admissions and Student Affairs
Scott Kelly

Director, Career Placement
Emily-Anne McCormack

Career Placement Officer
Jenna Kumabe

Finance and Grants Manager
Laura Lichtblau

IT Systems Manager
Michael Smith

Operations Manager
Nathalie Benitez

Professors
Raimondo Betti
Gautam Dasgupta
George Deodatis
Maria Q. Feng
Jacob Fish
Hoe I. Ling
Feniosky Peña-Mora
Andrew Smyth

Associate Professors
Sharon (Xuan) Di
Shiho Kawashima
Addis Kidane
Ioannis Kougioumtzoglou
Marianna Maiaru
WaiChing Sun
Haim Waisman
Huiming Yin

Assistant Professors
Marco Giometto
Markus Schlaepfer
Zhengbo Zou

Professor of Professional Practice
Kate Ascher

Lecturers in Discipline
Julius Chang
Ibrahim Odeh
Thomas Panayotidi

Adjunct Faculty
Director, Carleton Laboratory
Adrian Brügger

Manager, Carleton Laboratory
William A. Hunnicutt

Associate Manager, Carleton Laboratory
Freddie E. Wheeler

Senior Laboratory Engineer, Carleton Laboratory

Amos Fishman-Resheff

Manager, Centrifuge Laboratory

Liming Li

Senior Fabrication Engineer

Clara Wilson

Course Descriptions

AERO E3001 Foundation of Aerospace Engineering. *3.00 points*.
Prerequisites: (MATH UN1101 and MATH UN1102 and PHYS UN1401 and PHYS UN1402)
History and development of aviation and spaceflight; application of fundamental physics to analyze atmospheric and space flight; core principles of aerodynamics, propulsion, and flight mechanics; basic aircraft performance and stability characteristics; influence of space and atmospheric environment on vehicles; key lightweight materials and structural design considerations in aerospace applications. Course intended for undergraduate students. Students who take AERO E3001 may not take AERO E4001.

Fall 2026: AERO E3001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 3001	001/15050	T 1:10pm - 3:40pm 627 Seeley W. Mudd Building	Marianna Maiaru	3.00	1/30

AERO E4001 Foundation of Aerospace Engineering. *3.00 points*.
Prerequisites: (MATH UN1101 and MATH UN1102 and PHYS UN1401 and PHYS UN1402)
History and development of aviation and spaceflight; application of fundamental physics to analyze atmospheric and space flight; core principles of aerodynamics, propulsion, and flight mechanics; basic aircraft performance and stability characteristics; influence of space and atmospheric environment on vehicles; key lightweight materials and structural design considerations in aerospace applications. Course intended for graduate students. Students who have previously taken AERO E3001 may not take AERO E4001.

Fall 2026: AERO E4001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4001	001/15051	T 1:10pm - 3:40pm 627 Seeley W. Mudd Building	Marianna Maiaru	3.00	6/30

AERO E4101 Aerospace Structures. *3.00 points*.
Prerequisites: (ENME E3105 and ENME E3113) or (ENME E3105 and MECE E3414)
Analysis of aerospace structures (solid and thin-walled structures), including bending, shear, and torsion; aircraft loading bearing members; introduction to aerospace materials; analysis of structural instability; experimental method in aerospace structures.

Spring 2026: AERO E4101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4101	001/17326	T 4:10pm - 6:40pm 415 Schapiro Cepser	Addis Kidane	3.00	6/40

AHCE W4149 The Roman Art of Engineering: Traditions of Planning, Construction, and Innovation. *3.00 points*.
Interdisciplinary study of ancient Roman engineering and architecture in a course co-created between Arts # Sciences and Engineering. Construction principles, techniques, and materials: walls, columns, arches, vaults, domes. Iconic Roman buildings (Colosseum, Pantheon, Trajan's Column) and infrastructure (roads, bridges, aqueducts, baths, harbors, city walls). Project organization. Roman engineering and society: machines and human labor; engineers, architects, and the army; environmental impact. Comparisons with current practice as well as cross-cultural comparisons with other pre-modern societies across the globe. A Columbia Cross-Disciplinary Course

Fall 2026: AHCE W4149

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AHCE 4149	001/13453	T Th 4:10pm - 5:25pm 614 Schermerhorn Hall	Francesco de Angelis, Julius Chang	3.00	52/120

CEEM E3899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: CEEM E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CEEM 3899	001/20228		Xuan Di	0.00	1/20
CEEM 3899	002/20686		Marco Giometto	0.00	4/20

Summer 2026: CEEM E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CEEM 3899	001/12855		Huiming Yin	0.00	1/25
CEEM 3899	002/12864		Marco Giometto	0.00	1/25

CEEM E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: CEEM E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CEEM 4899	001/20229		Xuan Di	0.00	1/20

Summer 2026: CEEM E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CEEM 4899	001/12880		Xuan Di	0.00	0/25

CEOR E4011 INFRASTRUCTURE SYSTEMS OPTIMIZATION. *3.00 points*.
Lect.: 3.

Prerequisites: Basic linear algebra. Basic probability and statistics. Engineering economic concepts. Basic spreadsheet analysis and programming skills. Subject to instructor's permission. Infrastructure design and systems concepts, analysis, and design under competing/conflicting objectives, transportation network models, traffic assignments, optimization, and the simplex algorithm

Fall 2026: CEOR E4011

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CEOR 4011	001/14468	W 7:00pm - 9:30pm 327 Seeley W. Mudd Building	Xuan Di	3.00	13/30

CIEE E3111 UNCERTAIN/RISK-CIVIL INF SYST. *3.00 points*.
Prerequisites: Working knowledge of calculus.
Introduction to basic probability; hazard function; reliability function; stochastic models of natural and technological hazards; extreme value distributions; Monte Carlo simulation techniques; fundamentals of integrated risk assessment and risk management; topics in risk-based insurance; case studies involving civil infrastructure systems, environmental systems, mechanical and aerospace systems, construction management. Not open to undergraduate students

Fall 2026: CIEE E3111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEE 3111	001/14586	T 4:10pm - 6:40pm 717 Hamilton Hall	Ioannis Kougioumtzoglou	3.00	25/50

CIEE E3260 ENGINEERING FOR COMMUNITY DEVELOPMENT. *3.00 points*.
Lect: 3

Introduction to the challenges and realities of implementing design solutions with high-risk, low-resource communities in urban and rural settings in both developed and developing countries. History and theory of international development towards preparing globally responsible and informed professionals. Real-world examples of development work across technical sectors including water, sanitation, energy, health, communication technology, shelter, food systems, and environment. Role of engineering in achieving the Sustainable Development Goals. Course projects follow a Design for Impact process resulting in an engineering design, an action plan, and the identification of indicators for impact evaluation

CIEE E4111 UNCERTAIN/RISK-CIVIL INF SYST. *3.00 points*.
Prerequisites: Working knowledge of calculus.
Introduction to basic probability; hazard function; reliability function; stochastic models of natural and technological hazards; extreme value distributions; Monte Carlo simulation techniques; fundamentals of integrated risk assessment and risk management; topics in risk-based insurance; case studies involving civil infrastructure systems, environmental systems, mechanical and aerospace systems, construction management. Not open to undergraduate students

Fall 2026: CIEE E4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEE 4111	001/14587	T 4:10pm - 6:40pm 717 Hamilton Hall	Ioannis Kougioumtzoglou	3.00	28/75
CIEE 4111	V01/20101		Ioannis Kougioumtzoglou	3.00	0/99

CIEE E4116 Energy Harvesting. *3.00 points*.
Prerequisites: ENME E3114 or equivalent, or instructor's permission. Criterion of energy harvesting, identification of energy sources. Theory of vibrations of discrete and continuous system, measurement and analysis. Selection of materials for energy conversion, piezoelectric, electromagnetic, thermoelectric, photovoltaic, etc. Design and characterization, modeling and fabrication of vibration, motion, wind, wave, thermal gradient, and light energy harvesters; resonance phenomenon, power electronics and energy storage and management. Applications to buildings, geothermal systems, and transportation. To alternate with ENME E4115.

CIEN E0001 GEOTECHNICAL/STRUCTURAL TRACK. *0.00 points*.

CIEN E0002 CONSTRUCTION TRACK. *0.00 points*.

CIEN E0003 WATER RES/ENVIRONMENTAL TRACK. *0.00 points*.

CIEN E3000 THE ART OF STRUCTURAL DESIGN. *3.00 points*.
Lect: 3.

Basic scientific and engineering principles used for the design of buildings, bridges, and other parts of the built infrastructure. Application of principles to analysis and design of actual large-scale structures. Coverage of the history of major structural design innovations and of the engineers who introduced them. Critical examination of the unique aesthetic/artistic perspectives inherent in structural design. Consideration of management, socioeconomic, and ethical issues involved in design and construction of large-scale structures. Introduction to recent developments in sustainable engineering, including green building design and adaptable structural systems

Spring 2026: CIEN E3000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3000	001/11695	M W 2:40pm - 3:55pm 313 Fayerweather	George Deodatis	3.00	58/75

CIEN E3004 URBAN INFRASTRUCTURE SYSTEMS. *3.00 points*.
Introduction to: (a) the infrastructure systems that support urban socioeconomic activities and (b) fundamental system design and analysis methods. Coverage of water supply, transportation, buildings, and energy infrastructure, as well as their interdependencies. Emphasis upon the process that these systems serve, the factors that influence their performance, the basic mechanisms that govern their design and operation, and the impacts that they have regionally and globally. Student teams complete a design/analysis project on a large-scale urban development site in New York City with equal emphasis given to water resources/environmental engineering, geotechnical engineering, and construction engineering and management topics

Spring 2026: CIEN E3004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3004	001/11692	M 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Markus Schlaepfer	3.00	40/40

CIEN E3010 Introduction to Construction: Case Studies. *3.00 points*.
Introduction to basic principles of how builders construct different types of projects. Detailed weekly cases of construction processes for infrastructure and building projects highlighting major differences between project types; challenges and solutions typically faced by project teams during construction. Types of projects covered: tunnels, bridges, skyscrapers, neighborhood development, mega programs, airports, and education. Detailed case studies of past and current iconic national and international projects, including in New York area. Site visits to active construction projects to learn directly from site engineers and team. CEEM sophomores only

CIEN E3121 STRUCTURAL ANALYSIS. *3.00 points*.
Lect: 3.

Methods of structural analysis. Trusses, arches, cables, frames; influence lines; deflections; force method; displacement method; computer applications

Spring 2026: CIEN E3121

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3121	001/12150	M W 10:10am - 11:25am 829 Seeley W. Mudd Building	Maria Feng	3.00	15/35

CIEN E3125 STRUCTURAL DESIGN. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3113) ENME E3113
Design criteria for varied structural applications, including buildings and bridges; design of elements using steel, concrete, masonry, wood, and other materials

Spring 2026: CIEN E3125

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3125	001/11855	T Th 10:10am - 11:25am 415 Schapiro Cepser	Tom Panayotidi	3.00	18/35

CIEN E3126 COMPUTER-AIDED STRUCTRL DESIGN. *2 points*.
Lect: 2. Lab: 1.

Corequisites: CIEN E3125.
Corequisites: CIEN E3125. Introduction to software for structural analysis, design, and modeling with lab. Integration of software into project workflows. Introduction to best practices for modeling and verification of results using hand calculations.

Spring 2026: CIEN E3126

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3126	001/11857	Th 4:10pm - 6:40pm 252 Engineering Terrace	Bryan Minarczyk, Nicholas Katsandonis	2	20/22

CIEN E3127 STRUCTURAL DESIGN PROJECTS. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3125) and (CIEN E3126) or CIEN E3125 AND CIEN E3126; or instructor's permission.
Design of steel members in accordance with AISC 360: moment redistribution in beams; plastic analysis; bearing plates; beam-columns: exact and approximate second-order analysis; design by the Effective Length method and the Direct Analysis method. Design of concrete members in accordance with ACI 318: bar anchorage and development length, bar splices, design for shear, short columns, slender columns. AISC/ASCE NSSBC design project: design of a steel bridge in accordance with National Student Steel Bridge Competition rules; computer simulation and design by using SAP2000

Fall 2026: CIEN E3127

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3127	001/14469	M W 11:40am - 12:55pm 227 Seeley W. Mudd Building	Tom Panayotidi	3.00	17/35

CIEN E3128 DESIGN PROJECTS. *4.00 points*.
Lect: 4.

Prerequisites: (CIEN E3125) and (CIEN E3126) CIEN E3125 AND CIEN E3126
Capstone design project in civil engineering. This project integrates structural, geotechnical and environmental/water resources design problems with construction management tasks and sustainability, legal and other social issues. Project is completed in teams, and communication skills are stressed. Outside lecturers will address important current issues in engineering practice. Every student in the course will be exposed with equal emphasis to issues related to geotechnical engineering, water resources / environmental engineering, structural engineering, and construction engineering and management

Spring 2026: CIEN E3128

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3128	001/12146	Th 1:10pm - 2:25pm 252 Engineering Terrace	Tom Panayotidi	4.00	23/23
CIEN 3128	001/12146	T 1:10pm - 3:25pm 252 Engineering Terrace	Tom Panayotidi	4.00	23/23

CIEN E3129 PROJECT MGMT FOR CONSTRUCTION. *3.00 points*.
Lect: 3.

Prerequisites: Senior standing in Civil Engineering or instructor's permission.
Introduction to Project Management for design and construction processes. Elements of planning, estimating, scheduling, bidding, and contractual relationships. Computer scheduling and cost control. Critical path method. Design and construction activities. Field supervision

Fall 2026: CIEN E3129

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3129	001/14473	W 1:10pm - 3:40pm 227 Seeley W. Mudd Building	Julius Chang	3.00	27/35

CIEN E3141 SOIL MECHANICS. *4.00 points*.
Lect: 3. Lab 3.

Prerequisites: (ENME E3113) ENME E3113
Index properties and classification; compaction; permeability and seepage; effective stress and stress distribution; shear strength of soil; consolidation; slope stability

Fall 2026: CIEN E3141

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3141	001/15011	Th 10:00am - 12:00pm 161 Engineering Terrace	Hoe Ling	4.00	19/35
CIEN 3141	001/15011	M 4:10pm - 6:40pm 414 Schapiro Cepser	Hoe Ling	4.00	19/35

CIEN E3303 IND STUDIES-CIVIL ENGIN-JUNIOR. *1.00-3.00 points*.
By conference.

A project on civil engineering subjects approved by the chairman of the department

Spring 2026: CIEN E3303

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3303	001/19806		Raimondo Betti	1.00-3.00	0/20
CIEN 3303	002/19807		Adrian Brugger	1.00-3.00	5/20
CIEN 3303	003/19808		Gautam Dasgupta	1.00-3.00	0/20
CIEN 3303	004/19809		George Deodatis	1.00-3.00	1/20
CIEN 3303	005/19810		Xuan Di	1.00-3.00	7/50
CIEN 3303	006/19811		Maria Feng	1.00-3.00	0/20
CIEN 3303	007/19812		Jacob Fish	1.00-3.00	0/20
CIEN 3303	008/19813		Marco Giometto	1.00-3.00	0/20
CIEN 3303	009/19814		Shiho Kawashima	1.00-3.00	1/20
CIEN 3303	010/19815		Addis Kidane	1.00-3.00	0/20
CIEN 3303	011/19816		Ioannis Kougioumtzoglou	1.00-3.00	0/20
CIEN 3303	012/19817		Hoe Ling	1.00-3.00	0/20
CIEN 3303	013/19818		Marianna Maiaru	1.00-3.00	0/20
CIEN 3303	014/19819		Markus Schlaepfer	1.00-3.00	0/20
CIEN 3303	015/19820		Andrew Smyth	1.00-3.00	0/20
CIEN 3303	016/19821		Waiching Sun	1.00-3.00	0/20
CIEN 3303	017/19822		Haim Waisman	1.00-3.00	0/20
CIEN 3303	018/19823		Huiming Yin	1.00-3.00	1/20
CIEN 3303	019/19824		Zhengbo Zou	1.00-3.00	0/20

CIEN E3304 IND STUDIES-CIVIL ENGIN-SENIOR. *1.00-3.00 points*.
By conference.

A project on civil engineering subjects approved by the chairman of the department

Spring 2026: CIEN E3304

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3304	001/19825		Raimondo Betti	1.00-3.00	0/20
CIEN 3304	002/19826		Adrian Brugger	1.00-3.00	0/20
CIEN 3304	003/19827		Gautam Dasgupta	1.00-3.00	0/20
CIEN 3304	004/19828		George Deodatis	1.00-3.00	4/20
CIEN 3304	005/19829		Xuan Di	1.00-3.00	0/50
CIEN 3304	006/19830		Maria Feng	1.00-3.00	0/20
CIEN 3304	007/19831		Jacob Fish	1.00-3.00	0/20
CIEN 3304	008/19832		Marco Giometto	1.00-3.00	1/20
CIEN 3304	009/19833		Shiho Kawashima	1.00-3.00	2/20
CIEN 3304	010/19834		Addis Kidane	1.00-3.00	0/20
CIEN 3304	011/19835		Ioannis Kougioumtzoglou	1.00-3.00	0/20
CIEN 3304	012/19836		Hoe Ling	1.00-3.00	0/20
CIEN 3304	013/19837		Marianna Maiaru	1.00-3.00	0/20
CIEN 3304	014/19860		Markus Schlaepfer	1.00-3.00	0/20
CIEN 3304	015/19868		Andrew Smyth	1.00-3.00	0/20
CIEN 3304	016/19869		Waiching Sun	1.00-3.00	0/20
CIEN 3304	017/19870		Haim Waisman	1.00-3.00	0/20
CIEN 3304	018/19871		Huiming Yin	1.00-3.00	0/20
CIEN 3304	019/19872		Zhengbo Zou	1.00-3.00	0/20

Summer 2026: CIEN E3304

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3304	001/12814		Xuan Di	1.00-3.00	1/25

CIEN E3999 FIELDWORK. *1.00-1.50 points*.
Prerequisites: Obtained internship and approval from faculty adviser. CEEM undergraduate students only. Written application must be made prior to registration outlining proposed internship/study program. Final reports required. May not be taken for pass/fail credit or audited. International students must also consult with the International Students and Scholars Office

Summer 2026: CIEN E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3999	001/11048		Scott Kelly	1.00-1.50	4/20

Fall 2026: CIEN E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 3999	001/19822			1.00-1.50	0/25

CIEN E4011 BIG DATA IN TRANSPORTATION. *3.00 points*.
Major elements of transportation analytics. Develop basic skills in applying fundamentals of data analytics to transportation data analysis. Apply coding languages (e.g., MATLAB, Python) and visualization tools (e.g., Excel, Carto, R, Processing) to analyze transportation data. Infer policy implications from analytics results.

Spring 2026: CIEN E4011

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4011	001/11657	W 7:00pm - 9:30pm 337 Seeley W. Mudd Building	Xuan Di	3.00	16/30

CIEN E4012 Sustainable Urban Systems Engineering. *3.00 points*.
Prerequisites: Basic linear algebra. Basic probability theory and statistics. Basic programming skills.
Introduction to urban data analytics (analysis and visualization of new types of 'big' urban data, statistical tools for urban data analysis, machine learning methods, data privacy). Conceptualization of cities as complex adaptive systems (coarse-graining of urban dynamics, network models for infrastructure interdependencies, agent-based urban simulation). Integrated urban infrastructure systems design (basic design solutions for coupled, people-centric, and climate-resilient civil infrastructure systems, Monte Carlo simulations for infrastructure scenario generation)

Fall 2026: CIEN E4012

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4012	001/14474	M 1:10pm - 3:40pm 825 Seeley W. Mudd Building	Markus Schlaepfer	3.00	22/35

CIEN E4021 ELAS/PLAS ANALYSIS-STRUCTURES. *3.00 points*.
Lect: 3.

Overview of classical indeterminate structural analysis methods (force and displacement methods), approximate methods of analysis, plastic analysis methods, collapse analysis, shakedown theorem, structural optimization.

CIEN E4022 BRIDGE DESIGN # MANAGEMENT. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3125) or CIEN E3125
Bridge design history, methods of analysis, loads: static, live, dynamic. Design: allowable stress, ultimate strength, load resistance factor, supply/demand. Steel and concrete superstructures: suspension, cable stayed, prestressed, arches. Management of the assets, life-cycle cost, expected useful life, inspection, maintenance, repair, reconstruction. Bridge inventories, condition assessments, data acquisition and analysis, forecasts. Selected case histories and field visits

CIEN E4100 EARTHQUAKE # WIND ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3106) or ENME E3106
Basic concepts of seismology. Earthquake characteristics, magnitude, response spectrum, dynamic response of structures to ground motion. Base isolation and earthquake-resistant design. Wind loads and aeroelastic instabilities. Extreme winds. Wind effects on structures and gust factors

Spring 2026: CIEN E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4100	001/11659	T 4:10pm - 6:40pm 524 Seeley W. Mudd Building	Luciana Balsamo, Athina Spyridaki	3.00	31/50

CIEN E4121 Advanced Analysis and Design of Structures. *3.00 points*.
Prerequisites: (CIEN 3125E) is recommended
Advanced analysis and design methodologies and impact on efficient use of building materials. Effects on quality and safety in design of structures. Utilization of advanced techniques as prescribed by building code requirements for steel and concrete structures (AISC and ACI).

Fall 2026: CIEN E4121

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4121	001/14751	W 7:00pm - 9:30pm 337 Seeley W. Mudd Building	Tom Panayotidi	3.00	16/50

CIEN E4129 MANAGING ENG # CONST PROCESSES. *3.00 points*.
Lect: 3.

Prerequisites: Graduate standing in Civil Engineering, or instructor's permission.
Introduction to the principles, methods and tools necessary to manage design and construction processes. Elements of planning, estimating, scheduling, bidding and contractual relationships. Valuation of project cash flows. Critical path method. Survey of construction procedures. Cost control and effectiveness. Field supervision

Spring 2026: CIEN E4129

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4129	001/11662	T 4:10pm - 6:00pm 308a Lewisohn Hall	Timothy McManus	3.00	21/22

Fall 2026: CIEN E4129

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4129	001/14985	T 4:10pm - 6:40pm 825 Seeley W. Mudd Building	Timothy McManus	3.00	22/50

CIEN E4130 DESIGN OF CONSTRUCTION SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3125) CIEN E3125; Or the instructors permission.
Introduction to the design of systems that support construction activities and operations. Determination of design loads during construction. Design of excavation support systems, earth retaining systems, temporary supports and underpinning, concrete formwork and shoring systems. Cranes and erection systems. Tunneling systems. Instrumentation and monitoring. Students prepare and present term projects

Fall 2026: CIEN E4130

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4130	001/14475	Th 1:10pm - 3:40pm 308a Lewisohn Hall	Vincent Tirolo	3.00	14/40

CIEN E4131 PRIN OF CONSTRUCTN TECHNIQUES. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4129) or CIEN E4129
Current methods of construction, cost-effective designs, maintenance, safe work environment. Design functions, constructability, site and environmental issues

Spring 2026: CIEN E4131

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4131	001/12795	W 7:00pm - 9:30pm 524 Seeley W. Mudd Building	Dominick Pilla	3.00	30/50

Fall 2026: CIEN E4131

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4131	001/14590	T 7:00pm - 9:30pm 633 Seeley W. Mudd Building	Dominick Pilla	3.00	40/70

CIEN E4132 PREV#RESOL OF CONSTR DISPUTES. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4129) or CIEN E4129; or equivalent.
Contractual relationships in the engineering and construction industry and the actions that result in disputes. Emphasis on procedures required to prevent disputes and resolve them quickly and cost-effectively. Case studies requiring oral and written presentations

Spring 2026: CIEN E4132

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4132	001/11665	M 4:10pm - 6:40pm 545 Seeley W. Mudd Building	Gregory Chertoff, Denis Serkin	3.00	21/40
CIEN 4132	V01/17136		Gregory Chertoff, Denis Serkin	3.00	0/99

CIEN E4133 CAPITAL FACILITY PLANNING/FIN. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4129) or CIEN E4129; or equivalent.
Planning and financing of capital facilities with a strong emphasis upon civil infrastructure systems. Project feasibility and evaluation. Design of project delivery systems to encourage best value, innovation and private sector participation. Fundamentals of engineering economy and project finance. Elements of life cycle cost estimation and decision analysis. Environmental, institutional, social and political factors. Case studies from transportation, water supply and wastewater treatment

Fall 2026: CIEN E4133

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4133	001/19735	W 4:10pm - 6:40pm 414 Schapiro Cepser	Muqing Liu	3.00	4/50

CIEN E4134 CONSTRUCTION INDUSTRY LAW. *3.00 points*.
Lect: 3.

Prerequisites: Graduate standing or the instructor's permission.
Practical focus upon legal concepts applicable to the construction industry. Provides sufficient understanding to manage legal aspects, instead of being managed by them. Topics include contractual relationships, contract performance, contract flexibility and change orders, liability and negligence, dispute avoidance/resolution, surety bonds, insurance and site safety

Fall 2026: CIEN E4134

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4134	001/14585	M 7:00pm - 9:30pm 652 Schermerhorn Hall	Steven Charney, Scott Kelly	3.00	7/25

CIEN E4135 STRATEGIC MGT - ENG # CONSTR. *3.00 points*.
Lect: 3.

Core concepts of strategic planning, management and analysis within the construction industry. Industry analysis, strategic planning models and industry trends. Strategies for information technology, emerging markets and globalization. Case studies to demonstrate key concepts in real-world environments

CIEN E4136 Entrepreneurship in Engineering and Construction. *3 points*.
Lect: 3.

Capstone practicum where teams develop strategies and business plans for a new enterprise in the engineering and construction industry. Identification of attractive market segments and locations; development of an entry strategy; acquisition of financing, bonding and insurance; organizational design; plans for recruiting and retaining personnel; personnel compensation/incentives. Invited industry speakers.
Priority given to graduate students in Construction Engineering and Management.

Spring 2026: CIEN E4136

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4136	001/12694	Th 4:10pm - 6:40pm 524 Seeley W. Mudd Building	Pierce Reynoldson	3	17/40
CIEN 4136	V01/18016		Pierce Reynoldson	3	1/99

CIEN E4137 Managing Civil Infrastructure Systems. *3 points*.
Lect: 3.

Prerequisites: (IEOR E4003) and (CIEN E4133) or IEOR E4003 AND CIEN E4133
Examination of the fundamentals of infrastructure planning and management, with a focus on the application of rational methods that support infrastructure decision-making. Institutional environment and issues. Decision-making under certainty and uncertainty. Capital budgeting and financing. Group decision processes. Elements of decision and finance theory. Priority given to graduate students in Construction Engineering and Management.

Spring 2026: CIEN E4137

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4137	001/12147	M 7:00pm - 9:30pm 627 Seeley W. Mudd Building	Muqing Liu	3	26/50

CIEN E4138 REAL ESTATE FIN/CONST MANAG. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E2261) and (CIEN E3129) or instructor's permission. Introduction to financial mechanics of public and private real-estate development and management. Working from perspectives of developers, investors and taxpayers, financing of several types of real estate and infrastructure projects are covered. Basics of real-estate accounting and finance, followed by in-depth studies of private, public, and public/private-partnership projects and their financial structures. Focused on U.S.-based financing, with some international practices introduced and explored. Financial risks and rewards, and pertinent capital markets and their financing roles. Impacts and incentives of various government programs, such as LEED certification and solar power tax credits. Case studies provide opportunity to compare U.S. practices to several international methods.

Spring 2026: CIEN E4138

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4138	001/12703	W 4:10pm - 6:40pm 1024 Seeley W. Mudd Building	Kevin Riordan	3.00	29/50
CIEN 4138	V01/17238		Kevin Riordan	3.00	2/99

CIEN E4139 THRY/PRACT OF VIRTAL DSGN CONS. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4129) or CIEN E4129; or instructor's permission. History and development of Building Information Modeling (BIM), its uses in design and construction, and introduction to the importance of planning in BIM implementation. Role of visual design and construction concepts and methodologies, including integrated project delivery form in architecture, engineering, and construction industries from project design, cost estimating, scheduling, coordination, fabrication, installation, and financing

Fall 2026: CIEN E4139

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4139	001/14749	M 4:10pm - 6:40pm 252 Engineering Terrace	Ayse Polat	3.00	13/25

CIEN E4140 ENVIR,HLTH,SAFETY CONC CONSTR. *3.00 points*.
Lect: 3

Prerequisites: Graduate standing in Civil Engineering and Engineering Mechanics.
A definitive review of and comprehensive introduction to construction industry best practices and fundamental concepts of environmental health and safety management systems (EH#S) for the construction management field. How modern EH#S management system techniques and theories not only result in improved safe work environments but ultimately enhance operational processes and performance in construction projects

Fall 2026: CIEN E4140

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4140	001/14986	M 1:10pm - 3:40pm 337 Seeley W. Mudd Building	Paul Haining	3.00	10/50

CIEN E4141 PUBLIC-PRIVATE PARTNERSHIP IN GLOBAL INF. *3.00 points*.
Delivery of infrastructure assets through Public-Private Partnerships (PPP). Value for Money analysis. Project organization. Infrastructure sector characterization. Risk analysis, allocation and mitigation. Monte Carlo methods and Real Options. Project finance and financing instruments. Case studies from transportation, water supply and energy sectors

Spring 2026: CIEN E4141

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4141	001/11668	T 7:00pm - 9:30pm 524 Seeley W. Mudd Building	Scott Kelly, Patrick Foye	3.00	30/40
CIEN 4141	V01/16646		Patrick Foye	3.00	2/99

CIEN E4142 INTL CONSTRUCTION MGMT. *3.00 points*.
Prerequisites: CIEN E4129; or instructor's permission.
Complex global construction industry environment. Social, cultural, technological, and political risks; technical, financial, and contractual risk. Understanding of successful global project delivery principals and skills for construction professionals. Industry efforts and trends to support global operational mechanism. Global Case Studies. Engage with industry expert professionals. Student group projects with active ongoing global initiatives

Fall 2026: CIEN E4142

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4142	001/14591	Th 7:00pm - 9:30pm 327 Seeley W. Mudd Building	Ibrahim Odeh	3.00	19/40

CIEN E4144 Real Estate Land Development Engineering. *3.00 points*.
Prerequisites: Graduate and senior undergraduate students only. Third-year undergraduate students with instructor's permission.
Comprehensive review of various engineering disciplines in the process of real estate land development. Engineering disciplines covered include civil, infrastructure, transportation planning, environmental planning, permitting, environmental remediation, geotechnical, and waterfront/marine. Overview of land use and environmental law, architecture and urban planning, as related to land development. Discussion of how these subjects affect decisions—cost, schedule, programming—involved in real estate development

CIEN E4145 APPLIED USE OF AEC DATA. *3.00 points*.
Digital transformation optimizes day-to-day operations to provide maximum performance in Architecture, Engineering, and Construction (AEC) workflows. Focuses on broadening knowledge of AEC data leading to building data management. Use of open data sets from the design, construction, and operations of buildings to learn and practice data management and its applied use. Major technical topics include Project Management Information System (PMIS) and Facility Management (FM), leading to Digital Twin data management, data processing, and data visualization

Fall 2026: CIEN E4145

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4145	001/14753	W 7:00pm - 9:30pm 825 Seeley W. Mudd Building		3.00	5/40

CIEN E4146 Advanced AEC Data Management. *3.00 points*.
Prerequisites: CIEN E4145
Focused on broadening knowledge of AEC data management. Use of industry data sets from the design, construction, and operations of buildings to learn and practice data management and solve problems by aggregating industry data and creating data-driven reports in dashboard format. Exploration of industry data through ELT (Extract, Load, Transform) Services. Hands-on learning experiences through a series of workshops and case studies. Guides where predictive analysis is performed and how it is used for Project Management Information System (PMIS) and Facility Management (FM), leading to Digital Twin data management, data processing, and data visualization

CIEN E4148 Construction Engineering and Management Industry Field Studies. *1.00-3.00 points*.
Expose students to various aspects of project management in the construction industry, enhance learning experience with real-world challenges and prepare for internships and future employment.
Run for two semesters. First semester focuses on Traditional Project Management, and second semester focuses on Agile Project Management. For class project, development of a Project Management Plan (PMP) and an Operations Dashboard based on real-life examples of contracts (traditional project management) and operational excellence initiatives (agile project management)

Spring 2026: CIEN E4148

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4148	001/17191	F 12:00pm - 2:30pm 706 Seeley W. Mudd Building	Scott Kelly, Thomas Kyd	1.00-3.00	8/15
CIEN 4148	002/17192	F 12:00pm - 2:30pm 706 Seeley W. Mudd Building	Nare Aghasarkissian	1.00-3.00	7/15
CIEN 4148	003/17328	M 10:30am - 1:00pm 706 Seeley W. Mudd Building	Ibrahim Odeh	1.00-3.00	12/15
CIEN 4148	V03/18293		Ibrahim Odeh	1.00-3.00	1/99

Fall 2026: CIEN E4148

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4148	001/15021	W 1:10pm - 3:40pm 614 Martin Luther King Building	Ibrahim Odeh	1.00-3.00	12/15
CIEN 4148	V01/19983		Ibrahim Odeh	1.00-3.00	0/99

CIEN E4150 LEADERSHIP IN DESIGN # CONSTRUCTION. *3.00 points*.
Introduces and employs various tools, concepts, and analytical frameworks to enhance students' ability to define and analyze leadership issues. In-depth analysis of the leadership literature and practical situational immersion using industry case studies. Multiple guest lecturers from the private and public sectors throughout the semester. Term project exploring leadership challenges in the design and construction industry

Spring 2026: CIEN E4150

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4150	001/12155	Th 1:10pm - 3:40pm 706 Seeley W. Mudd Building	Fredric Bell	3.00	14/30

CIEN E4210 FORENSIC STRUCTURL ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: Working knowledge of structural analysis and design; graduate student standing or instructor's permission.
Review of significant failures, civil/structural engineering design and construction practices, ethical standards and the legal positions as necessary background to forensic engineering. Discussion of standard-of-care. Study of the process of engineering evaluation of structural defects and failures in construction and in service. Examination of the roles, activities, conduct and ethics of the forensic consultant and expert witness. Students are assigned projects of actual cases of non-performance or failure of steel, concrete, masonry, geotechnical and temporary structures, in order to perform, discuss and report their own investigations under the guidance of the instructor

Spring 2026: CIEN E4210

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4210	001/12168	T 7:00pm - 9:30pm 337 Seeley W. Mudd Building	Ezra Jampole, Troy Morgan	3.00	12/30

CIEN E4212 STRUCTURAL FAILURES. *3.00 points*.
Lect: 3.

Prerequisites: A course each in engineering materials, structural analysis, concrete design, steel design, soil mechanics and foundations, and construction; graduate student standing or instructor's permission.
The nature and causes of structural failures and the lessons learned from them; insight into failure investigation in the practice of forensic structural engineering. Case histories of actual failures of real-life structures during construction and in service are introduced, examined, analyzed, and discussed. Students are assigned documented cases of failures of structures of various types and materials to review, discuss, and, in some cases, to conduct investigations of the causes and responsibilities. Students are required to prepare written reports and make oral presentations of selected cases.

CIEN E4226 ADV DESIGN OF STEEL STRUCTURES. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3125) or CIEN E3125
Review of loads and structural design approaches. Material considerations in structural steel design. Behavior and design of rolled steel, welded, cold-formed light-gauge, and composite concrete/steel members. Design of multi-story buildings and space structures

Spring 2026: CIEN E4226

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4226	001/12235	Th 7:00pm - 9:30pm 627 Seeley W. Mudd Building	Virginia Mosquera, Amr Ibrahim Aly	3.00	30/50

CIEN E4232 ADVNCD DSGN-CONCRETE STRUCTURS. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3125) or CIEN E3125; or equivalent.
Design of concrete beams for combined torsion, shear and flexure; moment-curvature relation; bar cut-off locations; design of two-way slabs; strut-and-tie method for the design of deep beams and corbels; gravity and shear wall design; retaining wall design

Fall 2026: CIEN E4232

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4232	001/14752	F 4:10pm - 6:40pm 327 Seeley W. Mudd Building	Tom Panayotidi	3.00	18/50

CIEN E4233 DESIGN OF LARGE SCALE BRIDGES. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3121) and (CIEN E3127) or CIEN E3121 AND CIEN E3127; or equivalent.
Design of large-scale and complex bridges with emphasis on cable-supported structures. Static and dynamic loads, component design of towers, superstructures and cables; conceptual design of major bridge types including arches, cable stayed bridges and suspension bridges

Spring 2026: CIEN E4233

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4233	001/12241	W 7:00pm - 9:30pm 903 School Of Social Work	Theodore Zoli	3.00	15/50

CIEN E4234 Design of large-scale building structures. *3 points*.
Lect: 3.

Prerequisites: (CIEN E3121) and (CIEN E3127) CIEN E3127 AND CIEN E3121
Modern challenges in the design of large-scale building structures will be studied. Tall buildings, large convention centers and major sports stadiums present major opportunities for creative solutions and leadership on the part of engineers. This course is designed to expose the students to this environment by having them undertake the complete design of a large structure from initial design concepts on through all the major design decisions. The students work as members of a design team to overcome the challenges inherent in major projects. Topics include overview of major projects, project criteria and interface with architecture, design of foundations and structural systems, design challenges in the post 9/11 environment and roles, responsibilities and legal issues.

Spring 2026: CIEN E4234

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4234	001/12253	W 4:10pm - 6:40pm 516 Hamilton Hall	Elisabeth Malsch, Eli Gottlieb, Richard Tomasetti, Pierre Ghisbain	3	17/30

CIEN E4235 Multihazard design of structures. *3 points*.
Lect: 3.

Prerequisites: (CIEN E3125) or (CIEN E4232) or CIEN E3125 OR CIEN E4232; or instructor's permission.
Fundamental considerations of wave mechanics; design philosophies; reliability and risk concepts; basics of fluid mechanics; design of structures subjected to blast; elements of seismic design; elements of fire design; flood considerations; advanced analysis in support of structural design.

Fall 2026: CIEN E4235

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4235	001/14476	Th 7:00pm - 9:30pm 415 Schapiro Cepser	Virginia Mosquera	3	12/50

CIEN E4236 DESIGN-PRESTRESS CONCRET STRUC. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4232) or CIEN E4232; Or instructor's permission
Properties of materials used in prestressed concrete; pre-tensioning versus post-tensioning; loss of prestress due to elastic shortening, friction, anchorage slip, shrinkage, creep and relaxation; full versus partial prestressing; design of beams for flexure, shear and torsion; method of load balancing; anchorage zone design; calculation of deflection by the lump-sum and incremental time-step methods; continuous beams; composite construction; prestressed slabs and columns

CIEN E4237 ARCH DESIGN, COMPUT#METHOD. *3.00 points*.
Prerequisites: (CIEN E3121) and (CIEN E3125) or CIEN E3121 AND CIEN E3125; or equivalent.
Integrated methods of design and structural analysis between engineering and architecture. Lectures on historical precedents on material use, structural inventiveness and social importance. Labs on drafting and modeling software; physical modeling techniques and virtual reality visualization

CIEN E4241 GEOTECHNCL ENGNEERNG FUNDMNTLS. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3141) or CIEN E3141; or instructor's permission.
Bearing capacity and settlement of shallow and deep foundations; earth pressure theories; retaining walls and reinforced soil retaining walls; sheet pile walls; braced excavation; slope stability

Fall 2026: CIEN E4241

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4241	001/14592	M 7:10pm - 9:40pm 227 Seeley W. Mudd Building	Songtao Yang	3.00	23/50

CIEN E4242 GEOTECHNICAL EARTHQUAKE ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3141)
Seismicity, earthquake intensity, propagation of seismic waves, design of earthquake motion, seismic site response analysis, in situ and laboratory evaluation of dynamic soil properties, seismic performance of underground structures, seismic performance of port and harbor facilities, evaluation and mitigation of soil liquefaction and its consequences. Seismic earth pressures, slopes stability, safety of dams and embankments, seismic code provisions and practice. To alternate with E4244.

Spring 2026: CIEN E4242

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4242	001/12798	M 4:10pm - 6:40pm 516 Hamilton Hall	Hoe Ling	3.00	5/30

CIEN E4243 FOUNDATION ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3141) or CIEN E3141
Conventional types of foundations and foundation problems: subsurface exploration and testing. Performance of shallow and deep foundations and evaluation by field measurements. Case histories to illustrate typical design and construction problems. To alternate with CIEN E4246

CIEN E4244 Geosynthetics and Applications. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4241) or or equivalent
Properties of geosynthetics. Geosynthetic design for soil reinforcement. Geosynthetic applications in solid waste containment system. To alternate with CIEN E4242.

CIEN E4245 TUNNEL DESIGN # CONSTRUCTION. *3.00 points*.
Lect: 3.

Prerequisites: Familiarity with computer aided design, reinforced concrete design, geotechnical engineering, and the use of common computer applications is required.
Engineering design and construction of different types of tunnel, including cut and cover tunnel, rock tunnel, soft ground tunnel, immersed tub tunnel, and jacked tunnel. The design for the liner, excavation, and instrumentation are also covered. A field trip will be arranged to visit the tunneling site

CIEN E4247 DES OF LARGE-SCALE FOUND SYST. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E3141) CIEN E3141
Focus on deep foundations in difficult conditions and constraints of designing foundations. Design process from the start of field investigations through construction and the application of deep foundations

CIEN E4253 COMP SOLID MECHANICS WITH AI. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3332) or ENGI E1006 Knowledge of Python. MECE E6422 and COMS W4995 strongly recommended but not required.
Theoretical, computational, and data-driven/machine learning techniques to derive, test, and validate computer models for solid mechanics (e.g., soil, rubber, and metals). Machine learning and data-driven simulations enabled by deep learning.

CIEN E4256 Applied Machine Learning in Civil Engineering. *3.00 points*.
Prerequisites: Basic linear algebra. Basic probability and statistics. Familiarity with python.
Utilization of data in everyday civil infrastructure. Optimization of decision-making for owners, facility managers, and policy-makers based on predictive results. Provides students with basic understanding of machine learning concepts and methods to formulate civil engineering problems to prediction problems. Introduces students to classic machine learning algorithms, deep learning algorithms, algorithmic thinking, and probabilistic views, and their applications in existing civil engineering problems.

Fall 2026: CIEN E4256

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4256	001/14593	W 4:10pm - 6:40pm 214 Pupin Laboratories	Zhengbo Zou	3.00	23/50

CIEN E4258 Embodied AI for Construction and Facilities Management. *3.00 points*.
Prerequisites: (CIEN E4256) or (CIEN E4011) Basic familiarity with Python. Basic linear algebra. Basic probability and statistics.
Sensor modalities and their applications in construction and facilities management. Deep learning concepts and their application in robot perception. Markov Decision Process (MDP) and its application in planning and control. Formulation of embodied AI perception and control problems as MDP. Application of classic reinforcement learning algorithms to solve MDP problems. Analysis of agents' performance through objective and subjective metrics. Understanding the critical interactions between users/occupants and embodied AI agents. Hands-on experience with robot simulation and/or collaborative robots in controlled lab environments.

Spring 2026: CIEN E4258

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4258	001/13081	Th 10:10am - 12:40pm 644 Seeley W. Mudd Building	Zhengbo Zou	3.00	6/40

CIEN E4995 Topics In Civil Engineering. *3.00 points*.
Special topics sections arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit

CIEN E4999 FIELDWORK. *1.00-1.50 points*.
1-2 pts.

Prerequisites: Instructor's written approval.
May be repeated for credit, but no more than 3 total points may be used for degree credit. Only for Civil Engineering and Engineering Mechanics graduate students who include relevant off-campus work experience as part of their approved program of study. Final report and letter of evaluation required. May not be taken for pass/fail credit or audited

Spring 2026: CIEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4999	001/17143		Raimondo Betti, Scott Kelly	1.00-1.50	3/30

Summer 2026: CIEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4999	001/11049		Raimondo Betti, Scott Kelly	1.00-1.50	10/30

Fall 2026: CIEN E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 4999	001/19823		Raimondo Betti, Scott Kelly	1.00-1.50	0/25

CIEN E6246 ADVANCED SOIL MECHANICS. *3.00 points*.
Lect: 2.5.

Prerequisites: (CIEN E3141) CIEN E3141.
Stress-dilatancy of sand; failure criteria; critical state soil mechanics; limit analysis; finite element method and case histories of consolidation analysis.

CIEN E6248 EXPERIMENTAL SOIL MECHANICS. *3.00 points*.
Lect: 2.5.

Prerequisites: (CIEN E3141) CIEN E3141
Advanced soil testing, including triaxial and plane strain compression tests; small-strain measurement. Model testing; application (of test results) to design.

CIEN E9101 CIVIL ENGINEERING RESEARCH. *1.00-6.00 points*.
Advanced study in a specialized field under the supervision of a member of the department staff. Before registering, the student must submit an outline of the proposed work for approval of the supervisor and the department chair

Spring 2026: CIEN E9101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 9101	001/19998		Raimondo Betti	1.00-6.00	1/20
CIEN 9101	002/20012		Adrian Brugger	1.00-6.00	0/20
CIEN 9101	003/20013		Gautam Dasgupta	1.00-6.00	0/20
CIEN 9101	004/20014		George Deodatis	1.00-6.00	0/20
CIEN 9101	005/20015		Xuan Di	1.00-6.00	20/50
CIEN 9101	006/20016		Maria Feng	1.00-6.00	1/20
CIEN 9101	007/20017		Jacob Fish	1.00-6.00	2/20
CIEN 9101	008/20018		Marco Giometto	1.00-6.00	2/20
CIEN 9101	009/20019		Shiho Kawashima	1.00-6.00	0/20
CIEN 9101	010/20020		Addis Kidane	1.00-6.00	0/20
CIEN 9101	011/20021		Ioannis Kougioumtzoglou	1.00-6.00	1/20
CIEN 9101	012/20022		Hoe Ling	1.00-6.00	0/20
CIEN 9101	013/20023		Marianna Maiaru	1.00-6.00	4/20
CIEN 9101	014/20024		Ibrahim Odeh	1.00-6.00	0/20
CIEN 9101	015/20025		Markus Schlaepfer	1.00-6.00	0/20
CIEN 9101	016/20026		Andrew Smyth	1.00-6.00	0/20
CIEN 9101	017/20027		Waiching Sun	1.00-6.00	1/20
CIEN 9101	018/20028		Haim Waisman	1.00-6.00	1/20
CIEN 9101	019/20029		Huiming Yin	1.00-6.00	0/20
CIEN 9101	020/20030		Zhengbo Zou	1.00-6.00	3/20
CIEN 9101	021/20031		Fredric Bell	1.00-6.00	3/20

Summer 2026: CIEN E9101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 9101	001/11982		Huiming Yin	1.00-6.00	1/10
CIEN 9101	002/12143		Ibrahim Odeh	1.00-6.00	0/10
CIEN 9101	003/12884		Xuan Di	1.00-6.00	1/20
CIEN 9101	V02/12144		Ibrahim Odeh	1.00-6.00	3/99

CIEN E9500 DEPARTMENTAL SEMINAR. *0.00 points*.
All doctoral students are required to attend the department seminar as long as they are in residence. No degree credit is granted

Spring 2026: CIEN E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 9500	001/12261	T 1:30pm - 3:00pm 829 Seeley W. Mudd Building	Scott Kelly	0.00	11/40

Fall 2026: CIEN E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 9500	001/19687	T 1:30pm - 3:00pm 327 Seeley W. Mudd Building	Zhengbo Zou	0.00	1/35

CIEN E9800 DOCTORAL RESEARCH INSTRUCTION. *3.00-12.00 points*.
May be taken for 3, 6, 9 or 12 points, dependent on instructor permission.

A candidate for the Eng.Sc.D. degree in civil engineering must register for 12 points of doctoral research instruction. Registration in CIEN E9800 may not be used to satisfy the minimum residence requirement for the degree

CIEN E9900 DOCTORAL DISSERTATION. *0.00 points*.
A candidate for the doctorate may be required to register for this course every term after the students coursework has been completed and until the dissertation has been accepted

Spring 2026: CIEN E9900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 9900	001/17650		Raimondo Betti	0.00	1/10

Fall 2026: CIEN E9900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEN 9900	001/16496		Raimondo Betti	0.00	1/10

EACE E3250 Hydrosystems Engineering. *3.00 points*.
Prerequisites: CHEN E3110 OR ENME E3161; or equiv, or instructors permission
A quantitative introduction to hydrologic and hydraulic systems, with a focus on integrated modeling and analysis of the water cycle and associated mass transport for water resources and environmental engineering. Coverage of unit hydrologic processes such as precipitation, evaporation, infiltration, runoff generation, open channel and pipe flow, subsurface flow and well hydraulics in the context of example watersheds and specific integrative problems such as risk-based design for flood control, provision of water, and assessment of environmental impact or potential for non-point source pollution. Spatial hydrologic analysis using GIS and watershed models

Spring 2026: EACE E3250

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 3250	001/12796	M W 11:40am - 12:55pm 307 Uris Hall	Wenli Zhao	3.00	10/20

EACE E3255 ENVIRONMENTAL CONTROL AND POLLUTION REDUCTION. *3.00 points*.
Sources of solid/gaseous air pollution and the technologies used for modern methods of abatement. Air pollution and its abatement from combustion of coal, oil, and natural gas and the thermodynamics of heat engines in power generation. Catalytic emission control is contrasted to thermal processes for abating carbon monoxide, hydrocarbons, oxides of nitrogen and sulfur from vehicles and stationary sources. Processing of petroleum for generating fuels. Technological challenges of controlling greenhouse gas emissions. Biomass and the hydrogen economy coupled with fuel cells as future sources of energy

Spring 2026: EACE E3255

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 3255	001/12801	M W 10:10am - 11:25am 304 Hamilton Hall	Robert Farrauto	3.00	26/40

EACE E4163 Sustainable Water Treatment and Reuse. *3.00 points*.
Fundamentals of water pollution and wastewater characteristics. Chemistry, microbiology, and reaction kinetics. Design of primary, secondary, and advanced treatment systems. Small community and residential systems

Spring 2026: EACE E4163

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 4163	001/12803	Th 4:10pm - 6:40pm 467 Ext Schermerhorn Hall	Paul Knowles	3.00	24/40

EACE E4250 Hydrosystems Engineering. *3.00 points*.
Prerequisites: CHEN E3110 OR ENME E3161; or equiv, or instructors permission
Quantitative introduction to hydrologic and hydraulic systems, with a focus on integrated modeling and analysis of the water cycle and associated mass transport for water resources and environmental engineering. Coverage of unit hydrologic processes such as precipitation, evaporation, infiltration, runoff generation, open channel and pipe flow, subsurface flow and well hydraulics in the context of example watersheds and specific integrative problems such as risk-based design for flood control, provision of water, and assessment of environmental impact or potential for non-point source pollution. Spatial hydrologic analysis using GIS and watershed models

Spring 2026: EACE E4250

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 4250	001/12811	M W 11:40am - 12:55pm 307 Uris Hall	Wenli Zhao	3.00	12/24

EACE E4252 Foundations of Environmental Engineering. *3.00 points*.
Prerequisites: CHEM W1403 AND ENME E3161; or equiv, or instructors permission
Engineering aspects of problems involving human interaction with the natural environment. Review of fundamental principles that underlie the discipline of environmental engineering, i.e. constituent transport and transformation processes in environmental media such as water, air, and ecosystems. Engineering applications for addressing environmental problems such as water quality and treatment, air pollution emissions, and hazardous waste remediation. Presented in the context of current issues facing the practicing engineers and government agencies, including legal and regulatory framework, environmental impact assessments, and natural resource management

Spring 2026: EACE E4252

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 4252	001/12818	T Th 2:40pm - 3:55pm 333 Uris Hall	Benjamin Bostick	3.00	17/40

ECIA W4100 MGMT # DEVPT OF WATER SYSTEMS. *3.00 points*.
Lect: 3.

Decision analytic framework for operating, managing, and planning water systems, considering changing climate, values and needs. Public and private sector models explored through US-international case studies on topics ranging from integrated watershed management to the analysis of specific projects for flood mitigation, water and wastewater treatment, or distribution system evaluation and improvement

ENME E3105 MECHANICS. *4.00 points*.
Lect: 4.

Corequisites: ENME E3106,ENME E3113
Elements of statics; dynamics of a particle and systems of particles.

Spring 2026: ENME E3105

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3105	001/12107	M W 11:40am - 12:55pm 310 Fayerweather	Jeffrey Kysar	4.00	88/96
ENME 3105	001/12107	F 1:10pm - 2:25pm 310 Fayerweather	Jeffrey Kysar	4.00	88/96

Fall 2026: ENME E3105

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3105	001/14594	M W F 11:40am - 12:55pm 603 Hamilton Hall	Addis Kidane	4.00	43/54

ENME E3106 DYNAMICS AND VIBRATIONS. *3.00 points*.
Lect: 2.

Prerequisites: (MATH UN1201) MATH V1201; ENME E3105
Corequisites: ENME E3105.
Kinematics of rigid bodies; momentum and energy methods; vibrations of discrete and continuous systems; eigen-value problems, natural frequencies and modes. Basics of computer simulation of dynamics problems using MATLAB or Mathematica

Spring 2026: ENME E3106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3106	001/12280	M W 11:40am - 12:55pm 417 International Affairs Bldg	Andrew Smyth	3.00	119/116

ENME E3113 MECHANICS OF SOLIDS. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3105) or ENME E3105; or equivalent.
Stress and strain. Mechanical properties of materials. Axial load, bending, shear, and torsion. Stress transformation. Deflection of beams. Buckling of columns. Combined loadings. Thermal stresses

Fall 2026: ENME E3113

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3113	001/14470	M W 10:10am - 11:25am 633 Seeley W. Mudd Building	Raimondo Betti	3.00	27/60

ENME E3114 EXPERIMENTAL MECH OF MATERIALS. *4.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (ENME E3113) ENME E3113
Material behavior and constitutive relations. Mechanical properties of metals and cement composites. Structural materials. Modern construction materials. Experimental investigation of material properties and behavior of structural elements including fracture, fatigue, bending, torsion, buckling

Spring 2026: ENME E3114

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3114	001/12289	T Th 11:40am - 12:55pm 327 Seeley W. Mudd Building	Shiho Kawashima	4.00	17/35
ENME 3114	001/12289	W 1:00pm - 4:00pm 161 Engineering Terrace	Shiho Kawashima	4.00	17/35

ENME E3161 FLUID MECHANICS. *4.00 points*.
Lect: 3. Lab: 3.

Prerequisites: (ENME E3105) and ENME E3105; and ordinary differential equations.
Fluid statics. Fundamental principles and concepts of flow analysis. Differential and finite control volume approach to flow analysis. Dimensional analysis. Application of flow analysis: flow in pipes, external flow, flow in open channels

Fall 2026: ENME E3161

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3161	001/14471	T 10:00am - 1:00pm 161 Engineering Terrace	Marco Giometto	4.00	24/35
ENME 3161	001/14471	W 4:10pm - 6:40pm 825 Seeley W. Mudd Building	Marco Giometto	4.00	24/35

ENME E3332 A FIRST CRSE/FINITE ELEMENTS. *3.00 points*.
Lect: 3.

Prerequisites: Senior standing or instructor's permission. Recommended corequisite: differential equations.
Corequisites: (Recommended): differential equations
Focus on formulation and application of the finite element to engineering problems such as stress analysis, heat transfer, fluid flow, and electromagnetics. Topics include finite ele?ment formulation for one-dimensional problems, such as trusses, electrical and hydraulic systems; scalar field problems in two dimensions, such as heat transfer; and vector field problems, such as elasticity and finally usage of the commercial finite element program. Students taking ENME E3332 cannot take ENME E4332

Fall 2026: ENME E3332

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3332	001/14959	Th 1:10pm - 3:40pm 212a Lewisohn Hall	Jacob Fish	3.00	16/30

ENME E4113 ADVANCED MECHANICS OF SOLIDS. *3.00 points*.
Lect: 3.

Stress and deformation formulation in two-and three-dimensional solids; viscoelastic and plastic material in one and two dimensions energy methods

Spring 2026: ENME E4113

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4113	001/12290	W 1:10pm - 3:40pm 829 Seeley W. Mudd Building	Huiming Yin	3.00	3/25

ENME E4114 MECHANCS OF FRACTURE # FATIGUE. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate mechanics of solids course.
Elastic stresses at a crack; energy and stress intensity criteria for crack growth; effect of plastic zone at the crack; fracture testing applications. Fatigue characterization by stress-life and strain-life; damage index; crack propagation; fail safe and safe life analysis.

Spring 2026: ENME E4114

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4114	001/12885	Th 4:10pm - 6:40pm 227 Seeley W. Mudd Building	Adrian Brugger	3.00	3/30

ENME E4115 MICROMECH OF COMPOSITE MAT. *3.00 points*.
Lect: 3

Prerequisites: (ENME E4113) or ENME E4113; Or instructor's approval.
An introduction to the constitutive modeling of composite materials: Green's functions in heterogeneous media, Eshelby's equivalent inclusion methods, eigenstrains, spherical and ellipsoidal inclusions, dislocations, homogenization of elastic fields, elastic, viscoelastic and elasto-plastic constitutive modeling, micromechanics-based models

Fall 2026: ENME E4115

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4115	001/15016	W 1:10pm - 3:40pm 408 Hamilton Hall	Huiming Yin	3.00	3/25

ENME E4117 Mechanics of Fiber-Reinforced Composites. *3.00 points*.
Prerequisites: Linear and tensor algebra. Differential and integral calculus. Mechanics.
Overview of composite materials, including history, background, and manufacturing processes. Macro-mechanics: anisotropic elasticity and stress transformation. Micro-mechanics: Rule of Mixture, Composites Cylinder Model (CCM) and other models. Macro-mechanics: Classic Lamination Theory (CLT). Hygrothermal effects, residual stresses, Composite mechanical testing, fabrication. Failure modes and lamina-based failure theories. Bending and Buckling of composite plates. ICME of Composites (nano-, micro-, meso- and macro-scale analysis, experimental validation, process modeling, integration).

Spring 2026: ENME E4117

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4117	001/12681	W 7:00pm - 9:30pm 644 Seeley W. Mudd Building	Marianna Maiaru	3.00	8/40

Fall 2026: ENME E4117

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4117	001/15052	T 7:00pm - 9:30pm 337 Seeley W. Mudd Building	Marianna Maiaru	3.00	5/40

ENME E4202 ADVANCED MECHANICS. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3105) or ENME E3105
Differentiation of vector functions. Review of kinematics. Generalized coordinates and constraint equations. Generalized forces. Lagranges equations. Impulsive forces. Collisions. Hamiltonian. Hamiltons principle

ENME E4212 EXPERIMENTL SOLID MECHANCS. *3.00 points*.
Prerequisites: ENME E3113
Experimental techniques, including photoelasticity, strain measurements, digital image correlation, and other optics in stress analysis, emphasizing engineering applications. Fundamental concepts in solid mechanics and measurement science. Performance of high-quality experimental studies

ENME E4214 THEORY OF PLATES AND SHELLS. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3113) ENME E3113
Static flexural response of thin, elastic, rectangular, and circular plates. Exact (series) and approximate (Ritz) solutions. Circular cylindrical shells. Axisymmetric and non-axisymmetric membrane theory. Shells of arbitrary shape

Spring 2026: ENME E4214

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4214	001/17327	Th 10:10am - 12:40pm 604 Martin Luther King Building	Gautam Dasgupta	3.00	0/20

Fall 2026: ENME E4214

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4214	001/15013	Th 4:10pm - 6:40pm 522a Kent Hall	Gautam Dasgupta	3.00	2/25

ENME E4215 THEORY OF VIBRATIONS. *3.00 points*.
Lect: 3.

Frequencies and modes of discrete and continuous elastic systems. Forced vibrations-steady-state and transient motion. Effect of damping. Exact and approximate methods. Applications

Fall 2026: ENME E4215

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4215	001/14472	M 4:10pm - 6:40pm 545 Seeley W. Mudd Building	Raimondo Betti	3.00	14/35
ENME 4215	V01/18113		Raimondo Betti	3.00	2/99

ENME E4332 FINITE ELEMENT ANALYSIS I. *3.00 points*.
Lect: 3.

Prerequisites: Mechanics of solids, structural analysis, elementary computer programming MATLAB is recommended, linear algebra and ordinary differential equations.
Direct stiffness approach for trusses. Strong and weak forms for one-dimensional problems. Galerkin finite element formulation, shape functions, Gauss quadrature, convergence. Multidimensional scalar field problems (heat conduction), triangular and rectangular elements, Isoparametric formulation. Multidimensional vector field problems (linear elasticity). Practical FE modeling with commercial software (ABAQUS). Computer implementation of the finite element method. Advanced topics. Not open to undergraduate students

Fall 2026: ENME E4332

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 4332	001/14960	M 1:10pm - 3:40pm 420 Pupin Laboratories	Haim Waisman	3.00	24/50

ENME E4363 MULTISCALE COMP SCI # ENGIN. *3.00 points*.
Lect.: 3

Prerequisites: (ENME E4332) and ENME E4332; Elementary computer programming, linear algebra.
Introduction to multiscale analysis. Information-passing bridging techniques: among them, generalized mathematical homogenization theory, the heterogeneous multiscale method, variational multiscale method, the discontinuous Galerkin method and the kinetic Monte Carlo–based methods. Concurrent multiscale techniques: domain bridging, local enrichment, and multigrid-based concurrent multiscale methods. Analysis of multiscale systems

ENME E6215 PRIN/APP SENSORS STRC HLTH MON. *3.00 points*.
Lect: 2.5. Lab: 0.5.

Prerequisites: (ENME E4215) ENME E4215
Concepts, principles, and applications of various sensors for sensing structural parameters and nondestructive evaluation techniques for subsurface inspection, data acquisition, and signal processing techniques. Lectures, demonstrations, and hands-on laboratory experiments

Fall 2026: ENME E6215

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 6215	001/14595	W 10:10am - 12:40pm 522a Kent Hall	Maria Feng	3.00	1/20

ENME E6216 STRUCTURAL HEALTH MONITORING. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E4215) and (ENME E4332) ENME E4332 AND ENME E4215
Principles of traditional and emerging sensors, data acquisition and signal processing techniques, experimental modal analysis (input-output), operational modal analysis (output-only), model-based diagnostics of structural integrity, data-based diagnostics of structural integrity, long-term monitoring and intelligent maintenance. Lectures and demonstrations, hands-on laboratory experiments

Spring 2026: ENME E6216

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 6216	001/13070	M 1:10pm - 3:40pm 327 Seeley W. Mudd Building	Raimondo Betti	3.00	5/25

ENME E6220 STOCHASTIC ENGINEERING MECHANICS. *3.00 points*.
Lect: 3.

Prerequisites: (CIEN E4111) and (ENME E4215) or CIEN E4111 AND ENME E4215; or equivalent or instructor's permission
Review of random variables. Random process theory: stationary and ergodic processes, correlation functions and power spectra, non-stationary, non-white and non-Gaussian processes. Uncertainty quantification and simulation of environmental excitations and material/media properties, even when subject to limited/incomplete data: joint time-frequency analysis, sparse representations and compressive sampling concepts and tools. Stochastic dynamics and reliability assessment of diverse engineering systems: complex nonlinear/hysteretic behaviors and/or fractional derivative modeling. Emphasis on solution methodologies based on Monte Carlo simulation, statistical linearization, and Wiener path integral. Examples from civil, marine, mechanical and aerospace engineering

Spring 2026: ENME E6220

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 6220	001/12893	M 4:10pm - 6:40pm 424 Kent Hall	Ioannis Kougioumtzoglou	3.00	5/25

ENME E6320 COMPUTATIONAL POROMECHANICS. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3332) or instructor's permission
A fluid infiltrating porous solid is a multiphase material whose mechanical behavior is significantly influenced by the pore fluid. Diffusion, advection, capillarity, heating, cooling, and freezing of pore fluid, buildup of pore pressure, and mass exhanges among solid and fluid constituents all influence the stability and integrity of the solid skeleton, causing shrinkage, swelling, fracture, or liquefaction. These coupling phenomena are important for numerous disciplines, including geophysics, biomechanics, and material sciences. Fundamental principles of poromechanics essential for engineering practice and advanced study on porous media. Topics include balance principles, Biot's poroelasticity, mixture theory, constitutive modeling of path independent and dependent multiphase materials, numerical methods for parabolic and hyperbolic systems, inf-sup conditions, and common stabilization procedures for mixed finite element models, explicit and implicit time integrators, and operator splitting techniques for poromechanics problems.

Spring 2026: ENME E6320

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 6320	001/12892	F 1:10pm - 3:40pm 627 Seeley W. Mudd Building	Waiching Sun	3.00	2/25

ENME E6333 FINITE ELEM ANALYSIS II. *3.00 points*.
Lect: 2.5.

Prerequisites: (ENME E4332) ENME E4332
FE formulation for beams and plates. Generalized eigenvalue problems (vibrations and buckling). FE formulation for time-dependent parabolic and hyperbolic problems. Nonlinear problems, linearization, and solution algorithms. Geometric and material nonlinearities. Introduction to continuum mechanics. Total and updated Lagrangian formulations. Hyperelasticity and plasticity. Special topics: fracture and damage mechanics, extended finite element method

Spring 2026: ENME E6333

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 6333	001/13072	Th 7:00pm - 9:30pm 327 Seeley W. Mudd Building	Haim Waisman	3.00	7/25

ENME E6364 NONLINEAR COMPUTATIONAL MECH. *3.00 points*.
Prerequisites: (ENME E4332) or ENME E4332; or equivalent, elementary computer programming, linear algebra.
The formulations and solution strategies for finite element analysis of nonlinear problems are developed. Topics include the sources of nonlinear behavior (geometric, constitutive, boundary condition), derivation of the governing discrete equations for nonlinear systems such as large displacement, nonlinear elasticity, rate independent and dependent plasticity and other nonlinear constitutive laws, solution strategies for nonlinear problems (e.g. incrementation, iteration), and computational procedures for large systems of nonlinear algebraic equations

ENME E6370 TURBULENCE THEORY # MODELING. *3.00 points*.
Lec.: 3

Prerequisites: (ENME E3161) or ENME E3161
Ordinary and partial differential equations. Turbulence phenomenology; spatial and temporal scales in turbulent flows; statistical description, filtering and Reynolds decomposition, equations governing the resolved flow, fluctuations and their energetics; turbulence closure problem for RANS and LES; two equation turbulence models and second moment closures

Spring 2026: ENME E6370

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 6370	001/13077	W 4:10pm - 6:40pm 558 Ext Schermerhorn Hall	Marco Giometto	3.00	14/25

ENME E8310 ADV CONTINUUM MECHANICS. *4.00 points*.
Lect.: 3

Prerequisites: (MECE E6422) and (MECE E6423) MECE E6422 AND MECE E6423; Open to Ph.D. students and to M.S. students with instructor's permission.
Review of continuum mechanics in Cartesian coordinates; tensor calculus and the calculus of variation; large deformations in curvilinear coordinates; electricity problems and applications.

Fall 2026: ENME E8310

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 8310	001/15014	M F 9:00am - 11:30am 522a Kent Hall	Gautam Dasgupta	4.00	1/20

ENME E8320 VISCOELASTICITY AND PLASTICITY. *4.00 points*.
Lect: 3.

Prerequisites: (ENME E6315) or ENME E6315; or equivalent, or instructor's permission.
Constitutive equations of viscoelastic and plastic bodies. Formulation and methods of solution of the boundary value, problems of viscoelasticity and plasticity

GRAP E4005 COMPUTER GRAPHICS IN ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: Any programming language and linear algebra.
Numerical and symbolic (algebraic) problem solving with Mathematica. Formulation for graphics application in civil, mechanical, and bioengineering. Example of two-and three-dimensional curve and surface objects in C and Mathematica; special projects of interest to electrical and computer science

Spring 2026: GRAP E4005

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
GRAP 4005	001/13092	F 4:10pm - 6:40pm 327 Seeley W. Mudd Building	Gautam Dasgupta	3.00	3/25

MEEM E6432 SMALL-SCALE MECH BEHAVIOR. *3.00 points*.
Prerequisites: APMA E4200 AND ENME E3113; ENME E3113 or equivalent; APMA E4200 or equivalent
Mechanics of small-scale materials and structures require nonlinear kinematics and/or nonlinear stress vs. strain constitutive relations to predict mechanical behavior. Topics include variational calculus, deformation and vibration of beam, strings, plates, and membranes; fracture, delamination, bulging, buckling of thin films, among others. Thermodynamics of solids will be reviewed to provide the basis for a detailed discussion of nonlinear elastic behavior as well as the study of the equilibrium and stability of surfaces

PLCE GU4444 The Future City: Transforming Urban Infrastructure. *3.00 points*.
Introduces students to technological innovations that are helping cities around the world create healthier, safer, more equitable, and more resilient futures. Focus on architecture, urban design, real estate development, structural, civil and mechanical engineering, data analytics, and smart communication technologies. Course covers five distinct sectors in the field of urban infrastructure, including transportation and mobility, buildings, power, sanitation, and communications. A Columbia Cross-Disciplinary Course

Undergraduate Programs

The Department of Civil Engineering and Engineering Mechanics focuses on two broad areas of instruction and research. The first, the classical field of civil engineering, deals with the planning, design, construction, and maintenance of structures and the infrastructure. These include buildings, foundations, bridges, transportation facilities, nuclear and conventional power plants, hydraulic structures, and other facilities essential to society. The second is the science of mechanics and its applications to various engineering disciplines. Frequently referred to as applied mechanics, it includes the study of the mechanical properties of materials, stress analysis of stationary and movable structures, the dynamics and vibrations of complex structures, aero- and hydrodynamics, micro- and nanomechanics, and the mechanics of biological and energy systems.

Program Educational Objectives

The educational objective of the Civil Engineering program is to prepare graduates to achieve success in one or more of the following within a few years after graduation:

1. Graduate or professional studies—as evidenced by admission to a top-tier program, attainment of advanced degrees, research contributions, or professional recognition.
2. Engineering practice—as evidenced by entrepreneurship; employment in industry, government, academia, or nonprofit organizations in engineering; patents; or professional recognition.
3. Careers outside of engineering that take advantage of an engineering education—as evidenced by contributions appropriate to the chosen field.

Student Outcomes

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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- Civil Engineering Minor (p. 327)
- Engineering Mechanics Minor (p. 329)

Civil Engineering (BS)

The BS Civil Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Civil and Similarly Named Engineering Programs.

Program Educational Objectives

The educational objective of the Civil Engineering program is to prepare graduates to achieve success in one or more of the following within a few years after graduation:

1. Graduate or professional studies—as evidenced by admission to a top-tier program, attainment of advanced degrees, research contributions, or professional recognition.
2. Engineering practice—as evidenced by entrepreneurship; employment in industry, government, academia, or nonprofit organizations in engineering; patents; or professional recognition.
3. Careers outside of engineering that take advantage of an engineering education—as evidenced by contributions appropriate to the chosen field.

Student Outcomes

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1101	CALCULUS I

Choose one of the following Physics courses depending on sequence:

PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I

Choose a one-semester Chemistry lecture (taken Semester I, II, III, or IV):

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)

Choose a lab from the following (taken Semester I, II, III, or IV):

CHEM UN1500	GENERAL CHEMISTRY LABORATORY
Physics lab	

Choose one of the following Geology courses or equivalent (taken Semester I, II, III, or IV):

EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST
EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300	EARTH'S ENVIRO SYST: LIFE SYST
ENME E3105 (taken Semester I, II, III, or IV)	MECHANICS

CIEN E3000 (Spring semester; recommended but not required) (taken Semester I, II, or III)	THE ART OF STRUCTURAL DESIGN
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (or equivalent) (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

Choose a one-semester Chemistry lecture (taken Semester I, II, III, or IV):

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)

Choose a lab from the following (taken Semester I, II, III, or IV):

CHEM UN1500	GENERAL CHEMISTRY LABORATORY
Physics lab	

Choose one of the following Geology courses or equivalent (taken Semester I, II, III, or IV):

EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST
EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300	EARTH'S ENVIRO SYST: LIFE SYST

ENME E3105 (taken Semester I, II, III, or IV)	MECHANICS
CIEN E3000 (Spring semester; recommended but not required) (taken Semester I, II, or III)	THE ART OF STRUCTURAL DESIGN
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (or equivalent) (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on sequence:

PHYS UN1494 (or Chemistry lab Sequences 1 and 2)	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081 (Sequence 3)	INTERMEDIATE LABORATORY WORK

Choose a one-semester Chemistry lecture (taken Semester I, II, III, or IV):

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)

Choose a lab from the following (taken Semester I, II, III, or IV):

CHEM UN1500	GENERAL CHEMISTRY LABORATORY
Physics lab	

Choose one of the following Geology courses or equivalent (taken Semester I, II, III, or IV):

EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST
EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300	EARTH'S ENVIRO SYST: LIFE SYST

ENME E3105 (taken Semester I, II, III, or IV)	MECHANICS
CIEN E3000 (Spring semester; recommended but not required) (taken Semester I, II, or III)	THE ART OF STRUCTURAL DESIGN

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3-4)	

HUMA UN1121 or UN1123	Art Humanities
ENGI E1006 (or equivalent) (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Semester IV

APMA E2101	INTRO TO APPLIED MATHEMATICS

Choose a one-semester Chemistry lecture (taken Semester I, II, III, or IV):

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)

Choose a lab from the following (taken Semester I, II, III, or IV):

CHEM UN1500	GENERAL CHEMISTRY LABORATORY
Physics lab	

Choose one of the following Geology courses or equivalent (taken Semester I, II, III, or IV):

EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST
EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300	EARTH'S ENVIRO SYST: LIFE SYST
ENME E3105 (taken Semester I, II, III, or IV)	MECHANICS
CIEN E3004	URBAN INFRASTRUCTURE SYSTEMS

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3-4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Third Year

Semester V

ENME E3113	MECHANICS OF SOLIDS
ENME E3161	FLUID MECHANICS
CIEN E3141	SOIL MECHANICS

Nontech Electives (3 points)

Semester VI

CIEN E3125	STRUCTURAL DESIGN
CIEN E3126	COMPUTER-AIDED STRUCTRL DESIGN

Concentration Courses (see below)

Nontech Electives (3 points)

Fourth Year

Semester VII

CIEE E3111	UNCERTAIN/RISK-CIVIL INF SYST
CIEN E3129	PROJECT MGMT FOR CONSTRUCTION

Concentration Courses (see below)

Nontech Electives (3 points)

Semester VIII

CIEN E3128	DESIGN PROJECTS

Concentration Courses (see below)

Concentrations

Geotechnical Engineering or Structural Engineering

Third Year

Semester V

Tech Electives (3 points)

Semester VI

ENME E3106	DYNAMICS AND VIBRATIONS
ENME E3114	EXPERIMENTAL MECH OF MATERIALS
CIEN E3121	STRUCTURAL ANALYSIS

Fourth Year

Semester VII

ENME E3332	A FIRST CRSE/FINITE ELEMENTS

Choose one of the following:

CIEN E3127	STRUCTURAL DESIGN PROJECTS
CIEN E4241	GEOTECHNCL ENGNEERNG FUNDMNTLS

Tech Electives (3 points)

Semester VIII

Tech Electives (9 points)

Civil Engineering and Construction Management

Third Year

Semester V

Tech Electives (6 points)

Semester VI

ENME E3114	EXPERIMENTAL MECH OF MATERIALS

Choose one of the following:

CIEN E3121	STRUCTURAL ANALYSIS
EACE E3250	Hydrosystems Engineering

Fourth Year

Semester VII

CIEN E4133	CAPITAL FACILITY PLANNING/FIN

Choose one of the following:

CIEN E3127	STRUCTURAL DESIGN PROJECTS
CIEN E4241	GEOTECHNCL ENGNEERNG FUNDMNTLS

Tech Electives (3 points)

Semester VIII

CIEN E4131	PRIN OF CONSTRUCTN TECHNIQUES

Tech Electives (6 points)

Water Resources/Environmental Engineering

Third Year

Semester V

Tech Electives (6 points)

Semester VI

EACE E3255	ENVIRONMENTAL CONTROL AND POLLUTION REDUCTION
EACE E3250	Hydrosystems Engineering
CIEN E3303	IND STUDIES-CIVIL ENGIN-JUNIOR

Fourth Year

Semester VII

EAEE E4350	PLANNG/MGT-URBAN HYDROLGC SYST

Tech Electives (3 points)

Semester VIII

EACE E4163	Sustainable Water Treatment and Reuse
EAEE E4009	GIS-RES,ENVIR,INFRASTRUCTR MGT

Tech Electives (6 points)

Graduate Programs

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students – ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Civil Engineering and Engineering Mechanics (MS) (p. 138)
- Civil Engineering and Engineering Mechanics (EngScD, PhD) (p. 140)

Civil Engineering and Engineering Mechanics (MS)

Master of Science Degree Program

The Department of Civil Engineering and Engineering Mechanics offers a graduate program leading to the degree of Master of Science (M.S.) in Civil Engineering and Engineering Mechanics. The Master of Science degree is awarded upon the satisfactory completion of a minimum of 30 points of credit of approved graduate study extending over at least two semesters.

The M.S. program is very flexible and includes minimal core course requirements. Every student is assigned a faculty member as an academic adviser. Student and adviser meet regularly and plan together the sequence of courses that best fit the student's interests. While a suitable M.S. program will necessarily entail some degree of specialization, the program of study established between the student and the adviser should be well balanced, including basic subjects of broad importance as well as theory and applications. Students may take graduate-level courses from across various concentrations within the department and may complete multiple concentrations.

M.S. Degree Concentrations

A total of 30 credits (10 courses) are required in the Master of Science program in the Department of Civil Engineering and Engineering Mechanics, including the completion of at least 18 credits (six courses) within the CEEM Department. In order to complete a concentration, which would appear on a student's transcript, M.S. students must take 3 out of the following 12 core courses and complete the requirements of their chosen concentration(s).

Core Courses:

CIEE E4111	UNCERTAIN/RISK-CIVIL INF SYST
CIEN E4100	EARTHQUAKE # WIND ENGINEERING
CIEN E4131	PRIN OF CONSTRUCTN TECHNIQUES
CIEN E4133	CAPITAL FACILITY PLANNING/FIN
CIEN E4137	Managing Civil Infrastructure Systems
CIEN E4241	GEOTECHNCL ENGNEERNG FUNDMNTLS
CIEN E4253	COMP SOLID MECHANICS WITH AI
or CIEN E4256	Applied Machine Learning in Civil Engineering
ENME E4113	ADVANCED MECHANICS OF SOLIDS
ENME E4202	ADVANCED MECHANICS
ENME E4215	THEORY OF VIBRATIONS
ENME E4332	FINITE ELEMENT ANALYSIS I

Concentration Notes:

- Completing a formal concentration is optional. Students who do not wish to have a formal concentration must meet the minimum requirements for the M.S. degree, but they are not required to fulfill the core course requirement.
- CIEN E4100 EARTHQUAKE # WIND ENGINEERING**,** CIEN E4131 PRIN OF CONSTRUCTN TECHNIQUES**,** and CIEN E4241 GEOTECHNCL ENGNEERNG FUNDMNTLS are on the core list and are also part of certain concentrations. Students taking these courses may decide to count the course towards their core requirements or the concentration requirements if there is an overlap.
- Students may discuss substitutions for courses with their faculty advisor under certain circumstances, i.e. if a specified course in their concentration is not offered during a given semester, if the student took a comparable course in a previous degree program, etc.
  - The faculty advisor will be responsible for determining if the proposed course is a suitable substitution in their chosen concentration.
  - The Engineering School does not accept transfer credits towards graduate degree programs.

Advanced Infrastructure Materials

The **Advanced Infrastructure Materials** concentration focuses on the properties, design, analysis and testing of material systems used in civil engineering. Students would be required to take 3 out of the following 4 courses:

- CIEN E4300 INFRASTRUCTURAL MATERIALS
- ENME E4114 MECHANCS OF FRACTURE # FATIGUE
- ENME E4115 MICROMECH OF COMPOSITE MAT
- MSAE E4215 MECH BEHAVIOR OF MATERIALS

Computational and Data-Driven Engineering Mechanics

The **Computational and Data-Driven Engineering Mechanics** concentration is intended for students who wish to enrich their knowledge and learn the state-of-the-art in computational and data-driven methods and algorithms used to solve challenging problems in science and engineering. Students would be required to take 2 of the following 3 courses:

- ENME E4332 FINITE ELEMENT ANALYSIS I
- CIEN E4111
- MECE E4520 DATA SCIENCE FOR MECHANICAL SYSTEMS

Students fulfilling the Computational and Data-Driven Engineering Mechanics concentration must also complete 6 courses from the following list of selected electives:

CEOR E4011	INFRASTRUCTURE SYSTEMS OPTIMIZATION
CIEN E4011	BIG DATA IN TRANSPORTATION
CIEN E4021	ELAS/PLAS ANALYSIS-STRUCTURES
CIEN E4100	EARTHQUAKE # WIND ENGINEERING
CIEN E4213	BUCKLING OF STRUCTURES
CIEN E4235	Multihazard design of structures

CIEN E4241	GEOTECHNCL ENGNEERNG FUNDMNTLS
CIEN E4242	GEOTECHNICAL EARTHQUAKE ENGIN
CIEN E4253	COMP SOLID MECHANICS WITH AI
CIEN E6246	ADVANCED SOIL MECHANICS
CIEN E6248	EXPERIMENTAL SOIL MECHANICS
CIEE E4250	
ENME E4113	ADVANCED MECHANICS OF SOLIDS
ENME E4114	MECHANCS OF FRACTURE # FATIGUE
ENME E4115	MICROMECH OF COMPOSITE MAT
ENME E4202	ADVANCED MECHANICS
ENME E4214	THEORY OF PLATES AND SHELLS
ENME E4115	MICROMECH OF COMPOSITE MAT
ENME E4202	ADVANCED MECHANICS
ENME E4214	THEORY OF PLATES AND SHELLS
ENME E4215	THEORY OF VIBRATIONS
ENME E4363	MULTISCALE COMP SCI # ENGIN
ENME E6215	PRIN/APP SENSORS STRC HLTH MON
ENME E6216	STRUCTURAL HEALTH MONITORING
ENME E6220	STOCHASTIC ENGINEERING MECHANICS
ENME E6320	COMPUTATIONAL POROMECHANICS
ENME E6333	FINITE ELEM ANALYSIS II
ENME E6364	NONLINEAR COMPUTATIONAL MECH
ENME E6370	TURBULENCE THEORY # MODELING
ENME E8310	ADV CONTINUUM MECHANICS
ENME E8320	VISCOELASTICITY AND PLASTICITY
APMA E4001	PRINCIPLES OF APPLIED MATH
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
APMA E4301	NUMERICAL METHODS/PDE'S
APMA E4302	METHODS IN COMPUTATIONAL SCI
APMA E6302	NUMERICAL ANALYSIS OF PDE'S
CSEE W4121	COMPUTER SYSTEMS FOR DATA SCIENCE
COMS W4130	
COMS W4771	MACHINE LEARNING
COMS W4772	ADVANCED MACHINE LEARNING
COMS W4776	Neural Networks # Deep Learning
COMS W4995	TOPICS IN COMPUTER SCIENCE
MECE E6102	COMPUTATNL HEAT TRANSF-FL FLOW
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING

Independent research with faculty in CEEM (CIEN E9101) or in other SEAS departments.

Construction Engineering and Management

The **Construction Engineering and Management** concentration prepares students to effectively deliver and manage the capital facilities and infrastructure that provide the setting for human activity and support economic development. Students would be required to take 3 out of the following 4 courses:

- CIEN E4129 MANAGING ENG # CONST PROCESSES
- CIEN E4130 DESIGN OF CONSTRUCTION SYSTEMS
- CIEN E4131 PRIN OF CONSTRUCTN TECHNIQUES
- CIEN E4140 ENVIR,HLTH,SAFETY CONC CONSTR

Construction Strategic Management, Entrepreneurship, and Leadership

The **Strategic Management, Entrepreneurship, and Leadership for Engineering and Construction Organizations** concentration prepares students to effectively lead the identification and implementation of strategic directions for entrepreneurial engineering and construction organizations. Students would be required to take 3 out of the following 4 courses:

- CIEN E4135 STRATEGIC MGT - ENG # CONSTR
- CIEN E4136 Entrepreneurship in Engineering and Construction
- CIEN E4142 INTL CONSTRUCTION MGMT
- CIEN E6132 LEADERSHIP IN ENGINEERING#CONSTRUCTION

Engineering Mechanics

The **Engineering Mechanics** concentration is intended for those students who wish to acquire a strong theoretical mechanics foundation and also those who wish to consider pursuing a PhD degree later on. The major study areas are Mechanics of Solids, Mechanics of Fluids, Computational Mechanics, Stochastic Mechanics, Structural Mechanics, Experimental Mechanics, and Geo-Mechanics. Students would be required to take 3 out of the following 4 courses:

- ENME E4113 ADVANCED MECHANICS OF SOLIDS
- ENME E4202 ADVANCED MECHANICS
- ENME E4215 THEORY OF VIBRATIONS
- ENME E4363 MULTISCALE COMP SCI # ENGIN OR ENME E6333 FINITE ELEM ANALYSIS II

Environmental Engineering and Water Resources

The **Environmental Engineering and Water Resources** concentration is focused on training civil engineers who are interested in engaging in solving the world's environmental problems and contributing to the sustainable management of global water resources. Students would be required to take 3 out of the following 4 courses:

- EACE E4163 Sustainable Water Treatment and Reuse
- EACE E4252 Foundations of Environmental Engineering
- CIEE E4257 GROUND CONT TRANSP#REMED
- EAEE E4006 Field methods for environmental engineering

Geotechnical Engineering

The **Geotechnical Engineering** concentration focuses on a branch of civil engineering that deals with the behavior of soils, and the design and analysis of natural and man-made soil structures. Students would be required to take 3 out of the following 4 courses:

- CIEN E4241 GEOTECHNCL ENGNEERNG FUNDMNTLS
- CIEN E4242 GEOTECHNICAL EARTHQUAKE ENGIN
- CIEN E4243 FOUNDATION ENGINEERING OR CIEN E4246 EARTH RETAINING STRUCTURES
- CIEN E4247 DES OF LARGE-SCALE FOUND SYST

Real Estate Development, Construction, and Project Finance

The **Real Estate Development, Construction, and Project Finance** concentration prepares students to effectively engineer, construct, and finance real estate developments. Students would be required to take 3 out of the following 4 courses:

- CIEN E4132 PREV#RESOL OF CONSTR DISPUTES
- CIEN E4138 REAL ESTATE FIN/CONST MANAG
- CIEN E4141 PUBLIC-PRIVATE PARTNERSHIP IN GLOBAL INF
- CIEN E4144 Real Estate Land Development Engineering

Smart and Sustainable Cities

The **Smart and Sustainable Cities** concentration is intended for students who are interested in the development and monitoring of sustainable urban infrastructure and buildings. Students would be required to take 3 out of the following 4 courses:

- ENME E6215 PRIN/APP SENSORS STRC HLTH MON
- CIEN E4011 BIG DATA IN TRANSPORTATION
- CIEE E4116 Energy Harvesting
- EAEE E4350 PLANNG/MGT-URBAN HYDROLGC SYST

Structural Engineering

The **Structural Engineering** concentration is designed to provide a solid educational background on the theoretical fundamentals of structural engineering, which is strong with respect to the latest and most advanced methods of analysis and design, well informed on real-life applications and, above all, open to new technology and practices. Students would be required to take 3 out of the following 4 courses:

- CIEN E4100 EARTHQUAKE # WIND ENGINEERING
- CIEN E4226 ADV DESIGN OF STEEL STRUCTURES
- CIEN E4232 ADVNCD DSGN-CONCRETE STRUCTURS
- CIEN E4234 Design of large-scale building structures

Transportation Engineering

The **Transportation Engineering** concentration is designed to prepare students to design, build, and govern the next-generation transportation ecosystem that has undergone a radical revolution due to the emergence of advanced technologies, including shared mobility, vehicle connectivity, and autonomous driving, as well as the availability of big data. Students would be required to take 3 out of the following 4 courses:

- CIEN E4011 BIG DATA IN TRANSPORTATION
- CIEN E4012 Sustainable Urban Systems Engineering
- CEOR E4011 INFRASTRUCTURE SYSTEMS OPTIMIZATION
- IEOR E4418 TRANSPORTATION ANALYTICS # LOGISTICS

Civil Engineering and Engineering Mechanics (EngScD, PhD)

Doctoral Degree Programs

Two doctoral degrees in engineering are offered within the department: the Doctor of Engineering science (Eng.Sc.D.), administered by The Fu Foundation School of Engineering and Applied Science, and the Doctor of Philosophy (Ph.D.), administered by the Graduate School of Arts and Science. The Eng.Sc.D. and Ph.D. programs have nearly identical academic requirements with regard to courses, qualifying examinations, and the dissertation, but differ in residence requirements and in certain administrative details. A student must obtain the master's degree (M.S.) before enrolling as a candidate for either the Ph.D. or Eng.Sc.D. degree.

In conjunction with their faculty adviser, doctoral degree students plan an appropriate course of study related to their area of focus within the department. Doctoral degree students must complete a minimum of 30 credits of graduate-level coursework beyond the M.S. degree. Candidates for the Eng.Sc.D. degree must also accumulate 12 credits in the departmental course CIEN E9800 DOCTORAL RESEARCH INSTRUCTION. In addition to coursework requirements, doctoral degree students must write a dissertation embodying original research under the sponsorship of their faculty adviser.

Major research thrusts for the doctoral degree programs include:

- Computational mechanics
- Multiscale mechanics
- Poromechanics
- Dynamics and vibrations
- Infrastructure monitoring
- Cementitious materials and concrete
- Advanced infrastructure materials
- Structural safety and reliability
- Probabilistic mechanics
- Sustainable/green infrastructure
- Geomechanics
- Fluid mechanics
- Autonomous transportation
- Disasters and natural hazards

Civil Engineering

By selecting technical electives, students may focus on one of several areas of study or prepare for future endeavors such as architecture.

- **Construction Engineering and Management:** capital facility planning and financing, strategic management, managing engineering and construction processes, construction industry law, construction techniques, managing civil infrastructure systems, civil engineering and construction entrepreneurship
- **Environmental Engineering and Water Resources:** transport of water-borne substances, hydrology, sediment transport, hydrogeology, and geoenvironmental design of containment systems
- **Geotechnical Engineering:** soil mechanics, foundation engineering, earth-retaining structures, slopes, and geotechnical earthquake engineering
- **Forensic (Structural) Engineering:** investigation and determination of the causes of structural failures of buildings, bridges, and other constructed facilities
- **Structural Engineering:** applications to steel and concrete buildings, bridges, and other structures

Engineering Mechanics

Programs in engineering mechanics offer comprehensive training in the principles of applied mathematics and continuum mechanics and in the application of these principles to the solution of engineering problems. The emphasis is on basic principles, enabling students to choose from among a wide range of technical areas. Students may work on problems in such disciplines as systems analysis, acoustics, and stress analysis, and in fields as diverse as transportation, environmental, structural, nuclear, and aerospace engineering. Program areas include:

- **Continuum mechanics:** solid and fluid mechanics, theories of elastic and inelastic behavior, and damage mechanics
- **Vibrations:** nonlinear and random vibrations; dynamics of continuous media, of structures and rigid bodies, and of combined systems,

such as fluid-structure interaction; active, passive, and hybrid control systems for structures under seismic loading; dynamic soil-structure interaction effects on the seismic response of structures

- **Random processes and reliability:** problems in design against failure under earthquake, wind, and wave loadings; noise, and turbulent flows; analysis of structures with random properties
- **Fluid mechanics:** turbulent flows, two-phase flows, fluid-structure interaction, fluid-soil interaction, flow in porous media, computational methods for flow and transport processes, and flow and transport in fractured rock under mechanical loading
- **Computational mechanics**: finite element and boundary element techniques, symbolic computation, and bioengineering applications.

A flight structures program is designed to meet the needs of industry in the fields of high-speed and space flight. The emphasis is on mechanics, mathematics, fluid dynamics, flight structures, and control. The program is a part of the Guggenheim Institute of Flight Structures in the department. Specific information regarding degree requirements is available in the department office.

Computer Engineering Program

Administered by both the Electrical Engineering and Computer Science Departments through a joint Computer Engineering Committee. Student records are kept in the Electrical Engineering Department.

1300 S. W. Mudd, MC 4712
450 Computer Sciences
212-854-3105
compeng.columbia.edu

The computer engineering program is run jointly by the Computer Science and Electrical Engineering departments. It offers both B.S. and M.S. degrees.

The program covers some of engineering's most active, exciting, and critical areas, which lie at the interface between CS and EE. The focus of the major is on computer systems involving both digital hardware and software.

Some of the key topics covered are computer design (i.e., computer architecture); embedded systems (i.e., the design of dedicated hardware/software for cell phones, automobiles, robots, games, and aerospace); digital and VLSI circuit design; computer networks; design automation (i.e., CAD); and parallel and distributed systems (including architectures, programming, and compilers).

Students in the programs have two "home" departments. The Electrical Engineering Department maintains student records and coordinates advising appointments.

Program Chair

Mingoo Seok
1012 CEPSR

Computer Engineering Committee

Luca Carloni, Professor of Computer Science
Asaf Cidon, Assistant Professor of Electrical Engineering
Stephen A. Edwards, Associate Professor of Computer Science
Xiaofang Fred Jiang, Associate Professor of Electrical Engineering
Konstantinos Kaffes, Assistant Professor of Computer Science
Ethan Katz-Bassett, Associate Professor of Electrical Engineering
Tanvir A. Khan, Assistant Professor of Electrical Engineering
Martha A. Kim, Associate Professor of Computer Science
Vishal Misra, Professor of Computer Science
Daniel Rubenstein, Associate Professor of Computer Science
Mingoo Seok, Associate Professor of Electrical Engineering
Simha Sethumadhavan, Professor of Computer Science
Kenneth L. Shepard, Professor of Electrical Engineering and Biomedical Engineering
Charles A. Zukowski, Professor of Electrical Engineering
Gil Zussman, Professor of Electrical Engineering

Undergraduate Programs

This undergraduate program incorporates most of the core curricula in both electrical engineering and computer science so that students will be well prepared to work in the area of computer engineering, which substantially overlaps both fields. Both hardware and software aspects of computer science are included, and, in electrical engineering, students receive a solid grounding in circuit theory and in electronic circuits. The program includes several electrical engineering laboratory courses as well as the Computer Science Department's advanced programming course. Detailed lists of requirements can be found at compeng.columbia.edu.

Students will be prepared to work on all aspects of the design of digital hardware, as well as on the associated software that is now often an integral part of computer architecture. They will also be well equipped to work in the growing field of telecommunications. Students will have the prerequisites to delve more deeply into either hardware or software areas, and enter graduate programs in computer science, electrical engineering, or computer engineering. For example, they could take more advanced courses in VLSI, communications theory, computer architecture, electronic circuit theory, software engineering, or digital design.

Minors in electrical engineering and computer science are not open to computer engineering majors, due to excessive overlap.

- Computer Engineering (BS) (p. 141)

Computer Engineering (BS)

Computer Engineering Program

Technical Electives

The Computer Engineering Program includes 15 points of technical electives. All must be 3000 level or above, technical, and must not have significant overlap with other courses taken for the major. Adviser approval of technical electives is required.

Most courses at the 3000 level or above offered by the Computer Science and Electrical Engineering departments are eligible, and up to two from outside those departments can be considered for approval as well. If a department advertises that one of its courses can be used as a technical elective that does not necessarily mean it will be approved as a technical elective in the computer engineering program. There must be sufficient technical content and computer engineering connection within the entire 15 points, so approval of some courses may depend on the other electives chosen. Economics courses cannot be used as technical electives. COMS W3101 PROGRAMMING LANGUAGES/COMS W3102 DEVELOPMENT TECHNOLOGY courses, and not-very-technical courses

within the school of engineering, cannot be used as technical electives either.

Starting Early

Students are strongly encouraged to begin taking core computer engineering courses as sophomores. They start with ELEN E1201 INTRO-ELECTRICAL ENGINEERING in the second semester of their first year and may continue with other core courses one semester after that. For sample "early-starting" and "late-starting" programs, see the degree track charts. It must be emphasized that these charts present examples only; actual schedules may be customized in consultation with academic advisers.

An overview of the degree track in PDF format can be found here.

Early Starting Students

First Year

Semester I

MATH UN1101	CALCULUS I
Choose one of the following Physics courses depending on track:	
PHYS UN1401 (Track 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Track 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Track 3)	ACCELERATED PHYSICS I
Choose a one-semester Chemistry lecture (taken Semester I or II):	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
Choose a lab from the following (taken Semester I or II):	
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB
ELEN E1201 (taken Semester I or II)	INTRO-ELECTRICAL ENGINEERING
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II
Choose one of the following Physics courses depending on track:	
PHYS UN1402 (Track 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Track 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Track 3)	ACCELERATED PHYSICS II
Choose a one-semester Chemistry lecture (taken Semester I or II):	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
Choose a lab from the following (taken Semester I or II):	
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB
ELEN E1201 (taken Semester I or II)	INTRO-ELECTRICAL ENGINEERING
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
COMS W1004 or W1007	PROGRAMMING IN JAVA
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
Choose one of the following lab courses depending on track:	
PHYS UN1494 or CHEM UN1500 (Tracks 1 and 2)	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081 or CHEM UN1500 (Track 3)	INTERMEDIATE LABORATORY WORK
ELEN E3801	SIGNALS AND SYSTEMS
ELEN E3084	SIGNALS # SYSTEMS LABORATORY
Choose one of the following Required Nontechnical Electives:[1]	
HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
HUMA UN1121 or UN1123	Art Humanities
COMS W3203 (taken Semester III or IV)	DISCRETE MATHEMATICS

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
APMA E2101[2]	INTRO TO APPLIED MATHEMATICS
COMS W3134 or W3137	Data Structures in Java
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
ELEN E3082	DIGITAL SYSTEMS LABORATORY
Choose one of the following Required Nontechnical Electives:[1]	
HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
COMS W3203 (taken Semester III or IV)	DISCRETE MATHEMATICS

Third Year

Semester V

IEOR E3658[3]	PROBABILITY FOR ENGINEERS
COMS W3157	ADVANCED PROGRAMMING
ELEN E3201	CIRCUIT ANALYSIS
ELEN E3081	CIRCUIT ANALYSIS LABORATORY

Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[4]

Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)

Semester VI

ELEN E3331	ELECTRONIC CIRCUITS
COMS W3261	COMPUTER SCIENCE THEORY

Choose three of the following Core Required Courses (taken Semester VI, VII or VIII):

CSEE W4119	COMPUTER NETWORKS
EECS E4321	DIGITAL VLSI CIRCUITS
CSEE W4823	Advanced Logic Design
CSEE W4824	COMPUTER ARCHITECTURE
CSEE W4840	EMBEDDED SYSTEMS
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS

ELEN E3083	ELECTRONIC CIRCUITS LABORATORY

Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[4]

Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)

Fourth Year

Semester VII

COMS W4118 or W4115 (taken Semester VII or VIII)	OPERATING SYSTEMS I

Choose three of the following Core Required Courses (taken Semester VI, VII, or VIII):

CSEE W4119	COMPUTER NETWORKS
EECS E4321	DIGITAL VLSI CIRCUITS
CSEE W4823	Advanced Logic Design
CSEE W4824	COMPUTER ARCHITECTURE
CSEE W4840	EMBEDDED SYSTEMS
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS

Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[4]

Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)

Semester VIII

COMS W4118 or W4115 (taken Semester VII or VIII)	OPERATING SYSTEMS I

Choose three of the following Core Required Courses (taken Semester VI, VII, or VIII):

CSEE W4119	COMPUTER NETWORKS
EECS E4321	DIGITAL VLSI CIRCUITS
CSEE W4823	Advanced Logic Design
CSEE W4824	COMPUTER ARCHITECTURE
CSEE W4840	EMBEDDED SYSTEMS
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS

Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[4]

Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)

1 Some of these courses can be postponed to the junior or senior year to make room for taking the required core computer engineering courses.

2 APMA E2101 INTRO TO APPLIED MATHEMATICS may be replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH UN1210 ORDINARY DIFFERENTIAL EQUATION) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA, or MATH UN2010 LINEAR ALGEBRA, or COMS W3251 COMPUTATIONAL LINEAR ALGEBRA.

3 SIEO W3600 INTRO PROBABILITY/STATISTICS, STAT GU4203 PROBABILITY THEORY, and STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS can be used instead of IEOR E3658 PROBABILITY FOR ENGINEERS, but SIEO W3600 INTRO PROBABILITY/STATISTICS and STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS may not provide enough probability background for elective courses such as ELEN E3701 INTRO TO COMMUNICATION SYSTEMS. Students completing an economics minor who want such a background can take IEOR E3658 PROBABILITY FOR ENGINEERS and augment it with IEOR E4307 STATISTICS AND DATA ANALYSIS.

4 The total points of technical electives is reduced to 12 if APMA E2101 INTRO TO APPLIED MATHEMATICS has been replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA, or COMS W3251 COMPUTATIONAL LINEAR ALGEBRA. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can apply for this waiver, but the courses must have been at an advanced level for this to be considered.

For a discussion about programming languages used in the program, please see compeng.columbia.edu.

Late Starting Students

First Year

Semester I		**Points**
MATH UN1101	CALCULUS I	3.00
Choose one of the following Physics courses depending on track:		3-4.5
PHYS UN1401 (Track 1)	INTRO TO MECHANICS # THERMO	
PHYS UN1601 (Track 2)	PHYSICS I:MECHANICS/RELATIVITY	
PHYS UN2801 (Track 3)	ACCELERATED PHYSICS I	
Choose a one-semester Chemistry lecture (taken Semester I or II):		3-4
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES	
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES	
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY	
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)	
Choose a lab from the following (taken Semester I or II):		3
CHEM UN1500	GENERAL CHEMISTRY LABORATORY	

PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB	
ELEN E1201 (taken Semester I or II)[1]	INTRO-ELECTRICAL ENGINEERING	3.50
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING	3.00
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI	3.00
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES	1.00
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING	4.00
	Term Points	**26.5-29**
Semester II		
MATH UN1102	CALCULUS II	3.00
Choose one of the following Physics courses depending on track:		3-4.5
PHYS UN1402 (Track 1)	INTRO ELEC/MAGNETSM # OPTCS	
PHYS UN1602 (Track 2)	PHYSICS II: THERMO, ELEC # MAG	
PHYS UN2802 (Track 3)	ACCELERATED PHYSICS II	
Choose a one-semester Chemistry lecture (taken Semester I or II):		
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES	
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES	
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY	
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)	
Choose a lab from the following (taken Semester I or II):		3
CHEM UN1500	GENERAL CHEMISTRY LABORATORY	
PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB	
ELEN E1201 (taken Semester I or II)[1]	INTRO-ELECTRICAL ENGINEERING	3.50
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING	3.00
COMS W1004 or W1007	PROGRAMMING IN JAVA	3
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES	1.00
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING	4.00
	Term Points	**23.5-25**

Second Year

Semester III		
APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI	4.00
Choose one of the following lab courses depending on track:		3
PHYS UN1494 or CHEM UN1500 (Tracks 1 and 2)	INTRO TO EXPERIMENTAL PHYS-LAB	
PHYS UN3081 or CHEM UN1500 (Track 3)	INTERMEDIATE LABORATORY WORK	
Choose one of the following Required Nontechnical Electives:		3-4
HUMA CC1001	Literature Humanities I	
COCI CC1101	CONTEMP WESTERN CIVILIZATION I	
Global Core (3–4)		
HUMA UN1121 or UN1123	Art Humanities	3.00
COMS W3203	DISCRETE MATHEMATICS	4.00
	Term Points	**17-18**
Semester IV		
APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI	4.00
APMA E2101[2]	INTRO TO APPLIED MATHEMATICS	3.00
Choose one of the following Required Nontechnical Electives:		3-4
HUMA CC1002	Literature Humanities II	
COCI CC1102	CONTEMP WESTRN CIVILIZATION II	
Global Core (3–4)		
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS	4.00
	Term Points	**14-15**

Third Year

Semester V		
IEOR E3658[3]	PROBABILITY FOR ENGINEERS	3.00
COMS W3134 or W3137	Data Structures in Java	3
ELEN E3201	CIRCUIT ANALYSIS	3.50
ELEN E3801	SIGNALS AND SYSTEMS	3.50
ELEN E3081[4]	CIRCUIT ANALYSIS LABORATORY	1.00
ELEN E3084[4]	SIGNALS # SYSTEMS LABORATORY	1.00
Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[5]		15
Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)		27
	Term Points	**57**
Semester VI		
COMS W3157	ADVANCED PROGRAMMING	4.00
ELEN E3331	ELECTRONIC CIRCUITS	3.00
COMS W3261[6]	COMPUTER SCIENCE THEORY	3.00
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS	3.00
ELEN E3083[4]	ELECTRONIC CIRCUITS LABORATORY	1.00
ELEN E3082[4]	DIGITAL SYSTEMS LABORATORY	1.00
Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[5]		15
Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)		27
	Term Points	**57**

Fourth Year

Semester VII		
COMS W4118 or W4115 (taken Semester VII or VIII)	OPERATING SYSTEMS I	3.00
Choose three of the following Core Required Courses (taken Semester VII or VIII):		9
CSEE W4119	COMPUTER NETWORKS	
EECS E4321	DIGITAL VLSI CIRCUITS	
CSEE W4823	Advanced Logic Design	
CSEE W4824	COMPUTER ARCHITECTURE	
CSEE W4840	EMBEDDED SYSTEMS	
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS	
Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[5]		15
Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)		27
	Term Points	**54**
Semester VIII		
COMS W4118 or W4115 (taken Semester VII or VIII)	OPERATING SYSTEMS I	3.00
Choose three of the following Core Required Courses (taken Semester VII or VIII):		9
CSEE W4119	COMPUTER NETWORKS	
EECS E4321	DIGITAL VLSI CIRCUITS	
CSEE W4823	Advanced Logic Design	
CSEE W4824	COMPUTER ARCHITECTURE	
CSEE W4840	EMBEDDED SYSTEMS	
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS	
Tech Electives (15 points required; see details within the text) (taken Semester V, VI, VII or VIII)[5]		15
Nontech Electives (Complete 27-point requirement) (taken Semester V, VI, VII, or VIII)		27
	Term Points	**54**
	Total Points:	**303-309**

1 Transfer and combined-plan students are expected to have completed the equivalent of the first- and second-year program listed above before starting their junior year. Note that this includes some background in discrete math (see COMS W3203 DISCRETE MATHEMATICS) and electronic circuits (see ELEN E1201 INTRO-ELECTRICAL ENGINEERING). Transfer and combined-plan students are also expected to be familiar with Java before they start their junior year. If students must take the one-point Java course (COMS W3101 PROGRAMMING LANGUAGES, COMS W3102 DEVELOPMENT TECHNOLOGY, COMS W3103) junior year, prerequisite constraints make it difficult to complete the remaining computer engineering program by the end of the senior year.

2 APMA E2101 INTRO TO APPLIED MATHEMATICS may be replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA, or MATH UN2010 LINEAR ALGEBRA, or COMS W3251 COMPUTATIONAL LINEAR ALGEBRA.

3 SIEO W3600 INTRO PROBABILITY/STATISTICS, STAT GU4203 PROBABILITY THEORY, and STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS can be used instead of IEOR E3658 PROBABILITY FOR ENGINEERS, but SIEO W3600 INTRO PROBABILITY/STATISTICS and STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS may not provide enough probability background for elective courses such as ELEN E3701 INTRO TO COMMUNICATION SYSTEMS. Students completing an economics minor who want such a background can take IEOR E3658 PROBABILITY FOR ENGINEERS and augment it with IEOR E4307 STATISTICS AND DATA ANALYSIS.

4 If possible, ELEN E3081 CIRCUIT ANALYSIS LABORATORY and ELEN E3084 SIGNALS # SYSTEMS LABORATORY should be taken along with ELEN E3201 CIRCUIT ANALYSIS and ELEN E3801 SIGNALS AND SYSTEMS, respectively, and ELEN E3083 ELECTRONIC CIRCUITS LABORATORY and ELEN E3082 DIGITAL SYSTEMS LABORATORY taken with ELEN E3331 ELECTRONIC CIRCUITS and CSEE W3827 FUNDAMENTALS OF COMPUTER SYSTS respectively.

5 The total points of technical electives is reduced to 12 if APMA E2101 INTRO TO APPLIED MATHEMATICS has been replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA, or COMS W3251 COMPUTATIONAL LINEAR ALGEBRA. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can apply for this waiver, but the courses must have been at an advanced level for this to be considered.

6 COMS W3261 COMPUTER SCIENCE THEORY can be taken one semester later than pictured.

For a discussion about programming languages used in the program, please see compeng.columbia.edu.

Graduate Programs

- Computer Engineering Program (MS) (p. 146)

Computer Engineering Program (MS)

The Computer Engineering Program offers a course of study leading to the degree of Master of Science (M.S.). The basic courses in the M.S. program come from the Electrical Engineering and Computer Science Departments. Students completing the program are prepared to work (or study further) in such fields as digital computer design, digital communications, and the design of embedded computer systems.

Applicants are generally expected to have a bachelor's degree in computer engineering, computer science, or electrical engineering with at least a 3.2 GPA in technical courses. The Graduate Record Examination (GRE), General Test only, is required of all applicants.

Students must take at least 30 points of courses at Columbia University at or above the 4000 level. These must include at least 15 points from the courses listed below that are deemed core to computer engineering. Other courses may be chosen with the prior approval of a faculty adviser in the Computer Engineering Program.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

Core Computer Engineering Courses

CSEE W4119	COMPUTER NETWORKS
CSEE W4823	Advanced Logic Design
CSEE W4824	COMPUTER ARCHITECTURE
CSEE W4840	EMBEDDED SYSTEMS
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS
EECS E4321	DIGITAL VLSI CIRCUITS
EECS E4750	Heterogeneous Computing for Signal and Data Processing
EECS E4764	Artificial Intelligence of Things (AIoT)
COMS E6424	HARDWARE SECURITY
CSEE E6180	MODELING # PERFORMNCE EVALUATN
CSEE E6863	FORMAL VERIF HW SW SYSTEMS
CSEE E6868	EMBEDDED SCALABLE PLATFORMS
EECS E6321	Advanced digital electronic circuits
EECS E6692	TOPICS DATA-DRIVEN ANAL # COMP [1]
EECS E6897	Topics in Information Processing [2]
EECS E6894	TOPICS-INFORMATION PROCESSING [3]
ELEN E6775	TOPICS IN NETWORKING [4]

1 *Deep Learning on the Edge* is the only topics section applicable for this requirement.

2 *Distributed Storage Systems* is the only topics section applicable for this requirement.

3 *Hardware/Software Co-Design for Data Center Processing* is the only topics section applicable for this requirement.

4 *Advanced Computer Networks* is the only topics section applicable for this requirement.

The overall program must include at least 12 points of 6000-level *ELEN*, *EECS*, *CSEE*, or *COMS* courses (exclusive of seminars). No more than 9 points of research project may be taken for credit. No more than 3 points of a nontechnical elective (at or above the 4000 level and with adviser approval) may be included. A minimum GPA of at least 2.7 must be maintained, and all degree requirements must be completed within five years of the beginning of the first course credited toward the degree.

Computer Science

450 Computer Science, MC 0401
212-853-8400
cs.columbia.edu

The function and influence of the computer is pervasive in contemporary society. Today's computers process the daily transactions of international banks, the data from communications satellites, the images in video games, and even the fuel and ignition systems of automobiles.

Computer software is as commonplace in education and recreation as it is in science and business. There is virtually no field or profession that does not rely upon computer science for the problem-solving skills and the production expertise required in the efficient processing of information. Computer scientists, therefore, function in a wide variety of roles, ranging from pure theory and design to programming and marketing.

The computer science curriculum at Columbia places strong emphasis both on theoretical computer science and mathematics and on applied aspects of computer technology. A broad range of upper-level courses is available in such areas as artificial intelligence, machine learning, computer graphics, computer vision, robotics, computational complexity and the analysis of algorithms, combinatorial methods, computer architecture, computer-aided digital design, computer communications, databases, mathematical models for computation, optimization, and software systems.

Laboratory Facilities

The department has a dedicated computing work space for students with dedicated workstations as well as audiovisual equipment for group meetings, specialized office hours, and small seminars. The department also has its own 120-seat lecture hall featuring flexible seating, a dedicated podium computer, and presentation equipment, as well as video conferencing capabilities.

The department maintains its own dedicated Data Center for computational research, storage, and administrative systems. It houses several computer clusters for research and student use and several hundred research systems, all supported by more than a petabyte of storage. Services offered to the department utilize virtual machines (VMWare supporting more than 500 instances) and containerization (100 Docker containers).

In addition, the department has numerous individual laboratories with specialized hardware dedicated to particular research areas, including, but not limited to, robotics, computer vision, computer networks, computer security, computer architecture, speech processing, machine learning, and natural language processing.

Chair
Luca Carloni

Vice Chair
Itsik Pe'er

Director of Undergraduate Studies
Paul Blaer

Director of Finance and Administration
Maria Sukhanova

Director of Student and Academic Services
Carol Begg

Professors
Peter N. Belhumeur
David Blei
Andrew Blumberg
Luca Carloni
Xi Chen
Steven K. Feiner
Luis Gravano
Julia B. Hirschberg
Gail E. Kaiser
Tal Malkin
Kathleen R. McKeown
Vishal Misra
Shree Kumar Nayar
Jason Nieh
Christos Papadimitriou
Itsik Pe'er
Toniann Pitassi
Kenneth A. Ross
Tim Roughgarden
Daniel S. Rubenstein
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Rocco A. Servedio
Simha Sethumadhavan
Salvatore J. Stolfo
Bjarne Stroustrup
Vladimir Vapnik
Jeannette Wing
Junfeng Yang
Mihalis Yannakakis
Richard Zemei

Associate Professors
Josh Alman
Alexandr Andoni
Elias Bareinboim
Augustin Chaintreau

Lydia Chilton
Stephen A. Edwards
Roxana Geambasu
Ronghui Gu
Daniel Hsu
Suman Jana
Martha Allen Kim
David Knowles
Baishakhi Ray
Brian Smith
Carl Vondrick
Eugene Wu
Zhou Yu
Henry Yuen
Changxi Zheng
Xia Zhou

Assistant Professors
James Bartusek
Adam Block
John Hewitt
Aleksander Hołyński
Kostis Kaffes
Yunzhu Li
Silvia Sellán

Teaching Professor
Paul Blaer
Adam Cannon
Jae Woo Lee

Senior Lecturers in Discipline
Daniel Bauer
Brian Borowski
Tony Dear
Eleni Drinea
Chris Murphy
Ansaf Salleb-Aouissi
Nakul Verma

Lecturers in Discipline
Yining Liu

Joint
David Blei
Andrew Blumberg
Shih-Fu Chang
Clifford Stein

Affiliates
Anish Agarwal
Shipra Agrawal
Mohammed AlQuraishi
Elham Azizi
Paolo Blikstein
Asaf Cidon
Matei Ciocarlie
Rachel Cummings
Bianca Dumitrascu
Noemie Elhadad
Javad Ghaderi
Micah Goldblum
Gamze Gursoy
Xiaofan Jiang

Shalmali Joshi
Ethan Katz-Bassett
Tanvir Ahmed Khan
Eysa Lee
Hod Lipson
Lena Mamykina
Smaranda Mureson
Liam Paninski
Mark Santolucito
Lucy Simko
Kaveri Thakoor
Corey Toler-Franklin
Tiffany Tseng
Barbara Tversky
Venkat Venkatasubramanian
Junhao (Hao) Wen
Rebecca Wright
Lilly Xu
Xuhai (Orson) Xu
Gil Zussman

Senior Research Scientists

Gaston Ormazabal
Moti Yung

Emeritus

Alfred V. Aho
Peter K. Allen
Steven M. Bellovin
Edward G. Coffman Jr.
Zvi Galil
Jonathan L. Gross
John R. Kender
Steven M. Nowick
Henryk Wozniakowski
Yechiam Yemini

Course Descriptions

BINF GU4001 Introduction to Computational Biomedicine and Health. *3.00 points*.
This course offers a comprehensive introduction to the core computational methods driving modern biomedical research and health data science. As biological and clinical datasets grow in scale and complexity—from genomic sequences and molecular profiles to electronic health records (EHRs) and consumer health data—this course equips students with the essential computational foundations to model, analyze, and interpret high-dimensional biomedical data. Organized around key algorithmic challenges spanning Clinical Informatics, Consumer Health Informatics, and Bioinformatics, the course focuses on the design and application of algorithms and statistical models to solve real-world biomedical problems. Lectures emphasize practical techniques and showcase their use across diverse biomedical data types. Designed for advanced undergraduates and graduate students in biomedical informatics, computer science, biomedical engineering, applied mathematics, and related fields, this course builds a rigorous understanding of computational biomedicine. It serves as a core requirement for the Biomedical Informatics PhD and master's programs and is cross-listed with Computer Science. Students interested in careers in bioinformatics, health data science, computational biology, or biomedical AI will find this course especially valuable. As biomedical data continue to expand in size, diversity, and impact, this course provides a critical foundation in the algorithmic, statistical, and computational tools needed to advance the future of research at the intersection of computation and human health

Fall 2026: BINF GU4001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BINF 4001	001/16864	M W 4:10pm - 5:25pm 327 Seeley W. Mudd Building	Harry Reyes	3.00	24/35

BMCS E4480 Statistical machine learning for genomics. *3.00 points*.
Prerequisites: Proficiency in Python/R programming, and background in probability/statistics. Recommended: COMS W4771.
Introduction to statistical machine learning methods using applications in genomic data and in particular high-dimensional single-cell data. Concepts of molecular biology relevant to genomic technologies, challenges of high-dimensional genomic data analysis, bioinformatics preprocessing pipelines, dimensionality reduction, unsupervised learning, clustering, probabilistic modeling, hidden Markov models, Gibbs sampling, deep neural networks, gene regulation. Programming assignments and final project will be required

Fall 2026: BMCS E4480

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMCS 4480	001/11501	Th 10:10am - 12:40pm 331 Uris Hall	Elham Azizi	3.00	19/50

BMCS E4575 High-dimensional statistics for biomedical data. *3.00 points*.
Prerequisites: (APMA E2000 and COMS W4771 and MATH UN2010) or (APMA E2101) Strong background in Python (or R) programming-Background in probability/statistics is recommended.
Statistical machine learning techniques and advanced mathematical concepts for analysis of high-dimensional biomedical data. Topics include optimal transport and probabilistic modeling for multi-modal genomic and imaging data integration and analysis of spatial and temporal dynamics. Programming assignments, problem sets, and a final project will be required.

Spring 2026: BMCS E4575

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMCS 4575	001/13326	Th 10:10am - 12:40pm 829 Seeley W. Mudd Building	Elham Azizi, Andrew Blumberg	3.00	20/40

CBMF W4761 COMPUTATIONAL GENOMICS. *3.00 points*.
Lect: 3.

Prerequisites: Working knowledge of at least one programming language, and some background in probability and statistics.
Computational techniques for analyzing genomic data including DNA, RNA, protein and gene expression data. Basic concepts in molecular biology relevant to these analyses. Emphasis on techniques from artificial intelligence and machine learning. String-matching algorithms, dynamic programming, hidden Markov models, expectation-maximization, neural networks, clustering algorithms, support vector machines. Students with life sciences backgrounds who satisfy the prerequisites are encouraged to enroll

Spring 2026: CBMF W4761

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CBMF 4761	001/12331	M W 5:40pm - 6:55pm 209 Havemeyer Hall	Cassandra Burdziak	3.00	47/60

COMS W1001 INTRO TO INFORMATION SCIENCE. *3.00 points*.
Lect: 3.

Basic introduction to concepts and skills in Information Sciences: human-computer interfaces, representing information digitally, organizing and searching information on the internet, principles of algorithmic problem solving, introduction to database concepts, and introduction to programming in Python

COMS W1002 COMPUTING IN CONTEXT. *4.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Introduction to elementary computing concepts and Python programming with domain-specific applications. Shared CS concepts and Python programming lectures with track-specific sections. Track themes will vary but may include computing for the social sciences, computing for economics and finance, digital humanities, and more. Intended for nonmajors. Students may only receive credit for one of ENGI E1006 or COMS W1002

Fall 2026: COMS W1002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1002	001/13508	T Th 1:10pm - 2:25pm 417 International Affairs Bldg	Adam Cannon	4.00	115/200
COMS 1002	002/13509	T Th 1:10pm - 2:25pm 330 Uris Hall	Adam Cannon, Mark Santolucito	4.00	18/60
COMS 1002	003/13510	T Th 1:10pm - 2:25pm 326 Uris Hall	Yining Liu, Adam Cannon	4.00	15/60
COMS 1002	004/13511	T Th 1:10pm - 2:25pm 141 Uris Hall	Debasmita Bhattacharya, Adam Cannon	4.00	16/60

COMS W1004 PROGRAMMING IN JAVA. *3.00 points*.
Lect: 3.

A general introduction to computer science for science and engineering students interested in majoring in computer science or engineering. Covers fundamental concepts of computer science, algorithmic problem-solving capabilities, and introductory Java programming skills. Assumes no prior programming background. Columbia University students may receive credit for only one of the following two courses: *1004* or *1005*.

Spring 2026: COMS W1004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1004	001/12332	T Th 1:10pm - 2:25pm 501 Schermerhorn Hall	Christian Murphy	3.00	122/189
COMS 1004	002/12333	T Th 2:40pm - 3:55pm 501 Schermerhorn Hall	Christian Murphy	3.00	127/189

Fall 2026: COMS W1004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1004	001/13512	M W 2:40pm - 3:55pm 309 Havemeyer Hall	Paul Blaer	3.00	105/320
COMS 1004	002/13513	M W 5:40pm - 6:55pm 501 Northwest Corner	Paul Blaer	3.00	46/164

COMS W1012 COMPUTING IN CONTEXT REC. *0.00 points.*

Fall 2026: COMS W1012

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1012	001/13514	Th 7:10pm - 8:00pm 233 Seeley W. Mudd Building		0.00	0/40
COMS 1012	002/13515	Th 7:10pm - 8:00pm 829 Seeley W. Mudd Building		0.00	0/40
COMS 1012	003/13516	F 10:10am - 11:00am 963 Ext Schermerhorn Hall		0.00	0/40
COMS 1012	004/13517	F 11:10am - 12:00pm 963 Ext Schermerhorn Hall		0.00	0/40
COMS 1012	005/13518	Th 7:10pm - 8:00pm 644 Seeley W. Mudd Building		0.00	0/40
COMS 1012	006/13519	F 10:10am - 11:00am 303 Hamilton Hall		0.00	0/40
COMS 1012	007/13520	Th 7:10pm - 8:00pm 307 Uris Hall		0.00	0/40
COMS 1012	008/13521	F 10:10am - 11:00am 304 Hamilton Hall		0.00	0/40
COMS 1012	009/13522	Th 7:10pm - 8:00pm 227 Seeley W. Mudd Building		0.00	0/40
COMS 1012	010/13523	F 11:10am - 12:00pm 304 Hamilton Hall		0.00	0/40

COMS W1404 EMERGING SCHOLARS PROG SEMINAR. *1.00 point.*

Pass/Fail only.

Prerequisites: Students must be enrolled in an introductory computing course.
Corequisites: COMS W1001,COMS W1002,COMS W1004,COMS W1005,ENGI W1006,COMS X1016
Peer-led weekly seminar intended for first and second year undergraduates considering a major in Computer Science. Pass/fail only. May not be used towards satisfying the major or SEAS credit requirements.

Spring 2026: COMS W1404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1404	001/12334	F 10:10am - 11:25am 337 Seeley W. Mudd Building	Christian Murphy	1.00	15/16
COMS 1404	002/12335	F 11:40am - 12:55pm 337 Seeley W. Mudd Building	Christian Murphy	1.00	7/16
COMS 1404	003/12336	F 1:10pm - 2:25pm 337 Seeley W. Mudd Building	Christian Murphy	1.00	4/16
COMS 1404	004/12337	F 4:10pm - 5:25pm 337 Seeley W. Mudd Building	Christian Murphy	1.00	7/16
COMS 1404	005/12338	F 9:30am - 10:45am 327 Seeley W. Mudd Building	Christian Murphy	1.00	5/16
COMS 1404	006/12339	F 11:00am - 12:15pm 327 Seeley W. Mudd Building	Christian Murphy	1.00	0/16
COMS 1404	007/12340	F 12:30pm - 1:45pm 327 Seeley W. Mudd Building	Christian Murphy	1.00	0/16
COMS 1404	008/12341	F 2:00pm - 3:15pm 327 Seeley W. Mudd Building	Christian Murphy	1.00	4/16

Fall 2026: COMS W1404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1404	001/13524	F 10:10am - 11:25am 253 Engineering Terrace	Christian Murphy	1.00	0/16
COMS 1404	002/13525	F 11:40am - 12:55pm 253 Engineering Terrace	Christian Murphy	1.00	0/16
COMS 1404	003/13526	F 1:10pm - 2:25pm 253 Engineering Terrace	Christian Murphy	1.00	0/16
COMS 1404	004/13527	F 4:10pm - 5:25pm 502 Northwest Corner	Christian Murphy	1.00	0/16
COMS 1404	005/13528	F 9:30am - 10:45am 502 Northwest Corner	Christian Murphy	1.00	0/16
COMS 1404	006/13529	F 11:00am - 12:15pm 502 Northwest Corner	Christian Murphy	1.00	0/16
COMS 1404	007/13530	F 12:30pm - 1:45pm 502 Northwest Corner	Christian Murphy	1.00	0/16
COMS 1404	008/13531	F 2:00pm - 3:15pm 502 Northwest Corner	Christian Murphy	1.00	0/16

COMS W2132 Intermediate Computing in Python. *4.00 points*.
Prerequisites: (ENGI E1006) or (COMS W1002) or equivalent prior programming background in Python.
Essential data structures and algorithms in Python with practical software development skills, applications in a variety of areas including biology, natural language processing, data science and others.

Spring 2026: COMS W2132

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 2132	001/12342	M W 10:10am - 11:25am 451 Computer Science Bldg	Daniel Bauer	4.00	62/80

COMS W2702 AI in Context. *3.00 points*.
Prerequisites: STAT UN1201 or equivalent is strongly recommended.
An interdisciplinary introduction to the history, development and modern application of artificial intelligence in a variety of contexts. Context subjects and teaching staff will vary by semester.

Fall 2026: COMS W2702

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 2702	001/13532	T Th 11:40am - 12:55pm 417 International Affairs Bldg	Adam Cannon	3.00	161/200

COMS W3102 DEVELOPMENT TECHNOLOGY. *1.00-2.00 points*.
Lect: 2. Lab: 0-2.

Prerequisites: Fluency in at least one programming language.
Introduction to software development tools and environments. Each section devoted to a specific tool or environment. One-point sections meet for two hours each week for half a semester, and two point sections include an additional two-hour lab

COMS W3107 Software Quality and Design. *3.00 points*.
Prerequisites: (COMS W3134)
A course in designing, implementing, testing, and documenting high quality software. Focuses on software quality aspects such as reliability, efficiency, security, flexibility, and changeability.

Fall 2026: COMS W3107

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3107	001/13533	T Th 2:40pm - 3:55pm 833 Seeley W. Mudd Building	Christian Murphy	3.00	106/120

COMS W3132 Intermediate Computing in Python. *4.00 points*.
Prerequisites: ENGI E1006 OR COMS W1002; or equivalent Python programming experience. Intermediate interdisciplinary course in computing intended for non-CS majors.
Essential data structures and algorithms in Python with practical software development skills, applications in a variety of areas including biology, natural language processing, data science and others

COMS W3134 Data Structures in Java. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W1004) or COMS W1004; Knowledge of Java
Data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs. Programming techniques for processing such structures: sorting and searching, hashing, garbage collection. Storage management. Rudiments of the analysis of algorithms. Taught in Java. Note: Due to significant overlap, students may receive credit for only one of the following three courses: *COMS W3134*, *COMS W3136*, *COMS W3137*.

Spring 2026: COMS W3134

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3134	001/12344	M W 2:40pm - 3:55pm 417 International Affairs Bldg	Paul Blaer	3	224/320
COMS 3134	002/12345	M W 5:40pm - 6:55pm 501 Northwest Corner	Paul Blaer	3	140/164

Fall 2026: COMS W3134

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3134	001/13534	M W 4:10pm - 5:25pm 501 Schermerhorn Hall	Brian Borowski	3	87/175
COMS 3134	002/13535	M W 5:40pm - 6:55pm 501 Schermerhorn Hall	Brian Borowski	3	61/175

COMS W3136 ESSENTIAL DATA STRUCTURES. *4.00 points*.
Prerequisites: (COMS W1004) or (COMS W1005) or (COMS W1007) or (ENGI E1006) COMS W1005 OR COMS W1007 OR ENGI E1006 OR COMS W1004
A second programming course intended for nonmajors with at least one semester of introductory programming experience. Basic elements of programming in C and C , arraybased data structures, heaps, linked lists, C programming in UNIX environment, object-oriented programming in C , trees, graphs, generic programming, hash tables. Due to significant overlap, students may only receive credit for either COMS W3134, W3136, or W3137

Spring 2026: COMS W3136

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3136	001/19602	T 4:10pm - 6:30pm 330 Uris Hall	Brian Borowski	4.00	12/30

COMS W3137 HONORS DATA STRUCTURES # ALGOL. *4.00 points*.
Prerequisites: (COMS W1004) or (COMS W1007) COMS W1004 OR COMS W1007
Corequisites: COMS W3203
An honors introduction to data types and structures: arrays, stacks, singly and doubly linked lists, queues, trees, sets, and graphs. Programming techniques for processing such structures: sorting and searching, hashing, garbage collection. Storage management. Design and analysis of algorithms. Taught in Java. Note: Due to significant overlap, students may receive credit for only one of the following three courses: COMS W3134, W3136, or W3137

COMS W3157 ADVANCED PROGRAMMING. *4.00 points*.
Lect: 4.

Prerequisites: (COMS W3134) or (COMS W3137) COMS W3134 OR COMS W3137
C programming language and Unix systems programming. Also covers Git, Make, TCP/IP networking basics, C fundamentals

Spring 2026: COMS W3157

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3157	001/12346	M W 4:10pm - 5:25pm 501 Schermerhorn Hall	Brian Borowski	4.00	155/164
COMS 3157	002/12347	M W 5:40pm - 6:55pm 501 Schermerhorn Hall	Brian Borowski	4.00	106/164

Fall 2026: COMS W3157

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3157	001/13536	T Th 4:10pm - 5:25pm 417 International Affairs Bldg	Jae Lee	4.00	264/398
COMS 3157	002/13537	F 12:10pm - 2:00pm 330 Uris Hall	Jae Lee	4.00	0/60

COMS W3203 DISCRETE MATHEMATICS. *4.00 points*.
Lect: 3.

Prerequisites: Any introductory course in computer programming.
Logic and formal proofs, sequences and summation, mathematical induction, binomial coefficients, elements of finite probability, recurrence relations, equivalence relations and partial orderings, and topics in graph theory (including isomorphism, traversability, planarity, and colorings)

Spring 2026: COMS W3203

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3203	001/12348	T Th 11:40am - 12:55pm 301 Uris Hall	Ansaf Salleb-Aouissi	4.00	214/215
COMS 3203	002/19787	F 2:10pm - 4:40pm 833 Seeley W. Mudd Building	Tony Dear	4.00	48/120

Fall 2026: COMS W3203

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3203	001/13538	M W 4:10pm - 5:25pm 301 Pupin Laboratories	Gabriel Chuang, Augustin Chaintreau	4.00	272/272
COMS 3203	002/16959	M W 5:40pm - 6:55pm 451 Computer Science Bldg		4.00	0/110

COMS W3251 COMPUTATIONAL LINEAR ALGEBRA. *4.00 points*.

COMS W3261 COMPUTER SCIENCE THEORY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3203)
Corequisites: COMS W3134,COMS W3136,COMS W3137
Regular languages: deterministic and non-deterministic finite automata, regular expressions. Context-free languages: context-free grammars, push-down automata. Turing machines, the Chomsky hierarchy, and the Church-Turing thesis. Introduction to Complexity Theory and NP-Completeness.

Spring 2026: COMS W3261

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3261	001/12349	M W 1:10pm - 2:25pm 833 Seeley W. Mudd Building	Mihalis Yannakakis	3.00	105/110
COMS 3261	002/12350	M W 2:40pm - 3:55pm 833 Seeley W. Mudd Building	Mihalis Yannakakis	3.00	102/110

Fall 2026: COMS W3261

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3261	001/13539	T Th 8:40am - 9:55am 833 Seeley W. Mudd Building	Tal Malkin	3.00	105/105
COMS 3261	002/13540	T Th 10:10am - 11:25am Room TBA	Tal Malkin	3.00	104/105
COMS 3261	003/19825	T Th 11:40am - 12:55pm 633 Seeley W. Mudd Building	William Pires, Tal Malkin	3.00	3/70

COMS W3410 COMPUTERS AND SOCIETY. *3.00 points*.
Lect: 3.

Broader impact of computers. Social networks and privacy. Employment, intellectual property, and the media. Science and engineering ethics. Suitable for nonmajors

Fall 2026: COMS W3410

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3410	001/13541	T 4:10pm - 6:40pm 313 Fayerweather	Ronald Baecker	3.00	78/78

COMS W3770 Mathematics for Machine Learning. *3.00 points*.
Prerequisites: (MATH UN2010 or MATH UN2015 or APMA E2101 or APMA E3101 or COMS W3251) and (MATH UN1201 or MATH UN1205 or APMA E2000) and (STAT UN1201 or MATH UN2015 or IEOR E3658)
Familiarity with mathematical proof writing
Mathematical foundations of machine learning: Linear algebra, multivariable calculus, and probability and statistics. Comprehensive review and additional treatment of relevant topics used in the analysis and design of machine learning models. Preliminary exposure to core algorithms such as linear regression, gradient descent, principal component analysis, low-rank approximations, and kernel methods.

COMS W3902 UNDERGRADUATE THESIS. *0.00-6.00 points*.
Prerequisites: Agreement by a faculty member to serve as thesis adviser.
An independent theoretical or experimental investigation by an undergraduate major of an appropriate problem in computer science carried out under the supervision of a faculty member. A formal written report is mandatory and an oral presentation may also be required. May be taken over more than one term, in which case the grade is deferred until all 6 points have been completed. Consult the department for section assignment

COMS W3995 TOPICS IN COMPUTER SCIENCE. *3.00 points*.
Lect: 3.

Consult the department for section assignment. Special topics arranged as the need and availability arise. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit.

COMS W3998 UNDERGRAD PROJECTS IN COMPUTER SCIENCE. *1.00-3.00 points*.
Prerequisites: Approval by a faculty member who agrees to supervise the work.
Independent project involving laboratory work, computer programming, analytical investigation, or engineering design. May be repeated for credit. Consult the department for section assignment

COMS W3999 FIELDWORK. *1.00 point*.
Prerequisites: Obtained internship and approval from faculty advisor
May be repeated for credit, but no more than 3 total points may be used toward the 128-credit degree requirement. Only for SEAS computer science undergraduate students who include relevant off campus work experience as part of their approved program of study. Final report and letter of evaluation may be required. May not be used as a technical or nontechnical elective or as a GTE (general technical elective). May not be taken for pass/fail credit or audited

COMS W4111 INTRODUCTION TO DATABASES. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134) and (COMS W3136) and (COMS W3137) COMS W3134, COMS W3136, or COMS W3136; or instructor's permission
The fundamentals of database design and application development using databases: entity-relationship modeling, logical design of relational databases, relational data definition and manipulation languages, SQL, XML, query processing, physical database tuning, transaction processing, security. Programming projects are required.

Spring 2026: COMS W4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4111	002/12351	F 10:10am - 12:40pm 402 Chandler	Donald Ferguson	3.00	121/125

Fall 2026: COMS W4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4111	001/13651	T Th 11:40am - 12:55pm 301 Pupin Laboratories	Luis Gravano	3.00	221/200
COMS 4111	002/13652	Th 7:00pm - 9:30pm 451 Computer Science Bldg	Oktie Hassanzadeh	3.00	88/80

COMS W4112 DATABASE SYSTEM IMPLEMENTATION. *3.00 points*.
Lect: 2.5.

Prerequisites: (COMS W4111) and COMS W4111; fluency in Java or C++. CSEE W3827 is recommended.
The principles and practice of building large-scale database management systems. Storage methods and indexing, query processing and optimization, materialized views, transaction processing and recovery, object-relational databases, parallel and distributed databases, performance considerations. Programming projects are required

COMS W4113 FUND-LARGE-SCALE DIST SYSTEMS. *3.00 points*.
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3157 or COMS W4118 or CSEE W4119) *COMS W3134*, *W3136*, or *W3137*. *COMS W3157* or good working knowledge of C and C++. *COMS W4118* or *CSEE W4119*.
Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3157 or COMS W4118 or CSEE W4119) Design and implementation of large-scale distributed and cloud systems. Teaches abstractions, design and implementation techniques that enable the building of fast, scalable, fault-tolerant distributed systems. Topics include distributed communication models (e.g. sockets, remote procedure calls, distributed shared memory), distributed synchronization (clock synchronization, logical clocks, distributed mutex), distributed file systems, replication, consistency models, fault tolerance, distributed transactions, agreement and commitment, Paxos-based consensus, MapReduce infrastructures, scalable distributed databases. Combines concepts and algorithms with descriptions of real-world implementations at Google, Facebook, Yahoo, Microsoft, LinkedIn, etc

Fall 2026: COMS W4113

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4113	001/19581	M 7:00pm - 9:30pm 142 Uris Hall	Hubertus Franke	3.00	22/110
COMS 4113	V01/19960		Hubertus Franke	3.00	5/99

COMS W4115 PROGRAMMING LANG # TRANSLATORS. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3134) or (COMS W3136) or (COMS W3137) or (COMS W3261 and CSEE W3827) Or the instructor's permission
Modern programming languages and compiler design. Imperative, object-oriented, declarative, functional, and scripting languages. Language syntax, control structures, data types, procedures and parameters, binding, scope, run-time organization, and exception handling. Implementation of language translation tools including compilers and interpreters. Lexical, syntactic and semantic analysis; code generation; introduction to code optimization. Teams implement a language and its compiler.

Fall 2026: COMS W4115

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4115	001/13653	M W 4:10pm - 5:25pm 329 Pupin Laboratories	Ronghui Gu	3.00	83/100
COMS 4115	V01/18085		Ronghui Gu	3.00	3/99

COMS W4118 OPERATING SYSTEMS I. *3.00 points*.
Lect: 3.

Prerequisites: (CSEE W3827) and CSEE W3827; Knowledge of C and programming tools as covered in COMS COMS W3136, COMS W3157, or COMS W3101, or the instructor's permission.
Design and implementation of operating systems. Topics include process management, process synchronization and interprocess communication, memory management, virtual memory, interrupt handling, processor scheduling, device management, I/O, and file systems. Case study of the UNIX operating system. A programming project is required

Spring 2026: COMS W4118

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4118	001/12352	M 7:00pm - 9:30pm 451 Computer Science Bldg	Hubertus Franke	3.00	94/110
COMS 4118	V01/16647		Hubertus Franke	3.00	10/99

Fall 2026: COMS W4118

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4118	001/13654	T Th 4:10pm - 5:25pm 501 Northwest Corner	Jason Nieh	3.00	138/160
COMS 4118	V01/18086		Jason Nieh	3.00	8/99

COMS W4119 COMPUTER NETWORKS. *3.00 points*.
Prerequisites: Comfort with basic probability and programming fluency in Python, C++, Java, or Ruby.
Introduction to computer networks and the technical foundations of the internet, including applications, protocols, local area networks, algorithms for routing and congestion control, security, elementary performance evaluation. Several written and programming assignments required

COMS W4152 Engineering Software-as-a-Service. *3.00 points*.
Prerequisites: COMS W3134 AND COMS W3157 AND CSEE W3827
Modern software engineering concepts and practices including topics such as Software-as-a-Service, Service-oriented Architecture, Agile Development, Behavior-driven Development, Ruby on Rails, and Dev/ops

Fall 2026: COMS W4152

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4152	001/19583	T Th 8:40am - 9:55am 140 Uris Hall	Junfeng Yang, Raphael Sofaer	3.00	18/50

COMS W4153 Cloud Computing. *3.00 points*.
Prerequisites: COMS W4111
Software engineering skills necessary for developing cloud computing and software-as-a-service applications, covering topics such as service-oriented architectures, message-driven applications, and platform integration. Includes theoretical study, practical application, and collaborative project work

COMS W4156 Advanced Software Engineering. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3157)
Software lifecycle using frameworks, libraries and services. Major emphasis on software testing. Centers on a team project.

Fall 2026: COMS W4156

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4156	001/13655	T Th 10:10am - 11:25am 451 Computer Science Bldg	Gail Kaiser	3.00	117/110
COMS 4156	V01/18087		Gail Kaiser	3.00	10/99

COMS W4160 COMPUTER GRAPHICS. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3134) or (COMS W3136) or (COMS W3137)
COMS W3134 OR COMS W3136 OR COMS W3137; Strong programming background and some mathematical familiarity including linear algebra is required.
Introduction to computer graphics. Topics include 3D viewing and projections, geometric modeling using spline curves, graphics systems such as OpenGL, lighting and shading, and global illumination. Significant implementation is required: the final project involves writing an interactive 3D video game in OpenGL. Due to significant overlap in content, only one of COMS 4160 or Barnard COMS 3160BC may be taken for credit

Fall 2026: COMS W4160

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4160	001/13656	T Th 4:10pm - 5:25pm 451 Computer Science Bldg	Silvia Sellan	3.00	66/80

COMS W4165 COMPUT TECHNIQUES-PIXEL PROCSS. *3.00 points*.
Prerequisites: COMS W3137, COMS W3251 recommended, and a good working knowledge of UNIX and C. Intended for graduate students and advanced undergraduates.
An intensive introduction to image processing - digital filtering theory, image enhancement, image reconstruction, antialiasing, warping, and the state of the art in special effects. Topics from the basis of high-quality rendering in computer graphics and of low-level processing for computer vision, remote sensing, and medical imaging. Emphasizes computational techniques for implementing useful image-processing functions

COMS W4167 COMPUTER ANIMATION. *3.00 points*.
Lect: 3.

Theory and practice of physics-based animation algorithms, including animated clothing, hair, smoke, water, collisions, impact, and kitchen sinks. Topics covered: Integration of ordinary differential equations, formulation of physical models, treatment of discontinuities including collisions/contact, animation control, constrained Lagrangian Mechanics, friction/dissipation, continuum mechanics, finite elements, rigid bodies, thin shells, discretization of Navier-Stokes equations. General education requirement: quantitative and deductive reasoning (QUA).

Spring 2026: COMS W4167

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4167	001/16837	T Th 4:10pm - 5:25pm 214 Pupin Laboratories	Changxi Zheng	3.00	40/50

COMS W4170 USER INTERFACE DESIGN. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) COMS W3134 OR COMS W3136 OR COMS W3137
Introduction to the theory and practice of computer user interface design, emphasizing the software design of graphical user interfaces. Topics include basic interaction devices and techniques, human factors, interaction styles, dialogue design, and software infrastructure. Design and programming projects are required

Spring 2026: COMS W4170

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4170	001/12353	T 7:00pm - 9:30pm 301 Pupin Laboratories	Celeste Layne	3.00	195/200
COMS 4170	V01/19789		Celeste Layne	3.00	9/99

Fall 2026: COMS W4170

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4170	001/13657	T Th 5:40pm - 6:55pm 451 Computer Science Bldg	Silka Sietsma	3.00	88/80

COMS W4172 3D UI AND AUGMENTED REALITY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W4160) or (COMS W4170) or COMS W4160 OR COMS W4170; Or instructor's permission
Design, development, and evaluation of 3D user interfaces. Interaction techniques and metaphors, from desktop to immersive. Selection and manipulation. Travel and navigation. Symbolic, menu, gestural, and multimodal interaction. Dialogue design. 3D software support. 3D interaction devices and displays. Virtual and augmented reality. Tangible user interfaces. Review of relevant 3D math

Spring 2026: COMS W4172

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4172	001/12354	T Th 1:10pm - 2:25pm 233 Seeley W. Mudd Building	Steven Feiner	3.00	42/44

COMS W4181 SECURITY I. *3.00 points*.
Prerequisites: COMS W3157; or equivalent.
Introduction to security. Threat models. Operating system security features. Vulnerabilities and tools. Firewalls, virtual private networks, viruses. Mobile and app security. Usable security. Note: May not earn credit for both W4181 and W4180 or W4187.

Fall 2026: COMS W4181

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4181	001/13658	M W 4:10pm - 6:00pm 702 Hamilton Hall	Zhuo Zhang	3.00	81/86

COMS W4182 SECURITY II. *3.00 points*.
Prerequisites: COMS W4118 AND COMS W4181 AND CSEE W4119
Advanced security. Centralized, distributed, and cloud system security. Cryptographic protocol design choices. Hardware and software security techniques. Security testing and fuzzing. Blockchain. Human security issues. Note: May not earn credit for both W4182 and W4180 or W4187.

COMS W4186 MALWARE ANALYSIS#REVERSE ENGINEERING. *3.00 points*.
Prerequisites: COMS W3157 AND CSEE W3827; or equivalent.
Hands-on analysis of malware. How hackers package and hide malware and viruses to evade analysis. Disassemblers, debuggers, and other tools for reverse engineering. Deep study of Windows Internals and x86 assembly.

$100 Lab Fee.

Fall 2026: COMS W4186

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4186	001/13659	Th 4:10pm - 6:40pm 644 Seeley W. Mudd Building	Michael Sikorski	3.00	44/40
COMS 4186	V01/19691		Michael Sikorski	3.00	2/99

COMS W4203 GRAPH THEORY. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3203) COMS W3203
General introduction to graph theory. Isomorphism testing, algebraic specification, symmetries, spanning trees, traversability, planarity, drawings on higher-order surfaces, colorings, extremal graphs, random graphs, graphical measurement, directed graphs, Burnside-Polya counting, voltage graph theory.

COMS W4231 ANALYSIS OF ALGORITHMS I. *3.00 points*.

COMS W4232 Advanced Algorithms. *3.00 points*.
Prerequisite: Analysis of Algorithms (COMS W4231).

Prerequisites: see notes re: points COMS W4231
Introduces classic and modern algorithmic ideas that are central to many areas of Computer Science. The focus is on most powerful paradigms and techniques of how to design algorithms, and how to measure their efficiency. The intent is to be broad, covering a diversity of algorithmic techniques, rather than be deep. The covered topics have all been implemented and are widely used in industry. Topics include: hashing, sketching/streaming, nearest neighbor search, graph algorithms, spectral graph theory, linear programming, models for large-scale computation, and other related topics

Spring 2026: COMS W4232

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4232	001/12355	M W 2:40pm - 3:55pm 1127 Seeley W. Mudd Building	Alexandr Andoni	3.00	30/60
COMS 4232	V01/16649		Alexandr Andoni	3.00	6/99

COMS W4236 INTRO-COMPUTATIONAL COMPLEXITY. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3261) COMS W3261
Develops a quantitative theory of the computational difficulty of problems in terms of the resources (e.g. time, space) needed to solve them. Classification of problems into complexity classes, reductions, and completeness. Power and limitations of different modes of computation such as nondeterminism, randomization, interaction, and parallelism

Fall 2026: COMS W4236

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4236	001/13660	F 1:10pm - 3:40pm 415 Schapiro Cepser	Toniann Pitassi	3.00	32/40

COMS W4252 INTRO-COMPUTATIONAL LEARN THRY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (CSOR W4231) or (COMS W4236) or (COMS W3203) or (COMS W3261)
Possibilities and limitations of performing learning by computational agents. Topics include computational models of learning, polynomial time learnability, learning from examples and learning from queries to oracles. Computational and statistical limitations of learning. Applications to Boolean functions, geometric functions, automata.

COMS W4261 INTRO TO CRYPTOGRAPHY. *3.00 points*.
Lect: 2.5.

Prerequisites: COMS W3261 OR CSOR W4231; Comfort with basic discrete math and probability. Recommended: COMS W3261 or CSOR W4231.
An introduction to modern cryptography, focusing on the complexity-theoretic foundations of secure computation and communication in adversarial environments; a rigorous approach, based on precise definitions and provably secure protocols. Topics include private and public key encryption schemes, digital signatures, authentication, pseudorandom generators and functions, one-way functions, trapdoor functions, number theory and computational hardness, identification and zero knowledge protocols

COMS W4281 INTRO TO QUANTUM COMPUTING. *3.00 points*.
Lect: 3.

Introduction to quantum computing. Shor's factoring algorithm, Grover's database search algorithm, the quantum summation algorithm. Relationship between classical and quantum computing. Potential power of quantum computers.

Spring 2026: COMS W4281

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4281	001/12356	T Th 2:40pm - 3:55pm 451 Computer Science Bldg	James Bartusek	3.00	81/100

Fall 2026: COMS W4281

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4281	001/13661	F 2:10pm - 4:40pm 330 Uris Hall	Henry Yuen	3.00	19/60

COMS W4419 Internet Technology, Economics, and Policy. *3.00 points*.
Prerequisites: General engineering, economics, law or technology background. Programming background is not required.
Technology, economic and policy aspects of the Internet. Summarizes how the Internet works technically, including protocols, standards, radio spectrum, global infrastructure and interconnection. Micro-economics with a focus on media and telecommunication economic concerns, including competition and monopolies, platforms, and behavioral economics. US constitution, freedom of speech, administrative procedures act and regulatory process, universal service, role of FCC. Not a substitute for CSEE4119. Suitable for non-majors

Spring 2026: COMS W4419

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4419	001/12357	M W 4:10pm - 5:25pm 825 Seeley W. Mudd Building	Henning Schulzrinne	3.00	38/44

COMS W4444 PROGRAMMING # PROBLEM SOLVING. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 and COMS W3136) or (COMS W3137 and CSEE W3827)
Hands-on introduction to solving open-ended computational problems. Emphasis on creativity, cooperation, and collaboration. Projects spanning a variety of areas within computer science, typically requiring the development of computer programs. Generalization of solutions to broader problems, and specialization of complex problems to make them manageable. Team-oriented projects, student presentations, and in-class participation required.

Fall 2026: COMS W4444

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4444	001/13662	M W 1:10pm - 2:25pm 327 Seeley W. Mudd Building	Kenneth Ross	3.00	0/34

COMS W4460 PRIN-INNOVATN/ENTREPRENEURSHIP. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) Or instructor's permission
Team project centered course focused on principles of planning, creating, and growing a technology venture. Topics include: identifying and analyzing opportunities created by technology paradigm shifts, designing innovative products, protecting intellectual property, engineering innovative business models.

Spring 2026: COMS W4460

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4460	001/12358	M W 8:40am - 9:55am 415 Schapiro Cepser	William Reinisch	3.00	41/40

Fall 2026: COMS W4460

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4460	001/13663	M W 8:40am - 9:55am 451 Computer Science Bldg	William Reinisch	3.00	40/40

COMS W4701 ARTIFICIAL INTELLIGENCE. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and COMS W3134 OR COMS W3136 OR COMS W3137; Any course on probability
Prior knowledge of Python is recommended. Provides a broad understanding of the basic techniques for building intelligent computer systems. Topics include state-space problem representations, problem reduction and and-or graphs, game playing and heuristic search, predicate calculus, and resolution theorem proving, AI systems and languages for knowledge representation, machine learning and concept formation and other topics such as natural language processing may be included as time permits

Spring 2026: COMS W4701

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4701	001/12359	T Th 4:10pm - 5:25pm 402 Chandler	Yun Lin	3.00	118/120
COMS 4701	002/12360	T Th 6:40pm - 7:55pm 451 Computer Science Bldg	Yun Lin	3.00	104/110
COMS 4701	V02/20063		Yun Lin	3.00	8/99

Fall 2026: COMS W4701

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4701	001/13664	T Th 10:10am - 11:25am 601 Fairchild Life Sciences Bldg	Ansaf Salleb-Aouissi	3.00	145/70
COMS 4701	002/13665	T Th 11:40am - 12:55pm 301 Uris Hall	Ansaf Salleb-Aouissi	3.00	268/266
COMS 4701	003/17213	T Th 7:10pm - 8:25pm 301 Pupin Laboratories	Yun Lin	3.00	39/150
COMS 4701	004/17212	F 10:10am - 12:40pm 301 Uris Hall	Ansaf Salleb-Aouissi	3.00	165/150
COMS 4701	V01/18088		Ansaf Salleb-Aouissi	3.00	26/99

COMS W4705 NATURAL LANGUAGE PROCESSING. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or Python programming experience, probability theory, and linear algebra recommended. Some previous or concurrent exposure to AI and machine learning is benefici Some previous or concurrent exposure to AI or Machine Learning is recommended but not required.
Computational approaches to the analysis, understanding, and generation of natural language text at scale. Emphasis on machine learning techniques for NLP, including deep learning and large language models. Applications may include information extraction, sentiment analysis, question answering, summarization, machine translation, and conversational AI. Discussion of datasets, benchmarking and evaluation, interpretability, and ethical considerations. Due to significant overlap in content, only one of COMS 4705 or Barnard COMS 3705BC may be taken for credit.

Spring 2026: COMS W4705

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4705	001/12361	T Th 4:10pm - 5:25pm 451 Computer Science Bldg	Zhou Yu	3.00	104/110
COMS 4705	002/12627	F 1:10pm - 3:40pm 451 Computer Science Bldg	Daniel Bauer	3.00	102/110
COMS 4705	030/11555	M 7:00pm - 9:30pm 209 Havemeyer Hall	Andrei Simion	3.00	76/90
COMS 4705	V02/20123		Daniel Bauer	3.00	8/99

Fall 2026: COMS W4705

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4705	001/13666	M W 2:40pm - 3:55pm Cin Alfred Lerner Hall	John Hewitt	3.00	329/300
COMS 4705	030/14584	T 7:00pm - 9:30pm 833 Seeley W. Mudd Building	Andrei Simion	3.00	78/90
COMS 4705	V01/18089		John Hewitt	3.00	25/99

COMS W4710 Ethical and Responsible AI. *3.00 points*.
Prerequisites: (COMS W2132) or (COMS W3134) or (COMS W3136) or (COMS W3137) or (IEOR E2000) Programming proficiency in Python. Basic knowledge of probability theory and statistics. Familiarity with machine learning recommended.
Principles of Ethical Artificial Intelligence across technical and societal dimensions. Combines technical AI and machine learning implementations and ethical analysis. Students will learn to build, audit, and mitigate ethical risks in AI systems using tools like fairness libraries, explainability frameworks, and privacy-preserving techniques. Emphasizes coding, algorithmic critique, and real-world cases. Topics include: foundations of AI ethics, fairness, interpretability, explainability, accountability, privacy, robustness, alignment, safety, and societal benefit. Assessments include coding projects, bias auditing assignments, and ethical analysis papers.

Spring 2026: COMS W4710

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4710	001/12362	T Th 1:10pm - 2:25pm 614 Schermerhorn Hall	Ansaf Salleb-Aouissi	3.00	113/120
COMS 4710	V01/17540		Ansaf Salleb-Aouissi	3.00	31/99

COMS W4721 MACHINE LEARNING FOR DATA SCI. *3.00 points*.

Spring 2026: COMS W4721

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4721	001/11556	T Th 1:10pm - 2:25pm 142 Uris Hall	Yining Liu	3.00	97/100
COMS 4721	002/12505	T Th 2:40pm - 3:55pm 142 Uris Hall	Yining Liu	3.00	106/100
COMS 4721	C01/17685		Yining Liu	3.00	2/99

COMS W4726 Deep Learning for Data Science. *3.00 points*.

Prerequisites: This course presumes prior knowledge of machine learning equivalent to having taken an introductory course in ML. It also assumes the ability to code in Python.

Introductory course in deep learning covering core architectures (perceptrons, MLPs, CNNs, U-Nets, RNNs, transformers), training methods (supervised/adversarial loss, autoencoders, diffusion, RL), and key topics (regularization, optimization); includes hands-on implementation in PyTorch with coding, experiments, and paper reviews; students learn to design, build, train, and evaluate deep networks and engage with current research.

Fall 2026: COMS W4726

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4726	001/15508	M W 2:40pm - 3:55pm 403 International Affairs Bldg		3.00	69/70

COMS W4731 Computer Vision I: First Principles. *3.00 points*.

Lect: 3.

Prerequisites: Fundamentals of calculus, linear algebra, and C programming. Students without any of these prerequisites are advised to contact the instructor prior to taking the course.

Introductory course in computer vision. Topics include image formation and optics, image sensing, binary images, image processing and filtering, edge extraction and boundary detection, region growing and segmentation, pattern classification methods, brightness and reflectance, shape from shading and photometric stereo, texture, binocular stereo, optical flow and motion, 2D and 3D object representation, object recognition, vision systems and applications

Fall 2026: COMS W4731

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4731	001/13667	T Th 10:10am - 11:25am 142 Uris Hall	Shree Nayar	3.00	89/80
COMS 4731	002/17955	T Th 11:40am - 12:55pm 142 Uris Hall	Shree Nayar	3.00	34/80

COMS W4732 Computer Vision II: Learning. *3.00 points*.

Prerequisites: COMS W4731; Fundamentals of calculus, linear algebra, and Python programming. Students without any of these prerequisites are advised to contact the instructor prior to taking the course.

Advanced course in computer vision. Topics include convolutional networks and back-propagation, object and action recognition, self-supervised and few-shot learning, image synthesis and generative models, object tracking, vision and language, vision and audio, 3D representations, interpretability, and bias, ethics, and media deception

Spring 2026: COMS W4732

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4732	001/12363	F 9:10am - 11:40am 451 Computer Science Bldg	Aleksander Holynski	3.00	100/110

COMS W4733 COMPUTATIONAL ASPECTS OF ROBOTICS. *3.00 points*.

CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3251 or MATH UN2010 or APMA E2101 or APMA E3101 or MATH UN2015) and (STAT GU4001 or IEOR E3658 or STAT UN1201 or MATH UN2015) Proficiency in Python or a similar programming language. Introduction to fundamental problems and algorithms in robotics. Topics include configuration spaces, motion and sensor models, search and sampling-based planning, state estimation, localization and mapping, perception, and learning.

Fall 2026: COMS W4733

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4733	001/13668	F 1:10pm - 3:40pm 614 Schermerhorn Hall	Tony Dear	3.00	123/120
COMS 4733	V01/19745		Tony Dear	3.00	7/99

COMS W4735 VISUAL INTERFACES TO COMPUTERS. *3.00 points*.

Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) COMS W3134 OR COMS W3136 OR COMS W3137

Visual input as data and for control of computer systems. Survey and analysis of architecture, algorithms, and underlying assumptions of commercial and research systems that recognize and interpret human gestures, analyze imagery such as fingerprint or iris patterns, generate natural language descriptions of medical or map imagery. Explores foundations in human psychophysics, cognitive science, and artificial intelligence

COMS W4762 Machine Learning for Functional Genomics. *3 points*.

Prerequisites: Proficiency in a high level programming language Python/R/Julia. An introductory machine learning class such as COMS W4771 Machine Learning will be helpful but is not required.

This course will introduce modern probabilistic machine learning methods using applications in data analysis tasks from functional genomics, where massively-parallel sequencing is used to measure the state of cells: e.g. what genes are being expressed, what regions of DNA ("chromatin") are active ("open") or bound by specific proteins.

COMS W4771 MACHINE LEARNING. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (MATH UN1201 or MATH UN1205 or APMA E2000) and (COMS W3251 or MATH UN2010 or MATH UN2015) and (STAT UN1201 or STAT GU4001 or IEOR E3658 or MATH UN2015) and COMS W3203 and COMS W3134 General mathematical maturity. COMS W3770 is recommended for students who wish to refresh their math background. Basic statistical principles and algorithmic paradigms of supervised machine learning. Prerequisites: Multivariable calculus (e.g. MATH1201 or MATH1205 or APMA2000), linear algebra (e.g. COMS3251 or MATH2010 or MATH2015), probability (e.g. STAT1201 or STAT4001 or IEOR3658 or MATH2015), discrete math (COMS3203), and general mathematical maturity. Programming and algorithm analysis (e.g. COMS 3134). COMS 3770 is recommended for students who wish to refresh their math background.

Spring 2026: COMS W4771

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4771	001/12364	M W 2:40pm - 3:55pm 451 Computer Science Bldg	Tony Dear	3.00	101/110
COMS 4771	002/12366	M W 4:10pm - 5:25pm 451 Computer Science Bldg	Tony Dear	3.00	85/110
COMS 4771	V02/20064		Tony Dear	3.00	9/99

Fall 2026: COMS W4771

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4771	001/13670	T Th 1:10pm - 2:25pm 451 Computer Science Bldg	Nakul Verma	3.00	0/110
COMS 4771	002/13671	T Th 2:40pm - 3:55pm 451 Computer Science Bldg	Nakul Verma	3.00	0/110
COMS 4771	003/19971	F 1:10pm - 3:40pm 601 Fairchild Life Sciences Bldg	Nakul Verma	3.00	0/75

COMS W4773 Machine Learning Theory. *3 points*.
Prerequisites: COMS W4771
Core topics from unsupervised learning such as clustering, dimensionality reduction and density estimation will be studied in detail. Topics in clustering: k-means clustering, hierarchical clustering, spectral clustering, clustering with various forms of feedback, good initialization techniques and convergence analysis of various clustering procedures. Topics in dimensionality reduction: linear techniques such as PCA, ICA, Factor Analysis, Random Projections, non-linear techniques such as LLE, IsoMap, Laplacian Eigenmaps, tSNE, and study of embeddings of general metric spaces, what sorts of theoretical guarantees can one provide about such techniques. Miscellaneous topics: design and analysis of data structures for fast Nearest Neighbor search such as Cover Trees and LSH. Algorithms will be implemented in either Matlab or Python.

COMS W4774 Unsupervised Learning. *3.00 points*.
Prerequisites: COMS W4771 Background in probability and statistics, linear algebra, and multivariate calculus. Ability to program in a high-level language, and familiarity with basic algorithm design and coding principles
Core topics from unsupervised learning such as clustering, dimensionality reduction and density estimation will be studied in detail. Topics in clustering: k-means clustering, hierarchical clustering, spectral clustering, clustering with various forms of feedback, good initialization techniques and convergence analysis of various clustering procedures. Topics in dimensionality reduction: linear techniques such as PCA, ICA, Factor Analysis, Random Projections, non-linear techniques such as LLE, IsoMap, Laplacian Eigenmaps, tSNE, and study of embeddings of general metric spaces, what sorts of theoretical guarantees can one provide about such techniques. Miscellaneous topics: design and analysis of datastructures for fast Nearest Neighbor search such as Cover Trees and LSH. Algorithms will be implemented in either Matlab or Python.

COMS W4775 Causal Inference. *3.00 points*.
Prerequisites: COMS W4771 Discrete Math, Calculus, Statistics basic probability, modeling, experimental design, Some programming experience
Causal Inference theory and applications. The theoretical topics include the 3-layer causal hierarchy, causal bayesian networks, structural learning, the identification problem and the do-calculus, linear identifiability, bounding, and counterfactual analysis. The applied part includes intersection with statistics, the empirical-data sciences (social and health), and AI and ML.

COMS W4901 Projects in Computer Science. *1-3 points*.
Prerequisites: Approval by a faculty member who agrees to supervise the work.
A second-level independent project involving laboratory work, computer programming, analytical investigation, or engineering design. May be repeated for credit, but not for a total of more than 3 points of degree credit. Consult the department for section assignment.

COMS W4995 TOPICS IN COMPUTER SCIENCE. *3.00 points*.
Lect: 3.

Selected topics in computer science. Content and prerequisites vary between sections and semesters. May be repeated for credit. Check “topics course” webpage on the department website for more information on each section

Spring 2026: COMS W4995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4995	001/12367	M W 8:40am - 9:55am 451 Computer Science Bldg	Timothy Roughgarden	3.00	56/60
COMS 4995	002/12368	T 1:10pm - 3:40pm 644 Seeley W. Mudd Building	Gary Zamchick	3.00	37/40
COMS 4995	003/12369	F 1:10pm - 3:40pm 644 Seeley W. Mudd Building	Gary Zamchick	3.00	38/40
COMS 4995	004/12370	M W 2:40pm - 3:55pm 209 Havemeyer Hall	Jae Lee	3.00	84/110
COMS 4995	005/12372	M W 5:40pm - 6:55pm 402 Chandler	Jae Lee	3.00	110/126
COMS 4995	006/12373	Th 4:10pm - 6:40pm 1024 Seeley W. Mudd Building	Christian Swinehart	3.00	35/40
COMS 4995	007/12374	M 7:00pm - 9:30pm 310 Fayerweather	Yongwhan Lim	3.00	78/90
COMS 4995	008/12375	F 12:10pm - 2:00pm 825 Seeley W. Mudd Building	Suman Jana	3.00	20/30
COMS 4995	009/12628	T Th 1:10pm - 2:25pm 415 Schapiro Cepser	Adam Block	3.00	23/40
COMS 4995	010/16839	T Th 5:40pm - 6:55pm 601b Fairchild Life Sciences Bldg	Zhuo Zhang	3.00	24/25
COMS 4995	011/20140	T Th 1:10pm - 2:25pm 451 Computer Science Bldg	Kenneth St. Claire	3.00	51/50
COMS 4995	012/20388	F 2:00pm - 5:00pm None None	Lydia Chilton	3.00	138/150
COMS 4995	030/11588	W 7:05pm - 9:35pm 209 Havemeyer Hall	Adam Kelleher	3.00	41/75
COMS 4995	031/11649	M 4:10pm - 6:40pm 310 Fayerweather	Spencer Luo	3.00	78/90
COMS 4995	032/12504	Th 7:00pm - 9:30pm 310 Fayerweather	Andrei Simion	3.00	84/90

Fall 2026: COMS W4995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4995	001/13735	M W 1:10pm - 2:25pm 451 Computer Science Bldg	Stephen Edwards	3.00	27/110
COMS 4995	002/13736	F 10:10am - 12:40pm 327 Seeley W. Mudd Building	Bjarne Stroustrup	3.00	34/36
COMS 4995	003/13737	T Th 8:40am - 9:55am 451 Computer Science Bldg	Daniel Rubenstein	3.00	7/30
COMS 4995	004/13738	F 10:10am - 12:40pm 451 Computer Science Bldg	Baishakhi Ray	3.00	0/40
COMS 4995	005/13739	T 4:10pm - 6:40pm 333 Uris Hall	Paul Blaer, Jason Cahill	3.00	1/50
COMS 4995	006/13740	T 1:10pm - 3:40pm 825 Seeley W. Mudd Building	Gary Zamchick	3.00	44/40
COMS 4995	007/13741	M 7:00pm - 9:30pm 451 Computer Science Bldg	Yongwhan Lim	3.00	12/90
COMS 4995	008/13742	F 8:40am - 11:40am 644 Seeley W. Mudd Building	Eugene Wu	3.00	0/15
COMS 4995	009/13743	F 1:10pm - 3:40pm 303 Uris Hall	Yu Gu	3.00	64/60
COMS 4995	010/13744	T Th 2:40pm - 3:55pm	Peter	3.00	79/113

COMS E6111 ADVANCED DATABASE SYSTEMS. *3.00 points*.
Lect: 2.

Prerequisites: (COMS W4111) and COMS W4111; Working knowledge of Python or instructor's permission.
Continuation of (COMS W4111), covers the latest trends in both database research and industry. Programming projects in Python are required

COMS E6113 Topics in Database Systems. *3 points*.
Lect: 2.

Prerequisites: (COMS W4111) COMS W4111
Concentration on some database paradigm, such as deductive, heterogeneous, or object-oriented, and/or some database issue, such as data modeling, distribution, query processing, semantics, or transaction management. A substantial project is typically required. May be repeated for credit with instructor's permission.

Fall 2026: COMS E6113

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6113	001/13748	F 10:10am - 12:00pm 227 Seeley W. Mudd Building	Kostis Kaffes	3	0/30

COMS E6118 OPERATING SYSTEMS, II. *3.00 points*.
Lect: 2.

Prerequisites: (COMS W4118) COMS W4118
Corequisites: COMS W4119
Continuation of *COMS W4118*, with emphasis on distributed operating systems. Topics include interfaces to network protocols, distributed run-time binding, advanced virtual memory issues, advanced means of interprocess communication, file system design, design for extensibility, security in a distributed environment. Investigation is deeper and more hands-on than in *COMS W4118*. A programming project is required.

COMS E6156 TOPICS IN SOFTWARE ENGINEERING. *3.00 points*.
Topics in Software engineering arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes, it may be repeated for credit with advisor approval. Consult the department for section assignment

Spring 2026: COMS E6156

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6156	001/12376	T Th 10:10am - 11:25am 337 Seeley W. Mudd Building	Gail Kaiser	3.00	23/20
COMS 6156	V01/16728	T Th 10:10am - 11:25am Online Only	Gail Kaiser	3.00	5/99

COMS E6173 Virtual Reality and Augmented Reality. *3.00 points*.
Prerequisites: You will ideally have taken COMS W4172 3D User Interfaces and Augmented Reality or equivalent and be comfortable with developing in Unity. However, I am willing to admit students who don’t have this background, with the understanding that you will need.
This course will cover selected topics in virtual reality (VR) and augmented reality (AR). There are two main components, with everyone participating in both: papers and projects

Fall 2026: COMS E6173

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6173	001/13749	W 2:10pm - 4:00pm 224 Pupin Laboratories	Steven Feiner	3.00	0/26

COMS E6178 Human-Computer Interaction. *3.00 points*.
Prerequisites: COMS W4170
Human–computer interaction (HCI) studies (1) what computers are used for, (2) how people interact with computers, and (3) how either of those should change in the future. Topics include ubiquitous computing, mobile health, interaction techniques, social computing, mixed reality, accessibility, and ethics. Activities include readings, presentations, and discussions of research papers. Substantial HCI research project required

Spring 2026: COMS E6178

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6178	001/12377	W 1:10pm - 3:40pm 1024 Seeley W. Mudd Building	Brian Smith	3.00	34/33
COMS 6178	V01/16789		Brian Smith	3.00	6/99

COMS E6184 ANONYMITY # PRIVACY. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W4261) or (COMS W4180) or (CSEE W4119) or COMS W4261 OR COMS W4180 OR CSEE W4119
This course will cover the following topics: Legal and social framework for privacy. Data mining and databases. Anonymous commerce and Internet usage. Traffic analysis. Policy and national security considerations. Classes are seminars with students presenting papers and discussing them. Seminar focus changes frequently to remain timely.

Spring 2026: COMS E6184

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6184	001/16799	F 12:10pm - 2:00pm 545 Seeley W. Mudd Building	Sebastian Zimmeck	3.00	18/40
COMS 6184	V01/19636	F 12:10pm - 2:00pm Online Only	Sebastian Zimmeck	3.00	4/99

COMS E6185 INTRUSION DETECTION SYSTEMS. *3.00 points*.
Lect: 2.

Prerequisites: COMS W4180
Corequisites: COMS W4180
Corequisite: COMS 4180W. The state of threats against computers, and networked systems. An overview of computer security solutions and why they fail. Provides a detailed treatment for Network and Host-based Intrusion Detection and Intrusion Prevention systems. Considerable depth is provided on anomaly detection systems to detect new attacks. Covers issues and problems in email (spam, and viruses) and insider attacks (masquerading and impersonation)

COMS E6232 ANALYSIS OF ALGORITHMS II. *3.00 points*.
Lect: 2.

Prerequisites: (CSOR W4231) CSOR W4231
Continuation of CSOR W4231

COMS E6261 ADVANCED CRYPTOGRAPHY. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W4261) COMS W4261
A study of advanced cryptographic research topics such as: secure computation, zero knowledge, privacy, anonymity, cryptographic protocols. Concentration on theoretical foundations, rigorous approach, and provable security. Contents varies between offerings. May be repeated for credit

Spring 2026: COMS E6261

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6261	001/12378	Th 2:10pm - 4:00pm 524 Seeley W. Mudd Building	Tal Malkin, Miranda Christ	3.00	10/40

COMS E6424 HARDWARE SECURITY. *3.00 points*.

Spring 2026: COMS E6424

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6424	001/12380	M W 10:10am - 11:25am 1024 Seeley W. Mudd Building	Simha Sethumadhavan	3.00	31/30

COMS E6732 COMPUTATIONAL IMAGING. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W4731) or COMS W4731; or instructor's permission.
Computational imaging uses a combination of novel imaging optics and a computational module to produce new forms of visual information. Survey of the state-of-the-art in computational imaging. Review of recent papers on omnidirectional and panoramic imaging, catadioptric imaging, high dynamic range imaging, mosaicing and superresolution. Classes are seminars with the instructor, guest speakers, and students presenting papers and discussing them

Spring 2026: COMS E6732

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6732	001/12382	M 4:10pm - 6:00pm 453 Computer Science Bldg	Shree Nayar	3.00	10/20

COMS E6735 VISUAL DATABASES. *3.00 points*.
Lect: 3.

Prerequisites: COMS W4731 and COMS W4735 helpful but not required. Contact instructor if uncertain.
The analysis and retrieval of large collections of image and video data, with emphasis on visual semantics, human psychology, and user interfaces. Low-level processing: features and similarity measures; shot detection; key frame selection; machine learning methods for classification. Middle- level processing: organizational rules for videos, including unedited (home, educational), semiedited (sports, talk shows), edited (news, drama); human memory limits; progressive refinement; visualization techniques; incorporation of audio and text. Highlevel processing: extraction of thematic structures; ontologies, semantic filters, and learning; personalization of summaries and interfaces; detection of pacing and emotions. Examples and demonstrations from commercial and research systems throughout. Substantial course project or term paper required.

COMS E6900 TUTORIAL IN COMPUTER SCIENCE. *1.00-3.00 points*.
Prerequisites: Instructor's permission.
A reading course in an advanced topic for a small number of students, under faculty supervision

Fall 2026: COMS E6900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6900	052/13753		Timothy Roughgarden	1.00-3.00	0/10

COMS E6901 PROJECTS IN COMPUTER SCIENCE. *1.00-12.00 points*.
Prerequisites: Instructor's permission.
Software or hardware projects in computer science. Before registering, the student must submit a written proposal to the instructor for review. The proposal should give a brief outline of the project, estimated schedule of completion, and computer resources needed. Oral and written reports are required. May be taken over more than one semester, in which case the grade will be deferred until all 12 points have been completed. No more than 12 points of COMS E6901 may be taken. Consult the department for section assignment

Summer 2026: COMS E6901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6901	062/12868		Nakul Verma	1.00-12.00	3/15

COMS E6902 THESIS. *1.00-9.00 points*.
Available to M.S. and CSE candidates. An independent investigation of an appropriate problem in computer science carried out under the supervision of a faculty member. A formal written report is essential and an oral presentation may also be required. May be taken over more than one semester, in which case the grade will be deferred until all 9 points have been completed. No more than 9 points of COMS E6902 may be taken. Consult the department for section assignment

COMS E6910 FIELDWORK. *1.00 point*.
Prerequisites: Obtained internship and approval from faculty adviser. Only for M.S. in the Computer Science Department who need relevant work experience as part of their program of study.
Final report required. This course may not be taken for pass/fail credit or audited

COMS E6915 TECH WRITING FOR CS AND ENGINRS. *3.00 points*.
Prerequisites: Available to M.S. and Ph.D candidates in CS/CE and EE. Topics to help CS/CE and EE graduate students' communication skills. Emphasis on writing, presenting clear, concise proposals, journal articles, conference papers, theses, and technical presentations. Credit may not be used to satisfy degree requirements

COMS E6998 TOPICS IN COMPUTER SCIENCE. *3.00 points*.
Selected topics in computer science (advanced level). Content and prerequisites vary between sections and semesters. May be repeated for credit. Check "topics course" webpage on the department website for more information on each section.

Spring 2026: COMS E6998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6998	001/12384	M 4:10pm - 6:00pm 306 Uris Hall	Silvia Sellan	3.00	21/20
COMS 6998	002/12385	F 12:10pm - 2:00pm 829 Seeley W. Mudd Building	Vasileios Kalantzis	3.00	25/40
COMS 6998	003/12386	M 7:00pm - 9:30pm 614 Schermerhorn Hall	Kaoutar El Maghraoui	3.00	120/120
COMS 6998	004/12387	Th 4:10pm - 6:40pm 825 Seeley W. Mudd Building	IHsin Chung, Seetharami Seelam	3.00	43/44
COMS 6998	005/12388	T 2:10pm - 4:00pm 627 Seeley W. Mudd Building	Josh Alman	3.00	15/40
COMS 6998	006/12389	F 10:10am - 12:00pm 415 Schapiro Cepser	Henry Yuen	3.00	24/40
COMS 6998	007/12390	F 10:10am - 12:00pm 644 Seeley W. Mudd Building	Martha Kim	3.00	14/20
COMS 6998	008/12391	F 10:10am - 12:00pm 627 Seeley W. Mudd Building	Yunzhu Li	3.00	45/50
COMS 6998	009/12392	W 1:10pm - 3:55pm 337 Seeley W. Mudd Building	Toniann Pitassi	3.00	5/20
COMS 6998	010/12567	W 2:10pm - 4:00pm 333 Uris Hall	Richard Zemel	3.00	46/50
COMS 6998	V03/16790		Kaoutar El Maghraoui	3.00	14/99

Fall 2026: COMS E6998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 6998	001/13905	Th 2:10pm - 4:00pm 327 Seeley W. Mudd Building	Bjarne Stroustrup	3.00	12/36
COMS 6998	002/13906	W 8:10pm - 10:00pm 451 Computer Science Bldg	Yongwhan Lim, Josh Alman	3.00	5/50
COMS 6998	003/13907	Th 2:10pm - 4:00pm 227 Seeley W. Mudd Building	Jason Nieh	3.00	31/30
COMS 6998	004/13908	W 2:10pm - 4:00pm 825 Seeley W. Mudd Building	Richard Zemel	3.00	0/40
COMS 6998	005/13909	F 12:10pm - 2:00pm 644 Seeley W. Mudd Building	Xia Zhou	3.00	21/30
COMS 6998	006/13910	M 7:00pm - 9:30pm 833 Seeley W. Mudd Building	Kaoutar El Maghraoui	3.00	132/120
COMS 6998	007/13911	F 4:10pm - 6:00pm 451 Computer Science Bldg	Parijat Dube, Chen Wang	3.00	87/110
COMS 6998	008/13912	M 4:10pm - 6:00pm 1127 Seeley W. Mudd Building	Kaoutar El Maghraoui, Antoni Viros i Martin	3.00	44/40
COMS 6998	009/13913	T 12:10pm - 2:00pm 253 Engineering Terrace	Suman Jana	3.00	10/25
COMS 6998	010/13914	M W 2:40pm - 3:55pm 313 Fayerweather	Alexandr Andoni	3.00	39/78
COMS 6998	011/13915	M 4:10pm - 6:00pm 332 Uris Hall	Lydia Chilton	3.00	0/54
COMS 6998	012/13916	T 4:10pm - 6:00pm 829 Seeley W. Mudd Building	Christos Papadimitriou	3.00	0/40
COMS 6998	013/13917	F 8:10am - 10:00am 253 Engineering Terrace	Aleksander Holynski	3.00	10/25
COMS 6998	014/19577	M 7:10pm - 9:00pm	Behrang	3.00	2/56

COMS E9800 DIRECTED RESEARCH IN COMP SCI. *1.00-15.00 points*.
Prerequisites: Submission of an outline of the proposed research for approval by the faculty member who will supervise. The department must approve the number of points.
May be repeated for credit. This course is only for Eng.Sc.D. candidates

COMS E9902 SEMINAR IN COMPUTER SCIENCE. *3.00 points*.

Spring 2026: COMS E9902

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 9902	001/12393	T 2:40pm - 3:55pm 337 Seeley W. Mudd Building	Eugene Wu, Kostis Kaffes	3.00	25/25

Fall 2026: COMS E9902

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 9902	001/15324	T 2:40pm - 3:55pm 337 Seeley W. Mudd Building	John Hewitt, Silvia Sellan	3.00	23/25

COMS E9910 GRADUATE RESEARCH I. *1.00-6.00 points*.
Prerequisites: Submission of an outline of the proposed research for approval by the faculty member who will supervise. The department must approve the number of credits.
May be repeated for credit. This course is only for M.S. candidates holding GRA or TA appointments. Note: It is NOT required that a student take Graduate Research I prior to taking Graduate Research II. Consult the department for section assignment

COMS E9911 GRADUATE RESEARCH II. *1.00-15.00 points*.
Prerequisites: Submission of an outline of the proposed research for approval by the faculty member who will supervise.
The department must approve the number of points. May be repeated for credit. This course is only for M.S./Ph.D. and Ph.D. students. Note: It is NOT required that a student take Graduate Research, I prior to taking Graduate Research, II. Consult the department for section assignment

CSBS W3761 Lab in Computational Biology. *3.00 points*.
Prerequisites: (COMS W1002 and BIOL C2005) or (COMS W1004 and BIOL C2005) or (ENGI E1006 and BIOL C2005)
Hands-on experience addressing real-world biological questions through computational approaches. Biological data analysis for genomic, transcriptomic, and metagenomic data, using bioinformatics tools and pipelines for problems such as for sequence alignment, variant calling, and RNA-seq analysis. Topics include data processing, public database usage, genome assembly, metagenomic classification, and ethical considerations in genomics.

Fall 2026: CSBS W3761

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSBS 3761	001/14466	T Th 5:40pm - 6:55pm 233 Seeley W. Mudd Building	Itsik Pe'er	3.00	5/20

CSEE W3827 FUNDAMENTALS OF COMPUTER SYSTS. *3.00 points*.
Lect: 3.

Prerequisites: An introductory programming course.
Fundamentals of computer organization and digital logic. Boolean algebra, Karnaugh maps, basic gates and components, flipflops and latches, counters and state machines, basics of combinational and sequential digital design. Assembly language, instruction sets, ALU's, single-cycle and multi-cycle processor design, introduction to pipelined processors, caches, and virtual memory.

Spring 2026: CSEE W3827

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 3827	001/12394	T Th 10:10am - 11:25am 451 Computer Science Bldg	Daniel Rubenstein	3.00	119/110
CSEE 3827	002/12395	T Th 11:40am - 12:55pm 451 Computer Science Bldg	Daniel Rubenstein	3.00	122/110

Fall 2026: CSEE W3827

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 3827	001/14002	M W 1:10pm - 2:25pm Cin Alfred Lerner Hall	Martha Kim	3.00	300/300

CSEE W4119 COMPUTER NETWORKS. *3.00 points*.
Prerequisites: Comfort with basic probability. Programming fluency in Python, C++, Java, or Ruby please see section course page for specific language requirements.
Introduction to computer networks and the technical foundations of the Internet, including applications, protocols, local area networks, algorithms for routing and congestion control, security, elementary performance evaluation. Several written and programming assignments required

Spring 2026: CSEE W4119

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4119	001/12396	T Th 11:40am - 12:55pm 614 Schermerhorn Hall	Xia Zhou	3.00	135/140
CSEE 4119	V01/16651		Xia Zhou	3.00	10/99

Fall 2026: CSEE W4119

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4119	001/14072	M W 4:10pm - 5:25pm 451 Computer Science Bldg	Henning Schulzrinne	3.00	88/110
CSEE 4119	V01/18098		Henning Schulzrinne	3.00	7/99

CSEE W4121 COMPUTER SYSTEMS FOR DATA SCIENCE. *3.00 points*.
Prerequisites: Background in Computer System Organization and good working knowledge of C/C++. CSOR W4246 Algorithms for Data Science, STAT W4203 Probability Theory, or equivalent as approved by faculty advisor.
An introduction to computer architecture and distributed systems with an emphasis on warehouse scale computing systems. Topics will include fundamental tradeoffs in computer systems, hardware and software techniques for exploiting instruction-level parallelism, data-level parallelism and task level parallelism, scheduling, caching, prefetching, network and memory architecture, latency and throughput optimizations, specialization, and an introduction to programming data center computers

Spring 2026: CSEE W4121

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4121	001/16119	W 4:10pm - 6:40pm 301 Pupin Laboratories	Waqar Aqeel	3.00	192/200

CSEE W4823 Advanced Logic Design. *3 points*.
Lect: 3.

Prerequisites: (CSEE W3827) or CSEE W3827; Or a half semester introduction to digital logic, or the equivalent.
An introduction to modern digital system design. Advanced topics in digital logic: controller synthesis (Mealy and Moore machines); adders and multipliers; structured logic blocks (PLDs, PALs, ROMs); iterative circuits. Modern design methodology: register transfer level modelling (RTL); algorithmic state machines (ASMs); introduction to hardware description languages (VHDL or Verilog); system-level modelling and simulation; design examples.

Fall 2026: CSEE W4823

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4823	001/11345	T Th 1:10pm - 2:25pm 207 Mathematics Building	Mingoo Seok	3	116/120

CSEE W4824 COMPUTER ARCHITECTURE. *3.00 points*.
Lect: 3.

Prerequisites: (CSEE W3827) or CSEE W3827
Focuses on advanced topics in computer architecture, illustrated by case studies from classic and modern processors. Fundamentals of quantitative analysis. Pipelining. Memory hierarchy design. Instruction-level and thread-level parallelism. Data-level parallelism and graphics processing units. Multiprocessors. Cache coherence. Interconnection networks. Multi-core processors and systems-on-chip. Platform architectures for embedded, mobile, and cloud computing

Fall 2026: CSEE W4824

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4824	001/14003	M W 10:10am - 11:25am 451 Computer Science Bldg	Simha Sethumadhavan	3.00	0/110

CSEE W4840 EMBEDDED SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (CSEE W4823) CSEE W4823
Embedded system design and implementation combining hardware and software. I/O, interfacing, and peripherals. Weekly laboratory sessions and term project on design of a microprocessor-based embedded system including at least one custom peripheral. Knowledge of C programming and digital logic required

Spring 2026: CSEE W4840

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4840	001/12397	M W 1:10pm - 2:25pm 451 Computer Science Bldg	Stephen Edwards	3.00	100/110

CSEE W4868 SYSTEM-ON-CHIP PLATFORMS. *3.00 points*.
Prerequisites: (COMS W3157) and (CSEE W3827) COMS W3157 AND CSEE W3827
Design and programming of System-on-Chip (SoC) platforms. Topics include: overview of technology and economic trends, methodologies and supporting CAD tools for system-level design, models of computation, the SystemC language, transaction-level modeling, software simulation and virtual platforms, hardware-software partitioning, high-level synthesis, system programming and device drivers, on-chip communication, memory organization, power management and optimization, integration of programmable processor cores and specialized accelerators. Case studies of modern SoC platforms for various classes of applications

Fall 2026: CSEE W4868

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4868	001/14004	T Th 11:40am - 12:55pm 451 Computer Science Bldg	Luca Carloni	3.00	60/60

CSEE W6180 MODELING # PERFORMANCE EVALUATION. *3.00 points*.
Prerequisites: STAT W4001 AND COMS W4118
Introduction to queuing analysis and simulation techniques. Evaluation of time-sharing and multiprocessor systems. Topics include priority queuing, buffer storage, and disk access, interference and bus contention problems, and modeling of program behaviors

Fall 2026: CSEE W6180

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6180	001/14005	W 4:10pm - 6:00pm 227 Seeley W. Mudd Building	Vishal Misra	3.00	53/48

CSEE E6863 FORMAL VERIF HW SW SYSTEMS. *3.00 points*.
Lect: 2.

Prerequisites: (COMS W3261 and COMS W3137) or (COMS W3134 and COMS W3136)
Introduction to the theory and practice of formal methods for the design and analysis of correct (i.e. bug-free) concurrent and embedded hardware/software systems. Topics include temporal logics; model checking; deadlock and liveness issues; fairness; satisfiability (SAT) checkers; binary decision diagrams (BDDs); abstraction techniques; introduction to commercial formal verification tools. Industrial state-of-art, case studies and experiences: software analysis (C/C /Java), hardware verification (RTL).

Fall 2026: CSEE E6863

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6863	001/14006	M 6:10pm - 8:00pm 329 Pupin Laboratories	Michael Theobald, Franjo Ivancic	3.00	86/80

CSEE E6868 EMBEDDED SCALABLE PLATFORMS. *3.00 points*.
Lect: 2.

Prerequisites: (CSEE W4868) or CSEE W4868; Or instructor's permission
Inter-disciplinary graduate-level seminar on design and programming of embedded scalable platforms. Content varies between offerings to cover timely relevant issues and latest advances in system-on-chip design, embedded software programming, and electronic design automation. Requires substantial reading of research papers, class participation, and semester-long project

Spring 2026: CSEE E6868

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6868	001/12398	W 6:10pm - 8:00pm 451 Computer Science Bldg	Luca Carloni	3.00	28/30

CSEE E6915 Academic Writing and Great Presentations. *3.00 points*.
Prerequisites: For CS and EE Ph.D. students.
Principles of writing clear and rigorous science texts and giving great presentations. The Writing component focuses on the construction of logical arguments, reporting and interpretation of data, composing process, and strategies for redrafting and editing. Genres include Introductions, Data Commentaries, Results/Discussion, Conclusions, Abstracts, Requests for funding, Research statements, Professional emails, Blogs. The Presentation component looks at development of the presentation story, use of visuals, fluent delivery, asking and responding to questions. Speaking contexts include research talks, lab talks, conference presentations, poster talks, job talks, interviews, industry pitches. Pass/No Pass only, based on completion of assignments and participation in class exercises. Credit may not be used to satisfy degree requirements.

Spring 2026: CSEE E6915

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6915	001/16627	F 10:00am - 12:00pm 414 Pupin Laboratories	Janet Kayfetz	3.00	9/25

Fall 2026: CSEE E6915

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6915	001/15474	F 10:00am - 12:00pm 337 Seeley W. Mudd Building	Janet Kayfetz	3.00	5/25

CSOR W4223 Networks, Crowds, and the Web. *3.00 points*.
Prerequisites: The class assumes students are familiar with elementary concepts of probability (any class that includes probability suffices), and took one class of data structures or has experience programming with data.
Introduction of fundamental ideas and algorithms on networks of information collected by online services. Properties pervasive in large networks, dynamics of individuals that lead to large collective phenomena, mechanisms underlying the web economy, and results and tools informing societal impact of algorithms on privacy, polarization and discrimination covered.

Fall 2026: CSOR W4223

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSOR 4223	001/14007	T Th 10:10am - 11:25am 633 Seeley W. Mudd Building	Augustin Chaintreau	3.00	64/70
CSOR 4223	V01/18099		Augustin Chaintreau	3.00	12/99

CSOR W4231 ANALYSIS OF ALGORITHMS I. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136COMS W3137) and (COMS W3203)
Introduction to the design and analysis of efficient algorithms. Topics include models of computation, efficient sorting and searching, algorithms for algebraic problems, graph algorithms, dynamic programming, probabilistic methods, approximation algorithms, and NP-completeness.

Spring 2026: CSOR W4231

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSOR 4231	001/12399	F 10:10am - 12:40pm 614 Schermerhorn Hall	Eleni Drinea	3.00	60/120
CSOR 4231	002/12400	M W 1:10pm - 2:25pm 501 Northwest Corner	Alexandr Andoni, Stepan Zharkov	3.00	129/160
CSOR 4231	V01/18235		Eleni Drinea	3.00	14/99

Fall 2026: CSOR W4231

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSOR 4231	001/14008	M W 8:40am - 9:55am 614 Schermerhorn Hall	Xi Chen	3.00	108/120
CSOR 4231	002/14009	M W 2:40pm - 3:55pm 451 Computer Science Bldg	Mihalis Yannakakis	3.00	102/110
CSOR 4231	V01/18100		Xi Chen	3.00	6/99

CSOR W4246 ALGORITHMS FOR DATA SCIENCE. *3.00 points*.
Prerequisites: COMS W1007 Basic knowledge in programming (e.g. at the level of COMS W1007), a basic grounding in calculus and linear algebra.
Corequisites: COMS W4121
Methods for organizing data, e.g. hashing, trees, queues, lists,priority queues. Streaming algorithms for computing statistics on the data. Sorting and searching. Basic graph models and algorithms for searching, shortest paths, and matching. Dynamic programming. Linear and convex programming. Floating point arithmetic, stability of numerical algorithms, Eigenvalues, singular values, PCA, gradient descent, stochastic gradient descent, and block coordinate descent. Conjugate gradient, Newton and quasi-Newton methods. Large scale applications from signal processing, collaborative filtering, recommendations systems, etc.

Fall 2026: CSOR W4246

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSOR 4246	001/12497	T Th 11:40am - 12:55pm 833 Seeley W. Mudd Building	Eleni Drinea	3.00	86/120
CSOR 4246	002/12498	T Th 1:10pm - 2:25pm 833 Seeley W. Mudd Building	Eleni Drinea	3.00	130/120
CSOR 4246	V01/18101		Eleni Drinea	3.00	0/99

ECBM E4040 NEURAL NETWRKS # DEEP LEARNING. *3.00 points*.
Lect: 3.

Prerequisites: (BMEB W4020) or (BMEE E4030) or (ECBM E4090) or (EECS E4750) or (COMS W4771) or BMEB W4020 OR BMEE E4030 OR ECBM E4090 OR EECS E4750 OR COMS W4771; or equivalent.
Developing features - internal representations of the world, artificial neural networks, classifying handwritten digits with logistics regression, feedforward deep networks, back propagation in multilayer perceptrons, regularization of deep or distributed models, optimization for training deep models, convolutional neural networks, recurrent and recursive neural networks, deep learning in speech and object recognition

Fall 2026: ECBM E4040

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4040	001/11220		Zoran Kostic	3.00	109/152

ECBM E4060 INTRO-GENOMIC INFO SCI # TECH. *3.00 points*.
Lect: 3.

Introduction to computational biology with emphasis on genomic data science tools and methodologies for analyzing data, such as genomic sequences, gene expression measurements and the presence of mutations. Applications of machine learning and exploratory data analysis for predicting drug response and disease progression. Latest technologies related to genomic information, such as single-cell sequencing and CRISPR, and the contributions of genomic data science to the drug development process

Fall 2026: ECBM E4060

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4060	001/11270	M 7:00pm - 9:30pm 717 Hamilton Hall	Tai-Hsien Ou Yang	3.00	21/80

ECBM E4070 Computing with Brain Circuits of Model Organisms. *3.00 points*.
Prerequisites: BIOL W3004 AND ELEN E3801; and Python programming experience, or instructor's permission.
Building the functional map of the fruit fly brain. Molecular transduction and spatio-temporal encoding in the early visual system. Predictive coding in the Drosophila retina. Canonical circuits in motion detection. Canonical navigation circuits in the central complex. Molecular transduction and combinatorial encoding in the early olfactory system. Predictive coding in the antennal lobe. The functional role of the mushroom body and the lateral horn. Canonical circuits for associative learning and innate memory. Projects in Python

Spring 2026: ECBM E4070

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4070	001/11503	M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building	Aurel Lazar	3.00	16/50
ECBM 4070	V01/16652		Aurel Lazar	3.00	1/99

ECBM E4090 BRAIN COMPUTER INTERFACES LAB. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (ELEN E3801) ELEN E3801
Hands-on experience with basic neural interface technologies. Recording EEG (electroencephalogram) signals using data acquisition systems (non-invasive, scalp recordings). Real-time analysis and monitoring of brain responses. Analysis of intention and perception of external visual and audio signals

ECBM E6070 TPC NEUROSCI # DEEP LEARN. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in neuroscience and deep learning. Content varies from year to year, and different topics rotate through the course numbers 6070 to 6079.

Spring 2026: ECBM E6070

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 6070	001/11516	M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building	Aurel Lazar	3.00	10/50
ECBM 6070	V01/16655		Aurel Lazar	3.00	1/99

EEBM E6090 TPCS:COMPUT NEUROSCI/NEUROENGI. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099

EEBM E6099 TPCS:COMPUT NEUROSCI/NEUROENGI. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neurscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099

EECS E4321 DIGITAL VLSI CIRCUITS. *3.00 points*.
Lect: 3.

Prerequisites: Recommended preparation: ELEN E3106, ELEN E3331, and CSEE W3827.
Design and analysis of high speed logic and memory. Digital CMOS and BiCMOS device modeling. Integrated circuit fabrication and layout. Interconnect and parasitic elements. Static and dynamic techniques. Worst-case design. Heat removal and I/O. Yield and circuit reliability. Logic gates, pass logic, latches, PLAs, ROMs, RAMs, receivers, drivers, repeaters, sense amplifiers

Fall 2026: EECS E4321

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 4321	001/11272	T Th 2:40pm - 3:55pm Cin Alfred Lerner Hall	Kenneth Shepard	3.00	136/150

EECS E4750 Heterogeneous Computing for Signal and Data Processing. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (ELEN E3801) and (COMS W3134) or ELEN E3801 AND COMS W3134
Methods for deploying signal and data processing algorithms on contemporary general purpose graphics processing units (GPGPUs) and heterogeneous computing infrastructures. Using programming languages such as OpenCL and CUDA for computational speedup in audio, image and video processing and computational data analysis. Significant design project

Fall 2026: EECS E4750

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 4750	001/11276	Th 1:10pm - 3:40pm 627 Seeley W. Mudd Building	Zoran Kostic	3.00	54/50

EECS E4764 Artificial Intelligence of Things (AIoT). *3.00 points*.
Prerequisites: Knowledge of programming or instructor's permission. Suggested preparation: ELEN E4703, CSEE W4119, CSEE W4840, or related courses.
Artificial Intelligence of Things (AIoT), Internet of Things (IoT), and Cyber-Physical Systems (CPS). Embedded and mobile platforms. Embedded programming. Sensors, actuators, and interfaces. Wireless networking, web services, and databases. Edge and cloud computing. Large language models (LLMs) for AIoT. Time-series data visualization and analytics. Group projects to build end-to-end AIoT systems and applications

Fall 2026: EECS E4764

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 4764	001/11277	M W 2:40pm - 3:55pm 329 Pupin Laboratories	Xiaofan Jiang	3.00	110/100

EECS E6321 Advanced digital electronic circuits. *4.5 points*.
Lect: 3.

Prerequisites: (EECS E4321) EECS E4321
Advanced topics in the design of digital integrated circuits. Clocked and non-clocked combinational logic styles. Timing circuits: latches and flip-flops, phase-locked loops, delay-locked loops. SRAM and DRAM memory circuits. Modeling and analysis of on-chip interconnect. Power distribution and power-supply noise. Clocking, timing, and synchronization issues. Circuits for chip-to-chip electrical communication. Advanced technology issues that affect circuit design. The class may include a team circuit design project.

Spring 2026: EECS E6321

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6321	001/11561	T Th 2:40pm - 3:55pm 717 Hamilton Hall	Mingoo Seok	4.5	54/80

EECS E6690 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699.

Fall 2026: EECS E6690

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6690	001/15468	T 4:10pm - 6:40pm 1127 Seeley W. Mudd Building	Predrag Jelenkovic	3.00	3/60
EECS 6690	V01/18104		Predrag Jelenkovic	3.00	4/99

EECS E6691 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Spring 2026: EECS E6691

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6691	001/11527	W 10:10am - 12:40pm 627 Seeley W. Mudd Building	Zoran Kostic	3.00	18/50

EECS E6692 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

EECS E6693 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Fall 2026: EECS E6693

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6693	001/11295	M 4:10pm - 6:40pm 603 Hamilton Hall	Matthew Ziegler	3.00	49/54

EECS E6694 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Fall 2026: EECS E6694

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6694	001/11299	M W 10:10am - 11:25am 415 Schapiro Cepser	Micah Goldblum	3.00	43/40

EECS E6699 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Spring 2026: EECS E6699

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6699	001/16609	M 4:10pm - 6:40pm 614 Schermerhorn Hall	Predrag Jelenkovic	3.00	118/115

EECS E6720 BAYESIAN MOD MACHINE LEARNING. *3.00 points*.
Lect: 3.

Prerequisites: Basic calculus, linear algebra, probability, and programming.
Basic statistics and machine learning strongly recommended. Bayesian approaches to machine learning. Topics include mixed-membership models, latent factor models, Bayesian nonparametric methods, probit classification, hidden Markov models, Gaussian mixture models, model learning with mean-field variational inference, scalable inference for Big Data. Applications include image processing, topic modeling, collaborative filtering and recommendation systems

Spring 2026: EECS E6720

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6720	001/11563	W 4:10pm - 6:40pm 627 Seeley W. Mudd Building	John Paisley	3.00	32/50

EECS E6890 Topics in information processing. *3 points*.
Lect.: 2.

Advanced topics spanning Electrical Engineering and Computer Science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899.

Spring 2026: EECS E6890

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6890	001/11742	Th 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Zhaoyou Wang	3	11/30

EECS E6891 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

EECS E6892 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

Spring 2026: EECS E6892

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6892	001/11535	Th 10:10am - 12:40pm 141 Uris Hall	Javad Ghaderi	3.00	62/65
EECS 6892	V01/17138		Javad Ghaderi	3.00	4/5

EECS E6893 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899. Topic: Big Data Analytics

Fall 2026: EECS E6893

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6893	001/11313	F 7:00pm - 9:30pm 833 Seeley W. Mudd Building	Ching-yung Lin	3.00	82/150

EECS E6894 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

Fall 2026: EECS E6894

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6894	001/11314	M W 8:40am - 9:55am 141 Uris Hall	Tanvir Ahmed Khan	3.00	45/60

EECS E6895 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning Electrical Engineering and Computer Science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899. Topic: Advanced Big Data Analytics

Spring 2026: EECS E6895

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6895	001/11536	T 7:00pm - 9:30pm 501 Northwest Corner	Ching-yung Lin	3.00	73/80
EECS 6895	V01/16732		Ching-yung Lin	3.00	11/99

EECS E6896 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899. Topic: Quantum Computing and Communication

Fall 2026: EECS E6896

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6896	001/11315	M 4:10pm - 6:40pm 214 Pupin Laboratories	Alexei Ashikhmin	3.00	10/55

EECS E6897 Topics in Information Processing. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

EECS E6898 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

EECS E9601 Seminar in Data-Driven Analysis and Computation. *3.00 points*.
Lect.: 2.

Prerequisites: Open to doctoral candidates and qualified M.S. candidates with the instructor's permission.
Advanced topics and recent developments in mathematical techniques and computational tools for data science and engineering problems.

ENGI E1006 INTRO TO COMP FOR ENG/APP SCI. *3.00 points*.
An interdisciplinary course in computing intended for first year SEAS students. Introduces computational thinking, algorithmic problem solving and Python programming with applications in science and engineering. Assumes no prior programming background

Spring 2026: ENGI E1006

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 1006	001/12401	M W 2:40pm - 3:55pm 309 Havemeyer Hall	Daniel Bauer, Maxwell Levatich	3.00	205/200

Fall 2026: ENGI E1006

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 1006	001/14010	T Th 1:10pm - 2:25pm Cin Alfred Lerner Hall	Christian Murphy	3.00	111/250

ENGI E4300 Design Justice: Human-Centered Design and Social Justice. *3.00 points*.
Prerequisites: IEME E4200 or COMS W4170 Or instructor's permission.
Introduction to Human-Centered Design and Innovation. Unpack the role of design in the market economy for an individual consumer, for a designer/developer and for an enterprise or other organization. Consider how designing in good faith for most can lead to injustice for some. Examine how - to use the PROP framework of the Columbia School of Social Work[1] - power, race, oppression, and privilege can be executed through the design process. Equip students with tools to engage in the design process and to facilitate the engagement of others. Explore strategies for guiding design and innovation towards more just solutions. [1] https://socialwork.columbia.edu/about/dei/dei-mission-statement/

MECS E4510 EVOLUTIONARY COMPUTATION#DESIGN AUTOMATI. *3.00 points*.
Prerequisites: Basic programming experience in any language.
Fundamental and advanced topics in evolutionary algorithms and their application to open-ended optimization and computational design. Covers genetic algorithms, genetic programming, and evolutionary strategies, as well as governing dynamic of coevolution and symbiosis. Includes discussions of problem representations and applications to design problems in a variety of domains including software, electronics, and mechanics

MECS E4603 APPLIED ROBOTICS: ALGORITHMS#SOFTWARE. *3.00 points*.

MECS E6616 ROBOT LEARNING. *3.00 points*.
Prerequisites: (MECE E4602) and (MECS E4603) or (COMS W4733) MECE E4602 OR MECS E4603 OR COMS W4733
Robots using machine learning to achieve high performance in unscripted situations. Dimensionality reduction, classification, and regression problems in robotics. Deep Learning: Convolutional Neural Networks for robot vision, Recurrent Neural Networks, and sensorimotor robot control using neural networks. Model Predictive Control using learned dynamics models for legged robots and manipulators. Reinforcement Learning in robotics: model-based and model-free methods, deep reinforcement learning, sensorimotor control using reinforcement learning

Spring 2026: MECS E6616

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECS 6616	001/12169	M W 10:10am - 11:25am 203 Mathematics Building	Matei Ciocarlie	3.00	68/90

ORCA E2500 FOUNDATIONS OF DATA SCIENCE. *3.00 points*.
Prerequisites: MATH UN1101 and MATH UN1102 MATH V1101 AND MATH V1102; Some familiarity with programming.
Designed to provide an introduction to data science for sophomore SEAS majors. Combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? Teaches critical concepts and skills in computer programming, statistical inference, and machine learning, in conjunction with hands-on analysis of real-world datasets such as economic data, document collections, geographical data, and social networks. At least one project will address a problem relevant to New York City

Spring 2026: ORCA E2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCA 2500	001/13321	F 10:10am - 12:40pm 329 Pupin Laboratories	Daniel Fernandez	3.00	69/75

Fall 2026: ORCA E2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCA 2500	001/14744	F 10:10am - 12:40pm 833 Seeley W. Mudd Building	Daniel Fernandez	3.00	73/90

ORCA E4500 FOUNDATIONS OF DATA SCIENCE. *3.00 points*.
Prerequisites: MATH V1101 AND MATH V1102; Some familiarity with programming
Designed to provide an introduction to data science for sophomore SEAS majors. Combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? Teaches critical concepts and skills in computer programming, statistical inference, and machine learning, in conjunction with hands-on analysis of real-world datasets such as economic data, document collections, geographical data, and social networks

ORCS E4200 Data-driven Decision Modeling. *3.00 points*.
Introduction to modeling, estimating, and solving decision-making problems in the context of artificial intelligence and analytics. Potential topics include choice models, quantity models, online learning using multi-armed bandits, dynamic decision modeling, dynamic games, and Bayesian learning theory. Practice both theory and applications using Python programming

Fall 2026: ORCS E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4200	001/14745	T Th 4:10pm - 5:25pm 303 Seeley W. Mudd Building	Lily Xu	3.00	75/75

ORCS E4201 Policy for Privacy Technologies. *3.00 points*.
Introduction to privacy technologies, their use in practice, and privacy regulations. Potential topics include anonymization, differential privacy, cryptography, secure multi-party computation, and legislation. Course material will be abased in real-world use cases of these tools

Spring 2026: ORCS E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4201	001/17127	T Th 11:40am - 12:55pm 633 Seeley W. Mudd Building	Rachel Cummings	3.00	32/30

Fall 2026: ORCS E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4201	001/14879	M W 4:10pm - 5:25pm Cin Alfred Lerner Hall	Rachel Cummings	3.00	25/40

ORCS E4529 Reinforcement Learning. *3.00 points*.
Prerequisites: Probability and statistics, basic optimization e.g., familiarity with linear and convex optimization, gradient descent, basic algorithm design constructs, familiarity with programming in python. Markov Decision Processes (MDP) and Reinforcement Learning (RL) problems. Reinforcement Learning algorithms including Q-learning, policy gradient methods, actor-critic method. Reinforcement learning while doing exploration-exploitation dilemma, multi-armed bandit problem. Monte Carlo Tree Search methods, Distributional, Multi-agent, and Causal Reinforcement Learning

Fall 2026: ORCS E4529

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4529	001/14746	M W 1:10pm - 2:25pm 614 Schermerhorn Hall	Shipra Agrawal	3.00	90/90

Undergraduate Programs

Computer science majors at Columbia study an integrated curriculum, partially in areas with an immediate relationship to the computer, such as programming languages, operating systems, and computer architecture, and partially in theoretical computer science and mathematics. Thus, students obtain the background to pursue their interests both in applications and in theoretical developments.

Practical experience is an essential component of the computer science program. Undergraduate students are often involved in advanced faculty research projects using state-of-the-art computing facilities. Qualified majors sometimes serve as consultants at Columbia University Information Technology (CUIT), which operates several labs with microcomputers and terminals available at convenient locations on the campus.

Upper-level students in computer science may assist faculty members with research projects, particularly in the development of software. Ongoing faculty projects include algorithmic analysis, computational complexity, software tool design, distributed computation, modeling and performance evaluation, computer networks, computer architecture, CAD for digital systems, computer graphics, programming environments, expert systems, natural language processing, computer vision, robotics, computational biology, computer security, multicomputer design, user interfaces, VLSI applications, artificial intelligence, combinatorial modeling, virtual environments, and microprocessor applications. Students are strongly encouraged to arrange for participation by consulting individual faculty members and by attending the Computer Science Research Fair held at the beginning of each semester.

Most graduates of the computer science program at Columbia step directly into career positions in computer science with industry or government, or continue their education in graduate degree programs. Many choose to combine computer science with a second career interest by taking additional programs in business administration, medicine, or other professional studies.

For further information on the undergraduate computer science program, please see the home page and the Quick Guide at cs.columbia.edu/education/undergraduate.

- Computer Science (BS) (p. 171)
- Computer Science Minor (p. 328)
- Artificial Intelligence Minor

Computer Science (BS)

The CS Major Requirements

The Undergraduate program requires at minimum 62 points (including ENGI E1006 INTRO TO COMP FOR ENG/APP SCI as a prerequisite to the major) and is composed of four basic components:

- the **Computer Science Core** (7-8 courses),
- the **Area Foundation Courses** (4 courses),
- the **Computer Science Electives** (4 courses),
- and the **General Technical Electives** (4 courses).

Students are encouraged to work with their faculty adviser to create a plan tailored to fit their goals and interests. The department webpage provides several example programs for students interested in a variety of specific areas in computer science.

Note: All courses toward the CS major must be taken for a letter grade. A maximum of one course worth no more than 4 points passed with a grade of D may be counted toward the major.

Prerequisite to the CS Major

ENGI E1006 INTRO TO COMP FOR ENG/APP SCI. All CS majors should take this course in their first or second semester.

Mathematics Requirements

Calculus Requirement	
MATH UN1101	CALCULUS I
MATH UN1102	CALCULUS II
APMA E2000	MULTV. CALC. FOR ENGI # APP SCI
Linear Algebra Requirement	
Choose one of the following:	
COMS W3251	COMPUTATIONAL LINEAR ALGEBRA
MATH UN2010	LINEAR ALGEBRA
MATH UN2015	Linear Algebra and Probability [1]
MATH UN2020	Honors Linear Algebra
APMA E2101	INTRO TO APPLIED MATHEMATICS
APMA E3101	APPLIED MATH I: LINEAR ALGEBRA
Probability/Statistics Requirement	
Choose one of the following:	
IEOR E3658	PROBABILITY FOR ENGINEERS
STAT UN1201	CALC-BASED INTRO TO STATISTICS
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
MATH UN2015	Linear Algebra and Probability

[1] MATH UN2015 Linear Algebra and Probability may simultaneously satisfy both linear algebra and probability/statistics requirements without the need to take additional classes, thus reducing the total number of courses required.

Computer Science Core

COMS W1004	PROGRAMMING IN JAVA
or COMS W1007	
COMS W3134	Data Structures in Java
or COMS W3137	HONORS DATA STRUCTURES # ALGOL
COMS W3157	ADVANCED PROGRAMMING
COMS W3203	DISCRETE MATHEMATICS
COMS W3261	COMPUTER SCIENCE THEORY
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS

Area Foundation Courses

Choose four of the following:

COMS W4111	INTRODUCTION TO DATABASES
COMS W4113	FUND-LARGE-SCALE DIST SYSTEMS
COMS W4115	PROGRAMMING LANG # TRANSLATORS
COMS W4118	OPERATING SYSTEMS I
CSEE W4119	COMPUTER NETWORKS
COMS W4152	Engineering Software-as-a-Service
COMS W4156	Advanced Software Engineering
COMS W4160	COMPUTER GRAPHICS
COMS W4167	COMPUTER ANIMATION
COMS W4170	USER INTERFACE DESIGN
COMS W4181	SECURITY I
CSOR W4231	ANALYSIS OF ALGORITHMS I
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4731	Computer Vision I: First Principles
COMS W4733	COMPUTATIONAL ASPECTS OF ROBOTICS
CBMF W4761	COMPUTATIONAL GENOMICS
COMS W4771	MACHINE LEARNING
CSEE W4824	COMPUTER ARCHITECTURE
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS

Computer Science Electives

Any four COMS courses, or jointly offered computer science courses such as CSXX or XXCS courses (excluding CSER), that are worth at least 3 points and are at the 3000 level or above.

General Technical Electives

Four General Technical Elective (GTE) courses are required. GTE courses must be worth at least 3 points, at the 3000 level or above, and must be selected from the list of departments below. There are no exceptions.

- Any SEAS department
- Astronomy
- Biomedical Informatics
- Biological Science
- Chemistry
- Earth and Environmental Sciences
- Ecology, Evolution, and Environmental Biology
- Mathematics
- Physics
- Psychology
- Statistics
- Economics

Undergraduate Thesis

A student may, with adviser approval, choose to complete a thesis. A thesis may be used in place of up to 6 points from the Computer Science Electives requirement. A thesis may not be used in place of any Area Foundation Courses. A thesis consists of an independent theoretical or experimental investigation of an appropriate problem in computer science carried out under the supervision of a Computer Science

Department faculty member. A formal written report is mandatory and an oral presentation may also be required.

Restrictions

Transfer Credit:

Major: Up to four transfer courses are accepted toward the major. Calculus, linear algebra, and probability/statistics courses can be transferred in addition to the four-course limits.

Minor: Up to two transfer courses are accepted toward the minor. A transfer course in linear algebra or probability/statistics counts as one of the two allowed transfers.

All transfer courses must be reviewed as an equivalent to a COMS course by the Columbia instructor for that course and must have been passed with a B grade or higher.

Course restrictions:

Note: No more than 6 points of individual research, project, or thesis courses (including COMS W3902 UNDERGRADUATE THESIS, COMS W3998 UNDERGRAD PROJECTS IN COMPUTER SCIENCE, COMS W4901 Projects in Computer Science, COMS E6901 PROJECTS IN COMPUTER SCIENCE, and equivalent project/research courses from other departments) may be applied towards the computer science major. COMS W3999 FIELDWORK cannot be used as a CS elective. No more than one course from each set below may be applied towards the computer science major.

- IEOR E3658, STAT UN1201, STAT GU4001
- MATH UN2015, MATH UN2010, APMA E3101, COMS W3251
- COMS W4771, COMS W4721, STAT GU4241

Advanced Placement

Students who pass the Computer Science Advanced Placement (AP) Exam with a 4 or 5 will receive 3 points of credit and an exemption from COMS W1004 PROGRAMMING IN JAVA.

Computer Science Program

An overview of the degree track in PDF format can be found here. For program information before Fall 2023, please view the 2022–2023 Bulletin.

First Year

Semester I

MATH UN1101	CALCULUS I

Choose one of the following Physics courses depending on sequence:

PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I

Choose one of the following Chemistry/Biology courses (taken Semester I or II):

CHEM UN1403 (or higher)	GENERAL CHEMISTRY I-LECTURES
EEEB UN2001	ENVIRONMENTAL BIOLOGY I
EEEB UN2005 (or higher)	
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ECON UN1105 & UN1105 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)	INTRO TO COMP FOR ENG/APP SCI
COMS W1004 or W1007 (taken Semester I or II)	PROGRAMMING IN JAVA
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

Choose one of the following Chemistry/Biology courses (taken Semester I or II):

CHEM UN1403 (or higher)	GENERAL CHEMISTRY I-LECTURES
EEEB UN2001	ENVIRONMENTAL BIOLOGY I
EEEB UN2005 (or higher)	
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ECON UN1105 & UN1105 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)	INTRO TO COMP FOR ENG/APP SCI
COMS W1004 or W1007 (taken Semester I or II)	PROGRAMMING IN JAVA
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001	MULTV. CALC. FOR ENGI # APP SCI

Choose a lab from the following:

PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081	INTERMEDIATE LABORATORY WORK
CHEM UN1500	GENERAL CHEMISTRY LABORATORY

CHEM UN1507	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN3085	PHYSICL-ANALYTICL LABORATORY I
ECON UN1105 & UN1105 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Major Cultures (3–4)	
COMS W3134 or W3137	Data Structures in Java
COMS W3203	DISCRETE MATHEMATICS

Semester IV

ECON UN1105 & UN1105 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Major Cultures (3–4)	
HUMA UN1121 or UN1123	Art Humanities
COMS W3157	ADVANCED PROGRAMMING

Linear algebra or probability/statistics requirement (see list of accepted courses)[1]

Third Year

Semester V

CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
COMS W3261	COMPUTER SCIENCE THEORY

Linear Algebra or Probability/Statistics requirement (see list of accepted courses)

Tech Electives (6 points)

Semester VI

Nontech Electives (3 points)

Tech Electives (12 points)

Fourth Year

Semester VII

Nontech Electives (6 points)

Tech Electives (9 points)

Semester VIII

Nontech Electives (3 points)

Tech Electives (9 points)

Graduate Programs

The Department of Computer Science offers graduate programs leading to the degree of Master of Science and the degree of Doctor of Philosophy.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Computer Science (MS) (p. 174)
- Computer Science (PhD) (p. 174)
- Dual Degree Program in Journalism and Computer Science (p. 174)
- CS@CU MS Bridge Program in Computer Science (p. 174)

Computer Science (MS)

M.S. in Computer Science Program

The Master of Science (M.S.) program is intended for students with a bachelor's degree in Computer Science or a strongly related field who wish to broaden and deepen their understanding of computer science. Columbia University and the New York City environment provide excellent career opportunities with multiple industries. The program provides a unique opportunity to develop leading-edge in-depth knowledge of specific computer science disciplines. Students in the M.S. program must complete a total of 30 points (including at least 6 credits at the 6000 level) with a GPA of at least 2.7. Individual courses must be worth at least three points, unless special approval is obtained from the department. Every student completes Breadth and selects a track that focuses on a particular field of computer science. There are currently eight predefined M.S. tracks: Computational Biology; Computer Security; Foundations of Computer Science; Machine Learning; Natural Language Processing; Network Systems; Software Systems; Vision, Graphics, Interaction, and Robotics. Every track has a set of required courses and a wide range of elective courses that allow the students flexibility in designing their program according to their interests, under the guidance of a faculty adviser. Besides the eight predefined tracks, there is also the option, under the supervision of a faculty member, of a M.S. Personalized track for students who want to study an area of computer science that is not covered by one of the eight tracks, and the option of the M.S. Thesis track for students who want to do extensive research in a subfield and write an M.S. thesis. Students in all the tracks are encouraged to pursue research if they wish, and many participate in research projects with the faculty. The faculty in the department conduct research in all areas of computer science. For detailed information on the M.S. program, please see cs.columbia.edu/education/ms.

Students in the M.S. program must complete a total of 30 points (including at least 6 credits at the 6000 level) with a GPA of at least 2.7. Every student completes Breadth and selects a track that focuses on a particular field of computer science. There are currently eight predefined M.S. pathways: Computational Biology; Computer Security; Foundations of Computer Science; Machine Learning; Natural Language Processing; Network Systems; Software Systems; Vision, Graphics, Interaction, and Robotics. Every pathway has a set of required courses and a wide range of elective courses that allow the students flexibility in designing their program according to their interests, under the guidance of a faculty adviser. Besides the eight predefined pathways, there is also the option, under the supervision of a faculty member, of a M.S. Personalized pathway for students who want to study an area of computer science that is not covered by one of the eight pathways, and the option of the M.S. Thesis pathways for students who want to do extensive research in a subfield and write an M.S. thesis. Students in all the pathways are encouraged to pursue research if they wish, and many participate in research projects with the faculty. The faculty in the department conducts research in all areas of computer science. For detailed information on the M.S. program, please see cs.columbia.edu/education/ms.

Computer Science (PhD)

Ph.D. in Computer Science Program

The primary focus of the doctoral program is research, with the philosophy that students learn best by doing—beginning as apprentices and becoming junior colleagues working with faculty on scholarly research projects. The faculty in the department conduct research in all areas of computer science. The degree of Doctor of Philosophy requires a dissertation based on the candidate's original research, which is supervised by a faculty member, and all students in the Ph.D. program are actively engaged in research throughout the program. Ph.D. students spend at least half of their time on research under the direction of their faculty adviser from their first day in the program and devote themselves full time to research after coursework and other preliminaries have been completed. Ph.D. students are also expected to participate in departmental and laboratory activities full time on campus throughout the program, except possibly for summer internships elsewhere, and the department does not consider admission of part-time Ph.D. students. Further information is available at cs.columbia.edu/education/phd.

Dual Degree Program in Journalism and Computer Science

The Graduate School of Journalism and the School of Engineering and Applied Science offer a dual degree program leading to the M.S. degree in Journalism from the Graduate School of Journalism and the M.S. degree in Computer Science from the School of Engineering and Applied Science.

Admitted students enroll for a total of four semesters consisting of 27 points of Computer Science coursework in which an overall 2.7 GPA must be maintained and of 37 points of Journalism coursework. In addition to taking classes already offered at the two schools, students will take *Frontiers of computational journalism*, a course designed specifically for the dual program. The course will teach students about the impact of digital techniques on journalism; the emerging role of citizens in the news process; the influence of social media; and the changing business models that will support newsgathering. Students will use a hands-on approach to delve deeply into information design, focusing on how to build a site, section, or application from concept to development, ensuring the editorial goals are kept uppermost in mind. Further information is available at cs.columbia.edu/education/ms/journalism/.

CS@CU MS Bridge Program in Computer Science

The CS@CU MS Bridge Program in Computer Science offers prospective applicants from noncomputer science backgrounds, including those

without programming experience, the opportunity to acquire the knowledge and skills necessary to build careers in technology.

Admitted students will first take a total of seven undergraduate courses (the bridge curriculum) over two to three semesters, which will build the necessary foundation of programming and mathematical skills. There is flexibility for both scheduling and the choice of courses depending on a student's prior experience and concurrent obligations. Students will also be closely advised during this process in order to prepare for M.S. pathway selection. Once the bridge is completed with an overall 3.3 GPA or higher, students are then eligible to transition into the M.S. in Computer Science program. Further information is available at cs.columbia.edu/ms-bridge.

Earth and Environmental Engineering

Henry Krumb School of Mines
918 S. W. Mudd, MC 4711
212-854-2905
eee.columbia.edu

Our Mission

Earth and Environmental Engineering at the Henry Krumb School of Mines fosters excellence in education and research for the development and application of science and technology to maximize the quality of life for all, through the sustainable use and responsible management of Earth's resources. The department strives to provide education and carry out research that underpins the sustainable and equitable utilization of Earth's material, water, and energy resources at a scale that is beneficial to society. By leveraging cross-disciplinary opportunities afforded by the range of academic work in the department and the University, we tackle complex challenges that exist across the natural materials-water-energy-climate network of interdependencies.

Earth Resources and the Environment

The Earth and Environmental Engineering program fosters education and research in the development and application of technology for the sustainable development, use, and integrated management of Earth's resources. Resources are identified as minerals, energy, water, air, and land, as well as the physical, chemical, and biological components of the environment. There is close collaboration with other engineering disciplines, the Lamont-Doherty Earth Observatory, the International Research Institute for Climate Prediction, the Center for Environmental Research and Conservation, and other Columbia Earth Institute units.

The Henry Krumb School of Mines at Columbia University

The department is the direct lineage of the School of Mines of Columbia University, which was the first mining and metallurgy school in the U.S. (1864). It became the foundation for Columbia's School of Engineering and Applied Science and later the home of the Department of Mining, Metallurgical and Mineral Engineering. However, the title "School of Mines" was retained by Columbia University honoris causa. You can see the bronze statue of The Metallurgist (Le Marteleur) in front of Columbia's Mudd Hall that was named after an alumnus of the School of Mines.

One century after its formation, the School of Mines was renamed Henry Krumb School of Mines (HKSM) in honor of the generous alumnus of the School of Mines and his wife, LaVon Duddleson Krumb. HKSM has been a leader in mining and metallurgy research and education, including the first mining handbook by Professor Peel, the first mineral processing handbook by Professor Taggart, and other pioneering work in mineral benefaction, chemical thermodynamics, kinetics, transport phenomena in mineral extraction and processing, ecological and environmentally responsible mining, and pursuit of state-of-the-art research advancing responsible use of Earth's resources. The Henry Krumb School of Mines located in The Fu Foundation School of Engineering and Applied Science offers students interested in mining and metallurgy the opportunity to focus their studies in these fields with a B.S. in Mining within the department of Earth and Environmental Engineering.

In 1986, HKSM was designated by Governor Cuomo as the mining and Mineral Resources Research Institute of the State of New York.

Earth and Environmental Engineering (EEE)

With the creation of the Earth Institute at Columbia University, a major initiative in the study of Earth, its environment and society, the traditional programs of HKSM in mining, mineral processing, and extractive metallurgy were expanded in the late nineties to encompass environmental concerns related to the use of materials, energy and water resources, and to reflect one of nine departments of SEAS with a focus on the development and application of technology for the sustainable development, use and integrated management of Earth's resources.

As a result of the vast developments in the technologies and fields of environmental management, in 1996 and 1998, respectively, the engineering school created the M.S. program in Earth Resources Engineering and the B.S. program in Earth and Environmental Engineering to meet the needs of a changed society. Students interested in the traditional disciplines of mining, mineral engineering and metallurgy continue to study these fields through the Earth and Environmental Engineering department course offerings as well as the course offerings through the Material Science and Engineering program.

To compliment the B.S. program in Mining, the B.S. program in Earth and Environmental Engineering was initiated in the fall of 1998 and is now accredited by ABET.

The department builds upon this legacy every year through its core class and unofficial motto, "A Better Planet By Design," bringing together:

- water conservation, allocation, and decontamination
- climate change mitigation
- minerals, metals, and materials processing, extraction, and reuse
- waste and pollution prevention, mitigation and management
- renewable energy and carbon management

By bridging engineering scales from colloidal interfaces to resource distribution, the department now considers resource development both on Earth and off, with a new effort in space mining.

The EEE programs warmly welcomes Combined Plan students. Both mining and EEE minors are offered to all Columbia engineering students who wish to enrich their academic record by concentrating some of their technical electives on Earth/Environment/Mining subjects.

Research Centers Associated with Earth and Environmental Engineering

Center for Advanced Materials for Energy and Environment. The Center develops advanced materials to address challenges for closing the energy loop, carbon loop, and water loop.

Center for Life Cycle Analysis (CLCA). The Center for Life Cycle Analysis (CLCA) provides a framework for quantifying the potential environmental impacts of material and energy inputs and outputs of a process or product from "cradle to grave." For more information, visit clca.columbia.edu.

Columbia Climate School. For more information, visit climate.columbia.edu.

Columbia Electrochemical Energy Center (CEEC). For more information, visit ceec.engineering.columbia.edu.

Columbia Water Center. The Center was established in 2008 to address issues of Global Water Security. For more information, visit water.columbia.edu.

Earth Engineering Center (EEC). EEC has concentrated on advancing the goals of sustainable waste management in the U.S. and globally. For more information, visit earth.engineering.columbia.edu.

Industry/University Cooperative Research Center for Particulate and Surfactant Systems (CPaSS). The goals of CPaSS are to perform industrially relevant research to address the technological needs in commercial surfactant and polymer systems, develop new and more efficient surface-active reagents for specific applications in the industry and methodologies for optimizing their performance, promote the use of environmentally benign surfactants in a wide array of technological processes, and build a resource center to perform and provide state-of-the-art facilities for characterization of surface-active reagents. For more information, visit blogs.cuit.columbia.edu/iucrc/.

Langmuir Center for Colloids and Interfaces (LCCI). This center brings together experts from mineral engineering, applied chemistry, chemical engineering, biological sciences, and chemistry to probe complex interactions of colloids and interfaces with surfactants and macromolecules.

Lamont-Doherty Earth Observatory (LDEO). For more information, visit lamont.columbia.edu.

Lenfest Center for Sustainable Energy (LCSE). The mission of the Lenfest Center for Sustainable Energy is to advance science and develop innovative technologies that provide sustainable energy for all humanity while maintaining the stability of Earth's natural systems. For more information, visit energy.columbia.edu.

The Earth Institute. For more information, visit earth.columbia.edu.

Scholarships, Fellowships, and Internships

The department arranges for undergraduate summer internships after the sophomore and junior years. Undergraduates can also participate in graduate research projects under the work-study program. Graduate research and teaching assistantships, as well as fellowships funded by the Department, are available to qualified graduate students. GRE scores are required of all applicants for graduate studies.

Department Chair

Daniel Steingart

Director of Finance and Administration

Andrea El-Nems

Professors

Kartik Chandran
George Deodatis
Greeshma Gadikota
Pierre Gentine
Vjay Modi
Ismail C. Noyan
Daniel Steingart
Alan West

Associate Professor

Ngai Yin Yip

Assistant Professors

Adeyemi Adeleye
Pengbo Chu
Shaina Kelly
Oscar Nordness
Bolun Xu

Visiting Professor

Upmanu Lall

Lecturer

Professors of Professional Practice

Raymond S. Farinato
Robert Farrauto
D. R. Nagaraj

Adjunct Professors

Yuri Gorokhovich
Paul Knowles
Eric Rosenberg

Professors Emeritus

Ponisseril Somasundaran

Associate Research Scientist

Partha Patra

Course Descriptions

CHEE E4252 INTRO-SURFACE AND COLLOID SCI. *3.00 points*.
Lect: 3.

Prerequisites: Elemental physical chemistry.
The principles of surfaces and colloid chemistry critical to range of technologies indispensable to modern life. Surface and colloid chemistry has significance to life sciences, pharmaceuticals, agriculture, environmental remediation and waste management, earth resources recovery, electronics, advanced materials, enhanced oil recovery, and emerging extraterrestrial mining. Topics include: thermodynamics of surfaces, properties of surfactant solutions and surface films, electrokinetic phenomena at interfaces, principles of adsorption and mass transfer and modern experimental techniques. Leads to deeper understanding of interfacial engineering, particulate dispersions, emulsions, foams, aerosols, polymers in solution, and soft matter topics

Fall 2026: CHEE E4252

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEE 4252	001/14391	W 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Oscar Nordness	3.00	11/30

CHEE E6252 ADV SURFACE/COLLOID CHEMISTRY. *3.00 points*.
Lect:2. Lab:3.

Prerequisites: (CHEE E4252) CHEE E4252
Applications of surface chemistry principles to wetting, flocculation, flotation, separation techniques, catalysis, mass transfer, emulsions, foams, aerosols, membranes, biological surfactant systems, microbial surfaces, enhanced oil recovery, and pollution problems. Appropriate individual experiments and projects. Lab required

CIEE E3111 UNCERTAIN/RISK-CIVIL INF SYST. *3.00 points*.
Prerequisites: Working knowledge of calculus.
Introduction to basic probability; hazard function; reliability function; stochastic models of natural and technological hazards; extreme value distributions; Monte Carlo simulation techniques; fundamentals of integrated risk assessment and risk management; topics in risk-based insurance; case studies involving civil infrastructure systems, environmental systems, mechanical and aerospace systems, construction management. Not open to undergraduate students

Fall 2026: CIEE E3111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEE 3111	001/14586	T 4:10pm - 6:40pm 717 Hamilton Hall	Ioannis Kougioumtzoglou	3.00	25/50

CIEE E3260 ENGINEERING FOR COMMUNITY DEVELOPMENT. *3.00 points*.
Lect: 3

Introduction to the challenges and realities of implementing design solutions with high-risk, low-resource communities in urban and rural settings in both developed and developing countries. History and theory of international development towards preparing globally responsible and informed professionals. Real-world examples of development work across technical sectors including water, sanitation, energy, health, communication technology, shelter, food systems, and environment. Role of engineering in achieving the Sustainable Development Goals. Course projects follow a Design for Impact process resulting in an engineering design, an action plan, and the identification of indicators for impact evaluation

CIEE E4111 UNCERTAIN/RISK-CIVIL INF SYST. *3.00 points*.
Prerequisites: Working knowledge of calculus.
Introduction to basic probability; hazard function; reliability function; stochastic models of natural and technological hazards; extreme value distributions; Monte Carlo simulation techniques; fundamentals of integrated risk assessment and risk management; topics in risk-based insurance; case studies involving civil infrastructure systems, environmental systems, mechanical and aerospace systems, construction management. Not open to undergraduate students

Fall 2026: CIEE E4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CIEE 4111	001/14587	T 4:10pm - 6:40pm 717 Hamilton Hall	Ioannis Kougioumtzoglou	3.00	28/75
CIEE 4111	V01/20101		Ioannis Kougioumtzoglou	3.00	0/99

CIEE E4116 Energy Harvesting. *3.00 points*.
Prerequisites: ENME E3114 or equivalent, or instructor's permission.
Criterion of energy harvesting, identification of energy sources. Theory of vibrations of discrete and continuous system, measurement and analysis. Selection of materials for energy conversion, piezoelectric, electromagnetic, thermoelectric, photovoltaic, etc. Design and characterization, modeling and fabrication of vibration, motion, wind, wave, thermal gradient, and light energy harvesters; resonance phenomenon, power electronics and energy storage and management. Applications to buildings, geothermal systems, and transportation. To alternate with ENME E4115.

EACE E3250 Hydrosystems Engineering. *3.00 points*.
Prerequisites: CHEN E3110 OR ENME E3161; or equiv, or instructors permission
A quantitative introduction to hydrologic and hydraulic systems, with a focus on integrated modeling and analysis of the water cycle and associated mass transport for water resources and environmental engineering. Coverage of unit hydrologic processes such as precipitation, evaporation, infiltration, runoff generation, open channel and pipe flow, subsurface flow and well hydraulics in the context of example watersheds and specific integrative problems such as risk-based design for flood control, provision of water, and assessment of environmental impact or potential for non-point source pollution. Spatial hydrologic analysis using GIS and watershed models

Spring 2026: EACE E3250

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 3250	001/12796	M W 11:40am - 12:55pm 307 Uris Hall	Wenli Zhao	3.00	10/20

EACE E3255 ENVIRONMENTAL CONTROL AND POLLUTION REDUCTION. *3.00 points*.
Sources of solid/gaseous air pollution and the technologies used for modern methods of abatement. Air pollution and its abatement from combustion of coal, oil, and natural gas and the thermodynamics of heat engines in power generation. Catalytic emission control is contrasted to thermal processes for abating carbon monoxide, hydrocarbons, oxides of nitrogen and sulfur from vehicles and stationary sources. Processing of petroleum for generating fuels. Technological challenges of controlling greenhouse gas emissions. Biomass and the hydrogen economy coupled with fuel cells as future sources of energy

Spring 2026: EACE E3255

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 3255	001/12801	M W 10:10am - 11:25am 304 Hamilton Hall	Robert Farrauto	3.00	26/40

EACE E4163 Sustainable Water Treatment and Reuse. *3.00 points*.
Fundamentals of water pollution and wastewater characteristics. Chemistry, microbiology, and reaction kinetics. Design of primary, secondary, and advanced treatment systems. Small community and residential systems

Spring 2026: EACE E4163

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 4163	001/12803	Th 4:10pm - 6:40pm 467 Ext Schermerhorn Hall	Paul Knowles	3.00	24/40

EACE E4250 Hydrosystems Engineering. *3.00 points*.
Prerequisites: CHEN E3110 OR ENME E3161; or equiv, or instructors permission
Quantitative introduction to hydrologic and hydraulic systems, with a focus on integrated modeling and analysis of the water cycle and associated mass transport for water resources and environmental engineering. Coverage of unit hydrologic processes such as precipitation, evaporation, infiltration, runoff generation, open channel and pipe flow, subsurface flow and well hydraulics in the context of example watersheds and specific integrative problems such as risk-based design for flood control, provision of water, and assessment of environmental impact or potential for non-point source pollution. Spatial hydrologic analysis using GIS and watershed models

Spring 2026: EACE E4250

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 4250	001/12811	M W 11:40am - 12:55pm 307 Uris Hall	Wenli Zhao	3.00	12/24

EACE E4252 Foundations of Environmental Engineering. *3.00 points*.
Prerequisites: CHEM W1403 AND ENME E3161; or equiv, or instructors permission
Engineering aspects of problems involving human interaction with the natural environment. Review of fundamental principles that underlie the discipline of environmental engineering, i.e. constituent transport and transformation processes in environmental media such as water, air, and ecosystems. Engineering applications for addressing environmental problems such as water quality and treatment, air pollution emissions, and hazardous waste remediation. Presented in the context of current issues facing the practicing engineers and government agencies, including legal and regulatory framework, environmental impact assessments, and natural resource management

Spring 2026: EACE E4252

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EACE 4252	001/12818	T Th 2:40pm - 3:55pm 333 Uris Hall	Benjamin Bostick	3.00	17/40

EAEE E2100 A BETTER PLANET BY DESIGN. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lect: 3.

Introduction to design for a sustainable planet. Scientific understanding of the challenges. Innovative technologies for water, energy, food, materials provision. Multi-scale modeling and conceptual framework for understanding environmental, resource, human, ecological and economic impacts and design performance evaluation. Focus on the linkages between planetary, regional and urban water, energy, mineral, food, climate, economic and ecological cycles. Solution strategies for developed and developing country settings

Fall 2026: EAEE E2100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 2100	001/14400	M W 2:40pm - 3:55pm 633 Seeley W. Mudd Building	Adeyemi Adeleye	3.00	68/70

EAEE E3103 ENERGY,MINERALS,MATERIALS SYST. *3.00 points*.
Lect: 3.

Prerequisites: or equivalent.
Corequisites: EAEE E4180
Overview of energy resources, resource management from extraction and processing to recycling and final disposal of wastes. Resources availability and resource processing in the context of the global natural and anthropogenic material cycles; thermodynamic and chemical conditions including nonequilibrium effects that shape the resource base; extractive technologies and their impact on the environment and the biogeochemical cycles; chemical extraction from mineral ores, and metallurgical processes for extraction of metals. In analogy to metallurgical processing, power generation and the refining of fuels are treated as extraction and refining processes. Large scale of power generation and a discussion of its impact on the global biogeochemical cycles.

Fall 2026: EAEE E3103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3103	001/14390	T Th 11:40am - 12:55pm 825 Seeley W. Mudd Building	Raymond Farinato	3.00	17/40

EAEE E3200 TRANSPORT/CHEM RATE PHENOMENA. *3.00 points*.
Lect: 3.

Prerequisites: (APMA E2101) APMA E2101
Fluid statics. Basics of flow analysis. Dimensional analysis. Pipe flow. Fluid dynamics, heat and mass transfer. Effects of velocity, temperature, and concentration gradients 130 ENGINEERING 2021–2022 and material properties on fluid flow, heat and mass transfer. Applications to environmental engineering problems.

Fall 2026: EAEE E3200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3200	001/14392	M W 1:10pm - 2:25pm 414 Pupin Laboratories	Yin Yip Ngai	3.00	8/30

EAEE E3800 EARTH # ENVIR ENGIN LAB I. *2.00 points*.
Lect: 1. Lab: 3.

Experiments on fundamental aspects of Earth and environmental engineering with emphasis on the applications of chemistry, biology and thermodynamics to environmental processes: energy generation, analysis and purification of water, environmental biology, and biochemical treatment of wastes. Students will learn the laboratory procedures and use analytical equipment firsthand, hence demonstrating experimentally the theoretical concepts learned in class.

Spring 2026: EAEE E3800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3800	001/12886	T Th 11:00am - 1:00pm 332 Uris Hall	Luana Llanes	2.00	7/15

EAEE E3899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

EAEE E3900 UNDERGRAD RES-ENVIRONMTL ENGIN. *0.00-3.00 points*.
0-3 pts. Directed study.

This course may be repeated for credit, but no more than 3 points of this course may be counted towards the satisfaction of the B. S. degree requirements. Candidates for the B.S. degree may conduct an investigation in Earth and Environmental Engineering, or carry out a special project under the supervision of EAEE faculty. Credit for the course is contingent on the submission of an acceptable thesis or final report. This course cannot substitute for the Undergraduate design project (EAEE E3999x or EAEE E3999y)

Spring 2026: EAEE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3900	001/17340		Kartik Chandran	0.00-3.00	2/10
EAEE 3900	002/17341		Robert Farrauto	0.00-3.00	0/10
EAEE 3900	003/17342		Raymond Farinato	0.00-3.00	0/10
EAEE 3900	004/17343		Greeshma Gadikota	0.00-3.00	0/10
EAEE 3900	005/17344		Pierre Gentine	0.00-3.00	1/10
EAEE 3900	006/17345		Shaina Kelly	0.00-3.00	0/10
EAEE 3900	007/17346		Vijay Modi	0.00-3.00	0/10
EAEE 3900	008/17347		Nagaraj Devarayasamudram	0.00-3.00	0/10
EAEE 3900	009/17348		Dan Steingart	0.00-3.00	0/10
EAEE 3900	010/17349		Alan West	0.00-3.00	0/10
EAEE 3900	012/17350		Bolun Xu	0.00-3.00	0/10
EAEE 3900	013/17351		Yin Yip Ngai	0.00-3.00	1/10
EAEE 3900	014/17352		Adeyemi Adeleye	0.00-3.00	0/10
EAEE 3900	015/17353		Oscar Nordness	0.00-3.00	1/10

Fall 2026: EAEE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3900	001/14407		Kartik Chandran	0.00-3.00	0/10
EAEE 3900	002/14408		Robert Farrauto	0.00-3.00	0/10
EAEE 3900	003/14410		Raymond Farinato	0.00-3.00	1/10
EAEE 3900	004/14411			0.00-3.00	0/10
EAEE 3900	005/14412		Pierre Gentine	0.00-3.00	0/10
EAEE 3900	006/14413		Shaina Kelly	0.00-3.00	0/10
EAEE 3900	007/14414		Upmanu Lall	0.00-3.00	0/10
EAEE 3900	008/14415		Vijay Modi	0.00-3.00	0/10
EAEE 3900	009/14416		Nagaraj Devarayasamudram	0.00-3.00	0/10
EAEE 3900	010/14417		Dan Steingart	0.00-3.00	0/10
EAEE 3900	011/14418		Alan West	0.00-3.00	0/10
EAEE 3900	012/14419		Bolun Xu	0.00-3.00	0/10
EAEE 3900	013/14420		Yin Yip Ngai	0.00-3.00	1/10
EAEE 3900	014/14422		Adeyemi Adeleye	0.00-3.00	1/10
EAEE 3900	015/14424		Oscar Nordness	0.00-3.00	1/10

EAEE E3901 ENVIRONMENTAL MICROBIOLOGY. *3.00 points*.
Lect: 3.

Prerequisites: (CHEM UN1404) or CHEM C1404; or equivalent.
Fundamentals of microbiology, genetics and molecular biology, principles of microbial nutrition, energetics and kinetics, application of novel and state-of-the-art techniques in monitoring the structure and function of microbial communities in the environment, engineered processes for biochemical waste treatment and bioremediation, microorganisms and public health, global microbial elemental cycles

Fall 2026: EAEE E3901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3901	001/14397	T Th 2:40pm - 3:55pm 545 Seeley W. Mudd Building	Kartik Chandran	3.00	8/20

EAEE E3995 Fieldwork. *1.00-2.00 points*.
Prerequisites: Instructor's permission.
Obtained internship and approval from faculty adviser. Written application must be made prior to registration outlining proposed internship and study program. Final reports required. May not be taken for pass/fail credit or audited. Fieldwork credits may not count toward any major core, technical elective, and nontechnical requirements. International students must also consult with the International Students and Scholars Office. Note: only for EAEE undergraduate students who need relevant off-campus work experience as a part of their program of study as determined by instructor

Spring 2026: EAEE E3995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3995	001/20461		Bolun Xu	1.00-2.00	1/5

Summer 2026: EAEE E3995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3995	001/11464		Bolun Xu	1.00-2.00	1/10

EAEE E3998 UNDERGRADUATE PROJECT I. *2.00 points*.
2 pts. (each semeseter). Lect: 1. Lab: 2.

Prerequisites: Senior standing.
Students must enroll for both 3998x and 3999y during their senior year. Selection of an actual problem in Earth and environmental engineering, and design of an engineering solution including technical, economic, environmental, ethical, health and safety, social issues. Use of software for design, visualization, economic analysis, and report preparation. Students may work in teams. Presentation of results in a formal report and public presentation

Fall 2026: EAEE E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3998	001/14398		Dan Steingart	2.00	7/30

EAEE E3999 UNDERGRADUATE PROJECT II. *2.00 points*.
2 pts. (each semeseter). Lect: 1. Lab: 2.

Prerequisites: Senior standing.
Students must enroll for both 3998x and 3999y during their senior year. Selection of an actual problem in Earth and environmental engineering, and design of an engineering solution including technical, economic, environmental, ethical, health and safety, social issues. Use of software for design, visualization, economic analysis, and report preparation. Students may work in teams. Presentation of results in a formal report and public presentation

Spring 2026: EAEE E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3999	001/12889	F 5:00pm - 6:00pm 423 Kent Hall	Robert Farrauto	2.00	10/15

EAEE E4000 Machine learning for environmental engineering and science. *3.00 points*.
Prerequisites: Computer language Python or Julia, some linear algebra and machine learning.
Aimed at understanding and testing state-of?the-art methods in machine learning applied to environmental sciences and engineering problems. Potential applications include but are not limited to remote sensing, and environmental and geophysical fluid dynamics. Includes testing "vanilla" ML algorithms, feedforward neural networks, random forests, shallow vs deep networks, and the details of machine learning techniques

Fall 2026: EAEE E4000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4000	001/14403	M 4:10pm - 6:40pm 616 Martin Luther King Building		3.00	1/51

EAEE E4002 ALTERNATIVE ENERGY RESOURCES. *3.00 points*.
An engineering and economic analysis of past, present and future energy resources. Technological options and their role in the world energy markets. Understanding limits of energy and power density and its impact of resource adoption and feasibility. Comparison of renewable and non-renewable energy resources and analysis of the consequences of various technological choices and constraints. Economic considerations, energy availability, and the environmental consequences of large-scale, widespread use of each particular technology. Critical analysis of carbon dioxide capture and carbon dioxide disposal as a means of sustaining the fossil fuel options in comparison to dramatic increase of electrified resources

Spring 2026: EAEE E4002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4002	001/12894	M W 2:40pm - 3:55pm 428 Pupin Laboratories	Dan Steingart	3.00	97/100

EAEE E4003 AQUATIC CHEMISTRY. *3.00 points*.
Lect: 3.

Prerequisites: (CHEE E3010)
Corequisites: EAEE E3801
Principles of physical chemistry applied to equilibria and kinetics of aqueous solutions in contact with minerals and anthropogenic residues. The scientific background for addressing problems of aqueous pollution, water treatment, and sustainable production of materials with minimum environmental impact. Hydrolysis, oxidation-reduction, complex formation, dissolution and precipitation, predominance diagrams; examples of natural water systems, processes for water treatment and for the production of inorganic materials from minerals.

Spring 2026: EAEE E4003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4003	001/12985	T Th 8:40am - 9:55am 420 Pupin Laboratories	Oscar Nordness	3.00	11/50

EAEE E4006 Field methods for environmental engineering. *3 points*.
Lect: 1.5. Lab: 2.

Prerequisites: (ENME E3161) or ENME E3161; or equivalent or instructor's permission.
Principles and methods for designing, building and testing systems to sense the environment. Monitoring the atmosphere, water bodies and boundary interfaces between the two. Sensor systems for monitoring heat and mass flows, chemicals, and biota. Measurements of velocity, temperature, flux and concentration in the field. The class will involve planning and execution of a study to sense a local environmental system.

EAEE E4009 GIS-RES,ENVIR,INFRASTRUCTR MGT. *3.00 points*.
Lect: 3.

Prerequisites: Instructor's permission.
Basic concepts of spatial data representation and organization, and analytical tools are introduced and applied in a form of case studies from hydrology, environmental conservation, and emergency response to natural or man-made hazards, among others. Technical content includes geographic topics (map projections, cartography, etc.), spatial statistics, database design and use, interpolation and visualization of spatial surfaces and volumes, and multi-criteria decision analysis. Students will learn the basics of ArcGIS Pro, Model Builder and Python. Elective term projects or final exams emphasize spatial information synthesis towards the solution of a specific problem

Spring 2026: EAEE E4009

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4009	001/12991	M 7:10pm - 8:30pm 420 Pupin Laboratories	Yuri Gorokhovich	3.00	14/50
EAEE 4009	LAB/12994	M T 8:40pm - 9:55pm 420 Pupin Laboratories	Yuri Gorokhovich	3.00	0/50

EAEE E4011 Industrial ecology for manufacturing. *3 points*.
Lect: 3.

Prerequisites: (EAEE E4001) or EAEE E4001; or instructor's permission.
Application of industrial ecology to Design for Environment (DFE) of processes and products using environmental indices of resources consumption and pollution loads. Introduction of methodology for Life Cycle Assessment (LCA) of manufactured products. Analysis of several DFE and LCA case studies. Term project required on use of DFE/LCA on a specific product/process: (a) product design complete with materials and process selection, energy consumption, and waste loadings; (b) LCA of an existing industrial or consumer product using a commercially established method.

EAEE E4100 A Better Planet by Design (MS). *3.00 points*.
Foundational for the Master of Science in Earth and Environmental Engineering degree. Provides broader understanding of engineering tools critical/ essential to success in large-scale, engineering projects. Divided into two parts: Module on global/regional flows, and systems approach, and Module on Engineering Principles in Earth # Environmental Engineering. Guest lectures on several topics will be provided

Fall 2026: EAEE E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4100	001/14393	T 4:10pm - 6:40pm 644 Seeley W. Mudd Building	Luana Llanes	3.00	32/44

EAEE E4103 Environmental Soil Chemistry. *3.00 points*.
Prerequisites: (CHEE E3010) Or instructor's permission.
Introduction to principles of chemical reactions in soils, soil chemical properties and processes, and the chemical nature of soil solids. The scientific background for characterizing soil health, addressing soil pollution, performing soil remediation, and sustainable use of soil/ subsurface resources. Properties of elements and molecules in soil, soil water chemistry, redox reactions in natural systems, mineralogy and weathering processes in soils, soil carbon cycling, climate change impact on soil, soil organic matter formation and structure, and legacy and emerging contaminants.

Spring 2026: EAEE E4103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4103	001/13010	M W 1:10pm - 2:25pm 307 Uris Hall	Adeyemi Adeleye	3.00	4/40

EAEE E4140 ENVIRONMENTAL PHYSICOCHEMICAL PROCESSES. *3.00 points*.
Prerequisites: (EACE E4163 and EACE E4252) or the equivalent, or the instructor's permission
Fundamentals and applications of key physicochemical processes relevant to water quality engineering (such as water treatment, waste water treatment/reuse/recycling, desalination) and the natural environment (e.g. lakes, rivers, groundwater).

Spring 2026: EAEE E4140

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4140	001/13015	T Th 1:10pm - 2:25pm 333 Uris Hall	Yin Yip Ngai	3.00	8/35

EAEE E4160 SOLID # HAZARDOUS WASTE MGMT. *3.00 points*.
Lect: 3.

Generation, composition, collection, transport, storage and disposal of solid and hazardous waste. Impact on the environment and public health. Government regulations. Recycling and resource recovery

Fall 2026: EAEE E4160

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4160	001/14387	M W 9:10am - 10:25am 420 Pupin Laboratories	Xiaoyang Shi	3.00	20/50

EAEE E4180 ELECTROCHEMICAL ENERGY STORAGE SYSTEMS. *3.00 points*.
Lec: 3.

Prerequisites: (CHEM UN1403) and (CHEM UN1404) and (MECE E3301) and (PHYS UN1402) Or equivalent
Corequisites: CHEN E4201
EAEE E3103
Survey course on electrochemical energy storage with a focus on closed-form cells. Fundamentals of thermodynamics will be reviewed and fundamentals of electrochemistry introduced. Application of fundamentals to devices such as batteries, flow batteries, and fuel cells. Device optimization with respect to energy density, power density, cycle life and capital cost will be considered.

EAEE E4200 Introduction to Sustainable Production of Earth Mineral # Metal Resources. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E3103) and undergraduate level courses in chemistry especially inorganic, physical and organic and physics CHEM UN1404, PHYS UN1401, PHYS UN1402. A highly recommended course: CHEE E4252.
Introductory course focused on engineering principles and unit operations involved in sustainable processing of primary and secondary earth mineral and metal resources. Covers entire value chain, viz, aspects of economic resource deposits, mining, fundamental principles and processes for size reduction, separations based on physical and chemical properties of minerals and metals, solid-liquid separation, waste and pollution management, water and energy efficiency and management, safety and health, environmental impact assessment and control, and economic efficiency. Special emphasis on concepts and practical applications within "mines of the future" framework to highlight innovations and transformational technological changes in progress.

Fall 2026: EAEE E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4200	001/14394	M W 2:40pm - 3:55pm 603 Hamilton Hall	Pengbo Chu	3.00	12/40

EAEE E4220 Energy System Economics and Optimization. *3.00 points*.
Prerequisites: Basic linear algebra, basic probability and statistics, and basic programming skills.
Transitioning into a sustainable energy system is not only a technical challenge but also an economical one. Teaches students fundamentals of power system economics over which current electricity markets are designed. Also examines challenges and opportunities in future sustainable energy systems such as carbon tax, renewable energy, demand response, and energy storage. Covers mixed-integer linear programming and demonstrates how mathematical optimizations are integrated into energy system operations. Provides overview of current energy system research topics. Includes a project using mathematical tools to solve real-world problems in the energy system

EAEE E4222 Interfacial Engineering for Sustainable Energy and Materials. *3.00 points*.
Prerequisites: EAEE E3103; or equivalent or instructor's permission.
Cross disciplinary interfacial engineering principles and applications in sustainable energy and material science. Surface science and systems analysis across different technology sectors - material production and processing, waste management, device manufacture, composites, coatings, ceramics, membranes, biomaterials, and microelectronics

Spring 2026: EAEE E4222

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4222	001/13028	T Th 11:40am - 12:55pm 333 Uris Hall	Raymond Farinato	3.00	8/50
EAEE 4222	V01/17337		Raymond Farinato	3.00	1/99

EAEE E4228 Separation Science and Technology in Sustainable Earth Resources Development. *3.00 points*.
Prerequisites: EAEE E3103 and undergraduate level courses in chemistry especially inorganic, physical and organic. Recommended: EAEE E4252, EAEE E4003, and EAEE E4200.
Detailed study of the chemical and physicochemical principles underlying separations in development of earth resources in a safe and sustainable manner. Covers wide-range of solid-solid, solid-liquid and liquid-liquid separations used in processing of mineral resources. Interfacial science and engineering principles of important industrial processes of flotation, flocculation, dewatering, interfacial transport, magnetic/gravity/electrostatic separations, solvent extraction, solid-support extraction, crystallization and precipitation. Emphasis on concepts in interfacial chemistry and concepts associated with 'mines of the future' framework.

EAEE E4257 ENVIR DATA ANALYSIS # MODELING. *3.00 points*.
Lect: 3.

Prerequisites: (STAT W4001 and ENGI E1006) or (IEOR E3658 and ENGI E1006) or (IEOR E4150 and ENGI E1006)
Introduction parametric and non-parametric statistical models applied to climate and environmental data analysis. Time and space data analysis methods will be focused, including clustering, autoregressive models, trend analysis, Bayesian analysis, missing data imputation, geostatistics, principal components analysis. Application to problems of climate variation and change; hydrology; air, water and soil pollution dynamics; disease propagation; ecological change; and resource assessment. The class requires the use of R with hands-on programming applied to a current environmental data analysis problem.

Spring 2026: EAEE E4257

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4257	001/13037	M W 10:10am - 11:25am 420 Pupin Laboratories	Bolun Xu	3.00	31/50

EAEE E4262 Space Exploration and Mining. *3.00 points*.
Needs and opportunities for space exploration and mining, resources in planets and asteroids, history of human colonization, terraforming Mars, Titan, and Moon, safety and health issues, benign mining, space junk extraction, microbial mining

EAEE E4280 Issues Facing the Water Industry. *3.00 points*.
Prerequisites: CHEE E3010 AND EAEE E3200 AND EAEE E4003
Principles and practice of water treatment and utility management will be presented. Project-based class where students will work in teams to solve an issue for a water utility. Variety of external experts will lecture and serve as a resource for students for the project. Allows students to better understand the role of the water utility in providing safe drinking water in a sustainable manner. Students will become familiar with the challenges facing water utilities, gain knowledge in the design and operation of water treatment systems, and learn how to develop solutions to water supply and water quality issues which will allow them to pursue productive careers in the consulting, utility, or regulatory fields

Spring 2026: EAEE E4280

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4280	001/13045	M 4:10pm - 6:40pm 602 Northwest Corner	William Becker	3.00	4/30

EAEE E4300 INTRO TO CARBON MANAGEMENT. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level mathematics and science, or instructor's permission.
Introduction to natural and anthropogenic carbon cycle, and carbon - climate. Rationale and need to manage carbon and tools with which to do so (basic science, psychology, economics and policy background, negotiations - society; emphasis on interdisciplinary and inter-dependent approach). Simple carbon emission model to estimate the impacts of a specific intervention with regards to national, per capita and global emissions. Student-led case studies (e.g. reforestation, biofuels, CCS, efficiency, alternative energy) to illustrate necessary systems approach required to tackle global challenges

Fall 2026: EAEE E4300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4300	001/13492	M 4:10pm - 6:40pm 142 Uris Hall		3.00	34/50
EAEE 4300	V01/19957		Sara Hamilton	3.00	1/99

EAEE E4301 CARBON STORAGE. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level mathematics and science, or instructor's permission.
This course is intended to provide a quantitative introduction to storage of carbon derived from greenhouse gases, mainly CO2, with a focus on geological carbon storage and mineralization in saline aquifers, depleted hydrocarbon reservoirs, and "reactive" subsurface formations (rocks rich in Fe, Ca, and Mg) as well and other natural and engineered storage reservoirs (e.g., terrestrial storage, ocean storage, building materials). Course modules cover fundamental processes such as geochemical fluid-rock interactions and fluid flow, transport, and trapping of supercritical and/or dissolved CO2 in the context of pore-scale properties to field-scale example storage reservoirs and specific integrative problems such as reservoir characterization and modeling techniques, estimating storage capacity, and regulations and monitoring.

Fall 2026: EAEE E4301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4301	001/13491	M W 11:40am - 12:55pm 627 Seeley W. Mudd Building	Shaina Kelly	3.00	25/50
EAEE 4301	V01/18102		Shaina Kelly	3.00	1/99

EAEE E4302 CARBON CAPTURE. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level math and science or instructor's permission.
Major technologies to store carbon dioxide, geological, ocean, and in the carbon chemical pool. Carbon dioxide transport technologies also covered. In addition to basic science and engineering challenges of each technology, full spectrum of economic, environmental, regulatory, and political/policy aspects, and their implication for regional and global carbon management strategies of the future. Combination of lectures, class debates and breakout groups, student presentations, and independent final projects

Spring 2026: EAEE E4302

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4302	001/13052	T 4:10pm - 6:40pm 304 Hamilton Hall	Xiaoyang Shi	3.00	32/40

EAEE E4305 CO2 UTILIZATION AND CONVERSION. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level thermodynamics or instructor's permission.
Introduction to various CO2 utilization and conversion technologies that can reduce the overall carbon footprint of commodity chemicals and materials. Fundamentals of thermodynamics, fluid mechanics, reaction kinetics, catalysis and reactor design will be discussed using technological examples such as enhanced oil recovery, shale fracking, photo and electrochemical conversion of CO2 to chemical and fuels, and formation of solid carbonates and their various uses. Life cycle analyses of potential products and utilization schemes will also be discussed, as well as the use of renewable energy for CO2 conversion.

Spring 2026: EAEE E4305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4305	001/13054	M W 1:10pm - 2:25pm 420 Pupin Laboratories	Robert Farrauto	3.00	39/50

EAEE E4350 PLANNG/MGT-URBAN HYDROLGC SYST. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3161) or ENME E3161; or equivalent.
Introduction to runoff and drainage systems in an urban setting, including hydrologic and hydraulic analyses, flow and water quality monitoring, common regulatory issues, and mathematical modeling. Applications to problems of climate variation, land use changes, infrastructure operation and receiving water quality, developed using statistical packages, public-domain models, and Geographical Information Systems (GIS). Team projects that can lead to publication quality analyses in relevant fields of interest. Emphasis on the unique technical, regulatory, fiscal, policy, and other interdisciplinary issues that pose a challenge to effective planning and management of urban hydrologic systems

Fall 2026: EAEE E4350

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4350	001/13495	Th 4:10pm - 6:40pm 227 Seeley W. Mudd Building	Eric Rosenberg	3.00	12/30

EAEE E4550 CATALYSIS OF EMISSIONS CONTROL. *3.00 points*.
Lect: 3.

Prerequisites: One year of general college chemistry.
Fundamentals of heterogeneous catalysis including modern catalytic preparation techniques. Analysis and design of catalytic emissions control systems. Introduction to current industrial catalytic solutions for controlling gaseous emissions. Introduction to future catalytically enabled control technologies

Fall 2026: EAEE E4550

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4550	001/13496	M W 11:40am - 12:55pm 337 Seeley W. Mudd Building	Robert Farrauto	3.00	5/30
EAEE 4550	V01/19950		Robert Farrauto	3.00	0/99

EAEE E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

EAEE E4901 ENVIRONMENTAL MICROBIOLOGY. *3.00 points*.
Lect: 3.

Basic microbiological principles; microbial metabolism; identification and interactions of microbial populations responsible for the biotransformation of pollutants; mathematical modeling of microbially mediated processes; biotechnology and engineering applications using microbial systems for pollution control

Fall 2026: EAEE E4901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4901	001/14396	T Th 2:40pm - 3:55pm 545 Seeley W. Mudd Building	Kartik Chandran	3.00	9/25
EAEE 4901	V01/18103		Kartik Chandran	3.00	0/99

EAEE E4990 Special Topics in Earth and Environmental Engineering. *3.00 points*.
Special topics in earth and environmental engineering. Content and prerequisites vary between sections and semesters. May be repeated for credit

Spring 2026: EAEE E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4990	001/18033	M W 6:10pm - 7:25pm 415 Schapiro Cepser	Candace Agonafir	3.00	9/40

Fall 2026: EAEE E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4990	001/16750		Gregory Elsaesser	3.00	1/20
EAEE 4990	002/16751	M W 6:10pm - 7:25pm 253 Engineering Terrace	Candace Agonafir	3.00	2/20

EAEE E4999 FIELDWORK. *1.00 point*.
Prerequisites: Instructor's written permission.
Only EAEE graduate students who need relevant off-campus work experience as part of their program of study as determined by the instructor. Written application must be made prior to registration outlining proposed study program. Final reports required. This course may not be taken for pass/ fail credit or audited. International students must also consult with the International Students and Scholars Office

Summer 2026: EAEE E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4999	001/11465		Yin Yip Ngai	1.00	0/10

EAEE E6132 Numerical methods in geomechanics. *3 points*.
Lect: 3.

Prerequisites: (EAEE E3112) and (CIEN E4241) or CIEN E4241; and EAEE E3112 or instructor's permission.
A detailed survey of numerical methods used in geomechanics, emphasizing the Finite Element Method (FEM). Review of the behavior of geological materials. Water and heat flow problems. FEM techniques for solving nonlinear problems, and simulating incremental excavation and loading on the surface and underground.

EAEE E6140 ENVIRONMENTAL PHYSICOCHEMICAL PROCESSES. *3.00 points*.
Prerequisites: CIEE E4163 AND CIEE E4252; or the equivalent, or the instructor's permission.
Prerequisites: (CIEE E4252) and (CIEE E4163) or the equivalent, or the instructors permission. Fundamentals and applications of key physicochemical processes relevant to water quality engineering (such as water treatment, waste water treatment/reuse/recycling, desalination) and the natural environment (e.g. lakes, rivers, groundwater)

EAEE E6150 INDUSTRIAL CATALYSIS. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E4550) or EAEE E4550; or equivalent, or instructors permission.
Fundamental principles of kinetics, characterization and preparation of catalysts for production of petroleum products for conventional transportation fuels, specialty chemicals, polymers, food products, hydrogen and fuel cells and the application of catalysis in biomass conversion to fuel. Update of the ever changing demands and challenges in environmental applications, focusing on advanced catalytic applications as described in modern literature and patents

EAEE E6181 Advanced Electrochemical Energy Storage. *3.00 points*.
Prerequisites: EAEE E4002 AND EAEE E4180
Most modern commercial implementations of electrochemical energy storage are not fully deterministic: provides context and best-hypotheses for modern challenges. Topics include current understanding of Lithium/Lithium Anode Solid-Electrolyte-Interphase, Reversible and Irreversible Side Reactions in Redox flow systems, electrochemically correlated mechanical fracture at multiple scales, relationships between electrolyte solvation and electrode insertion, roughening, smoothing, and detachment behavior of metal anodes, best practices in structural, chemical, and microscopic characterization, morphological vs. macro-homogenous transport models, particle to electrode to cell nonlinearity

EAEE E6212 CARBON SEQUESTRATION. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E3200) or EAEE E3200; or equivalent or instructor's permission.
New technologies for capturing carbon dioxide and disposing of it away from the atmosphere. Detailed discussion of the extent of the human modifications to the natural carbon cycle, the motivation and scope of future carbon management strategies and the role of carbon sequestration. Introduction of several carbon sequestration technologies that allow for the capture and permanent disposal of carbon dioxide. Engineering issues in their implementation, economic impacts, and the environmental issues raised by the various methods.

Fall 2026: EAEE E6212

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 6212	001/13494	M 4:10pm - 6:40pm 142 Uris Hall		3.00	6/25

EAEE E6990 Advanced Topics in Earth and Environmental Engineering. *3.00 points*.
Advanced topics in earth and environmental engineering for senior graduate students. Content and prerequisites vary between sections and semesters. May be repeated for credit

EAEE E8229 SEL TPC:PROC MINERALS # WASTES. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (CHEE E4252) or CHEE E4252; or instructor's permission.
Critical discussion of current research topics and publications in the area of flotation, flocculation, and other mineral processing techniques, particularly mechanisms of adsorption, interactions of particles in solution, thinning of liquid films, and optimization techniques.

EAEE E9271 EARTH # ENVIRONMNTL ENG THESIS. *0.00-6.00 points*.
0-6 pts.

Research work culminating in a creditable dissertation on a problem of a fundamental nature selected in conference between student and adviser. Wide latitude is permitted in choice of a subject, but independent work of distinctly graduate character is required in its handling

Spring 2026: EAEE E9271

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9271	001/17354		Kartik Chandran	0.00-6.00	0/10
EAEE 9271	002/17355		Robert Farrauto	0.00-6.00	3/10
EAEE 9271	003/17356		Raymond Farinato	0.00-6.00	0/10
EAEE 9271	004/17357		Greeshma Gadikota	0.00-6.00	0/10
EAEE 9271	005/17358		Pierre Gentine	0.00-6.00	1/10
EAEE 9271	006/17359		Shaina Kelly	0.00-6.00	0/10
EAEE 9271	007/17360		Vijay Modi	0.00-6.00	0/10
EAEE 9271	008/17361		Nagaraj Devarayasamudram	0.00-6.00	0/10
EAEE 9271	009/17362		Dan Steingart	0.00-6.00	0/10
EAEE 9271	010/17363		Alan West	0.00-6.00	0/10
EAEE 9271	011/17364		Bolun Xu	0.00-6.00	0/10
EAEE 9271	012/17365		Yin Yip Ngai	0.00-6.00	2/10
EAEE 9271	013/17366		Adeyemi Adeleye	0.00-6.00	2/10
EAEE 9271	014/17367		Oscar Nordness	0.00-6.00	0/10

Summer 2026: EAEE E9271

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9271	001/12917		Adeyemi Adeleye	0.00-6.00	0/5

EAEE E9280 EARTH # ENVIRONMENTAL COLLOQ. *0.00 points*.
Lect: 1.5.

All graduate students are required to attend the departmental colloquium as long as they are in residence. Advanced doctoral students may be excused after three years of residence. No degree credit is granted

Spring 2026: EAEE E9280

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9280	001/13057	Th 10:10am - 11:25am 602 Hamilton Hall	Oscar Nordness	0.00	44/85

Fall 2026: EAEE E9280

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9280	001/14401	Th 11:00am - 12:00pm 702 Hamilton Hall	Oscar Nordness	0.00	29/80

EAEE E9305 EARTH/ENVIRONMNTL ENG RESEARCH. *0.00-12.00 points*.
0-12 pts.

Graduate research directed toward solution of a problem in mineral processing or chemical metallurgy

Spring 2026: EAEE E9305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9305	001/17368		Kartik Chandran	0.00-12.00	3/10
EAEE 9305	002/17369		Robert Farrauto	0.00-12.00	6/10
EAEE 9305	003/17370		Raymond Farinato	0.00-12.00	1/10
EAEE 9305	004/17371		Greeshma Gadikota	0.00-12.00	5/10
EAEE 9305	005/17372		Pierre Gentine	0.00-12.00	4/10
EAEE 9305	006/17373		Shaina Kelly	0.00-12.00	8/10
EAEE 9305	007/17374		Vijay Modi	0.00-12.00	1/10
EAEE 9305	008/17375		Nagaraj Devarayasamudram	0.00-12.00	0/10
EAEE 9305	009/17376		Dan Steingart	0.00-12.00	2/10
EAEE 9305	010/17377		Alan West	0.00-12.00	0/10
EAEE 9305	011/17383		Bolun Xu	0.00-12.00	6/10
EAEE 9305	012/17379		Yin Yip Ngai	0.00-12.00	0/10
EAEE 9305	013/17380		Adeyemi Adeleye	0.00-12.00	4/10
EAEE 9305	014/17381		Oscar Nordness	0.00-12.00	3/10
EAEE 9305	015/20077		Pengbo Chu	0.00-12.00	1/10

Summer 2026: EAEE E9305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9305	001/12830		Adeyemi Adeleye	0.00-12.00	1/5
EAEE 9305	002/12867		Dan Steingart	0.00-12.00	2/5
EAEE 9305	006/11964		Shaina Kelly	0.00-12.00	4/10

Fall 2026: EAEE E9305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9305	001/14425		Kartik Chandran	0.00-12.00	2/20
EAEE 9305	002/14426		Robert Farrauto	0.00-12.00	6/20
EAEE 9305	003/14427		Raymond Farinato	0.00-12.00	1/20
EAEE 9305	004/14428		Pengbo Chu	0.00-12.00	1/20
EAEE 9305	005/14429		Pierre Gentine	0.00-12.00	3/20
EAEE 9305	006/14430		Shaina Kelly	0.00-12.00	6/20
EAEE 9305	007/14431		Upmanu Lall	0.00-12.00	0/20
EAEE 9305	008/14432		Vijay Modi	0.00-12.00	1/20
EAEE 9305	009/14433		Nagaraj Devarayasamudram	0.00-12.00	0/20
EAEE 9305	010/14434		Dan Steingart	0.00-12.00	2/20
EAEE 9305	011/14435		Alan West	0.00-12.00	1/20
EAEE 9305	012/14436		Bolun Xu	0.00-12.00	2/20
EAEE 9305	013/14437		Yin Yip Ngai	0.00-12.00	3/20
EAEE 9305	014/14438		Oscar Nordness	0.00-12.00	4/20
EAEE 9305	015/14439		Adeyemi Adeleye	0.00-12.00	0/20
EAEE 9305	016/14440		Greeshma Gadikota	0.00-12.00	4/20

EAEE E9800 DOCTORAL RESEARCH INSTRUCTION. *0.00-12.00 points*.
3, 6, 9 or 12 pts.

A candidate for the Eng.Sc.D. degree in mineral engineering must register for 12 points of doctoral research instruction. Registration in EAEE E9800 may not be used to satisfy the minimum residence requirement for the degree

Spring 2026: EAEE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9800	001/18211		Upmanu Lall	0.00-12.00	3/5
EAEE 9800	002/19632		Kartik Chandran	0.00-12.00	0/2

Summer 2026: EAEE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9800	001/12829		Upmanu Lall	0.00-12.00	0/2

Fall 2026: EAEE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9800	001/14441		Kartik Chandran	0.00-12.00	1/5
EAEE 9800	002/15834		Upmanu Lall	0.00-12.00	0/2

ECIA W4100 MGMT # DEVPT OF WATER SYSTEMS. *3.00 points*.
Lect: 3.

Decision analytic framework for operating, managing, and planning water systems, considering changing climate, values and needs. Public and private sector models explored through US-international case studies on topics ranging from integrated watershed management to the analysis of specific projects for flood mitigation, water and wastewater treatment, or distribution system evaluation and improvement

EEEL E4220 Energy System Economics and Optimization. *3.00 points*.
Prerequisites: Basic linear algebra. Basic probability and statistics. Basic programming skills.
Fundamental of power system economics over which the current electricity markets are designed. Formulation of unit commitment and economic dispatch as mathematical optimization. Modeling of thermal generators, renewable generators, energy storage, and other grid resources in power system optimization. Introduction of equilibriums in electricity markets. Introduction of ancillary service markets. Overview of current energy system research topics. Designed for masters and doctoral students, but is also open to undergraduates with the appropriate foundation classes

Fall 2026: EEEL E4220

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEEL 4220	001/14399	M W 10:10am - 11:25am 603 Hamilton Hall	Bolun Xu	3.00	33/54

EESC UN3109 CLIMATE PHYSICS. *3.00 points*.
This is a calculus-based treatment of climate system physics and the mechanisms of anthropogenic climate change. By the end of this course, students will understand: how solar radiation and rotating fluid dynamics determine the basic climate state, mechanisms of natural variability and change in climate, why anthropogenic climate change is occurring, and which scientific uncertainties are most important to estimates of 21st century change. This course is designed for undergraduate students seeking a quantitative introduction to climate and climate change science. EESC V2100 (Climate Systems) is not a prerequisite, but can also be taken for credit if it is taken before this course

Spring 2026: EESC UN3109

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EESC 3109	001/12416	T Th 10:10am - 11:25am 555 Ext Schermerhorn Hall	Adam Sobel	3.00	9/25

EESC GR5400 DYNAMICS CLIMATE VAR # CHNG. *3.00 points*.
Required for students in the Climate and Society MA Program. An overview of how the climate system works on large scales of space and time, with particular attention to the science and methods underlying forecasts of climate variability and climate change. This course serves as the basic physical science course for the MA program in Climate and Society

EESC GR5404 REGIONAL CLIMATE AND CLIMATE IMPACTS. *3.00 points*.
Course is required for the MA in Climate and Society program. Open to a maximum of 8 additional graduate students, admitted by application to and with the instructor's permission.

Prerequisites: EESC GU5400EESC GU5401
The dynamics of environment and society interact with climate and can be modified through use of modern climate information. To arrive at the best use of climate information, there is a need to see climate in a balanced way, among the myriad of factors at play. Equally, there is a need to appreciate the range of climate information available and to grasp its underlying basis and the reasons for varying levels of certainty. This includes subseasonal to seasonal climate forecasts for developing climate services for better adapting to climate stresses, and decadal and climate change projections for improved climate policy. Many decisions in society are at more local scales, and regional climate information considered at appropriate scales and appropriately translated to be accessible and salient to stakeholders is key. Students will build a sufficient understanding of the science behind the information, and analyze examples of how the information can and is being used. This course will prepare the ground for a holistic understanding needed for wise use of climate information

ENGI E8000 DOCTORAL FIELD WORK. *1.00 point*.
Fieldwork is integral to the academic preparation and professional development of doctoral students. This course provides the academic framework for fieldwork experience required for the student's program of study. Fieldwork documentation and faculty adviser approval is required prior to registration. A final written report must be submitted. This course will count toward the degree program and cannot be taken for pass/fail credit or audited. With approval from the department chair or the doctoral program director, doctoral students can register for this course at most twice. In rare situations, exceptions may be granted by the Dean's Office to register for the course more than twice (e.g., doctoral students funded by industrial grants who wish to perform doctoral fieldwork for their corporate sponsor). The doctoral student must be registered for this course during the same term as the fieldwork experience.

EAEE E1100 A BETTER PLANET BY DESIGN. *3.00 points*.

EAEE E2100 A BETTER PLANET BY DESIGN. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lect: 3.

Introduction to design for a sustainable planet. Scientific understanding of the challenges. Innovative technologies for water, energy, food, materials provision. Multi-scale modeling and conceptual framework for understanding environmental, resource, human, ecological and economic impacts and design performance evaluation. Focus on the linkages between planetary, regional and urban water, energy, mineral, food, climate, economic and ecological cycles. Solution strategies for developed and developing country settings

Fall 2026: EAEE E2100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 2100	001/14400	M W 2:40pm - 3:55pm 633 Seeley W. Mudd Building	Adeyemi Adeleye	3.00	68/70

EAEE E3103 ENERGY,MINERALS,MATERIALS SYST. *3.00 points*.
Lect: 3.

Prerequisites: or equivalent.
Corequisites: EAEE E4180
Overview of energy resources, resource management from extraction and processing to recycling and final disposal of wastes. Resources availability and resource processing in the context of the global natural and anthropogenic material cycles; thermodynamic and chemical conditions including nonequilibrium effects that shape the resource base; extractive technologies and their impact on the environment and the biogeochemical cycles; chemical extraction from mineral ores, and metallurgical processes for extraction of metals. In analogy to metallurgical processing, power generation and the refining of fuels are treated as extraction and refining processes. Large scale of power generation and a discussion of its impact on the global biogeochemical cycles.

Fall 2026: EAEE E3103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3103	001/14390	T Th 11:40am - 12:55pm 825 Seeley W. Mudd Building	Raymond Farinato	3.00	17/40

EAEE E3112 Introduction to rock mechanics. *3 points*.
Lect: 3.

Prerequisites: (EAEE E3101) and (ENME E3111) or EAEE E3101 and ENME 3111, or their equivalents.
Rock as an engineering material, geometry and strength of rock joints, geotechnical classification of rock masses, strength and failure of rock, field investigations prior to excavation in rock, rock reinforcement, analysis and support of rock slopes and tunnels, and case histories.

EAEE E3185 Summer fieldwork for earth and environmental engineers. *0.5 points*.
Undergraduates in Earth and Environmental Engineering may spend up to 3 weeks in the field under staff direction. The course consists of mine, landfill, plant, and major excavation site visits and brief instruction of surveying methods. A final report is required.

EAEE E3200 TRANSPORT/CHEM RATE PHENOMENA. *3.00 points*.
Lect: 3.

Prerequisites: (APMA E2101) APMA E2101
Fluid statics. Basics of flow analysis. Dimensional analysis. Pipe flow. Fluid dynamics, heat and mass transfer. Effects of velocity, temperature, and concentration gradients 130 ENGINEERING 2021–2022 and material properties on fluid flow, heat and mass transfer. Applications to environmental engineering problems.

Fall 2026: EAEE E3200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3200	001/14392	M W 1:10pm - 2:25pm 414 Pupin Laboratories	Yin Yip Ngai	3.00	8/30

EAEE E3800 EARTH # ENVIR ENGIN LAB I. *2.00 points*.
Lect: 1. Lab: 3.

Experiments on fundamental aspects of Earth and environmental engineering with emphasis on the applications of chemistry, biology and thermodynamics to environmental processes: energy generation, analysis and purification of water, environmental biology, and biochemical treatment of wastes. Students will learn the laboratory procedures and use analytical equipment firsthand, hence demonstrating experimentally the theoretical concepts learned in class.

Spring 2026: EAEE E3800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3800	001/12886	T Th 11:00am - 1:00pm 332 Uris Hall	Luana Llanes	2.00	7/15

EAEE E3899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

EAEE E3900 UNDERGRAD RES-ENVIRONMTL ENGIN. *0.00-3.00 points*.
0-3 pts. Directed study.

This course may be repeated for credit, but no more than 3 points of this course may be counted towards the satisfaction of the B. S. degree requirements. Candidates for the B.S. degree may conduct an investigation in Earth and Environmental Engineering, or carry out a special project under the supervision of EAEE faculty. Credit for the course is contingent on the submission of an acceptable thesis or final report. This course cannot substitute for the Undergraduate design project (EAEE E3999x or EAEE E3999y)

Spring 2026: EAEE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3900	001/17340		Kartik Chandran	0.00-3.00	2/10
EAEE 3900	002/17341		Robert Farrauto	0.00-3.00	0/10
EAEE 3900	003/17342		Raymond Farinato	0.00-3.00	0/10
EAEE 3900	004/17343		Greeshma Gadikota	0.00-3.00	0/10
EAEE 3900	005/17344		Pierre Gentine	0.00-3.00	1/10
EAEE 3900	006/17345		Shaina Kelly	0.00-3.00	0/10
EAEE 3900	007/17346		Vijay Modi	0.00-3.00	0/10
EAEE 3900	008/17347		Nagaraj Devarayasamudram	0.00-3.00	0/10
EAEE 3900	009/17348		Dan Steingart	0.00-3.00	0/10
EAEE 3900	010/17349		Alan West	0.00-3.00	0/10
EAEE 3900	012/17350		Bolun Xu	0.00-3.00	0/10
EAEE 3900	013/17351		Yin Yip Ngai	0.00-3.00	1/10
EAEE 3900	014/17352		Adeyemi Adeleye	0.00-3.00	0/10
EAEE 3900	015/17353		Oscar Nordness	0.00-3.00	1/10

Fall 2026: EAEE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3900	001/14407		Kartik Chandran	0.00-3.00	0/10
EAEE 3900	002/14408		Robert Farrauto	0.00-3.00	0/10
EAEE 3900	003/14410		Raymond Farinato	0.00-3.00	1/10
EAEE 3900	004/14411			0.00-3.00	0/10
EAEE 3900	005/14412		Pierre Gentine	0.00-3.00	0/10
EAEE 3900	006/14413		Shaina Kelly	0.00-3.00	0/10
EAEE 3900	007/14414		Upmanu Lall	0.00-3.00	0/10
EAEE 3900	008/14415		Vijay Modi	0.00-3.00	0/10
EAEE 3900	009/14416		Nagaraj Devarayasamudram	0.00-3.00	0/10
EAEE 3900	010/14417		Dan Steingart	0.00-3.00	0/10
EAEE 3900	011/14418		Alan West	0.00-3.00	0/10
EAEE 3900	012/14419		Bolun Xu	0.00-3.00	0/10
EAEE 3900	013/14420		Yin Yip Ngai	0.00-3.00	1/10
EAEE 3900	014/14422		Adeyemi Adeleye	0.00-3.00	1/10
EAEE 3900	015/14424		Oscar Nordness	0.00-3.00	1/10

EAEE E3901 ENVIRONMENTAL MICROBIOLOGY. *3.00 points*.
Lect: 3.

Prerequisites: (CHEM UN1404) or CHEM C1404; or equivalent.
Fundamentals of microbiology, genetics and molecular biology, principles of microbial nutrition, energetics and kinetics, application of novel and state-of-the-art techniques in monitoring the structure and function of microbial communities in the environment, engineered processes for biochemical waste treatment and bioremediation, microorganisms and public health, global microbial elemental cycles

Fall 2026: EAEE E3901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3901	001/14397	T Th 2:40pm - 3:55pm 545 Seeley W. Mudd Building	Kartik Chandran	3.00	8/20

EAEE E3995 Fieldwork. *1.00-2.00 points*.
Prerequisites: Instructor's permission.
Obtained internship and approval from faculty adviser. Written application must be made prior to registration outlining proposed internship and study program. Final reports required. May not be taken for pass/fail credit or audited. Fieldwork credits may not count toward any major core, technical elective, and nontechnical requirements. International students must also consult with the International Students and Scholars Office. Note: only for EAEE undergraduate students who need relevant off-campus work experience as a part of their program of study as determined by instructor

Spring 2026: EAEE E3995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3995	001/20461		Bolun Xu	1.00-2.00	1/5

Summer 2026: EAEE E3995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3995	001/11464		Bolun Xu	1.00-2.00	1/10

EAEE E3998 UNDERGRADUATE PROJECT I. *2.00 points*.
2 pts. (each semeseter). Lect: 1. Lab: 2.

Prerequisites: Senior standing.
Students must enroll for both 3998x and 3999y during their senior year. Selection of an actual problem in Earth and environmental engineering, and design of an engineering solution including technical, economic, environmental, ethical, health and safety, social issues. Use of software for design, visualization, economic analysis, and report preparation. Students may work in teams. Presentation of results in a formal report and public presentation

Fall 2026: EAEE E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3998	001/14398		Dan Steingart	2.00	7/30

EAEE E3999 UNDERGRADUATE PROJECT II. *2.00 points*.
2 pts. (each semeseter). Lect: 1. Lab: 2.

Prerequisites: Senior standing.
Students must enroll for both 3998x and 3999y during their senior year. Selection of an actual problem in Earth and environmental engineering, and design of an engineering solution including technical, economic, environmental, ethical, health and safety, social issues. Use of software for design, visualization, economic analysis, and report preparation. Students may work in teams. Presentation of results in a formal report and public presentation

Spring 2026: EAEE E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 3999	001/12889	F 5:00pm - 6:00pm 423 Kent Hall	Robert Farrauto	2.00	10/15

EAEE E4000 Machine learning for environmental engineering and science. *3.00 points*.
Prerequisites: Computer language Python or Julia, some linear algebra and machine learning.
Aimed at understanding and testing state-of?the-art methods in machine learning applied to environmental sciences and engineering problems. Potential applications include but are not limited to remote sensing, and environmental and geophysical fluid dynamics. Includes testing "vanilla" ML algorithms, feedforward neural networks, random forests, shallow vs deep networks, and the details of machine learning techniques

Fall 2026: EAEE E4000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4000	001/14403	M 4:10pm - 6:40pm 616 Martin Luther King Building		3.00	1/51

EAEE E4001 INDUST ECOLOGY-EARTH RESOURCES. *3.00 points*.
Lect: 3.

Industrial ecology examines how to reconfigure industrial activities so as to minimize the adverse environmental and material resource effects on the planet. Engineering applications of methodology of industrial ecology in the analysis of current processes and products and the selection or design of environmentally superior alternatives. Home assignments of illustrative quantitative problems

EAEE E4002 ALTERNATIVE ENERGY RESOURCES. *3.00 points*.
An engineering and economic analysis of past, present and future energy resources. Technological options and their role in the world energy markets. Understanding limits of energy and power density and its impact of resource adoption and feasibility. Comparison of renewable and non-renewable energy resources and analysis of the consequences of various technological choices and constraints. Economic considerations, energy availability, and the environmental consequences of large-scale, widespread use of each particular technology. Critical analysis of carbon dioxide capture and carbon dioxide disposal as a means of sustaining the fossil fuel options in comparison to dramatic increase of electrified resources

Spring 2026: EAEE E4002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4002	001/12894	M W 2:40pm - 3:55pm 428 Pupin Laboratories	Dan Steingart	3.00	97/100

EAEE E4003 AQUATIC CHEMISTRY. *3.00 points*.
Lect: 3.

Prerequisites: (CHEE E3010)
Corequisites: EAEE E3801
Principles of physical chemistry applied to equilibria and kinetics of aqueous solutions in contact with minerals and anthropogenic residues. The scientific background for addressing problems of aqueous pollution, water treatment, and sustainable production of materials with minimum environmental impact. Hydrolysis, oxidation-reduction, complex formation, dissolution and precipitation, predominance diagrams; examples of natural water systems, processes for water treatment and for the production of inorganic materials from minerals.

Spring 2026: EAEE E4003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4003	001/12985	T Th 8:40am - 9:55am 420 Pupin Laboratories	Oscar Nordness	3.00	11/50

EAEE E4006 Field methods for environmental engineering. *3 points*.
Lect: 1.5. Lab: 2.

Prerequisites: (ENME E3161) or ENME E3161; or equivalent or instructor's permission.
Principles and methods for designing, building and testing systems to sense the environment. Monitoring the atmosphere, water bodies and boundary interfaces between the two. Sensor systems for monitoring heat and mass flows, chemicals, and biota. Measurements of velocity, temperature, flux and concentration in the field. The class will involve planning and execution of a study to sense a local environmental system.

EAEE E4009 GIS-RES,ENVIR,INFRASTRUCTR MGT. *3.00 points*.
Lect: 3.

Prerequisites: Instructor's permission.
Basic concepts of spatial data representation and organization, and analytical tools are introduced and applied in a form of case studies from hydrology, environmental conservation, and emergency response to natural or man-made hazards, among others. Technical content includes geographic topics (map projections, cartography, etc.), spatial statistics, database design and use, interpolation and visualization of spatial surfaces and volumes, and multi-criteria decision analysis. Students will learn the basics of ArcGIS Pro, Model Builder and Python. Elective term projects or final exams emphasize spatial information synthesis towards the solution of a specific problem

Spring 2026: EAEE E4009

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4009	001/12991	M 7:10pm - 8:30pm 420 Pupin Laboratories	Yuri Gorokhovich	3.00	14/50
EAEE 4009	LAB/12994	M T 8:40pm - 9:55pm 420 Pupin Laboratories	Yuri Gorokhovich	3.00	0/50

EAEE E4011 Industrial ecology for manufacturing. *3 points*.
Lect: 3.

Prerequisites: (EAEE E4001) or EAEE E4001; or instructor's permission.
Application of industrial ecology to Design for Environment (DFE) of processes and products using environmental indices of resources consumption and pollution loads. Introduction of methodology for Life Cycle Assessment (LCA) of manufactured products. Analysis of several DFE and LCA case studies. Term project required on use of DFE/LCA on a specific product/process: (a) product design complete with materials and process selection, energy consumption, and waste loadings; (b) LCA of an existing industrial or consumer product using a commercially established method.

EAEE E4100 A Better Planet by Design (MS). *3.00 points*.
Foundational for the Master of Science in Earth and Environmental Engineering degree. Provides broader understanding of engineering tools critical/ essential to success in large-scale, engineering projects. Divided into two parts: Module on global/regional flows, and systems approach, and Module on Engineering Principles in Earth # Environmental Engineering. Guest lectures on several topics will be provided

Fall 2026: EAEE E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4100	001/14393	T 4:10pm - 6:40pm 644 Seeley W. Mudd Building	Luana Llanes	3.00	32/44

EAEE E4103 Environmental Soil Chemistry. *3.00 points*.
Prerequisites: (CHEE E3010) Or instructor's permission.
Introduction to principles of chemical reactions in soils, soil chemical properties and processes, and the chemical nature of soil solids. The scientific background for characterizing soil health, addressing soil pollution, performing soil remediation, and sustainable use of soil/ subsurface resources. Properties of elements and molecules in soil, soil water chemistry, redox reactions in natural systems, mineralogy and weathering processes in soils, soil carbon cycling, climate change impact on soil, soil organic matter formation and structure, and legacy and emerging contaminants.

Spring 2026: EAEE E4103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4103	001/13010	M W 1:10pm - 2:25pm 307 Uris Hall	Adeyemi Adeleye	3.00	4/40

EAEE E4140 ENVIRONMENTAL PHYSICOCHEMICAL PROCESSES. *3.00 points*.
Prerequisites: (EACE E4163 and EACE E4252) or the equivalent, or the instructor's permission
Fundamentals and applications of key physicochemical processes relevant to water quality engineering (such as water treatment, waste water treatment/reuse/recycling, desalination) and the natural environment (e.g. lakes, rivers, groundwater).

Spring 2026: EAEE E4140

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4140	001/13015	T Th 1:10pm - 2:25pm 333 Uris Hall	Yin Yip Ngai	3.00	8/35

EAEE E4150 AIR POLLUTION PREVENTION/CONTR. *3.00 points*.
Lect: 3.

Adverse effects of air pollution, sources and transport media, monitoring and modeling of air quality, collection and treatment techniques, pollution prevention through waste minimalization and clean technologies, laws, regulations, standards, and guidelines

EAEE E4160 SOLID # HAZARDOUS WASTE MGMT. *3.00 points*.
Lect: 3.

Generation, composition, collection, transport, storage and disposal of solid and hazardous waste. Impact on the environment and public health. Government regulations. Recycling and resource recovery

Fall 2026: EAEE E4160

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4160	001/14387	M W 9:10am - 10:25am 420 Pupin Laboratories	Xiaoyang Shi	3.00	20/50

EAEE E4180 ELECTROCHEMICAL ENERGY STORAGE SYSTEMS. *3.00 points*.
Lec: 3.

Prerequisites: (CHEM UN1403) and (CHEM UN1404) and (MECE E3301) and (PHYS UN1402) Or equivalent
Corequisites: CHEN E4201
EAEE E3103
Survey course on electrochemical energy storage with a focus on closed-form cells. Fundamentals of thermodynamics will be reviewed and fundamentals of electrochemistry introduced. Application of fundamentals to devices such as batteries, flow batteries, and fuel cells. Device optimization with respect to energy density, power density, cycle life and capital cost will be considered.

EAEE E4190 PHOTOVOLTAIC SYSTEMS ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: Senior standing or instructor's permission.
A systems approach for intermittent renewable energy involving the study of resources, generation, demand, storage, transmission, economics and politic. Study of current and emerging photovoltaic technologies, with focus on basic sustainability metrics (e.g. cost, resource availability, and life-cycle environmental impacts). The status and potential of 1st and 2nd generation photovoltaic technologies (e.g. crystalline and amorphous Si, CdTe, CIGS) and emerging 3rd generation ones. Storage options to overcome the intermittency constraint. Large scales of renewable energy technologies and plug-in hybrid electric cars

EAEE E4200 Introduction to Sustainable Production of Earth Mineral # Metal Resources. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E3103) and undergraduate level courses in chemistry especially inorganic, physical and organic and physics CHEM UN1404, PHYS UN1401, PHYS UN1402. A highly recommended course: CHEE E4252.
Introductory course focused on engineering principles and unit operations involved in sustainable processing of primary and secondary earth mineral and metal resources. Covers entire value chain, viz, aspects of economic resource deposits, mining, fundamental principles and processes for size reduction, separations based on physical and chemical properties of minerals and metals, solid-liquid separation, waste and pollution management, water and energy efficiency and management, safety and health, environmental impact assessment and control, and economic efficiency. Special emphasis on concepts and practical applications within "mines of the future" framework to highlight innovations and transformational technological changes in progress.

Fall 2026: EAEE E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4200	001/14394	M W 2:40pm - 3:55pm 603 Hamilton Hall	Pengbo Chu	3.00	12/40

EAEE E4210 THERMAL TREATMNT-WASTE/BIO MAT. *3.00 points*.
Lect: 3.

Prerequisites: (CHEE E3010) or CHEE E3010; or equivalent or instructors permission.
Origins, quantities generated, and characterization of solid wastes. Chemical and physical phenomena in the combustion or gasification of wastes. Application of thermal conversion technologies, ranging from combustion to gasification and pyrolysis. Quantitative description of the dominant waste to energy processes used worldwide, including feedstock preparation, moving grate and fluid bed combustion, heat transfer from combustion gases to steam, mitigation of high-temperature corrosion, electricity generation, district heating, metal recovery, emission control, and beneficial use of ash residues

EAEE E4220 Energy System Economics and Optimization. *3.00 points*.
Prerequisites: Basic linear algebra, basic probability and statistics, and basic programming skills.
Transitioning into a sustainable energy system is not only a technical challenge but also an economical one. Teaches students fundamentals of power system economics over which current electricity markets are designed. Also examines challenges and opportunities in future sustainable energy systems such as carbon tax, renewable energy, demand response, and energy storage. Covers mixed-integer linear programming and demonstrates how mathematical optimizations are integrated into energy system operations. Provides overview of current energy system research topics. Includes a project using mathematical tools to solve real-world problems in the energy system

EAEE E4222 Interfacial Engineering for Sustainable Energy and Materials. *3.00 points*.
Prerequisites: EAEE E3103; or equivalent or instructor's permission.
Cross disciplinary interfacial engineering principles and applications in sustainable energy and material science. Surface science and systems analysis across different technology sectors - material production and processing, waste management, device manufacture, composites, coatings, ceramics, membranes, biomaterials, and microelectronics

Spring 2026: EAEE E4222

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4222	001/13028	T Th 11:40am - 12:55pm 333 Uris Hall	Raymond Farinato	3.00	8/50
EAEE 4222	V01/17337		Raymond Farinato	3.00	1/99

EAEE E4228 Separation Science and Technology in Sustainable Earth Resources Development. *3.00 points*.
Prerequisites: EAEE E3103 and undergraduate level courses in chemistry especially inorganic, physical and organic. Recommended: EAEE E4252, EAEE E4003, and EAEE E4200.
Detailed study of the chemical and physicochemical principles underlying separations in development of earth resources in a safe and sustainable manner. Covers wide-range of solid-solid, solid-liquid and liquid-liquid separations used in processing of mineral resources. Interfacial science and engineering principles of important industrial processes of flotation, flocculation, dewatering, interfacial transport, magnetic/gravity/electrostatic separations, solvent extraction, solid-support extraction, crystallization and precipitation. Emphasis on concepts in interfacial chemistry and concepts associated with 'mines of the future' framework.

EAEE E4257 ENVIR DATA ANALYSIS # MODELING. *3.00 points*.
Lect: 3.

Prerequisites: (STAT W4001 and ENGI E1006) or (IEOR E3658 and ENGI E1006) or (IEOR E4150 and ENGI E1006)
Introduction parametric and non-parametric statistical models applied to climate and environmental data analysis. Time and space data analysis methods will be focused, including clustering, autoregressive models, trend analysis, Bayesian analysis, missing data imputation, geostatistics, principal components analysis. Application to problems of climate variation and change; hydrology; air, water and soil pollution dynamics; disease propagation; ecological change; and resource assessment. The class requires the use of R with hands-on programming applied to a current environmental data analysis problem.

Spring 2026: EAEE E4257

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4257	001/13037	M W 10:10am - 11:25am 420 Pupin Laboratories	Bolun Xu	3.00	31/50

EAEE E4262 Space Exploration and Mining. *3.00 points*.
Needs and opportunities for space exploration and mining, resources in planets and asteroids, history of human colonization, terraforming Mars, Titan, and Moon, safety and health issues, benign mining, space junk extraction, microbial mining

EAEE E4280 Issues Facing the Water Industry. *3.00 points*.
Prerequisites: CHEE E3010 AND EAEE E3200 AND EAEE E4003
Principles and practice of water treatment and utility management will be presented. Project-based class where students will work in teams to solve an issue for a water utility. Variety of external experts will lecture and serve as a resource for students for the project. Allows students to better understand the role of the water utility in providing safe drinking water in a sustainable manner. Students will become familiar with the challenges facing water utilities, gain knowledge in the design and operation of water treatment systems, and learn how to develop solutions to water supply and water quality issues which will allow them to pursue productive careers in the consulting, utility, or regulatory fields

Spring 2026: EAEE E4280

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4280	001/13045	M 4:10pm - 6:40pm 602 Northwest Corner	William Becker	3.00	4/30

EAEE E4300 INTRO TO CARBON MANAGEMENT. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level mathematics and science, or instructor's permission.
Introduction to natural and anthropogenic carbon cycle, and carbon - climate. Rationale and need to manage carbon and tools with which to do so (basic science, psychology, economics and policy background, negotiations - society; emphasis on interdisciplinary and inter-dependent approach). Simple carbon emission model to estimate the impacts of a specific intervention with regards to national, per capita and global emissions. Student-led case studies (e.g. reforestation, biofuels, CCS, efficiency, alternative energy) to illustrate necessary systems approach required to tackle global challenges

Fall 2026: EAEE E4300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4300	001/13492	M 4:10pm - 6:40pm 142 Uris Hall		3.00	34/50
EAEE 4300	V01/19957		Sara Hamilton	3.00	1/99

EAEE E4301 CARBON STORAGE. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level mathematics and science, or instructor's permission.
This course is intended to provide a quantitative introduction to storage of carbon derived from greenhouse gases, mainly CO2, with a focus on geological carbon storage and mineralization in saline aquifers, depleted hydrocarbon reservoirs, and "reactive" subsurface formations (rocks rich in Fe, Ca, and Mg) as well and other natural and engineered storage reservoirs (e.g., terrestrial storage, ocean storage, building materials). Course modules cover fundamental processes such as geochemical fluid-rock interactions and fluid flow, transport, and trapping of supercritical and/or dissolved CO2 in the context of pore-scale properties to field-scale example storage reservoirs and specific integrative problems such as reservoir characterization and modeling techniques, estimating storage capacity, and regulations and monitoring.

Fall 2026: EAEE E4301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4301	001/13491	M W 11:40am - 12:55pm 627 Seeley W. Mudd Building	Shaina Kelly	3.00	25/50
EAEE 4301	V01/18102		Shaina Kelly	3.00	1/99

EAEE E4302 CARBON CAPTURE. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level math and science or instructor's permission.
Major technologies to store carbon dioxide, geological, ocean, and in the carbon chemical pool. Carbon dioxide transport technologies also covered. In addition to basic science and engineering challenges of each technology, full spectrum of economic, environmental, regulatory, and political/policy aspects, and their implication for regional and global carbon management strategies of the future. Combination of lectures, class debates and breakout groups, student presentations, and independent final projects

Spring 2026: EAEE E4302

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4302	001/13052	T 4:10pm - 6:40pm 304 Hamilton Hall	Xiaoyang Shi	3.00	32/40

EAEE E4303 CARBON MEASUREMNT # MONITORING. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level math and science or instructor permission.
Sources of various GHGs (whether fossil/industrial or biogenic), their chemical behavior, interactions, and global warming potential once airborne; available measurement, monitoring, and detection technologies to track gas emissions, including leakage from storage sites. Carbon accounting and reporting methodologies such as life cycle analysis, and corporate carbon footprinting. In addition to basic science and engineering challenges of each technology, full spectrum of economic, environmental, regulatory, and political/policy aspects, and their implication for regional and global carbon management strategies of the future. Combination of lectures, class debates and breakout groups, student presentations, and independent final projects

EAEE E4304 CLOSING THE CARBON CYCLE. *3.00 points*.
Lect: 3.

Prerequisites: Calculus, basic inorganic chemistry and basic physics including thermodynamics or instructor's permission.
Introduction to complex systems, their impact on our understanding and predictability of the carbon cycle , the use of systems analysis and modeling tools, as well as Bayesian statistics and decision theory for evaluating various solutions to close the carbon cycle, a detailed examination of the geochemical carbon cycle, major conceptual models that couple its changes to climate change, analysis of the anthropogenic carbon sources and sinks and role of carbon in energy production, closing the carbon cycle impacts on energy security, economic development and climate change protection, analysis of solutions to close the carbon cycle

EAEE E4305 CO2 UTILIZATION AND CONVERSION. *3.00 points*.
Lect: 3.

Prerequisites: Undergraduate level thermodynamics or instructor's permission.
Introduction to various CO2 utilization and conversion technologies that can reduce the overall carbon footprint of commodity chemicals and materials. Fundamentals of thermodynamics, fluid mechanics, reaction kinetics, catalysis and reactor design will be discussed using technological examples such as enhanced oil recovery, shale fracking, photo and electrochemical conversion of CO2 to chemical and fuels, and formation of solid carbonates and their various uses. Life cycle analyses of potential products and utilization schemes will also be discussed, as well as the use of renewable energy for CO2 conversion.

Spring 2026: EAEE E4305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4305	001/13054	M W 1:10pm - 2:25pm 420 Pupin Laboratories	Robert Farrauto	3.00	39/50

EAEE E4350 PLANNG/MGT-URBAN HYDROLGC SYST. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3161) or ENME E3161; or equivalent.
Introduction to runoff and drainage systems in an urban setting, including hydrologic and hydraulic analyses, flow and water quality monitoring, common regulatory issues, and mathematical modeling. Applications to problems of climate variation, land use changes, infrastructure operation and receiving water quality, developed using statistical packages, public-domain models, and Geographical Information Systems (GIS). Team projects that can lead to publication quality analyses in relevant fields of interest. Emphasis on the unique technical, regulatory, fiscal, policy, and other interdisciplinary issues that pose a challenge to effective planning and management of urban hydrologic systems

Fall 2026: EAEE E4350

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4350	001/13495	Th 4:10pm - 6:40pm 227 Seeley W. Mudd Building	Eric Rosenberg	3.00	12/30

EAEE E4361 ECON-EARTH RESOURCE INDUSTRIES. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E3103) or EAEE E3103; or instructor's permission.
Definition of terms. Survey of earth resource industries: resources, reserves, production, global trade, consumption of mineral commodities and fuels. Economics of recycling and substitution. Methods of project evaluation: estimation of operating costs and capital requirements, project feasibility, risk assessment, and environmental compliance. Cost estimation for reclamation/remediation projects. Financing of reclamation costs at abandoned mine sites and waste-disposal postclosure liability.

EAEE E4550 CATALYSIS OF EMISSIONS CONTROL. *3.00 points*.
Lect: 3.

Prerequisites: One year of general college chemistry.
Fundamentals of heterogeneous catalysis including modern catalytic preparation techniques. Analysis and design of catalytic emissions control systems. Introduction to current industrial catalytic solutions for controlling gaseous emissions. Introduction to future catalytically enabled control technologies

Fall 2026: EAEE E4550

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4550	001/13496	M W 11:40am - 12:55pm 337 Seeley W. Mudd Building	Robert Farrauto	3.00	5/30
EAEE 4550	V01/19950		Robert Farrauto	3.00	0/99

EAEE E4560 PARTICLE TECHNOLOGY. *3.00 points*.
Introduction to engineering processes involving particulates and powders. The fundamentals of particle characterization, multiphase flow behavior, particle formation, processing and utilization of particles in various engineering applications with examples in energy and environment related technologies. Engineering of functionalized particles and design of multiphase reactors and processing units with emphasis on fluidization technology. Particle technology is an interdisciplinary field. Due to the complexity of particulate systems, particle technology is often treated as art rather than science. In this course, the fundamental principles governing the key aspects of particle science and technology are introduced along with various industrial examples

EAEE E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

EAEE E4900 APP TRANSP/CHEM RATE PHENOMENA. *3.00 points*.

EAEE E4901 ENVIRONMENTAL MICROBIOLOGY. *3.00 points*.
Lect: 3.

Basic microbiological principles; microbial metabolism; identification and interactions of microbial populations responsible for the biotransformation of pollutants; mathematical modeling of microbially mediated processes; biotechnology and engineering applications using microbial systems for pollution control

Fall 2026: EAEE E4901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4901	001/14396	T Th 2:40pm - 3:55pm 545 Seeley W. Mudd Building	Kartik Chandran	3.00	9/25
EAEE 4901	V01/18103		Kartik Chandran	3.00	0/99

EAEE E4950 ENIVRON BIOCHEMICAL PROCESSES. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E4901) and (EAEE E4003) and (CIEE E4252) or CIEE E425E AND EAEE E4003 AND EAEE E4901; or instructor's permission.
Qualitative and quantitative considerations in engineered environmental biochemical processes. Characterization of multiple microbial reactions in a community and techniques for determining associated kinetic and stoichiometric parameters. Engineering design of several bioreactor configurations employed for biochemical waste treatment. Mathematical modeling of engineered biological reactors using state-of-the-art simulation packages

EAEE E4951 Engineering systems for water treatment and re-use. *3 points*.
Lect: 3.

Prerequisites: (CIEE E4163) and (EAEE E3901) or CIEE E4163 and EAEE E3901 or the instructor's permission.
Application of fundamental principles to designing water treatment and reuse plants. Development of process designs for a potable water treatment plant, a biological wastewater treatment plant, or a water reclamation and reuse facility by students working in teams. Student work in evaluation of water quality and pilot plant data, screening process alternatives, conducting regulatory reviews and recommending a process for implementation, supported by engineering drawings and capital operating costs. Periodic oral progress reports and a full engineering report are required. Presentations by practicing engineers, utility personnel, and regulators; and field trips to water, wastewater, and water reuse facilities.

EAEE E4980 Urban environmental technology and policy. *3 points*.
Lect: 3.

Progress of urban pollution engineering via contaminant abatement technology, government policy, and public action in urban pollution. Pollutant impact on modern urban environmental quality, natural resources, and government, municipal, and social planning and management programs. Strong emphasis on current and twentieth-century waste management in New York City.

EAEE E4990 Special Topics in Earth and Environmental Engineering. *3.00 points*.
Special topics in earth and environmental engineering. Content and prerequisites vary between sections and semesters. May be repeated for credit

Spring 2026: EAEE E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4990	001/18033	M W 6:10pm - 7:25pm 415 Schapiro Cepser	Candace Agonafir	3.00	9/40

Fall 2026: EAEE E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4990	001/16750		Gregory Elsaesser	3.00	1/20
EAEE 4990	002/16751	M W 6:10pm - 7:25pm 253 Engineering Terrace	Candace Agonafir	3.00	2/20

EAEE E4999 FIELDWORK. *1.00 point*.
Prerequisites: Instructor's written permission.
Only EAEE graduate students who need relevant off-campus work experience as part of their program of study as determined by the instructor. Written application must be made prior to registration outlining proposed study program. Final reports required. This course may not be taken for pass/ fail credit or audited. International students must also consult with the International Students and Scholars Office

Summer 2026: EAEE E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 4999	001/11465		Yin Yip Ngai	1.00	0/10

EAEE E6000 Special Topics in Earth and Environmental Engineering. *3.00 points*.
Current topics in earth and environmental engineering. Subject matter will vary by year. Instructors may impose prerequisites depending on the topic

EAEE E6132 Numerical methods in geomechanics. *3 points*.
Lect: 3.

Prerequisites: (EAEE E3112) and (CIEN E4241) or CIEN E4241; and EAEE E3112 or instructor's permission.
A detailed survey of numerical methods used in geomechanics, emphasizing the Finite Element Method (FEM). Review of the behavior of geological materials. Water and heat flow problems. FEM techniques for solving nonlinear problems, and simulating incremental excavation and loading on the surface and underground.

EAEE E6140 ENVIRONMENTAL PHYSICOCHEMICAL PROCESSES. *3.00 points*.
Prerequisites: CIEE E4163 AND CIEE E4252; or the equivalent, or the instructor's permission.
Prerequisites: (CIEE E4252) and (CIEE E4163) or the equivalent, or the instructors permission. Fundamentals and applications of key physicochemical processes relevant to water quality engineering (such as water treatment, waste water treatment/reuse/recycling, desalination) and the natural environment (e.g. lakes, rivers, groundwater)

EAEE E6150 INDUSTRIAL CATALYSIS. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E4550) or EAEE E4550; or equivalent, or instructors permission.
Fundamental principles of kinetics, characterization and preparation of catalysts for production of petroleum products for conventional transportation fuels, specialty chemicals, polymers, food products, hydrogen and fuel cells and the application of catalysis in biomass conversion to fuel. Update of the ever changing demands and challenges in environmental applications, focusing on advanced catalytic applications as described in modern literature and patents

EAEE E6151 Applied geophysics. *3 points*.
Lect: 3.

Potential field data, prospecting, wave equations. Huygens' principle, Green's functions, Kirchoff equation, WKB approximation, ray tracing. Wave propagation, parameters. Computer applications. Wavelet processing, filters and seismic data. Stratified Earth model, seismic processing and profiling. Radon transform and Fourier migration. Multidimensional geological interpretation.

EAEE E6181 Advanced Electrochemical Energy Storage. *3.00 points*.
Prerequisites: EAEE E4002 AND EAEE E4180
Most modern commercial implementations of electrochemical energy storage are not fully deterministic: provides context and best-hypotheses for modern challenges. Topics include current understanding of Lithium/Lithium Anode Solid-Electrolyte-Interphase, Reversible and Irreversible Side Reactions in Redox flow systems, electrochemically correlated mechanical fracture at multiple scales, relationships between electrolyte solvation and electrode insertion, roughening, smoothing, and detachment behavior of metal anodes, best practices in structural, chemical, and microscopic characterization, morphological vs. macro-homogenous transport models, particle to electrode to cell nonlinearity

EAEE E6210 QUANT ENVIRONMTL RISK ANALYSIS. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E3101) and (STAT GU4001) or EAEE E3101, SIEO W4150, or equivalent.
Comprises the tools necessary for technical professionals to produce meaningful risk analyses. Review of relevant probability and statistics; incorporation of probability in facility failure analysis. Availability, assessment, and incorporation of risk-related data. Contaminant transport to exposed individuals; uptake, morbidity, and mortality. Computational tools necessary to risk modeling. Use and applicability of resulting measurements of risk, and their use in public policy and regulation.

EAEE E6212 CARBON SEQUESTRATION. *3.00 points*.
Lect: 3.

Prerequisites: (EAEE E3200) or EAEE E3200; or equivalent or instructor's permission.
New technologies for capturing carbon dioxide and disposing of it away from the atmosphere. Detailed discussion of the extent of the human modifications to the natural carbon cycle, the motivation and scope of future carbon management strategies and the role of carbon sequestration. Introduction of several carbon sequestration technologies that allow for the capture and permanent disposal of carbon dioxide. Engineering issues in their implementation, economic impacts, and the environmental issues raised by the various methods.

Fall 2026: EAEE E6212

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 6212	001/13494	M 4:10pm - 6:40pm 142 Uris Hall		3.00	6/25

EAEE E6220 Remedial and corrective action. *3 points*.
Lect: 3.

Prerequisites: (EAEE E4160) or EAEE E4160 or the equivalent.
Integrates the engineering aspects of cleanup of hazardous materials in the environment. Site assessment/investigation. Site closure, containment, and control techniques and technologies. Techniques used to treat hazardous materials in the environment, in situ and removal for treatment, focusing on those aspects that are unique to the application of those technologies in an uncontrolled natural environment. Management, safety, and training issues.

EAEE E6239 WATER,SANITATION # HUM HEALTH. *3.00 points*.

EAEE E6990 Advanced Topics in Earth and Environmental Engineering. *3.00 points*.
Advanced topics in earth and environmental engineering for senior graduate students. Content and prerequisites vary between sections and semesters. May be repeated for credit

EAEE E8229 SEL TPC:PROC MINERALS # WASTES. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (CHEE E4252) or CHEE E4252; or instructor's permission.
Critical discussion of current research topics and publications in the area of flotation, flocculation, and other mineral processing techniques, particularly mechanisms of adsorption, interactions of particles in solution, thinning of liquid films, and optimization techniques.

EAEE E8233 RES TPCS IN PARTICLE PROCESSNG. *0.00-1.00 points*.
Emergent findings in the interactions of particles with reagents and solutions, especially inorganics, surfactants, and polymers in solution, and their role in grinding, flotation, agglomeration, filtration, enhanced oil recovery, and other mineral processing operations

EAEE E9271 EARTH # ENVIRONMNTL ENG THESIS. *0.00-6.00 points*.
0-6 pts.

Research work culminating in a creditable dissertation on a problem of a fundamental nature selected in conference between student and adviser. Wide latitude is permitted in choice of a subject, but independent work of distinctly graduate character is required in its handling

Spring 2026: EAEE E9271

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9271	001/17354		Kartik Chandran	0.00-6.00	0/10
EAEE 9271	002/17355		Robert Farrauto	0.00-6.00	3/10
EAEE 9271	003/17356		Raymond Farinato	0.00-6.00	0/10
EAEE 9271	004/17357		Greeshma Gadikota	0.00-6.00	0/10
EAEE 9271	005/17358		Pierre Gentine	0.00-6.00	1/10
EAEE 9271	006/17359		Shaina Kelly	0.00-6.00	0/10
EAEE 9271	007/17360		Vijay Modi	0.00-6.00	0/10
EAEE 9271	008/17361		Nagaraj Devarayasamudram	0.00-6.00	0/10
EAEE 9271	009/17362		Dan Steingart	0.00-6.00	0/10
EAEE 9271	010/17363		Alan West	0.00-6.00	0/10
EAEE 9271	011/17364		Bolun Xu	0.00-6.00	0/10
EAEE 9271	012/17365		Yin Yip Ngai	0.00-6.00	2/10
EAEE 9271	013/17366		Adeyemi Adeleye	0.00-6.00	2/10
EAEE 9271	014/17367		Oscar Nordness	0.00-6.00	0/10

Summer 2026: EAEE E9271

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9271	001/12917		Adeyemi Adeleye	0.00-6.00	0/5

EAEE E9273 EARTH/ENVIRONMENTL ENG REPORTS. *0.00-4.00 points*.
May substitute for the formal master's thesis, EAEE E9271, upon recommendation of the department

EAEE E9274 EARTH/ENVIRONMENTL ENG REPORTS. *0.00-4.00 points*.
0-4 pts.

May substitute for the formal master's thesis, EAEE E9271, upon recommendation of the department

EAEE E9280 EARTH # ENVIRONMENTAL COLLOQ. *0.00 points*.
Lect: 1.5.

All graduate students are required to attend the departmental colloquium as long as they are in residence. Advanced doctoral students may be excused after three years of residence. No degree credit is granted

Spring 2026: EAEE E9280

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9280	001/13057	Th 10:10am - 11:25am 602 Hamilton Hall	Oscar Nordness	0.00	44/85

Fall 2026: EAEE E9280

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9280	001/14401	Th 11:00am - 12:00pm 702 Hamilton Hall	Oscar Nordness	0.00	29/80

EAEE E9282 MINERAL ENGINEERING SEMINAR. *0.00 points*.

EAEE E9305 EARTH/ENVIRONMNTL ENG RESEARCH. *0.00-12.00 points*.
0-12 pts.

Graduate research directed toward solution of a problem in mineral processing or chemical metallurgy

Spring 2026: EAEE E9305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9305	001/17368		Kartik Chandran	0.00-12.00	3/10
EAEE 9305	002/17369		Robert Farrauto	0.00-12.00	6/10
EAEE 9305	003/17370		Raymond Farinato	0.00-12.00	1/10
EAEE 9305	004/17371		Greeshma Gadikota	0.00-12.00	5/10
EAEE 9305	005/17372		Pierre Gentine	0.00-12.00	4/10
EAEE 9305	006/17373		Shaina Kelly	0.00-12.00	8/10
EAEE 9305	007/17374		Vijay Modi	0.00-12.00	1/10
EAEE 9305	008/17375		Nagaraj Devarayasamudram	0.00-12.00	0/10
EAEE 9305	009/17376		Dan Steingart	0.00-12.00	2/10
EAEE 9305	010/17377		Alan West	0.00-12.00	0/10
EAEE 9305	011/17383		Bolun Xu	0.00-12.00	6/10
EAEE 9305	012/17379		Yin Yip Ngai	0.00-12.00	0/10
EAEE 9305	013/17380		Adeyemi Adeleye	0.00-12.00	4/10
EAEE 9305	014/17381		Oscar Nordness	0.00-12.00	3/10
EAEE 9305	015/20077		Pengbo Chu	0.00-12.00	1/10

Summer 2026: EAEE E9305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9305	001/12830		Adeyemi Adeleye	0.00-12.00	1/5
EAEE 9305	002/12867		Dan Steingart	0.00-12.00	2/5
EAEE 9305	006/11964		Shaina Kelly	0.00-12.00	4/10

Fall 2026: EAEE E9305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9305	001/14425		Kartik Chandran	0.00-12.00	2/20
EAEE 9305	002/14426		Robert Farrauto	0.00-12.00	6/20
EAEE 9305	003/14427		Raymond Farinato	0.00-12.00	1/20
EAEE 9305	004/14428		Pengbo Chu	0.00-12.00	1/20
EAEE 9305	005/14429		Pierre Gentine	0.00-12.00	3/20
EAEE 9305	006/14430		Shaina Kelly	0.00-12.00	6/20
EAEE 9305	007/14431		Upmanu Lall	0.00-12.00	0/20
EAEE 9305	008/14432		Vijay Modi	0.00-12.00	1/20
EAEE 9305	009/14433		Nagaraj Devarayasamudram	0.00-12.00	0/20
EAEE 9305	010/14434		Dan Steingart	0.00-12.00	2/20
EAEE 9305	011/14435		Alan West	0.00-12.00	1/20
EAEE 9305	012/14436		Bolun Xu	0.00-12.00	2/20
EAEE 9305	013/14437		Yin Yip Ngai	0.00-12.00	3/20
EAEE 9305	014/14438		Oscar Nordness	0.00-12.00	4/20
EAEE 9305	015/14439		Adeyemi Adeleye	0.00-12.00	0/20
EAEE 9305	016/14440		Greeshma Gadikota	0.00-12.00	4/20

EAEE E9800 DOCTORAL RESEARCH INSTRUCTION. *0.00-12.00 points*.
3, 6, 9 or 12 pts.

A candidate for the Eng.Sc.D. degree in mineral engineering must register for 12 points of doctoral research instruction. Registration in EAEE E9800 may not be used to satisfy the minimum residence requirement for the degree

Spring 2026: EAEE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9800	001/18211		Upmanu Lall	0.00-12.00	3/5
EAEE 9800	002/19632		Kartik Chandran	0.00-12.00	0/2

Summer 2026: EAEE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9800	001/12829		Upmanu Lall	0.00-12.00	0/2

Fall 2026: EAEE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EAEE 9800	001/14441		Kartik Chandran	0.00-12.00	1/5
EAEE 9800	002/15834		Upmanu Lall	0.00-12.00	0/2

EAEE E9900 DOCTORAL DISSERTATION. *0.00 points*.
0 pts.

A candidate for the doctorate may be required to register for this course every term after the students course work has been completed, and until the dissertation has been accepted

EAEE P6329 WATER,SANITATION # HUM HEALTH. *3.00 points*.
Lect.: 3

Prerequisites: Instructor's permission.
In-depth analysis of issues relating to water, sanitation, and hygiene in both the developed and developing worlds. Hydrologic cycle, major causes of enteric morbidity and mortality, and design, financing and implementation of sanitation systems. For both engineering and public health students; intended to foster dialog between the two communities

EAEE S9305 EARTH/ENVIRONMNTL ENG RESEARCH. *0.00-4.00 points*.
Graduate research directed toward solution of a problem in mineral processing or chemical metallurgy

EAEE S9900 Doctoral dissertation. *0 points*.
0 pts.

A candidate for the doctorate may be required to register for this course every term after the student's course work has been completed, and until the dissertation has been accepted.

EAEE W4304 Closing the carbon cycle. *3 points*.
Lect: 3.

Prerequisites: Calculus, basic inorganic chemistry and basic physics including thermodynamics or permission of the instructor. Introduction to complex systems, their impact on our understanding and predictability of the carbon cycle , the use of systems analysis and modeling tools, as well as Bayesian statistics and decision theory for evaluating various solutions to close the carbon cycle, a detailed examination of the geochemical carbon cycle, major conceptual models that couple its changes to climate change, analysis of the anthropogenic carbon sources and sinks and role of carbon in energy production, closing the carbon cycle impact s on energy security, economic development and climate change protection, analysis of solutions to close the carbon cycle .

Undergraduate Programs

- Earth and Environmental Engineering (BS) (p. 198)
- Mining Engineering (BS)
- Earth and Environmental Engineering Minor (p. 328)

Earth and Environmental Engineering (BS)

The Bachelor of Science (B.S.) degree in Earth and Environmental Engineering prepares students for careers in the public and private sector concerned with primary materials (minerals, fuels, water) and the environment. Graduates are also prepared to continue with further studies in Earth/Environmental sciences and engineering, business, public policy, international studies, law, and medicine.

The BS Earth and Environmental Engineering program is accredited by the Engineering Accreditation Commission of ABET, under the commission's General Criteria and Program Criteria for Environmental Engineering and Similarly Named Engineering Programs.

Practice and theory are both critical to the advancement of earth and environmental engineering; the department works actively with students to reach their learning outcomes and research and career goals.

Undergraduate Program Educational Objectives

1. Graduates equipped with the necessary tools (mathematics, chemistry, physics, earth sciences, and engineering science) will understand and implement the underlying principles used in the engineering of processes and systems.
2. Graduates will be able to pursue careers in industry, government agencies, and other organizations concerned with the environment and the provision of primary and secondary materials and energy, as well as continue their education as graduate students in related disciplines.
3. Graduates will possess the basic skills needed for the practice of earth and environmental engineering, including measurement and control of material flows through the environment; assessment of environmental impact of past, present, and future industrial activities; and analysis and design of processes for remediation, recycling, and disposal of used materials.
4. Graduates will practice their profession with excellent written and communication skills and with professional ethics and responsibilities.

Undergraduate Student Outcomes

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Curriculum

The first two years of the EEE program are similar to those of other engineering programs. Students are provided with a strong foundation in basic sciences and mathematics, as well as the liberal arts core. Specific to the EEE program is an early and sustained introduction to earth science and environmental engineering, and options for a number of science courses to meet the specific interests of each student. The junior and senior years of the program consist of a group of required courses in engineering science and a broad selection of technical electives organized. The department website at eee.columbia.edu details the required courses and other information.

Several Columbia departments, such as Civil Engineering, Mechanical Engineering, and Earth and Environmental Sciences (Lamont-Doherty Earth Observatory), as well as the Mailman School of Public Health, contribute courses to the EEE program. EEE students are strongly encouraged to work as summer interns in industry or agencies on projects related to Earth and Environmental Engineering.

Earth and Environmental Engineering Program

An overview of the degree track in PDF format can be found here.

First Year

Semester I

Choose one of the following Mathematics courses:[1]

MATH UN1101	CALCULUS I
MATH UN1207	HONORS MATHEMATICS A

Choose one of the following Physics courses:[1]

PHYS UN1401	INTRO TO MECHANICS # THERMO
PHYS UN1601	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801	ACCELERATED PHYSICS I

Choose one of the following Chemistry courses:[1]

CHEM UN1403 & CHEM UN1500 (taken Semester I or II)	GENERAL CHEMISTRY I-LECTURES
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

Choose one of the following Mathematics courses:

MATH UN1102	CALCULUS II
MATH UN1208	HONORS MATHEMATICS B

Choose one of the following Physics courses:

PHYS UN1402	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802	ACCELERATED PHYSICS II

Choose one of the following Chemistry courses:

CHEM UN1404 & CHEM UN1500 (taken Semester I or II)	GENERAL CHEMISTRY II-LECTURES
CHEM UN1507	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN2046 & CHEM UN1507	INTENSVE ORG CHEM-FOR 1ST YEAR
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

Choose one of the following Mathematics courses:

APMA E2000 & APMA E2001	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Chemistry/Physics/Biology courses:

CHEM UN2443	ORGANIC CHEMISTRY I-LECTURES
PHYS UN1403	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601	PHYSICS III:CLASS/QUANTUM WAVE
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

Choose one of the following Required Professional and Technical Electives:

EESC UN2100	EARTH'S ENVIRO SYST: CLIM SYST
EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EAEE E2100	A BETTER PLANET BY DESIGN
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Semester IV

Choose one of the following Mathematics courses:

APMA E2101	INTRO TO APPLIED MATHEMATICS
MATH UN2030	ORDINARY DIFFERENTIAL EQUATIONS
EACE E4252	Foundations of Environmental Engineering

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
HUMA UN1121 or UN1123	Art Humanities
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS

Third Year

Semester V

EAEE E3103	ENERGY,MINERALS,MATERIALS SYST
EAEE E3200	TRANSPORT/CHEM RATE PHENOMENA
CHEE E3010	PRIN-CHEM ENGIN-THERMODYNAMICS

Nontech Elective (3 points)

Semester VI

EAEE E4003	AQUATIC CHEMISTRY
EACE E3250	Hydrosystems Engineering
EAEE E3800	EARTH # ENVIR ENGIN LAB I
EAEE E3901	ENVIRONMENTAL MICROBIOLOGY

Tech Elective (3 points)

Fourth Year

Semester VII

EAEE E3998	UNDERGRADUATE PROJECT I
EAEE E4160	SOLID # HAZARDOUS WASTE MGMT

Tech Elective (6 points)

Nontech Elective (3 points)

Semester VIII

EACE E3255	ENVIRONMENTAL CONTROL AND POLLUTION REDUCTION
EAEE E3999	UNDERGRADUATE PROJECT II

Tech Elective (9 points)

Nontech Electives (6 points)

[1] Course may follow a sequential order, please review the degree track PDF linked at the top of this page for more information on how to complete your Math, Physics, and Chemistry requirement.

Graduate Programs

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Earth and Environmental Engineering (MS-EEE) (p. 201)
- Carbon Management (MS) (p. 202)
- Professional Degree; Engineer of Mines (p. 202)
- Earth and Environmental Engineering (EngScD, PhD) (p. 202)

Earth and Environmental Engineering (MS-EEE)

M.S. in Earth and Environmental Engineering (M.S.-EEE)

The M.S.-EEE program is designed for engineers and scientists who plan to pursue, or are already engaged in, environmental management/development careers. The focus of the program is the environmentally sound mining and processing of primary materials (minerals, energy, and water) to the recycling and proper disposal of used materials. The program also includes technologies for assessment and remediation of damages to the environment including water treatment, processing of mine tailings, and carbon capture, utilization and storage. Students can choose a pace that allows them to complete the M.S.-EEE requirements while being employed.

M.S.-EEE graduates are specially qualified to work for engineering, financial startup, and operating companies engaged in the earth resources development and environmental industries and technologies, environmental groups in all industries, and for city, state, and federal agencies responsible for the environment and energy/resource conservation. At the present time, the U.S. environmental industry comprises nearly 30,000 big and small businesses with total revenues of more than $150 billion. Sustainable development, climate change adaptation and mitigation, as well as environmental quality have become top priorities of government and industries in the United States and many other nations.

This M.S. program is offered in collaboration with the Departments of Civil Engineering and Earth and Environmental Sciences. Many of the teaching faculty are affiliated with Columbia's Earth Engineering Center. For students with a B.S. in engineering, at least 30 points (ten courses) are required. Students may carry out a research project (3 credits) or write a thesis worth 6 points. A number of areas of study are available for the M.S.-EEE, and students may choose courses that match their interest and career plans.

Additionally, there are three elective specializations in the program, in each of which there are a number of required specific core courses and electives. The specializations are described briefly below; details and the lists of specific courses for each track are available from the department. Students interested in a specific focus in Mining Engineering or related fields should consult their faculty adviser for relevant course listings.

Water Resources and Climate Risks

Climate-induced risk is a significant component of decision making for the planning, design, and operation of water resource systems, and related sectors such as energy, health, agriculture, ecological resources, and natural hazards control. Climatic uncertainties can be broadly classified into two areas:

1. those related to anthropogenic climate change;
2. those related to seasonal- to century-scale natural variations.

Climate change impacts the design of physical, social, and financial infrastructure systems to support the sectors listed above. The climate variability and predictability issues impact systems operation, and hence design. The goal of the M.S. specialization in water resources and climate risks is to provide

1. a capacity for understanding and quantifying the projections for climate change and variability in the context of decisions for water resources and related sectors of impact; and
2. skills for integrated risk assessment and management for operations and design, as well as for regional policy analysis and management.

Required classes include:

- EACE E4252 Foundations of Environmental Engineering
- EACE E4163 Sustainable Water Treatment and Reuse
- EAEE E4257 ENVIR DATA ANALYSIS # MODELING

Sustainable Energy

Building and shaping the energy infrastructure of the twenty-first century is one of the central tasks for modern engineering. The purpose of the sustainable energy specialization is to expose students to modern energy technologies and infrastructures and to the associated environmental, health, and resource limitations. Emphasis will be on energy generation and use technologies that aim to overcome the limits to growth that are experienced today. Energy and economic well-being are tightly coupled. Fossil fuel resources are still plentiful, but access to energy is limited by environmental and economic constraints. A future world population of 10 billion people trying to approach the standard of living of the developed nations cannot rely on today's energy technologies and infrastructures without severe environmental impacts. Concerns over climate change and changes in ocean chemistry require reductions in carbon dioxide emissions, but most alternatives to conventional fossil fuels, including nuclear energy, are too expensive to fill the gap. Yet access to clean, cheap energy is critical for providing minimal resources: water, food, housing, and transportation.

Specialization-specific classes will sketch out the availability of resources, their geographic distribution, the economic and environmental cost of resource extraction, and avenues for increasing energy utilization efficiency, such as cogeneration, district heating, and distributed generation of energy. Classes will discuss technologies for efficiency improvement in the generation and consumption sector; energy recovery from solid wastes; alternatives to fossil fuels, including solar and wind energy, energy storage; and technologies for addressing the environmental concerns over the use of fossil fuels. Classes on climate change, air quality, and health impacts focus on the consequences of energy use. Policy and its interactions with environmental sciences and energy engineering will be another aspect of the specialization. Additional specialization may consider region-specific energy development. Required classes include:

- EAEE E4002 ALTERNATIVE ENERGY RESOURCES
- EEEL E4220 Energy System Economics and Optimization

Sustainable Mining and Materials

Earth mineral and metal resources are the backbone of civilization and are critical to economic development and meeting the demands of a growing population. their development today faces several big challenges:

1. declining value content in the available ore bodies and poor quality of the resources;
2. increasing focus on safety and health risks, and environmental impacts;
3. inefficient and high energy and water consumption;
4. huge risks associated with waste generation and management.

It is well recognized in the earth resource development industry that the traditional processing paradigm is no longer sustainable and cannot address these serious challenges. The overall goal of industry to develop and implement technologies for sensible and sustainable use of earth resources is part of a "mines of the future" paradigm, which encompasses topics such as mine-to-metal integration, modular processing, digital optimization, machine learning and AI, sensors and chemometrics, benign process chemicals, and a host of other forward-looking concepts. A similar effort and outlook exists for urban mining and recycling. The transformation of waste to energy and the recovery of minerals from recycling streams are examples of these areas that EEE is a world leader in. The EEE program in Sustainable Mining and Materials integrates foundational engineering principles and processes with the transformational innovations under development in the earth resources management sector. Core classes include:

- EAEE E4160 SOLID # HAZARDOUS WASTE MGMT
- EAEE E4200 Introduction to Sustainable Production of Earth Mineral # Metal Resources
- EAEE E4228 Separation Science and Technology in Sustainable Earth Resources Development

Carbon Management (MS)

M.S. in Carbon Management (MCM)

The program is designed to prepare students to create and implement multi- faceted solutions to the carbon problem with an in-depth understanding of the complexity and multidisciplinary nature of the issues.

Coursework includes 30 credits of graduate coursework. Depending on student's backgrounds, some undergraduate level science courses may be required. Each student will develop an academic plan with the program director. There are three options for completing the 30 credits:

- 30 credits of lecture courses
- 24 credits of lecture courses and 6 credits of research with a culminating Master's Thesis
- 27 credits of lecture courses and 3 credits of research with a concluding report

Core Courses	
EAEE E4002	ALTERNATIVE ENERGY RESOURCES
EAEE E4100	A Better Planet by Design (MS)
EAEE E4300	INTRO TO CARBON MANAGEMENT
or EAEE E6212	CARBON SEQUESTRATION
EAEE E4302	CARBON CAPTURE
EAEE E4301	CARBON STORAGE
EAEE E4305	CO2 UTILIZATION AND CONVERSION

Professional Degree; Engineer of Mines

The program is designed for engineers who wish to do advanced work beyond the level of the M.S. degree but who do not desire to emphasize research. Admissions requirements include Undergraduate engineering degree, minimum 3.0 GPA, and GRE.

Candidates must complete at least 30 credits of graduate work beyond the M.S., or 60 points of graduate work beyond the B.S. No thesis is required. All degree requirements must be completed within 5 years of the beginning of the first course credited toward the degree.

Coursework includes four core required courses and six elective courses from a pre-approved list of choices.

Core Courses	
EAEE E4001	INDUST ECOLOGY-EARTH RESOURCES
EAEE E4006	Field methods for environmental engineering
EAEE E4009	GIS-RES,ENVIR,INFRASTRUCTR MGT
EAEE E4011	Industrial ecology for manufacturing

Elective courses must be six courses at the 4000 or higher level from within the Earth and Environmental Engineering Department, the Chemical Engineering Department, or others as approved by the adviser. These include but are not limited to:

EAEE E4900	APP TRANSP/CHEM RATE PHENOMENA
CHEE E4252	INTRO-SURFACE AND COLLOID SCI
EACE E4252	Foundations of Environmental Engineering
EAEE E4257	ENVIR DATA ANALYSIS # MODELING
EAEE E4160	SOLID # HAZARDOUS WASTE MGMT
EAEE E4300	INTRO TO CARBON MANAGEMENT
EAEE E6132	Numerical methods in geomechanics
EAEE E6140	ENVIRONMENTAL PHYSICOCHEMICAL PROCESSES
EAEE E6150	INDUSTRIAL CATALYSIS
EAEE E6212	CARBON SEQUESTRATION

Although not required, interested students may choose to complete up to six credits in EAEE E9305 EARTH/ENVIRONMNTL ENG RESEARCH.

Earth and Environmental Engineering (EngScD, PhD)

Doctoral Programs

EEE offers two doctoral degrees:

- the Eng.Sc.D. degree, administered by Columbia Engineering; and
- the Ph.D. degree, administered by the Graduate School of Arts and Sciences.

Doctoral Qualifying Examination and Research Proposal

Doctoral candidates are required to pass a qualifying examination. This examination is offered twice an academic year: once in the Fall and once in the Spring semesters.

Purpose

The qualifying exam evaluates whether doctoral students, after completing two semesters of courses, should continue with PhD research.

Prerequisite

To take the qualifying exam, students need

- To be enrolled in the MS/PhD Program in EEE
- At least 20 credits (two semesters) of coursework (credits from research do not count) and have taken at least two courses taught by EEE faculty members who are not their primary advisors.
- An overall GPA of 3.5 or higher

Format

Students should work with their advisor to select a committee composed of three EEE department members who represent focal areas of the department (energy, water, and material cycles). The PhD advisor may be a committee member.

One week before the exam, each committee member will provide a peer-reviewed research article (not a review paper) that the committee member believes is the intersection between the examinee's research topic and the examiner's area of expertise within EEE.

Students should give a 20-minute, uninterrupted presentation about their research and the three papers, followed by 40 minutes of questions and answers by the exam committee.

Evaluation criteria include the fundamental knowledge of DEEE's focal areas and the presentation's clarity. The evaluation can result in the following grades: Pass or Fail. **There are no retakes of the exam.**

Thesis Proposal

Students must submit a research proposal and present it to their advisory committee. The student advisory committee consists of at least three faculty members, including the advisor; at least two hold primary appointments in DEEE (with one tenured Full Professor).

A 10-page report (single-spaced) will be submitted to the committee seven days before the exam and used as part of the evaluation.

Students are generally expected to submit their thesis proposal after three semesters of doctoral studies.

The student advisory committee considers the scope of the proposed research, its suitability for doctoral research, and the appropriateness of the research plan.

The outcome of the evaluation of the thesis proposal: Pass, Fail, Conditional Pass (Conditional Pass: students will have to revise the proposal following comments by the members of the advisory committee and present the revised proposal within 6 months).

Electrical Engineering

1300 S. W. Mudd, MC 4712
212-854-3105
ee.columbia.edu

Contemporary Electrical Engineering is a broad discipline that encompasses a wide range of activities. A common theme is the use of electrical and electromagnetic signals for the generation, transmission, processing, storage, conversion, and control of information and energy. An equally important aspect is the human interface and the role of individuals as the sources and recipients of information. The rates at which information is transmitted today range from megabits per second to gigabits per second and in some cases, as high as terabits per second. The range of frequencies over which these processes are studied extends from direct current (i.e., zero frequency), to microwave and optical frequencies.

The need for increasingly faster and more sophisticated methods of handling information poses a major challenge to the electrical engineer. New materials, devices, systems, and network concepts are needed to build the advanced communications and information handling systems of the future. Innovations in electrical engineering have had a dramatic impact on the way in which we work and live: the transistor, integrated circuits, computers, radio and television, satellite transmission systems, lasers, fiber optic transmission systems, and medical electronics.

The faculty of the Electrical Engineering Department at Columbia University is dedicated to the continued development of further innovations through its program of academic instruction and research. Our undergraduate program in electrical engineering is designed to prepare students for a career in industry, research, or business by providing them with a thorough foundation of the fundamental concepts and analytical tools of contemporary electrical engineering. A wide range of elective courses permits the student to emphasize specific disciplines such as communications, devices, circuits, or signal processing.

Undergraduates have an opportunity to learn firsthand about current research activities by participating in a program of undergraduate research projects with the faculty.

A master's level program in electrical engineering permits graduate students to further specialize their knowledge and skills within a wide range of disciplines. For those who are interested in pursuing a career in teaching, research, or advanced development, our Ph.D. program offers the opportunity to conduct research under faculty supervision at the leading edge of technology and applied science. Seminars are offered in all research areas.

The Electrical Engineering Department, along with the Computer Science Department, also offers B.S. and M.S. programs in computer engineering. Details on those programs can be found in the Computer Engineering section in this bulletin.

Research Activities

The research interests of the faculty encompass a number of rapidly growing areas, vital to the development of future technology, that will affect almost every aspect of society: signals, information, and data; networking and communications; nanoscale structures nd integrated solid-state devices; nanoelectronics and nanophotonics; integrated circuits and systems; systems biology; neuroengineering;

and smart electric energy. Details on all of these areas can be found at ee.columbia.edu/research.

The Signals, Information and Data area concerns the representation, processing, analysis, and communication of information embedded in signals and datasets arising in a wide range of application areas, including audio, video, images, communications, and biology. Research interests include the development of models, algorithms and analyses for sensing, detection and estimation, statistical and machine learning, and the recognition, organization, and understanding of the information content of signals and data.

The Networking and Communications area focuses on the design and performance evaluation of communication systems and data networks of all kinds, including wireless/cellular, optical, ultra-low power, vehicular, mobile, wearable, data center networks, cyber physical systems, and the internet. Methods range from analyzing and refining existing approaches to the development of new and evolving networking techniques and systems.

The Systems Biology and Neuroengineering area aims to understand and analyze biological systems within the living cell and in the brain. Examples of related tasks are biomolecular data analysis for medical applications, synthetic biology, establishing the principles of neuroinformation processing in the brain for developing robust sensory processing and motor control algorithms, accelerating the clinical translation of devices that make contact with neurons, and building massively parallel brain-computer interfaces.

The Integrated Circuits and Systems area focuses on the integration of circuits and systems on semiconductor platforms. Research spans the analysis, design, simulation, and validation of analog, mixed-mode, (sub) mm-wave, RF, power, and digital circuits, and their applications from computation and sensing to cyber-physical and implantable biomedical systems.

The area of Nanoscale Structures and Integrated Devices applies fundamental physical principles to develop revolutionary new electronic, photonic, and optical devices made from conventional and emerging materials, including graphene, 2D semiconductors, and organic semiconductors. Research includes nanofabrication, characterization, and electromagnetic design of quantum device structures and complex silicon photonic circuits that impact numerous fields from Lidar and optogenetics to low-energy computation and flexible electronics.

The smart electric energy area focuses on the optimization of the generation, conversion, distribution, and consumption of electric energy as well as the electrification of energy systems. Research spans the analysis, design, and control of power electronics, motor drive, and energy storage systems, grid resilience and security, and Internet-of-Things. Applications include transportation electrification, smart grid, renewable energy, and smart building systems.

Laboratory Facilities

Current research activities are fully supported by more than a dozen well-equipped research laboratories run by the department faculty. In addition, faculty and students have access to a clean room for micro- and nanofabrication, a materials-characterization facility, and an electron-microscopy facility, managed by the Columbia Nano Initiative. Faculty laboratories include Digital Video and Multimedia Networking Laboratory, Wireless and Mobile Networking Laboratory, Network Algorithms Laboratory, Genomic Information Systems Laboratory, Structure-Function Imaging Laboratory, Neural Acoustic Processing Laboratory, Signal Processing and Communication Laboratory, Translational Neuroelectronics Laboratory, Bionet Laboratory, Molecular Beam Epitaxy Laboratory, Surface Analysis Laboratory, Laboratory for Unconventional Electronics, Advanced Semiconductor Device Laboratory, Motor Drives and Power Electronics Laboratory, Intelligent and Connected Systems Laboratory, Columbia Integrated Systems Laboratory (CISL), Analog & RF IC Design Laboratory, VLSI Design Laboratory, High Speed and mmWave IC Laboratory, Analog and Mixed Signal IC Laboratory, Bioelectronics Laboratory, Lightwave Laboratory, and Nano Photonics Laboratory.

Laboratory instruction is provided in a suite of newly-renovated facilities on the twelfth floor of the S. W. Mudd Building. These teaching laboratories are used for circuit prototyping, device measurement, VLSI design, embedded systems design, as well as computer engineering and Internet-of-Things experiments.

Chair

Gil Zussman
Mudd 1305

Vice Chair

Javad Ghaderi Dehkordi

Director of Finance and Administration

Rocio M. Pena
Mudd 1303

Professors

Dimitris Anastassiou
Keren Bergman
Shih-Fu Chang
Alexander Gaeta, *Applied Physics and Materials Science*
Predrag Jelenkovic
Peter Kinget
Harish Krishnaswamy
Ioannis (John) Kymissis
Aurel A. Lazar
Michal Lipson
Paul Sajda, *Biomedical Engineering*
Henning G. Schulzrinne, *Computer Science*
Kenneth L. Shepard
Yannis P. Tsividis
Wen I. Wang
Xiaodang Wang
Charles A. Zukowski
Gil Zussman

Associate Professors

James David Anderson
Asaf Cidon
Javad Ghaderi Dehkordi
Christine P. Hendon
Xiaofan (Fred) Jiang
Ethan Benjamin Katz-Bassett
Nima Mesgarani
John W. Paisley
Matthias Preindl
Mingoo Seok
John N. Wright

Assistant Professors

Professors of Professional Practice

Homayoon Beigi
Zoran Kostic

Associate Professor of Professional Practice

Xiang Meng

Senior Lecturer in Discipline

David G. Vallancourt

Adjunct Professors

Xin Zhang
Thomas Woo
Anwar Walid
Chong Li
Chonggang Wang
Ching-Yung Lin
Alexei Ashikhmin
Janet Kayfetz
Irving Kalet

Adjunct Associate Professors

Ilija Hadzic
Jin Hui
Jennifer Pollock
Matthew Ziegler
Guido Jajamovich

Adjunct Assistant Professors

Ahmed Mousa
Mohamed K. Kamaludeen
Subhajit Ray
Emily Naviasky

Staff Associate

Tai-Hsien Ou Yang

Senior Research Scientist

Debasis Mitra

Adjunct Senior Associate Research Scientist

Alan E. Willner

Adjunct Associate Research Scientist

Ilaria Fratelli
Hyomin Ko

Associate Research Scientists

Alejandro Akrouh
Jason Fabbri
Navid Rahbariasr
Taeju Lee

Postdoctoral Research Scientists

Jeremy A Johnston
Jongwoon Kim
Jieyu Li
Soo Young Park
Jhonatan Tavori
Linfang Wang
Peng Wang
Heyu Yin
Hassan ZivariFard
Volkan Arslan
Guy Eichler

Course Descriptions

BMEB W4020 Computational neuroscience: circuits in the brain. *3 points*.
Lect: 3.

Prerequisites: (ELEN E3801) or (BIOL UN3004) ELEN E3801 OR BIOL W3004
The biophysics of computation: modeling biological neurons, the Hodgkin-Huxley neuron, modeling channel conductances and synapses as memristive systems, bursting neurons and central pattern generators, I/O equivalence and spiking neuron models. Information representation and neural encoding: stimulus representation with time encoding machines, the geometry of time encoding, encoding with neural circuits with feedback, population time encoding machines. Dendritic computation: elements of spike processing and neural computation, synaptic plasticity and learning algorithms, unsupervised learning and spike time-dependent plasticity, basic dendritic integration. Projects in MATLAB.

Fall 2026: BMEB W4020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BMEB 4020	001/11269	T 7:00pm - 9:30pm 602 Hamilton Hall	Aurel Lazar	3	36/80

CSEE W4119 COMPUTER NETWORKS. *3.00 points*.
Prerequisites: Comfort with basic probability. Programming fluency in Python, C++, Java, or Ruby please see section course page for specific language requirements.
Introduction to computer networks and the technical foundations of the Internet, including applications, protocols, local area networks, algorithms for routing and congestion control, security, elementary performance evaluation. Several written and programming assignments required

Spring 2026: CSEE W4119

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4119	001/12396	T Th 11:40am - 12:55pm 614 Schermerhorn Hall	Xia Zhou	3.00	135/140
CSEE 4119	V01/16651		Xia Zhou	3.00	10/99

Fall 2026: CSEE W4119

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4119	001/14072	M W 4:10pm - 5:25pm 451 Computer Science Bldg	Henning Schulzrinne	3.00	88/110
CSEE 4119	V01/18098		Henning Schulzrinne	3.00	7/99

CSEE W4121 COMPUTER SYSTEMS FOR DATA SCIENCE. *3.00 points*.
Prerequisites: Background in Computer System Organization and good working knowledge of C/C++. CSOR W4246 Algorithms for Data Science, STAT W4203 Probability Theory, or equivalent as approved by faculty advisor.
An introduction to computer architecture and distributed systems with an emphasis on warehouse scale computing systems. Topics will include fundamental tradeoffs in computer systems, hardware and software techniques for exploiting instruction-level parallelism, data-level parallelism and task level parallelism, scheduling, caching, prefetching, network and memory architecture, latency and throughput optimizations, specialization, and an introduction to programming data center computers

Spring 2026: CSEE W4121

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4121	001/16119	W 4:10pm - 6:40pm 301 Pupin Laboratories	Waqar Aqeel	3.00	192/200

CSEE W4823 Advanced Logic Design. *3 points*.
Lect: 3.

Prerequisites: (CSEE W3827) or CSEE W3827; Or a half semester introduction to digital logic, or the equivalent.
An introduction to modern digital system design. Advanced topics in digital logic: controller synthesis (Mealy and Moore machines); adders and multipliers; structured logic blocks (PLDs, PALs, ROMs); iterative circuits. Modern design methodology: register transfer level modelling (RTL); algorithmic state machines (ASMs); introduction to hardware description languages (VHDL or Verilog); system-level modelling and simulation; design examples.

Fall 2026: CSEE W4823

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4823	001/11345	T Th 1:10pm - 2:25pm 207 Mathematics Building	Mingoo Seok	3	116/120

CSEE W4824 COMPUTER ARCHITECTURE. *3.00 points*.
Lect: 3.

Prerequisites: (CSEE W3827) or CSEE W3827
Focuses on advanced topics in computer architecture, illustrated by case studies from classic and modern processors. Fundamentals of quantitative analysis. Pipelining. Memory hierarchy design. Instruction-level and thread-level parallelism. Data-level parallelism and graphics processing units. Multiprocessors. Cache coherence. Interconnection networks. Multi-core processors and systems-on-chip. Platform architectures for embedded, mobile, and cloud computing

Fall 2026: CSEE W4824

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4824	001/14003	M W 10:10am - 11:25am 451 Computer Science Bldg	Simha Sethumadhavan	3.00	0/110

CSEE E6915 Academic Writing and Great Presentations. *3.00 points*.
Prerequisites: For CS and EE Ph.D. students.
Principles of writing clear and rigorous science texts and giving great presentations. The Writing component focuses on the construction of logical arguments, reporting and interpretation of data, composing process, and strategies for redrafting and editing. Genres include Introductions, Data Commentaries, Results/Discussion, Conclusions, Abstracts, Requests for funding, Research statements, Professional emails, Blogs. The Presentation component looks at development of the presentation story, use of visuals, fluent delivery, asking and responding to questions. Speaking contexts include research talks, lab talks, conference presentations, poster talks, job talks, interviews, industry pitches. Pass/No Pass only, based on completion of assignments and participation in class exercises. Credit may not be used to satisfy degree requirements.

Spring 2026: CSEE E6915

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6915	001/16627	F 10:00am - 12:00pm 414 Pupin Laboratories	Janet Kayfetz	3.00	9/25

Fall 2026: CSEE E6915

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 6915	001/15474	F 10:00am - 12:00pm 337 Seeley W. Mudd Building	Janet Kayfetz	3.00	5/25

ECBM E4040 NEURAL NETWRKS # DEEP LEARNING. *3.00 points*.
Lect: 3.

Prerequisites: (BMEB W4020) or (BMEE E4030) or (ECBM E4090) or (EECS E4750) or (COMS W4771) or BMEB W4020 OR BMEE E4030 OR ECBM E4090 OR EECS E4750 OR COMS W4771; or equivalent.
Developing features - internal representations of the world, artificial neural networks, classifying handwritten digits with logistics regression, feedforward deep networks, back propagation in multilayer perceptrons, regularization of deep or distributed models, optimization for training deep models, convolutional neural networks, recurrent and recursive neural networks, deep learning in speech and object recognition

Fall 2026: ECBM E4040

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4040	001/11220		Zoran Kostic	3.00	109/152

ECBM E4060 INTRO-GENOMIC INFO SCI # TECH. *3.00 points*.
Lect: 3.

Introduction to computational biology with emphasis on genomic data science tools and methodologies for analyzing data, such as genomic sequences, gene expression measurements and the presence of mutations. Applications of machine learning and exploratory data analysis for predicting drug response and disease progression. Latest technologies related to genomic information, such as single-cell sequencing and CRISPR, and the contributions of genomic data science to the drug development process

Fall 2026: ECBM E4060

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4060	001/11270	M 7:00pm - 9:30pm 717 Hamilton Hall	Tai-Hsien Ou Yang	3.00	21/80

ECBM E4070 Computing with Brain Circuits of Model Organisms. *3.00 points*.
Prerequisites: BIOL W3004 AND ELEN E3801; and Python programming experience, or instructor's permission.
Building the functional map of the fruit fly brain. Molecular transduction and spatio-temporal encoding in the early visual system. Predictive coding in the Drosophila retina. Canonical circuits in motion detection. Canonical navigation circuits in the central complex. Molecular transduction and combinatorial encoding in the early olfactory system. Predictive coding in the antennal lobe. The functional role of the mushroom body and the lateral horn. Canonical circuits for associative learning and innate memory. Projects in Python

Spring 2026: ECBM E4070

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 4070	001/11503	M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building	Aurel Lazar	3.00	16/50
ECBM 4070	V01/16652		Aurel Lazar	3.00	1/99

ECBM E4090 BRAIN COMPUTER INTERFACES LAB. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (ELEN E3801) ELEN E3801
Hands-on experience with basic neural interface technologies. Recording EEG (electroencephalogram) signals using data acquisition systems (non-invasive, scalp recordings). Real-time analysis and monitoring of brain responses. Analysis of intention and perception of external visual and audio signals

ECBM E6070 TPC NEUROSCI # DEEP LEARN. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in neuroscience and deep learning. Content varies from year to year, and different topics rotate through the course numbers 6070 to 6079.

Spring 2026: ECBM E6070

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ECBM 6070	001/11516	M 7:00pm - 9:30pm 1127 Seeley W. Mudd Building	Aurel Lazar	3.00	10/50
ECBM 6070	V01/16655		Aurel Lazar	3.00	1/99

EEBM E6090 TPCS:COMPUT NEUROSCI/NEUROENGI. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099

EEBM E6091 TPCS IN COMP NEUROSCI/ENGINEERING. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099. Topic: Devices and Analysis for Neural Circuits

EEBM E6095 TOPICS IN COMP NEUROSI # ENG. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in computational neuroscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090 to 6099

EEBM E6099 TPCS:COMPUT NEUROSCI/NEUROENGI. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in computational neurscience and neuroengineering. Content varies from year to year, and different topics rotate through the course numbers 6090-6099

EECS E4321 DIGITAL VLSI CIRCUITS. *3.00 points*.
Lect: 3.

Prerequisites: Recommended preparation: ELEN E3106, ELEN E3331, and CSEE W3827.
Design and analysis of high speed logic and memory. Digital CMOS and BiCMOS device modeling. Integrated circuit fabrication and layout. Interconnect and parasitic elements. Static and dynamic techniques. Worst-case design. Heat removal and I/O. Yield and circuit reliability. Logic gates, pass logic, latches, PLAs, ROMs, RAMs, receivers, drivers, repeaters, sense amplifiers

Fall 2026: EECS E4321

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 4321	001/11272	T Th 2:40pm - 3:55pm Cin Alfred Lerner Hall	Kenneth Shepard	3.00	136/150

EECS E4750 Heterogeneous Computing for Signal and Data Processing. *3.00 points*.
Lect: 2. Lab: 3.

Prerequisites: (ELEN E3801) and (COMS W3134) or ELEN E3801 AND COMS W3134
Methods for deploying signal and data processing algorithms on contemporary general purpose graphics processing units (GPGPUs) and heterogeneous computing infrastructures. Using programming languages such as OpenCL and CUDA for computational speedup in audio, image and video processing and computational data analysis. Significant design project

Fall 2026: EECS E4750

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 4750	001/11276	Th 1:10pm - 3:40pm 627 Seeley W. Mudd Building	Zoran Kostic	3.00	54/50

EECS E4764 Artificial Intelligence of Things (AIoT). *3.00 points*.
Prerequisites: Knowledge of programming or instructor's permission.
Suggested preparation: ELEN E4703, CSEE W4119, CSEE W4840, or related courses.
Artificial Intelligence of Things (AIoT), Internet of Things (IoT), and Cyber-Physical Systems (CPS). Embedded and mobile platforms. Embedded programming. Sensors, actuators, and interfaces. Wireless networking, web services, and databases. Edge and cloud computing. Large language models (LLMs) for AIoT. Time-series data visualization and analytics. Group projects to build end-to-end AIoT systems and applications

Fall 2026: EECS E4764

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 4764	001/11277	M W 2:40pm - 3:55pm 329 Pupin Laboratories	Xiaofan Jiang	3.00	110/100

EECS E6321 Advanced digital electronic circuits. *4.5 points*.
Lect: 3.

Prerequisites: (EECS E4321) EECS E4321
Advanced topics in the design of digital integrated circuits. Clocked and non-clocked combinational logic styles. Timing circuits: latches and flip-flops, phase-locked loops, delay-locked loops. SRAM and DRAM memory circuits. Modeling and analysis of on-chip interconnect. Power distribution and power-supply noise. Clocking, timing, and synchronization issues. Circuits for chip-to-chip electrical communication. Advanced technology issues that affect circuit design. The class may include a team circuit design project.

Spring 2026: EECS E6321

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6321	001/11561	T Th 2:40pm - 3:55pm 717 Hamilton Hall	Mingoo Seok	4.5	54/80

EECS E6690 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Lect: 2.

Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699.

Fall 2026: EECS E6690

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6690	001/15468	T 4:10pm - 6:40pm 1127 Seeley W. Mudd Building	Predrag Jelenkovic	3.00	3/60
EECS 6690	V01/18104		Predrag Jelenkovic	3.00	4/99

EECS E6691 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Spring 2026: EECS E6691

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6691	001/11527	W 10:10am - 12:40pm 627 Seeley W. Mudd Building	Zoran Kostic	3.00	18/50

EECS E6692 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

EECS E6693 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Fall 2026: EECS E6693

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6693	001/11295	M 4:10pm - 6:40pm 603 Hamilton Hall	Matthew Ziegler	3.00	49/54

EECS E6694 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Fall 2026: EECS E6694

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6694	001/11299	M W 10:10am - 11:25am 415 Schapiro Cepser	Micah Goldblum	3.00	43/40

EECS E6699 TOPICS DATA-DRIVEN ANAL # COMP. *3.00 points*.
Prerequisites: Instructor's permission.
Selected advanced topics in data-driven analysis and computation. Content varies from year to year, and different topics rotate through the course numbers 6690 to 6699

Spring 2026: EECS E6699

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6699	001/16609	M 4:10pm - 6:40pm 614 Schermerhorn Hall	Predrag Jelenkovic	3.00	118/115

EECS E6720 BAYESIAN MOD MACHINE LEARNING. *3.00 points*.
Lect: 3.

Prerequisites: Basic calculus, linear algebra, probability, and programming.
Basic statistics and machine learning strongly recommended. Bayesian approaches to machine learning. Topics include mixed-membership models, latent factor models, Bayesian nonparametric methods, probit classification, hidden Markov models, Gaussian mixture models, model learning with mean-field variational inference, scalable inference for Big Data. Applications include image processing, topic modeling, collaborative filtering and recommendation systems

Spring 2026: EECS E6720

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6720	001/11563	W 4:10pm - 6:40pm 627 Seeley W. Mudd Building	John Paisley	3.00	32/50

EECS E6791 Advanced Deep Learning. *3.00 points*.
Prerequisites: Machine Learning, Linear Algebra, Probability and statistics. EECS E4040 Neural Networks and Deep Learning (or similar) E4620 - Numerical Methods for Data Science (or similar)
A graduate level deep learning course focusing on attention and transformer architectures. Introduces selection of transformer-based models applied to language, vision and audio problems, generative, diffusion, state-space, and mixture of expert models. Analysis of zero-shot learning, hallucinations, graph neural networks, multimodal architectures, and agents. Multiple object detection methods are compared. Course is executed in hybrid presentation/flipped-classroom styles, with practical exercises and student presentations on design and operation of DL models.

EECS E6792 Deep Learning on the Edge. *3.00 points*.
Prerequisites: Machine Learning, Linear Algebra, Probability and statistics, EECS E4040 Neural Networks and Deep Learning (or similar) E4620 - Numerical Methods for Data Science (or similar) Working knowledge of Python and a DL SW framework such as TensorFlow or PyTorch
Advanced-level lab-based course. Build and experiment with deep-learning models implemented on low-power GPU edge computing device. Topics: architectures of low-power GPU devices, algorithms and DL models suitable for edge implementation, CUDA language, pre-processing of data, labeling for ground-truth annotation, profiling techniques, connectivity between edge devices and cloud computing servers, real-life data for experimentation, comparison of performance for a variety of methods, comparison of performance of edge-computing and cloud computing approaches.

Spring 2026: EECS E6792

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6792	001/19983	W 1:10pm - 3:40pm 644 Seeley W. Mudd Building	Zoran Kostic	3.00	21/25

EECS E6890 Topics in information processing. *3 points*.
Lect.: 2.

Advanced topics spanning Electrical Engineering and Computer Science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899.

Spring 2026: EECS E6890

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6890	001/11742	Th 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Zhaoyou Wang	3	11/30

EECS E6891 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

EECS E6892 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

Spring 2026: EECS E6892

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6892	001/11535	Th 10:10am - 12:40pm 141 Uris Hall	Javad Ghaderi	3.00	62/65
EECS 6892	V01/17138		Javad Ghaderi	3.00	4/5

EECS E6893 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899. Topic: Big Data Analytics

Fall 2026: EECS E6893

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6893	001/11313	F 7:00pm - 9:30pm 833 Seeley W. Mudd Building	Ching-yung Lin	3.00	82/150

EECS E6894 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

Fall 2026: EECS E6894

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6894	001/11314	M W 8:40am - 9:55am 141 Uris Hall	Tanvir Ahmed Khan	3.00	45/60

EECS E6895 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning Electrical Engineering and Computer Science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899. Topic: Advanced Big Data Analytics

Spring 2026: EECS E6895

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6895	001/11536	T 7:00pm - 9:30pm 501 Northwest Corner	Ching-yung Lin	3.00	73/80
EECS 6895	V01/16732		Ching-yung Lin	3.00	11/99

EECS E6896 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899. Topic: Quantum Computing and Communication

Fall 2026: EECS E6896

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EECS 6896	001/11315	M 4:10pm - 6:40pm 214 Pupin Laboratories	Alexei Ashikhmin	3.00	10/55

EECS E6897 Topics in Information Processing. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

EECS E6898 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

EECS E9601 Seminar in Data-Driven Analysis and Computation. *3.00 points*.
Lect.: 2.

Prerequisites: Open to doctoral candidates and qualified M.S. candidates with the instructor's permission.
Advanced topics and recent developments in mathematical techniques and computational tools for data science and engineering problems.

EEEL E4220 Energy System Economics and Optimization. *3.00 points*.
Prerequisites: Basic linear algebra. Basic probability and statistics. Basic programming skills.
Fundamental of power system economics over which the current electricity markets are designed. Formulation of unit commitment and economic dispatch as mathematical optimization. Modeling of thermal generators, renewable generators, energy storage, and other grid resources in power system optimization. Introduction of equilibriums in electricity markets. Introduction of ancillary service markets. Overview of current energy system research topics. Designed for masters and doctoral students, but is also open to undergraduates with the appropriate foundation classes

Fall 2026: EEEL E4220

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEEL 4220	001/14399	M W 10:10am - 11:25am 603 Hamilton Hall	Bolun Xu	3.00	33/54

EEME E3601 Introduction to Continuous Control Systems. *3.00 points*.
Lect: 3.

Prerequisites: (MATH UN2030 and APMA E3101)
Introduction to continuous systems with the treatment of classical and state-space formulations. Mathematical concepts, complex variables, integral transforms and their inverses, differential equations, and relevant linear algebra. Classical feedback control, time/frequency domain design, stability analysis, Laplace transform formulation and solutions, block diagram simplification and manipulation, signal flow graphs, modeling physical systems and linearization. state-space formulation and modeling, in parallel with classical single-input single-output formulation, connections between the two formulations. Transient and steady state analysis, methods of stability analysis, such as root locus methods, Nyquist stability criterion, Routh Hurwitz criterion, pole/zero placement, Bode plot analysis, Nichols chart analysis, phase lead and lag compensators, controllability, observability, realization of canonical forms, state estimation in multivariable systems, time-variant systems. Introduction to advanced stability analysis such as Lyapunov stability and simple optimal control formulation. May not take for credit if already received credit for EEME E4600.

Fall 2026: EEME E3601

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEME 3601	001/11349	W 4:10pm - 6:40pm 142 Uris Hall	Homayoon Beigi	3.00	76/105

EEME E4601 DISCRETE CONTROL SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (EEME E3601) or (EEME E6601)
The course studies control strategies and their implementation in the discrete domain. Introduction with examples; review of continuous control and Laplace Transforms; review of continuous state-space representation and Solutions; review of difference equations, discretization in time and frequency, the WKS (aka Shannon) sampling theorem, windowing, filters, Transforms: Fourier series, Fourier transform, z-transform and their inverses; Ideal sampler, Sample-and-hold devices, zero, one, polygonal, and slewer hold; Transfer functions, block diagrams, and signal flow graphs for discrete systems; Discrete State-Space transformation, controllabililty, observability, and stability in the state-space domain. Discrete time and z domain analysis, steady state analysis, discrete-time root-locus, and pole-zero placement; Discrete Nyquist stability criterion, Bode plot, Gain and Phase Margin analysis, Nichols chart, bandwidth and sensitivity analysis; Design criteria, self-tuning regulator, Kalman filter, and simulation, followed by advanced stability analysis such as Lyapunov stability; Overview of the discrete Euler-Lagrange equations, discrete maximum and minimum principle, optimal linear discrete regulator design, optimality and dynamic programming.

Spring 2026: EEME E4601

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEME 4601	001/12106	W 4:10pm - 6:40pm 1127 Seeley W. Mudd Building	Homayoon Beigi	3.00	24/50
EEME 4601	V01/16657		Homayoon Beigi	3.00	4/99

EEME E6602 MODERN CONTROL THEORY. *3.00 points*.
Lect: 3.

Singular value decomposition. ARX model and state space model system identification. Recursive least squares filters and Kalman filters. LQR, H**∞,** linear robust control, predictive control, adaptive control. Liapunov and Popov stability. Nonlinear adaptive control, nonlinear robust control, sliding mode control.

EEME E8601 ADV TOPICS IN CONTROL THEORY. *3.00 points*.
Lect: 3.

Prerequisites: (EEME E4601 and EEME E6601) or instructor's permission. May be taken more than once, since the content changes from year to year, electing different topics from control theory such as learning and repetitive control, adaptive control, system identification, Kalman filtering, etc.

EEOR E4650 CONVEX OPTIMIZATION FOR ENG. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3801) or ELEN E3801; or instructor's permission.
Theory of convex optimization; numerical algorithms; applications in circuits, communications, control, signal processing and power systems

Fall 2026: EEOR E4650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEOR 4650	001/11281	Th 10:10am - 12:40pm 141 Uris Hall	James Anderson	3.00	24/60

EEOR E6616 CONVEX OPTIMIZATION. *3.00 points*.
Lect: 2.5.

Prerequisites: (IEOR E6613) and (EEOR E4650) EEOR E4650 AND IEOR E6613
Convex sets and functions, and operations preserving convexity. Convex optimization problems. Convex duality. Applications of convex optimization problems ranging from signal processing and information theory to revenue management. Convex optimization in Banach spaces. Algorithms for solving constrained convex optimization problems

Spring 2026: EEOR E6616

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEOR 6616	001/13265	M W 4:10pm - 5:25pm 233 Seeley W. Mudd Building	Bento Natura	3.00	17/40
EEOR 6616	V01/19800		Bento Natura	3.00	2/99

ELEN E1101 THE DIGITAL INFORMATION AGE. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lect: 3.

An introduction to information transmission and storage, including technological issues. Binary numbers; elementary computer logic; digital speech and image coding; basics of compact disks, telephones, modems, faxes, UPC bar codes, and the World Wide Web. Projects include implementing simple digital logic systems and Web pages. Intended primarily for students outside the School of Engineering and Applied Science. The only prerequisite is a working knowledge of elementary algebra

Fall 2026: ELEN E1101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 1101	001/11218	T Th 11:40am - 12:55pm 627 Seeley W. Mudd Building	David Vallancourt	3.00	15/50

ELEN E1201 INTRO-ELECTRICAL ENGINEERING. *3.50 points*.
Lect: 3. Lab:1.

Prerequisites: (MATH UN1101)
Basic concepts of electrical engineering. Exploration of selected topics and their application. Electrical variables, circuit laws, nonlinear and linear elements, ideal and real sources, transducers, operational amplifiers in simple circuits, external behavior of diodes and transistors, first order RC and RL circuits. Digital representation of a signal, digital logic gates, flipflops. A lab is an integral part of the course. Required of electrical engineering and computer engineering majors.

Spring 2026: ELEN E1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 1201	001/11494	M W 4:10pm - 5:25pm 501 Northwest Corner	David Vallancourt	3.50	129/160

Fall 2026: ELEN E1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 1201	001/11256	T Th 4:10pm - 5:25pm 301 Pupin Laboratories	David Vallancourt	3.50	81/120

ELEN E3043 SOLID ST,MICROWAVE,FBR OPT LAB. *3.00 points*.
Lect: 1. Lab: 6.

Prerequisites: (ELEN E3106) and ELEN E3401)
Optical electronics and communications. Microwave circuits. Physical electronics.

Fall 2026: ELEN E3043

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3043	001/11257	W 4:10pm - 6:40pm 633 Seeley W. Mudd Building	Wen Wang	3.00	61/80

ELEN E3081 CIRCUIT ANALYSIS LABORATORY. *1.00 point*.
Lab: 3.

Prerequisites: (ELEN E1201) or equivalent.
Corequisites: ELEN E3201
Companion lab course for ELEN E3201. Experiments cover such topics as: use of measurement instruments; HSPICE simulation; basic network theorems; linearization of nonlinear circuits using negative feedback; op-amp circuits; integrators; second order RLC circuits. The lab generally meets on alternate weeks.

Fall 2026: ELEN E3081

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3081	001/11219	M 2:40pm - 5:10pm 1206 Seeley W. Mudd Building	David Vallancourt	1.00	27/36
ELEN 3081	002/11258	Th 10:10am - 12:40pm 1206 Seeley W. Mudd Building	David Vallancourt	1.00	22/36
ELEN 3081	003/11259	F 10:10am - 12:40pm 1206 Seeley W. Mudd Building	David Vallancourt	1.00	27/36

ELEN E3082 DIGITAL SYSTEMS LABORATORY. *1.00 point*.
Lab: 3.

Corequisites: CSEE W3827
Companion lab course for CSEE W3827. Experiments cover such topics as logic gates; flip-flops; shift registers; counters; combinational logic circuits; sequential logic circuits; programmable logic devices. The lab generally meets on alternate weeks.

Spring 2026: ELEN E3082

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3082	001/11791	M 4:10pm - 6:40pm Room TBA	Kenneth Shepard	1.00	34/42
ELEN 3082	001/11791	M 4:10pm - 6:40pm 1205 Seeley W. Mudd Building	Kenneth Shepard	1.00	34/42
ELEN 3082	002/11792	T 4:10pm - 6:40pm Room TBA	Kenneth Shepard	1.00	36/42
ELEN 3082	002/11792	T 4:10pm - 6:40pm 1205 Seeley W. Mudd Building	Kenneth Shepard	1.00	36/42
ELEN 3082	003/11793	F 1:10pm - 3:40pm Room TBA	Kenneth Shepard	1.00	28/42
ELEN 3082	003/11793	F 1:10pm - 3:40pm 1205 Seeley W. Mudd Building	Kenneth Shepard	1.00	28/42

ELEN E3083 ELECTRONIC CIRCUITS LABORATORY. *1.00 point*.
Lab: 3.

Prerequisites: (ELEN E3081)
Corequisites: ELEN E3331
Companion lab course for ELEN E3331. Experiments cover such topics as macromodeling of nonidealities of opamps using SPICE; Schmitt triggers and astable multivibrations using op-amps and diodes; logic inverters and amplifiers using bipolar junction transistors; logic inverters and ring oscillators using MOSFETs; filter design using opamps. The lab generally meets on alternate weeks.

Spring 2026: ELEN E3083

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3083	001/11794	M 4:10pm - 6:40pm Room TBA	David Vallancourt	1.00	39/46
ELEN 3083	001/11794	M 4:10pm - 6:40pm 1205 Seeley W. Mudd Building	David Vallancourt	1.00	39/46
ELEN 3083	002/11795	T 4:10pm - 6:40pm Room TBA	David Vallancourt	1.00	42/46
ELEN 3083	003/11796	F 1:10pm - 3:40pm Room TBA	David Vallancourt	1.00	21/46
ELEN 3083	003/11796	F 1:10pm - 3:40pm 1205 Seeley W. Mudd Building	David Vallancourt	1.00	21/46

ELEN E3084 SIGNALS # SYSTEMS LABORATORY. *1.00 point*.
Lab: 3.

Corequisites: ELEN E3801
Companion lab course for ELEN E3801. Experiments cover topics such as: introduction and use of MATLAB for numerical and symbolic calculations; linearity and time invariance; continuous-time convolution; Fourier-series expansion and signal reconstruction; impulse response and transfer function; forced response. The lab generally meets on alternate weeks.

Fall 2026: ELEN E3084

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3084	001/11260	M 6:10pm - 8:40pm 1235 Seeley W. Mudd Building	Xiaodong Wang	1.00	27/36
ELEN 3084	002/11261	Th 4:10pm - 6:40pm 1235 Seeley W. Mudd Building	Xiaodong Wang	1.00	7/36
ELEN 3084	003/11262	F 1:10pm - 3:40pm 1235 Seeley W. Mudd Building	Xiaodong Wang	1.00	8/36
ELEN 3084	004/11346	T 4:10pm - 6:40pm 1235 Seeley W. Mudd Building	Xiaodong Wang	1.00	25/36

ELEN E3106 SOLID STATE DEVICES-MATERIALS. *3.50 points*.
Lect: 3. Recit: 1.

Prerequisites: (MATH UN1201) or (APMA E2000)
Corequisites: PHYS UN1403,PHYS UN2601
Crystal structure and energy band theory of solids. Carrier concentration and transport in semiconductors. P-n junction and junction transistors. Semiconductor surface and MOS transistors. Optical effects and optoelectronic devices. Fabrication of devices and the effect of process variation and distribution statistics on device and circuit performance.

Fall 2026: ELEN E3106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3106	001/11263	T Th 11:40am - 12:55pm 402 Chandler	Savannah Eisner	3.50	63/100

ELEN E3201 CIRCUIT ANALYSIS. *3.50 points*.
Lect: 3. Recit: 1.

Prerequisites: (ELEN E1201) or equivalent.
Corequisites: MATH UN1201,APMA E2000
A course on analysis of linear and nonlinear circuits and their applications. Formulation of circuit equations. Network theorems. Transient response of first and second order circuits. Sinusoidal steady state-analysis. Frequency response of linear circuits. Poles and zeros. Bode plots. Two-port networks.

Fall 2026: ELEN E3201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3201	001/11264	M W 11:40am - 12:55pm 207 Mathematics Building	Charles Zukowski	3.50	80/130

ELEN E3331 ELECTRONIC CIRCUITS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3201)
Corequisites: ELEN E3083
Operational amplifier circuits. Diodes and diode circuits. MOS and bipolar junction transistors. Biasing techniques. Small-signal models. Single-stage transistor amplifiers. Analysis and design of CMOS logic gates. A/D and D/A converters.

Spring 2026: ELEN E3331

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3331	001/11498	M W 11:40am - 12:55pm 209 Havemeyer Hall	David Vallancourt	3.00	104/108

ELEN E3390 EE SENIOR DESIGN PROJECT. *3.00 points*.
Prerequisites: (ELEN E3399) and completion of most other required EE courses.
Students work in teams to specify, design, implement and test an engineering prototype. Involves technical as well as non-technical considerations, such as manufacturability, impact on the environment, economics, adherence to engineering standards, and other real-world constraints. Projects are presented publicly by each design team in a school-wide expo.

Spring 2026: ELEN E3390

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3390	001/11499	T Th 11:40am - 12:55pm 1206 Seeley W. Mudd Building	David Vallancourt	3.00	1/40
ELEN 3390	002/16896	F 6:00pm - 7:00pm 1206 Seeley W. Mudd Building	David Vallancourt	3.00	20/40

ELEN E3399 ELECTRICAL ENGINEERING PRACTICE. *1.00 point*.
Design project planning, written and oral technical communication, the origin and role of standards, engineering ethics, and practical aspects of engineering as a profession, such as career development and societal and environmental impact. Generally taken fall of senior year just before ELEN E3390

Fall 2026: ELEN E3399

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3399	001/11265	M 11:40am - 12:55pm 313 Fayerweather	David Vallancourt	1.00	38/80
ELEN 3399	002/11500	F 6:00pm - 7:00pm 627 Seeley W. Mudd Building	David Vallancourt	1.00	21/50

ELEN E3401 ELECTROMAGNETICS. *4.00 points*.
Lect: 3.

Prerequisites: (MATH UN1201 or APMA E2000) and PHYS UN1402 or PHYS UN1602) or equivalents.
Basic field concepts. Interaction of time-varying electromagnetic fields. Field calculation of lumped circuit parameters. Transition from electrostatic to quasistatic and electromagnetic regimes. Transmission lines. Energy transfer, dissipation, and storage. Waveguides. Radiation.

Spring 2026: ELEN E3401

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3401	001/11501	M W 2:40pm - 3:55pm 141 Uris Hall	Keren Bergman	4.00	73/80

ELEN E3701 INTRO TO COMMUNICATION SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3801)
Corequisites: IEOR E3658
A basic course in communication theory, stressing modern digital communication systems. Nyquist sampling, PAM and PCM/DPCM systems, time division multipliexing, high frequency digital (ASK, OOK, FSK, PSK) systems, and AM and FM systems. An introduction to noise processes, detecting signals in the presence of noise, Shannons theorem on channel capacity, and elements of coding theory.

Spring 2026: ELEN E3701

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3701	001/11502	T Th 2:40pm - 3:55pm 633 Seeley W. Mudd Building	Irving Kalet	3.00	59/65

ELEN E3801 SIGNALS AND SYSTEMS. *3.50 points*.
Lect: 3.

Corequisites: MATH UN1201,APMA E2000
Modeling, description, and classification of signals and systems. Continuous-time systems. Time domain analysis, convolution. Frequency domain analysis, transfer functions. Fourier series. Fourier and Laplace transforms. Discrete-time systems and the Z transform.

Fall 2026: ELEN E3801

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3801	001/11316	T Th 7:10pm - 8:25pm 207 Mathematics Building	Xiaodong Wang	3.50	88/150

ELEN E3990 FIELDWORK. *1.00-2.00 points*.
Prerequisites: Obtained internship and approval from a faculty adviser. May be repeated for credit, but no more than 3 total points may be used for degree credit. Only for Electrical Engineering and Computer Engineering undergraduate students who include relevant off-campus work experience as part of their approved program of study. Final report and letter of evaluation required. May not be used as technical or nontechnical electives or to satisfy any other Electrical Engineering or Computer Engineering major requirements. May not be taken for pass/fail credit or audited.

Spring 2026: ELEN E3990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3990	001/16708		Xiaodong Wang	1.00-2.00	2/99

Summer 2026: ELEN E3990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3990	001/11131		Xiaodong Wang	1.00-2.00	2/99

Fall 2026: ELEN E3990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3990	001/20104		Xiaodong Wang	1.00-2.00	0/99

ELEN E3998 PROJECTS IN ELEC ENGINEERING. *0.00-3.00 points*.
0 to 3 pts.

Prerequisites: Requires approval by a faculty member who agrees to supervise the work.
May be repeated for credit, but no more than 3 total points may be used for degree credit. Independent project involving laboratory work, computer programming, analytical investigation, or engineering design

Spring 2026: ELEN E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3998	001/16530		Dimitris Anastassiou	0.00-3.00	0/90
ELEN 3998	002/16531		Keren Bergman	0.00-3.00	0/90
ELEN 3998	003/16537		Shih-Fu Chang	0.00-3.00	0/90
ELEN 3998	004/16538		Javad Ghaderi	0.00-3.00	0/90
ELEN 3998	005/16539		Christine Hendon	0.00-3.00	0/90
ELEN 3998	006/16540		Predrag Jelenkovic	0.00-3.00	0/90
ELEN 3998	007/16544		Xiaofan Jiang	0.00-3.00	0/90
ELEN 3998	008/16545		Ethan Katz-Bassett	0.00-3.00	0/90
ELEN 3998	009/16546		Dion Khodagholy Araghy	0.00-3.00	0/90
ELEN 3998	010/16543		Peter Kinget	0.00-3.00	0/90
ELEN 3998	011/16542		Zoran Kostic	0.00-3.00	0/90
ELEN 3998	012/16541		Harish Krishnaswamy	0.00-3.00	0/90
ELEN 3998	013/16555		Ioannis Kymissis	0.00-3.00	1/90
ELEN 3998	014/16556		Aurel Lazar	0.00-3.00	0/90
ELEN 3998	015/16561		Michal Lipson	0.00-3.00	0/90
ELEN 3998	016/16560		Nima Mesgarani	0.00-3.00	3/90
ELEN 3998	017/16559		Debasis Mitra	0.00-3.00	0/90
ELEN 3998	018/16558		John Paisley	0.00-3.00	0/90
ELEN 3998	019/16557		Matthias Preindl	0.00-3.00	1/90
ELEN 3998	020/16562		Mingoo Seok	0.00-3.00	0/90
ELEN 3998	021/16554		Kenneth Shepard	0.00-3.00	0/90
ELEN 3998	022/16553		Tanvir Ahmed Khan	0.00-3.00	0/90
ELEN 3998	023/16536		Yannis Tsividis	0.00-3.00	0/90
ELEN 3998	024/16534		David Vallancourt	0.00-3.00	3/90
ELEN 3998	025/16532		Wen Wang	0.00-3.00	0/90
ELEN 3998	026/16535		Xiaodong Wang	0.00-3.00	0/90
ELEN 3998	027/16551		John Wright	0.00-3.00	0/90
ELEN 3998	028/16552		Charles Zukowski	0.00-3.00	0/90
ELEN 3998	029/16549		Gil Zussman	0.00-3.00	0/90
ELEN 3998	030/16548		Alexander Gaeta	0.00-3.00	0/99
ELEN 3998	036/16547		Homayoon Beigi	0.00-3.00	0/99

Fall 2026: ELEN E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 3998	001/16337		Dimitris Anastassiou	0.00-3.00	0/50
ELEN 3998	002/16338		Keren Bergman	0.00-3.00	0/50
ELEN 3998	003/16339		Shih-Fu Chang	0.00-3.00	0/50
ELEN 3998	004/16340		Javad Ghaderi	0.00-3.00	0/50
ELEN 3998	005/16341		Christine Hendon	0.00-3.00	0/50
ELEN 3998	006/16342		Predrag Jelenkovic	0.00-3.00	0/50

ELEN E4106 Advanced Solid State Devices and Materials. *3.00 points*.
Prerequisites: APMA E2000 and MATH UN1201
Corequisites: PHYS UN2601
PHYS UN1403
Crystal structure and energy band theory of solids. Carrier concentration and transport in semiconductors. P-n junction and junction transistors. Semiconductor surface and MOS transistors. Optical effects and optoelectronic devices. Fabrication of devices and the effect of process variation and distribution statistics on device and circuit performance. Course shares lectures with ELEN E3106, but the work requirements differ. Undergraduate students are not eligible to register.

Fall 2026: ELEN E4106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4106	001/11271	T Th 11:40am - 12:55pm 402 Chandler	Savannah Eisner	3.00	21/30
ELEN 4106	V01/18105		Savannah Eisner	3.00	1/99

ELEN E4193 MOD DISPLAY SCI # TECHNOLOGY. *3.00 points*.
Lect: 3.

Prerequisites: Linear algebra, differential equations, and basic semiconductor physics.
Introduction to modern display systems in an engineering context. The basis for visual perception, image representation, color space, metrics of illumination. Physics of luminescence, propagation and manipulation of light in anisotropic media, emissive displays, and spatial light modulators. Fundamentals of display addressing, the Alt-Pleshko theorem, multiple line addressing. Large area electronics, fabrication, and device integration of commercially important display types. A series of short laboratories will reinforce material from the lectures. Enrollment may be limited

Spring 2026: ELEN E4193

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4193	001/16432	M W 10:10am - 11:25am 516 Hamilton Hall	Ioannis Kymissis, Peter Ballentine	3.00	36/54

ELEN E4215 ANALOG FILTER SYNTHESIS/DESIGN. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3201) and (ELEN E3801) or ELEN E3201 AND ELEN E3801; or equivalent.
Approximation techniques for magnitude, phase, and delay specifications, transfer function realization sensitivity, passive LC filters, active RC filters, MOSFET-C filters, Gm-C filters, switched-capacitor filters, automatic tuning techniques for integrated filters. Filter noise. A design project is an integral part of the course

ELEN E4312 ANALOG ELECTRONIC CIRCUITS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3331) and (ELEN E3801) ELEN E3331 AND ELEN E3801
Differential and multistage amplifiers; small-signal analysis; biasing techniques; frequency response; negative feedback; stability criteria; frequency compensation techniques. Analog layout techniques. An extensive design project is an integral part of the course

Fall 2026: ELEN E4312

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4312	001/12139	F 10:10am - 12:40pm 329 Pupin Laboratories		3.00	105/100

ELEN E4314 COMMUNICATION CIRCUITS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E4312) ELEN E4312
Principles of electronic circuits used in the generation, transmission, and reception of signal waveforms, as used in analog and digital communication systems. Nonlinearity and distortion; power amplifiers; tuned amplifiers; oscillators; multipliers and mixers; modulators and demodulators; phase-locked loops. An extensive design project is an integral part of the course

Spring 2026: ELEN E4314

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4314	001/17117	Th 4:10pm - 6:40pm 702 Hamilton Hall	Emily Naviasky	3.00	25/60

ELEN E4361 POWER ELECTRONICS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3331) and (ELEN E3801) ELEN E3331 AND ELEN E3801
Introduction to power electronics; power semiconductor devices: power diodes, thyristors, commutation techniques, power transistors, power MOSFETs, Triac, IGBTs, etc. and switch selection; non-sinusoidal power definitions and computations, modeling, and simulation; half-wave rectifiers; single-phase, full-wave rectifiers; three-phase rectifiers; AC voltage controllers; DC/DC buck, boost, and buck-boost converters; discontinuous conduction mode of operation; DC power supplies: Flyback, Forward converter; DC/AC inverters, PWM techniques; three-phase inverters

Fall 2026: ELEN E4361

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4361	001/15410	M 1:10pm - 3:40pm 142 Uris Hall	Matthias Preindl	3.00	36/80

ELEN E4401 WAVE TRANSMISSION-FIBER OPTICS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3401) or ELEN E3401; or equivalent.
Waves and Maxwell's equations. Field energetics, dispersion, complex power. Waves in dielectrics and in conductors. Reflection and refraction. Oblique incidence and total internal reflection. Transmission lines and conducting waveguides. Planar and circular dielectric waveguides; integrated optics and optical fibers. Hybrid and LP modes. Graded-index fibers. Mode coupling; wave launching

ELEN E4411 FUNDAMENTALS OF PHOTONICS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3401) or ELEN E3401; or equivalent.
Planar resonators. Photons and photon streams. Photons and atoms: energy levels and band structure; interactions of photons with matter; absorption, stimulated and spontaneous emission; thermal light, luminescence light. Laser amplifiers: gain, saturation, and phase shift; rate equations; pumping. Lasers: theory of oscillation; laser output characteristics. Photons in semiconductors: generation, recombination, and injection; heterostructures; absorption and gain coefficients. Semiconductor photon sources: LEDs; semiconductor optical amplifiers; homojunction and heterojunction laser diodes. Semiconductor photon detectors: p-n, p-i-n, and heterostructure photo diodes; avalanche photodiodes

Fall 2026: ELEN E4411

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4411	001/11273	T 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Michal Lipson	3.00	53/52

ELEN E4488 OPTICAL SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3401) ELEN E3401; or equivalent.
Introduction to optical systems based on physical design and engineering principles. Fundamental geometrical and wave optics with specific emphasis on developing analytical and numerical tools used in optical engineering design. Focus on applications that employ optical systems and networks, including examples in holographic imaging, tomography, Fourier imaging, confocal microscopy, optical signal processing, fiber optic communication systems, optical interconnects and networks

Summer 2026: ELEN E4488

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4488	D01/11966		Christine Hendon	3.00	4/99

Fall 2026: ELEN E4488

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4488	001/11274	Th 10:10am - 12:40pm 1024 Seeley W. Mudd Building	Christine Hendon	3.00	20/50
ELEN 4488	V01/18106		Christine Hendon	3.00	2/99

ELEN E4510 Grid Modernization # Clean Tech. *3.00 points*.
Lect: 3.

Prerequisites: Familiarity with material covered in ELEN 3201 Circuit Analysis
Covers solar energy, battery storage, electric vehicles, and data centers — treated as sub-transmission level loads — as key distributed energy resources. Students learn how advanced metering data enables grid optimization through demand-side management, distributed energy resource coordination, and distribution system control. Topics include smart inverters, flexible loads, and cybersecurity for modern grid operations.

Spring 2026: ELEN E4510

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4510	001/17121	W 7:00pm - 9:30pm 304 Hamilton Hall	Sindhu Suresh	3.00	28/35

ELEN E4511 POWER SYSTEMS ANALYSIS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3201) and (ELEN E3401) or ELEN E3201 AND ELEN E3401; or equivalents, or instructor's permission.
Modeling of power networks, steady-state and transient behaviors, control and optimization, electricity market, and smart grid

Fall 2026: ELEN E4511

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4511	001/11275	W 7:00pm - 9:30pm 1024 Seeley W. Mudd Building	Ahmed Mousa	3.00	30/55
ELEN 4511	V01/18107		Ahmed Mousa	3.00	4/99

ELEN E4650 CONVEX OPTIMIZATION-EE. *3.00 points*.
Prerequisites: ELEN E3801; or instructor's permission.
Theory of convex optimization; numerical algorithms; applications in circuits, communications, control, signal processing and power systems

ELEN E4702 DIGITAL COMMUNICATIONS. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3701) or ELEN E3701; or equivalent.
Digital communications for both point-to-point and switched applications is further developed. Optimum receiver structures and transmitter signal shaping for both binary and M-ary signal transmission. An introduction to block codes and convolutional codes, with application to space communications

Spring 2026: ELEN E4702

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4702	001/11504	W 7:00pm - 9:30pm 627 Seeley W. Mudd Building	Alexei Ashikhmin	3.00	6/50

ELEN E4720 Machine Learning for Signals, Information and Data. *3.00 points*.

Fall 2026: ELEN E4720

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4720	001/11282	W 10:10am - 12:40pm 313 Fayerweather	John Paisley	3.00	88/80

ELEN E4730 Quantum Optimization and Machine Learning. *3.00 points*.
Prerequisites: probability theory, linear algebra
An introduction to the recent development in quantum optimization and quantum machine learning using gate-based Noisy Intermediate Scale Quantum (NISQ) computers. IBM's quantum programming framework Qiskit is utilized. Qbits, quantum gates and quantum measurements, quantum algorithms (Grover's search, Simon's algorithm, quantum Fourier transform, quantum phase estimation) quantum optimization (quantum annealing, QAOA, variational quantum eigensolver), quantum machine learning (quantum support vector machine, quantum neural networks)

Spring 2026: ELEN E4730

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4730	001/11508	T Th 2:40pm - 3:55pm 545 Seeley W. Mudd Building	Xiaodong Wang, Jeremy Johnston	3.00	19/30
ELEN 4730	V01/17541		Xiaodong Wang, Jeremy Johnston	3.00	2/99

ELEN E4810 DIGITAL SIGNAL PROCESSING. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3801) ELEN E3801
Digital filtering in time and frequency domain, including properties of discrete-time signals and systems, sampling theory, transform analysis, system structures, IIR and FIR filter design techniques, the discrete Fourier transform, fast Fourier transforms

Fall 2026: ELEN E4810

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4810	001/11645	M 10:10am - 12:40pm 833 Seeley W. Mudd Building	Guido Jajamovich	3.00	52/70
ELEN 4810	V01/18108		Guido Jajamovich	3.00	2/99

ELEN E4815 RANDOM SIGNALS # NOISE. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3658) or equivalent.
Corequisites: ELEN E6717
Characterization of stochastic processes as models of signals and noise; stationarity, ergodicity, correlation functions, and power spectra. Gaussian processes as models of noise in linear and nonlinear systems; linear and nonlinear transformations of random processes; orthogonal series representations. Applications to circuits and devices, to communication, control, filtering, and prediction.

Spring 2026: ELEN E4815

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4815	001/11509	T Th 11:40am - 12:55pm 1127 Seeley W. Mudd Building	Irving Kalet	3.00	43/60
ELEN 4815	V01/16735		Irving Kalet	3.00	1/99

ELEN E4830 Image Processing and Computer Vision. *3.00 points*.
Lect: 3.

Introduction to the mathematical tools and algorithmic implementation for representation, processing, and reconstruction of digital images, videos, and visual sensory data. Image representation, filtering, transform, quality enhancement, restoration, feature extraction, object segmentation, motion analysis, stitching, depth estimation, 3D reconstruction, classification, and coding for data compression. A series of programming assignments reinforces material from the lectures

Spring 2026: ELEN E4830

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4830	001/11512	Th 10:10am - 12:40pm 303 Uris Hall	Christine Hendon	3.00	13/60
ELEN 4830	V01/16658		Christine Hendon	3.00	2/99

ELEN E4901 TOPICS IN EE # CE. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 4900 to 4909

ELEN E4902 TOPICS IN EE # CE. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 4900 to 4909

ELEN E4904 TOPICS IN EE # CE. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 4900 to 4909

Spring 2026: ELEN E4904

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4904	001/11515	T 1:10pm - 3:40pm 702 Hamilton Hall	Hui Jin	3.00	30/80

ELEN E4906 TOPICS IN EE # CE. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 4900 to 4909

ELEN E4944 PRNCPLS OF DEVICE MICROFABRCTN. *3.00 points*.
Lect: 3.

Science and technology of conventional and advanced microfabrication techniques for electronics, integrated and discrete components. Topics include diffusion; ion implantation, thin-film growth including oxides and metals, molecular beam and liquid-phase epitaxy; optical and advanced lithography; and plasma and wet etching

Fall 2026: ELEN E4944

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4944	001/16507	M W 1:10pm - 2:25pm 233 Seeley W. Mudd Building	Jose Bahamonde, Ioannis Kymissis	3.00	17/50

ELEN E4998 INTERMEDIATE PROJECTS. *0.00-3.00 points*.
0 to 3 pts.

Prerequisites: Requires approval by a faculty member who agrees to supervise the work.
May be repeated for credit, but no more than 3 total points may be used for degree credit. Substantial independent project involving laboratory work, computer programming, analytical investigation, or engineering design

Spring 2026: ELEN E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4998	001/16564		Dimitris Anastassiou	0.00-3.00	0/90
ELEN 4998	002/16565		Keren Bergman	0.00-3.00	0/90
ELEN 4998	004/16566		Javad Ghaderi	0.00-3.00	0/90
ELEN 4998	005/16570		Christine Hendon	0.00-3.00	1/90
ELEN 4998	006/16571		Predrag Jelenkovic	0.00-3.00	0/90
ELEN 4998	007/16574		Xiaofan Jiang	0.00-3.00	0/90
ELEN 4998	008/16575		Ethan Katz-Bassett	0.00-3.00	0/90
ELEN 4998	009/16576		Dion Khodagholy Araghy	0.00-3.00	0/90
ELEN 4998	010/16577		Peter Kinget	0.00-3.00	0/90
ELEN 4998	011/16578		Zoran Kostic	0.00-3.00	0/90
ELEN 4998	012/16580		Harish Krishnaswamy	0.00-3.00	0/90
ELEN 4998	013/16582		Ioannis Kymissis	0.00-3.00	0/90
ELEN 4998	014/16581		Aurel Lazar	0.00-3.00	0/90
ELEN 4998	015/16583		Michal Lipson	0.00-3.00	0/90
ELEN 4998	016/16584		Nima Mesgarani	0.00-3.00	0/90
ELEN 4998	017/16585		Debasis Mitra	0.00-3.00	0/90
ELEN 4998	018/16586		John Paisley	0.00-3.00	0/90
ELEN 4998	019/16587		Matthias Preindl	0.00-3.00	0/90
ELEN 4998	020/16588		Mingoo Seok	0.00-3.00	0/90
ELEN 4998	021/16597		Kenneth Shepard	0.00-3.00	0/90
ELEN 4998	022/16589		Tanvir Ahmed Khan	0.00-3.00	0/90
ELEN 4998	023/16594		Yannis Tsividis	0.00-3.00	0/90
ELEN 4998	024/16595		David Vallancourt	0.00-3.00	0/90
ELEN 4998	025/16596		Wen Wang	0.00-3.00	0/90
ELEN 4998	026/16593		Xiaodong Wang	0.00-3.00	0/90
ELEN 4998	027/16592		John Wright	0.00-3.00	0/90
ELEN 4998	028/16591		Charles Zukowski	0.00-3.00	0/90
ELEN 4998	029/16590		Gil Zussman	0.00-3.00	6/90
ELEN 4998	031/16572		Savannah Eisner	0.00-3.00	1/99
ELEN 4998	035/20450		Micah Goldblum	0.00-3.00	1/99
ELEN 4998	036/16573		Homayoon Beigi	0.00-3.00	0/99
ELEN 4998	037/20554		Paul Sajda	0.00-3.00	1/90

Summer 2026: ELEN E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4998	001/11994		Navid Asr	0.00-3.00	2/5

Fall 2026: ELEN E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 4998	001/16370		Dimitris Anastassiou	0.00-3.00	0/50
ELEN 4998	002/16371		Keren	0.00-3.00	0/50

ELEN E6001 ADVANCED PROJECTS. *1.00-4.00 points*.
Prerequisites: Requires approval by a faculty member who agrees to supervise the work.
May be repeated for up to 6 points of credit. Graduate-level projects in various areas of electrical engineering and computer science. In consultation with an instructor, each student designs his or her project depending on the students previous training and experience. Students should consult with a professor in their area for detailed arrangements no later than the last day of registration

Summer 2026: ELEN E6001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6001	001/11831		Homayoon Beigi	1.00-4.00	1/5
ELEN 6001	002/11832		Xiaodong Wang	1.00-4.00	3/5
ELEN 6001	003/11993		Navid Asr	1.00-4.00	1/5
ELEN 6001	004/12832		Tanvir Ahmed Khan	1.00-4.00	1/5
ELEN 6001	011/12875		Zoran Kostic	1.00-4.00	1/5

Fall 2026: ELEN E6001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6001	001/16401		Dimitris Anastassiou	1.00-4.00	0/50
ELEN 6001	002/16402		Keren Bergman	1.00-4.00	2/50
ELEN 6001	003/16403		Shih-Fu Chang	1.00-4.00	0/50
ELEN 6001	004/16404		Javad Ghaderi	1.00-4.00	0/50
ELEN 6001	005/16405		Christine Hendon	1.00-4.00	0/50
ELEN 6001	006/16406		Predrag Jelenkovic	1.00-4.00	0/50
ELEN 6001	007/16407		Xiaofan Jiang	1.00-4.00	0/50
ELEN 6001	008/16408		Ethan Katz-Bassett	1.00-4.00	1/50
ELEN 6001	009/16411		Dion Khodagholy Araghy	1.00-4.00	0/50
ELEN 6001	010/16412		Peter Kinget	1.00-4.00	0/50
ELEN 6001	011/16413		Zoran Kostic	1.00-4.00	0/50
ELEN 6001	012/16414		Harish Krishnaswamy	1.00-4.00	0/50
ELEN 6001	013/16415		Ioannis Kymissis	1.00-4.00	1/50
ELEN 6001	014/16410		Aurel Lazar	1.00-4.00	0/50
ELEN 6001	015/16409		Michal Lipson	1.00-4.00	1/50
ELEN 6001	016/16416		Nima Mesgarani	1.00-4.00	0/50
ELEN 6001	017/16417		Debasis Mitra	1.00-4.00	0/50
ELEN 6001	018/16437		John Paisley	1.00-4.00	0/50
ELEN 6001	019/16436		Matthias Preindl	1.00-4.00	1/50
ELEN 6001	020/16435		Mingoo Seok	1.00-4.00	0/50
ELEN 6001	021/16434		Kenneth Shepard	1.00-4.00	0/50
ELEN 6001	022/16433		Tanvir Ahmed Khan	1.00-4.00	0/50
ELEN 6001	023/16432		Yannis Tsividis	1.00-4.00	0/50
ELEN 6001	024/16431		David Vallancourt	1.00-4.00	0/50
ELEN 6001	025/16430		Wen Wang	1.00-4.00	0/50
ELEN 6001	026/16429		Xiaodong Wang	1.00-4.00	3/50
ELEN 6001	027/16428		John Wright	1.00-4.00	0/50
ELEN 6001	028/16427		Charles Zukowski	1.00-4.00	0/50
ELEN 6001	029/16426		Gil Zussman	1.00-4.00	0/50
ELEN 6001	030/16425		Alexander Gaeta	1.00-4.00	0/50
ELEN 6001	031/16424		Savannah Eisner	1.00-4.00	1/50
ELEN 6001	032/16423		James	1.00-4.00	1/50

ELEN E6002 ADVANCED PROJECTS. *1.00-4.00 points*.
Prerequisites: Requires approval by a faculty member who agrees to supervise the work.
May be repeated for up to 6 points of credit. Graduate-level projects in various areas of electrical engineering and computer science. In consultation with an instructor, each student designs his or her project depending on the students previous training and experience. Students should consult with a professor in their area for detailed arrangements no later than the last day of registration

Spring 2026: ELEN E6002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6002	001/16321		Dimitris Anastassiou	1.00-4.00	0/90
ELEN 6002	002/16323		Keren Bergman	1.00-4.00	0/90
ELEN 6002	003/16324		Shih-Fu Chang	1.00-4.00	0/90
ELEN 6002	004/16325		Javad Ghaderi	1.00-4.00	0/90
ELEN 6002	005/16340		Christine Hendon	1.00-4.00	1/90
ELEN 6002	006/16342		Predrag Jelenkovic	1.00-4.00	0/90
ELEN 6002	007/16343		Xiaofan Jiang	1.00-4.00	3/90
ELEN 6002	008/16344		Ethan Katz-Bassett	1.00-4.00	1/90
ELEN 6002	009/16362		Dion Khodagholy Araghy	1.00-4.00	0/90
ELEN 6002	010/16364		Peter Kinget	1.00-4.00	0/90
ELEN 6002	011/16361		Zoran Kostic	1.00-4.00	7/90
ELEN 6002	012/16360		Harish Krishnaswamy	1.00-4.00	0/90
ELEN 6002	013/16359		Ioannis Kymissis	1.00-4.00	3/90
ELEN 6002	014/16352		Aurel Lazar	1.00-4.00	0/90
ELEN 6002	015/16351		Michal Lipson	1.00-4.00	0/90
ELEN 6002	016/16353		Nima Mesgarani	1.00-4.00	2/90
ELEN 6002	017/16355		Debasis Mitra	1.00-4.00	0/90
ELEN 6002	018/16356		John Paisley	1.00-4.00	0/90
ELEN 6002	019/16358		Matthias Preindl	1.00-4.00	2/90
ELEN 6002	020/16350		Mingoo Seok	1.00-4.00	5/90
ELEN 6002	021/16349		Kenneth Shepard	1.00-4.00	0/90
ELEN 6002	022/16348		Tanvir Ahmed Khan	1.00-4.00	4/90
ELEN 6002	023/16347		Yannis Tsividis	1.00-4.00	0/90
ELEN 6002	024/16346		David Vallancourt	1.00-4.00	0/90
ELEN 6002	025/16345		Wen Wang	1.00-4.00	0/90
ELEN 6002	026/16339		Xiaodong Wang	1.00-4.00	0/90
ELEN 6002	027/16338		John Wright	1.00-4.00	0/90
ELEN 6002	028/16337		Charles Zukowski	1.00-4.00	0/90
ELEN 6002	029/16336		Gil Zussman	1.00-4.00	1/90
ELEN 6002	030/16335		Alexander Gaeta	1.00-4.00	0/90
ELEN 6002	031/16333		Savannah Eisner	1.00-4.00	3/90
ELEN 6002	032/16331		James Anderson	1.00-4.00	1/90
ELEN 6002	033/16330		Asaf Cidon	1.00-4.00	3/99
ELEN 6002	034/16328		Xiang Meng	1.00-4.00	1/99
ELEN 6002	035/16327		Micah Goldblum	1.00-4.00	1/99
ELEN 6002	036/16329		Homayoon Beigi	1.00-4.00	1/99
ELEN 6002	037/16326		Henning Schulzrinne	1.00-4.00	1/99
ELEN 6002	038/20073		Navid Asr	1.00-4.00	2/99

ELEN E6003 MASTER'S THESIS. *3.00 points*.
Prerequisites: ELEN E6001 OR ELEN E6002; A minimum of 3 points of credit in ELEN E6001 or ELEN E6002 advanced projects with the same instructor, the instructor's permission, and completion of at least 12 points of credit in the MS program with a GPA of at least 3.5.
Research in an area of Electrical Engineering culminating in a verbal presentation and a written thesis document approved by the thesis instructor. Must obtain permission from a thesis instructor to enroll. Thesis projects span at least two terms: an ELEN E6001 or E6002 Advanced Project followed by the E6003 Master's Thesis with the same instructor. Students must use a department recommended format for thesis writing. Counts towards the amount of research credit in the MS program

Spring 2026: ELEN E6003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6003	011/20276		Zoran Kostic	3.00	0/15
ELEN 6003	019/20517		Matthias Preindl	3.00	1/15

Fall 2026: ELEN E6003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6003	001/19820		Keren Bergman	3.00	0/5
ELEN 6003	029/19819		Gil Zussman	3.00	0/50

ELEN E6302 MOS TRANSISTORS. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E3106) ELEN E3106; or equivalent.
Operation and modeling of MOS transistors. MOS two- and three-terminal structures. The MOS transistor as a four-terminal device; general charge-sheet modeling; strong, moderate, and weak inversion models; short-and-narrow-channel effects; ion-implanted devices; scaling considerations in VLSI; charge modeling; large-signal transient and small-signal modeling for quasistatic and nonquasistatic operation

ELEN E6312 ADV ANALOG INTEGRATED CIRCUITS. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E4312) ELEN E4312
Integrated circuit device characteristics and models; temperature- and supply-independent biasing; IC operational amplifier analysis and design and their applications; feedback amplifiers, stability and frequency compensation techniques; noise in circuits and low-noise design; mismatch in circuits and low-offset design. Computer-aided analysis techniques are used in homework(s) or a design project

Spring 2026: ELEN E6312

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6312	001/11518	T 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Armagan Dascurcu	3.00	35/50
ELEN 6312	V01/20312		Armagan Dascurcu	3.00	0/99

ELEN E6316 Analog-Digital Interfaces in VLSI. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E4312) ELEN E4312; or equivalent.
Analog-to-digital and digital-to-analog conversion techniques for very large scale integrated circuits and systems. Precision sampling; quantization; A/D and D/A converter architectures and metrics; Nyquist architectures; oversampling architectures; correction techniques; system considerations. A design project is an integral part of this course

Spring 2026: ELEN E6316

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6316	001/16605	T 7:00pm - 9:30pm 702 Hamilton Hall	Timothy Dickson	3.00	37/60

ELEN E6318 MICROWAVE CIRCUIT DESIGN. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3331) and (ELEN E3401) or ELEN E3331 AND ELEN E3401; or equivalents.
Introduction to microwave engineering and microwave circuit design. Review of transmission lines. Smith chart, S-parameters, microwave impedance matching, transformation and power combining networks, active and passive microwave devices, S-parameter-based design of RF and microwave amplifiers. A microwave circuit design project (using microwave CAD) is an integral part of the course

Spring 2026: ELEN E6318

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6318	001/17120	M 4:10pm - 6:40pm 313 Fayerweather	Yves Baeyens	3.00	30/45

ELEN E6320 MILLIMETER-WAVE IC DESIGN. *3.00 points*.
Lect: 3.

Principles behind the implementation of millimeter-wave (30GHz-300GHz) wireless circuits and systems in silicon-based technologies. Silicon-based active and passive devices for millimeter-wave operation, millimeter-wave low-noise amplifiers, power amplifiers, oscillators and VCOs, oscillator phase noise theory, mixers and frequency dividers for PLLs. A design project is an integral part of the course.

Fall 2026: ELEN E6320

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6320	001/11546	Th 4:10pm - 6:40pm 545 Seeley W. Mudd Building	Harish Krishnaswamy	3.00	23/40
ELEN 6320	V01/18109		Harish Krishnaswamy	3.00	1/99

ELEN E6324 Principles of RF and Microwave Measurement. *3.00 points*.
Pre-requisites: ELEN E4314 or equivalent, or the instructor's permission

Principles behind, and techniques related to, RF and microwave simulation and measurements. S parameters; simulations and measurements for small-signal and large signal / nonlinear circuits in the time and frequency domains; noise

ELEN E6331 PRINCPLS SEMICONDUCTR PHYSCS I. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E4301) ELEN E4301
Designed for students interested in research in semiconductor materials and devices. Topics include energy bands: nearly free electron and tight-binding approximations, the k.p. method, quantitative calculation of band structures and their applications to quantum structure transistors, photodetectors, and lasers; semiconductor statistics, Boltzmann transport equation, scattering processes, quantum effect in transport phenomena, properties of heterostructures. Quantum mechanical treatment throughout

ELEN E6333 Semiconductor device physics. *3 points*.
Lect: 2.

Prerequisites: (ELEN E4301) or ELEN E3106 OR ELEN E4301; or equivalent.
Physics and properties of semiconductors. Transport and recombination of excess carriers. Schottky, P-N, MOS, and heterojunction diodes. Field effect and bipolar junction transistors. Dielectric and optical properties. Optical devices including semiconductor lamps, lasers, and detectors.

Spring 2026: ELEN E6333

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6333	001/11521	Th 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Xiang Meng	3	42/50

ELEN E6340 Power Management Integrated Circuits. *3.00 points*.
Prerequisites: (ELEN E4312) and (ELEN E4361)
Modern power management integrated circuits (PMIC) design introduced comperhensively. Advanced topics in power management introduced, including linear regulators, digital linear regulators, switch-mode power converters, control schemes for DC-DC converters, compensation methods of DC-DC converters, power losses in DC-DC converters, switched capacitor converters, power converter modeling and simulation, design examples.

Fall 2026: ELEN E6340

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6340	001/11287	M 7:00pm - 9:30pm 310 Fayerweather	XIN ZHANG	3.00	44/78

ELEN E6350 VLSI DESIGN LABORATORY. *3.00 points*.
Lab: 3.

Prerequisites: (ELEN E4321) and (ELEN E4312) or instructor's permission.
Design of a CMOS mixed-signal integrated circuit. The class divides up into teams to work on mixed-signal integrated circuit designs. The chips are fabricated to be tested the following term. Lectures cover use of computer-aided design tools, design issues specific to the projects, and chip integration issues. This course shares lectures with E4350, but the complexity requirements of integrated circuits are higher.

Spring 2026: ELEN E6350

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6350	001/18125	Th 4:10pm - 6:40pm 601 Fairchild Life Sciences Bldg	Harish Krishnaswamy	3.00	33/35

ELEN E6412 LIGHTWAVE DEVICES. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E4411) ELEN E4411
Electro-optics: principles; electro-optics of liquid crystals and photo-refractive materials. Nonlinear optics: second-order nonlinear optics; third-order nonlinear optics; pulse propagation and solitons. Acousto-optics: interaction of light and sound; acousto-optic devices. Photonic switching and computing: photonic switches; all-optical switches; bistable optical devices. Introduction to fiber-optic communications: components of the fiber-optic link; modulation, multiplexing and coupling; system performance; receiver sensitivity; coherent optical communications

Fall 2026: ELEN E6412

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6412	001/11289	W 4:10pm - 6:40pm 616 Martin Luther King Building	Xiang Meng	3.00	30/50

ELEN E6413 LIGHTWAVE SYSTEMS. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E4411) ELEN E4411; Recommended preparation: ELEN E6412.
Fiber optics. Guiding, dispersion, attenuation, and nonlinear properties of fibers. Optical modulation schemes. Photonic components, optical amplifiers. Semiconductor laser transmitters. Receiver design. Fiber optic telecommunication links. Nonregenerative transmission using erbium-doped fiber amplifier chains. Coherent detection. Local area networks. Advanced topics in light wave networks

ELEN E6414 PHOTONIC INTEGRATED CIRCUITS. *3.00 points*.
Lect: 3.

Photonic integrated circuits are important subsystem components for telecommunications, optically controlled radar, optical signal processing, and photonic local area networks. An introduction to the devices and the design of these circuits. Principle and modeling of dielectric waveguides (including silica on silicon and InP based materials), waveguide devices (simple and star couplers), and surface diffractive elements. Discussion of numerical techniques for modeling circuits, including beam propagation and finite difference codes, and design of other devices: optical isolators, demultiplexers

Spring 2026: ELEN E6414

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6414	001/11522	W 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Michal Lipson	3.00	28/30

ELEN E6430 APPLIED QUANTUM OPTICS. *3.00 points*.
Lect: 2.

Prerequisites: Background in electromagnetism ELEN E3401, ELEN E4401, ELEN E4411, or Physics GR6092 and quantum mechanics APPH E3100, APPH E4100, or PHYS GU402x.
An introduction to fundamental concepts of quantum optics and quantum electrodynamics with an emphasis on applications in nanophotonic devices. The quantization of the electromagnetic field; coherent and squeezed states of light; interaction between light and electrons in the language of quantum electrodynamics (QED); optical resonators and cavity QED; low-threshold lasers; and entangled states of light

Fall 2026: ELEN E6430

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6430	001/11290	Th 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Xiang Meng	3.00	30/50

ELEN E6488 Optical interconnects and interconnection networks. *3 points*.
Lect: 2.

Prerequisites: (ELEN E4411) or (ELEN E4488) or ELEN E4411 OR ELEN E4488; or an equivalent photonics course.
Introduction to optical interconnects and interconnection networks for digital systems. Fundamental optical interconnects technologies, optical interconnection network design, characterization, and performance evaluation. Enabling photonic technologies including free-space structures, hybrid and monolithic integration platforms for photonic on-chip, chip-to-chip, backplane, and node-to-node interconnects, as well as photonic networks on-chip.

Fall 2026: ELEN E6488

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6488	001/11292	M 1:10pm - 3:40pm 227 Seeley W. Mudd Building	Keren Bergman	3	24/40

ELEN E6713 Topics in communications. *3 points*.
Lect: 3.

Prerequisites: (ELEN E6712) or (ELEN E4702) or (ELEN E4703) or ELEN E6712 OR ELEN E4702 OR ELEN E4703; or equivalent, or instructor's permission.
Advanced topics in communications, such as turbo codes, LDPC codes, multiuser communications, network coding, cross-layer optimization, cognitive radio. Content may vary from year to year to reflect the latest development in the field.

ELEN E6717 Classical and Quantum Information Theory. *3.00 points*.
Lect: 2.

Prerequisites: (IEOR E3658) or or a course in stochastic processes.
Corequisites: ELEN E4815
Classical and quantum information measures. Source coding theorem. Capacity of discrete memoryless channels and the noisy channel coding theorem. The rate-distortion theory. Gaussian channel capacity. Quantum source coding. Quantum channel capacity.

ELEN E6718 ERROR CORRECTING CODES. *3.00 points*.
Lect: 2.

Prerequisites: (IEOR E3658) IEOR E3658
Main concepts of error control codes. Linear block codes. Elements of algebra: Galois fields. BCH and Reed Solomon codes. Convolutional Codes. Modern, capacity-achieving codes: Low Density Parity Check codes, TURBO codes, and Polar codes. EXIT Charts analysis

ELEN E6730 Quantum Sensing Theory. *3.00 points*.
Introduction to quantum detection and estimation theory and its applications to quantum communications, quantum radar, quantum metrology, and quantum tomography. Background on quantum mechanics, quantum detection, composite quantum systems, Gaussian states, and quantum estimation

Spring 2026: ELEN E6730

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6730	001/11562	F 1:10pm - 3:40pm 1024 Seeley W. Mudd Building	Xiaodong Wang	3.00	7/30
ELEN 6730	V01/17542		Xiaodong Wang	3.00	4/99

ELEN E6761 COMPUTER COMMUNICATNS NETWORKS. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3658) or equivalent, or instructor's permission.
Recommended: CSEE W4119.
Corequisites: ELEN E6950
Analytical approach to the design of (data) communication networks. Necessary tools for performance analysis and design of network protocols and algorithms. Practical engineering applications in layered Internet protocols in Data link layer, Network layer, and Transport layer. Review of relevant aspects of stochastic processes, control, and optimization.

Fall 2026: ELEN E6761

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6761	001/11303	T Th 10:10am - 11:25am 524 Seeley W. Mudd Building	Javad Ghaderi	3.00	18/50
ELEN 6761	V01/18110		Javad Ghaderi	3.00	0/5

ELEN E6767 INTERNET ECON, ENG # SOCIETY. *3.00 points*.
Prerequisites: (CSEE W4119) or (ELEN E6761) CSEE W4119 or ELEN E6761 recommended, and ability to comprehend and track development of sophisticated models.
Mathematical models, analyses of economics and networking interdependencies in the internet. Topics include microeconomics of pricing and regulations in communications industry, game theory in revenue allocations, ISP settlements, network externalities, two-sided markets. Economic principles in networking and network design, decentralized vs. centralized resource allocation, “price of anarchy,” congestion control. Case studies of topical internet issues. Societal and industry implications of internet evolution.

Fall 2026: ELEN E6767

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6767	001/11305	M W 11:40am - 12:55pm 545 Seeley W. Mudd Building	Debasis Mitra	3.00	17/30
ELEN 6767	V01/18111		Debasis Mitra	3.00	1/5

ELEN E6770 TOPICS IN NETWORKING. *3.00 points*.
Lect: 2.

Further study of areas such as communication protocols and architectures, flow and congestion control in data networks, performance evaluation in integrated networks. Content varies from year to year, and different topics rotate through the course numbers 6770 to 6779

Fall 2026: ELEN E6770

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6770	001/11306	F 4:10pm - 6:40pm 214 Pupin Laboratories	Thomas Woo	3.00	16/55

ELEN E6771 TOPICS IN NETWORKING. *3.00 points*.
Further study of areas such as communication protocols and architectures, flow and congestion control in data networks, performance evaluation in integrated networks. Content varies from year to year, and different topics rotate through the course numbers 6770 to 6779

Spring 2026: ELEN E6771

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6771	001/16607	F 1:10pm - 3:40pm 141 Uris Hall	Doru Calin	3.00	6/60

ELEN E6772 TOPICS IN NETWORKING. *3.00 points*.
Further study of areas such as communication protocols and architectures, flow and congestion control in data networks, performance evaluation in integrated networks. Content varies from year to year, and different topics rotate through the course numbers 6770 to 6779

Spring 2026: ELEN E6772

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6772	001/11526	W 7:00pm - 9:30pm 633 Seeley W. Mudd Building	Anwar Walid	3.00	27/50

ELEN E6773 TOPICS IN NETWORKING. *3.00 points*.
Further study of areas such as communication protocols and architectures, flow and congestion control in data networks, performance evaluation in integrated networks. Content varies from year to year, and different topics rotate through the course numbers 6770 to 6779

ELEN E6774 TOPICS IN NETWORKING. *3.00 points*.
Further study of areas such as communication protocols and architectures, flow and congestion control in data networks, performance evaluation in integrated networks. Content varies from year to year, and different topics rotate through the course numbers 6770 to 6779

ELEN E6775 TOPICS IN NETWORKING. *3.00 points*.

ELEN E6776 TOPICS IN NETWORKING. *3.00 points*.
Further study of areas such as communication protocols and architectures, flow and congestion control in data networks, performance evaluation in integrated networks. Content varies from year to year, and different topics rotate through the course numbers 6770 to 6779

Fall 2026: ELEN E6776

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6776	001/11308	W 7:00pm - 9:30pm 303 Uris Hall	Anwar Walid	3.00	1/55

ELEN E6820 SPEECH#AUDIO PROC#REC. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E4810) or ELEN E4810; or instructor's permission.
Fundamentals of digital speech processing and audio signals. Acoustic and perceptual basics of audio. Short-time Fourier analysis. Analysis and filterbank models. Speech and audio coding, compression, and reconstruction. Acoustic feature extraction and classification. Recognition techniques for speech and other sounds, including hidden Markov models

ELEN E6873 Statistical signal processing and learning. *3.00 points*.
Prerequisites: ELEN E4815
Introduction to the fundamental principles of statistical signal processing related to detection and estimation. Hypothesis testing, signal detection, parameter estimation, signal estimation, and selected advanced topics. Suitable for students doing research in communications, control, signal processing, and related areas

Spring 2026: ELEN E6873

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6873	001/11531	M 10:10am - 12:40pm 330 Uris Hall	Guido Jajamovich	3.00	12/60

ELEN E6876 Sparse and Low-Dimensional Models for High-Dimensional Data. *3.00 points*.
Prerequisites: ELEN E4815; or equivalent and linear algebra.
Recommended: ELEN E4810 or equivalent.
Overview of theory, computation and applications for sparse and low-dimensional data modeling. Recoverability of sparse and low-rank models. Optimization methods for low-dim data modeling. Applications to imaging, neuroscience, communications, web data

ELEN E6882 TOPICS IN SIGNAL PROCESSING. *3.00 points*.
Prerequisites: ELEN E4810
Advanced topics in signal processing, such as multidimensional signal processing, image feature extraction, image/video editing and indexing, advanced digital filter design, multirate signal processing, adaptive signal processing, and wave-form coding of signals. Content varies from year to year, and different topics rotate through the course numbers 6880 to 6889

ELEN E6883 TOPICS IN SIGNAL PROCESSING. *3.00 points*.
Prerequisites: ELEN E4810
Advanced topics in signal processing, such as multidimensional signal processing, image feature extraction, image/video editing and indexing, advanced digital filter design, multirate signal processing, adaptive signal processing, and wave-form coding of signals. Content varies from year to year, and different topics rotate through the course numbers 6880 to 6889

Spring 2026: ELEN E6883

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6883	001/11533	F 8:10am - 10:00am 627 Seeley W. Mudd Building	Chong Li, Chonggang Wang	3.00	49/50

ELEN E6884 TOPICS IN SIGNAL PROCESSING. *3.00 points*.
Prerequisites: ELEN E4810
Advanced topics in signal processing, such as multidimensional signal processing, image feature extraction, image/video editing and indexing, advanced digital filter design, multirate signal processing, adaptive signal processing, and wave-form coding of signals. Content varies from year to year, and different topics rotate through the course numbers 6880 to 6889

ELEN E6885 Topics in signal processing. *3 points*.
Prerequisites: (ELEN E4810) ELEN E4810
Topic: Reinforcement Learning.

Fall 2026: ELEN E6885

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6885	001/11311	F 8:10am - 10:00am 524 Seeley W. Mudd Building	Chong Li, Chonggang Wang	3	43/55
ELEN 6885	V01/18112		Chong Li	3	2/99

ELEN E6887 TOPICS IN SIGNAL PROCESSING. *3.00 points*.

Fall 2026: ELEN E6887

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6887	001/11347	T 1:10pm - 3:40pm 214 Pupin Laboratories	Hui Jin	3.00	15/55

ELEN E6889 TOPICS IN SIGNAL PROCESSING. *3.00 points*.
Prerequisites: ELEN E4810 ELEN E4810
Advanced topics in signal processing, such as multidimensional signal processing, image feature extraction, image/video editing and indexing, advanced digital filter design, multirate signal processing, adaptive signal processing, and wave-form coding of signals. Content varies from year to year, and different topics rotate through the course numbers 6880 to 6889. Topic: Large Data Stream Processing

Spring 2026: ELEN E6889

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6889	001/13665	Th 7:00pm - 9:30pm 633 Seeley W. Mudd Building	Deepak Turaga	3.00	13/70

ELEN E6895 TOPICS-INFORMATION PROCESSING. *3.00 points*.
Advanced topics spanning electrical engineering and computer science such as speech processing and recognition, image and multimedia content analysis, and other areas drawing on signal processing, information theory, machine learning, pattern recognition, and related topics. Content varies from year to year, and different topics rotate through the course numbers 6890 to 6899

ELEN E6901 TPCS-ELEC # COMPUT ENGINEERING. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 6900 to 6909

ELEN E6904 TPCS-ELEC # COMPUT ENGINEERING. *3.00 points*.
Prerequisites: Instructor's permission.
Analysis, modeling and design of transceiver architectures for wireless communication and sensing. Fundamentals of RF system analysis and design. Introduction to discrete-time behavioral modeling of transceiver analog blocks and digital methods for compensating analog impairments. Topics include transceiver architectures for ultra-low power communication, high-throughput sub-THz communication and compressed-sampling architectures for energy-efficient wideband spectrum sensing and rapid direction-of-arrival finding

ELEN E6905 TPCS-ELEC # COMPUT ENGINEERING. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 6900 to 6909

ELEN E6906 TPCS-ELEC # COMPUT ENGINEERING. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 6900 to 6909

ELEN E6907 TPCS-ELEC # COMPUT ENGINEERING. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 6900 to 6909

ELEN E6908 TOPICS IN ELECTRICAL AND COMPUTER ENGINE. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 6900 to 6909

Spring 2026: ELEN E6908

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6908	001/11534	M 1:10pm - 3:40pm 717 Hamilton Hall	Xiaofan Jiang	3.00	57/80

ELEN E6909 TPCS-ELECTRICAL # COMPUTER ENGINEERING. *3.00 points*.
Prerequisites: Instructor's permission.
Selected topics in electrical and computer engineering. Content varies from year to year, and different topics rotate through the course numbers 6900 to 6909

ELEN E6920 TOPICS IN VLSI SYSTEMS DESIGN. *3.00 points*.
Lect: 2.

Prerequisites: (EECS E4321) ELEN E4321
A comprehensive introduction to modern power management integrated circuits (PMIC) design. Advanced topics in power management will be introduced including: linear regulators; digital linear regulator; switch-mode power converter; control schemes for DC-DC converters; power losses in DC-DC converter; switched capacitor converters; wireless power conversion; power converter modeling and simulation; design examples. Topics may change from year to year

ELEN E6945 DEVICE NANOFABRICATION. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3106) and (ELEN E3401) or ELEN E3106 AND ELEN E3401; or equivalents. Recommended: ELEN E4944.
This course provides an understanding of the methods used for structuring matter on the nanometer length: thin-film technology; lithographic patterning and technologies including photon, electron, ion and atom, scanning probe, soft lithography, and nanoimprinting; pattern transfer; self-assembly; process integration; and applications

Spring 2026: ELEN E6945

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6945	001/18124	Th 1:10pm - 3:40pm 214 Pupin Laboratories	Jose Bahamonde	3.00	0/50

ELEN E6999 FIELDWORK. *1.00-1.50 points*.
Prerequisites: Obtained internship and approval from a faculty advisor. May be repeated for credit, but no more than 3 total points may be used for degree credit. Only for electrical engineering and computer engineering graduate students who include relevant off-campus work experience as part of their approved program of study. Final report required. May not be taken for pass/fail credit or audited

Spring 2026: ELEN E6999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6999	001/16613		James Anderson	1.00-1.50	0
ELEN 6999	002/16614		Zoran Kostic	1.00-1.50	0

Summer 2026: ELEN E6999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6999	001/11132		James Anderson	1.00-1.50	7/50
ELEN 6999	002/11133		Zoran Kostic	1.00-1.50	6/50
ELEN 6999	003/11134		Homayoon Beigi	1.00-1.50	7/50
ELEN 6999	004/11135		Aurel Lazar	1.00-1.50	5/50
ELEN 6999	005/11136		Asaf Cidon	1.00-1.50	5/50
ELEN 6999	006/11137		Predrag Jelenkovic	1.00-1.50	5/50

Fall 2026: ELEN E6999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 6999	001/19916		James Anderson	1.00-1.50	2/50
ELEN 6999	002/19915		Zoran Kostic	1.00-1.50	0/50
ELEN 6999	003/19912		Homayoon Beigi	1.00-1.50	1/50
ELEN 6999	004/19914		Aurel Lazar	1.00-1.50	0/50
ELEN 6999	005/19913		Asaf Cidon	1.00-1.50	0/50
ELEN 6999	006/19911		Predrag Jelenkovic	1.00-1.50	0/50

ELEN E9001 RESEARCH I. *0.00-6.00 points*.
0 to 6 pts.

Prerequisites: Requires approval by a faculty member who agrees to supervise the work.
Points of credit to be approved by the department. Requires submission of an outline of the proposed research for approval by the faculty member who is to supervise the work of the student. The research facilities of the department are available to qualified students interested in advanced study

Fall 2026: ELEN E9001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 9001	001/16438		Dimitris Anastassiou	0.00-6.00	0/50
ELEN 9001	002/16509		Keren Bergman	0.00-6.00	1/50
ELEN 9001	003/16439		Shih-Fu Chang	0.00-6.00	0/50
ELEN 9001	004/16440		Javad Ghaderi	0.00-6.00	0/50
ELEN 9001	005/16441		Christine Hendon	0.00-6.00	0/50
ELEN 9001	006/16442		Predrag Jelenkovic	0.00-6.00	0/50
ELEN 9001	007/16443		Xiaofan Jiang	0.00-6.00	0/50
ELEN 9001	008/16444		Ethan Katz-Bassett	0.00-6.00	0/50
ELEN 9001	009/16445		Dion Khodagholy Araghy	0.00-6.00	0/50
ELEN 9001	010/16446		Peter Kinget	0.00-6.00	0/50
ELEN 9001	011/16447		Zoran Kostic	0.00-6.00	1/50
ELEN 9001	012/16448		Harish Krishnaswamy	0.00-6.00	0/50
ELEN 9001	013/16449		Ioannis Kymissis	0.00-6.00	1/50
ELEN 9001	014/16450		Aurel Lazar	0.00-6.00	1/50
ELEN 9001	015/16451		Michal Lipson	0.00-6.00	0/50
ELEN 9001	016/16452		Nima Mesgarani	0.00-6.00	0/50
ELEN 9001	017/16453		Debasis Mitra	0.00-6.00	0/50
ELEN 9001	018/16454		John Paisley	0.00-6.00	0/50
ELEN 9001	019/16455		Matthias Preindl	0.00-6.00	0/50
ELEN 9001	020/16456		Mingoo Seok	0.00-6.00	1/50
ELEN 9001	021/16457		Kenneth Shepard	0.00-6.00	1/50
ELEN 9001	022/16458		Tanvir Ahmed Khan	0.00-6.00	0/50
ELEN 9001	023/16459		Yannis Tsividis	0.00-6.00	0/50
ELEN 9001	024/16460		David Vallancourt	0.00-6.00	0/50
ELEN 9001	025/16461		Wen Wang	0.00-6.00	0/50
ELEN 9001	026/16462		Xiaodong Wang	0.00-6.00	3/50
ELEN 9001	027/16463		John Wright	0.00-6.00	0/50
ELEN 9001	028/16464		Charles Zukowski	0.00-6.00	0/50
ELEN 9001	029/16465		Gil Zussman	0.00-6.00	0/50
ELEN 9001	030/16466		Alexander Gaeta	0.00-6.00	0/50
ELEN 9001	031/16467		Savannah Eisner	0.00-6.00	2/50
ELEN 9001	032/16468		James Anderson	0.00-6.00	0/50
ELEN 9001	033/16469		Asaf Cidon	0.00-6.00	1/99
ELEN 9001	034/16470		Xiang Meng	0.00-6.00	0/99
ELEN 9001	035/16471		Micah Goldblum	0.00-6.00	0/50

ELEN E9002 RESEARCH II. *0.00-6.00 points*.
0 to 6 pts.

Prerequisites: Requires approval by a faculty member who agrees to supervise the work.
Points of credit to be approved by the department. Requires submission of an outline of the proposed research for approval by the faculty member who is to supervise the work of the student. The research facilities of the department are available to qualified students interested in advanced study

Spring 2026: ELEN E9002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 9002	001/16365		Dimitris Anastassiou	0.00-6.00	0/90
ELEN 9002	002/16366		Keren Bergman	0.00-6.00	3/90
ELEN 9002	003/16368		Shih-Fu Chang	0.00-6.00	0/90
ELEN 9002	004/16369		Javad Ghaderi	0.00-6.00	0/90
ELEN 9002	005/16375		Christine Hendon	0.00-6.00	0/90
ELEN 9002	006/16376		Predrag Jelenkovic	0.00-6.00	0/90
ELEN 9002	007/16372		Xiaofan Jiang	0.00-6.00	2/90
ELEN 9002	008/16371		Ethan Katz-Bassett	0.00-6.00	0/90
ELEN 9002	009/16370		Dion Khodagholy Araghy	0.00-6.00	0/90
ELEN 9002	010/16374		Peter Kinget	0.00-6.00	0/90
ELEN 9002	011/16373		Zoran Kostic	0.00-6.00	2/90
ELEN 9002	012/16379		Harish Krishnaswamy	0.00-6.00	1/90
ELEN 9002	013/16378		Ioannis Kymissis	0.00-6.00	2/90
ELEN 9002	014/16377		Aurel Lazar	0.00-6.00	1/90
ELEN 9002	015/16381		Michal Lipson	0.00-6.00	0/90
ELEN 9002	016/16380		Nima Mesgarani	0.00-6.00	6/90
ELEN 9002	017/16383		Debasis Mitra	0.00-6.00	0/90
ELEN 9002	018/16384		John Paisley	0.00-6.00	0/90
ELEN 9002	019/16385		Matthias Preindl	0.00-6.00	4/90
ELEN 9002	020/16386		Mingoo Seok	0.00-6.00	0/90
ELEN 9002	021/16387		Kenneth Shepard	0.00-6.00	5/90
ELEN 9002	022/16389		Tanvir Ahmed Khan	0.00-6.00	1/90
ELEN 9002	023/16390		Yannis Tsividis	0.00-6.00	0/90
ELEN 9002	024/16392		David Vallancourt	0.00-6.00	0/90
ELEN 9002	025/16394		Wen Wang	0.00-6.00	0/90
ELEN 9002	026/16396		Xiaodong Wang	0.00-6.00	0/90
ELEN 9002	027/16397		John Wright	0.00-6.00	0/90
ELEN 9002	028/16399		Charles Zukowski	0.00-6.00	0/90
ELEN 9002	029/16400		Gil Zussman	0.00-6.00	0/90
ELEN 9002	030/16402		James Anderson	0.00-6.00	0/90
ELEN 9002	031/16403		Savannah Eisner	0.00-6.00	1/99
ELEN 9002	032/16404		James Anderson	0.00-6.00	0/99
ELEN 9002	033/16406		Asaf Cidon	0.00-6.00	0/99
ELEN 9002	034/16408		Xiang Meng	0.00-6.00	0/99
ELEN 9002	035/16409		Micah Goldblum	0.00-6.00	3/99

ELEN E9301 SEMINAR IN ELECTRONIC DEVICES. *3.00 points*.
Lect: 2.

Prerequisites: Open to doctoral candidates, and to qualified M.S. candidates with instructor's permission.
Theoretical and experimental studies of semiconductor physics, devices, and technology

ELEN E9302 SEMINAR IN WIRELESS AND EDGE NETWORKING. *3.00 points*.
Open to doctoral candidates, and to qualified M.S. candidates with the instructor's permission. Study of recent developments in electronic circuits

ELEN E9303 Seminar in electronic circuits. *3 points*.
Lect: 2.

Open to doctoral candidates, and to qualified M.S. candidates with the instructor's permission. Study of recent developments in electronic circuits.

ELEN E9403 SEMINAR IN PHOTONICS. *3.00 points*.
Lect: 2.

Prerequisites: (ELEN E4411) ELEN E4411
Open to doctoral candidates and to qualified M.S. candidates with instructor's permission. Recent experimental and theoretical developments in various areas of photonics research. Examples of topics that may be treated include squeezed-light generation, quantum optics, photon detection, nonlinear optical effects, and ultrafast optics

ELEN E9701 Seminar in information and communication theories. *3 points*.
Lect: 2.

Open to doctoral candidates, and to qualified M.S. candidates with the instructor's permission. Recent developments in telecommunication networks, information and communication theories, and related topics.

Spring 2026: ELEN E9701

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 9701	001/18223	F 1:10pm - 3:40pm 306 Uris Hall	Gil Zussman	3	8/20

ELEN E9800 DOCTORAL RESEARCH INSTRUCTION. *1.00-12.00 points*.
3, 6, 9 or 12 pts.

A candidate for the Eng.Sc.D. degree in electrical engineering must register for 12 points of doctoral research instruction. Registration in ELEN E9800 may not be used to satisfy the minimum residence requirement for the degree

Spring 2026: ELEN E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 9800	005/18326		Christine Hendon	1.00-12.00	0/99
ELEN 9800	026/20587		Xiaodong Wang	1.00-12.00	0/50

Fall 2026: ELEN E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ELEN 9800	004/16510		Christine Hendon	1.00-12.00	0/50

Undergraduate Programs

- Electrical Engineering (BS) (p. 226)
- Electrical Engineering (BS/MS) (p. 233)
- Computer Engineering Program (p. 141)
- Electrical Engineering Minor (p. 329)

Electrical Engineering (BS)

The Program Educational Objectives of the Electrical Engineering program, in support of the mission of the School, is to prepare graduates to achieve success in one or more of the following within a few years after graduation:

1. Graduate or professional studies—as evidenced by admission to a top-tier program, attainment of advanced degrees, research contributions, or professional recognition.
2. Engineering practice—as evidenced by entrepreneurship; employment in industry, government, academia, or nonprofit organizations in engineering; patents; or professional recognition.
3. Careers outside of engineering that take advantage of an engineering education—as evidenced by contributions appropriate to the chosen field.

The Electrical Engineering program will prepare its undergraduates to achieve the following Student Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The B.S. program in electrical engineering at Columbia University seeks to provide a broad and solid foundation in the current theory and practice of electrical engineering, including familiarity with basic tools of math and science, an ability to communicate ideas, and a humanities background sufficient to understand the social implications of engineering practice. Graduates should be qualified to enter the profession of engineering, to continue toward a career in engineering research, or to enter other fields in which engineering knowledge is essential. Required nontechnical courses cover civilization and culture, philosophy, economics, and a number of additional electives. English communication skills are an important aspect of these courses. Required science courses cover basic chemistry and physics, whereas math requirements cover calculus, differential equations, probability, and linear algebra. Two rigorous introductory computer science courses cover basic computer skills. Core electrical engineering courses cover the main components of modern electrical engineering and illustrate basic engineering principles. Topics include a sequence of two courses on circuit theory and electronic circuits, one course on semiconductor devices, one on electromagnetics, one on signals and systems, one on digital systems, and one on communications or networking. Engineering practice is developed further through a sequence of laboratory courses, starting with a first-year course to introduce hands-on experience early and to motivate theoretical work. Simple creative design experiences start immediately in this first-year course. Following this is a sequence of lab courses that parallel the core lecture courses. Opportunities for exploring design can be found both within these lab courses and in the parallel lecture courses, often coupled with experimentation and computer simulation, respectively. The culmination of the laboratory sequence and the design experiences introduced throughout earlier courses is a senior design course (capstone design course), which includes a significant design project that ties together the core program, encourages creativity, explores practical aspects of engineering practice, and provides additional experience with communication skills in an engineering context. Finally, several technical electives are required, chosen to provide both breadth and depth in a specific area of interest. More detailed program objectives and outcomes are posted at ee.columbia.edu.

The BS Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Electrical, Computer, Communications, Telecommunication(s), and Similarly Named Engineering Programs.

There is a strong interaction between the Department of Electrical Engineering and the Departments of Computer Science, Applied Physics and Applied Mathematics, Industrial Engineering and Operations Research, Physics, and Chemistry.

EE Core Curriculum

All electrical engineering (EE) students must take a set of core courses, which collectively provide the student with fundamental skills, expose them to the breadth of EE, and serve as a springboard for more advanced work, or for work in areas not covered in the core. These courses are shown on the charts in Undergraduate Degree Tracks. A full curriculum checklist is also posted at ee.columbia.edu.

Technical Electives

The 18-point technical elective requirement for the electrical engineering program consists of three components: depth, breadth, and other. A general outline is provided here, and more specific course restrictions can be found at ee.columbia.edu. For any course not clearly listed there, adviser approval is necessary.

The *depth* component must consist of at least 6 points of electrical engineering courses in one of four defined areas:

1. photonics, solid-state devices, and electromagnetics;
2. circuits and electronics;
3. signals and systems; and
4. communications and networking.

The depth requirement provides an opportunity to pursue particular interests and exposure to the process of exploring a discipline in depth

—an essential process that can be applied later to other disciplines, if desired.

The *breadth* component must consist of at least 6 additional points of courses that are outside of the chosen depth area and have significant engineering content. These courses can be from other departments within the School. The breadth requirement precludes overspecialization. Breadth is particularly important today, as innovation requires more and more of an interdisciplinary approach, and exposure to other fields is known to help one's creativity in one's own main field. Breadth also reduces the chance of obsolescence as technology changes.

Any remaining technical elective courses, beyond the minimum 12 points of depth and breadth, do not have to be engineering courses but must be technical. Generally, math and science courses that do not overlap with courses used to fill other requirements are allowed.

If another department advertises that one of their courses can be used as a technical elective, that does not necessarily mean it will be approved as a technical elective in the electrical engineering program. Which courses are approved depends on other electives chosen due to the depth and breadth restrictions, and the need for sufficient engineering and technical content within the entire 18 points. Electrical engineering technical electives must also be 3000 level or above and must not have significant overlap with other courses taken for the major.

Starting Early

The EE curriculum is designed to allow students to start their study of EE in their first year. This motivates students early and allows them to spread nontechnical requirements more evenly. It also makes evident the need for advanced math and physics concepts, and motivates the study of such concepts. Finally, it allows more time for students to take classes in a chosen depth area, or gives them more time to explore before choosing a depth area. Students can start with ELEN E1201 INTRO-ELECTRICAL ENGINEERING in the second semester of their first year, and can continue with other core courses one semester after that, as shown in the "early-starting students" chart. It is emphasized that both the early- and traditional-starting sample programs shown in the charts are examples only; schedules may vary depending on student preparation and interests.

Transfer Students

Transfer students coming to Columbia as juniors with sufficient general background can complete all requirements for the B.S. degree in electrical engineering. Such students fall into one of two categories:

Plan 1: Students coming to Columbia without having taken the equivalent of ELEN E1201 INTRO-ELECTRICAL ENGINEERING must take this course in their junior year. This requires postponing the core courses in circuits and electronics until the senior year, and thus does not allow taking electives in that area; thus, such students cannot choose circuits and electronics as a depth area.

Plan 2: This plan is for students who have taken a course equivalent to ELEN E1201 INTRO-ELECTRICAL ENGINEERING at their school of origin, including a laboratory component. Many pre-engineering programs and physics departments at four-year colleges offer such courses. Such students can start taking circuits at Columbia immediately, and thus can choose circuits and electronics as a depth area.

It is stressed that ELEN E1201 INTRO-ELECTRICAL ENGINEERING or its equivalent is a key part of the EE curriculum. The preparation provided by this course is essential for a number of other core courses.

Sample programs for both Plan 1 and Plan 2 transfer students can be found at ee.columbia.edu.

Electrical Engineering Program

An overview of the degree track in PDF format can be found here.

Early-Starting Students (p. 227)
Traditional-Staring Students (p. 230)

Electrical Engineering Program

Early-Starting Students

First Year

Semester I

MATH UN1101	CALCULUS I
Choose one of the following Physics courses depending on sequence:	
PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I
Choose a one-semester Chemistry lecture:	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
ELEN E1201 (taken Semester I or II)	INTRO-ELECTRICAL ENGINEERING
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):	
HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)	Art Humanities
Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):	
HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS

ENGI E1006 (taken Semester I or II)[1]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

ELEN E1201 (taken Semester I or II)	INTRO-ELECTRICAL ENGINEERING
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)	Art Humanities

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	

ECON UN1105 & ECON UN1155 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)[1]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
ELEN E3201	CIRCUIT ANALYSIS
ELEN E3801	SIGNALS AND SYSTEMS
ELEN E3081[2]	CIRCUIT ANALYSIS LABORATORY
ELEN E3084[2]	SIGNALS # SYSTEMS LABORATORY

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)	Art Humanities

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	

ECON UN1105 & ECON UN1155 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
APMA E2101[3]	INTRO TO APPLIED MATHEMATICS
ELEN E3331	ELECTRONIC CIRCUITS
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
ELEN E3083[2]	ELECTRONIC CIRCUITS LABORATORY
ELEN E3082[2]	DIGITAL SYSTEMS LABORATORY

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)	Art Humanities

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS

Third Year

Semester V

Choose one of the following Physics courses depending on sequence:

PHYS UN1403 (Sequence 1)	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Sequence 2)	PHYSICS III:CLASS/QUANTUM WAVE
PHYS UN3081 (Sequence 3)	INTERMEDIATE LABORATORY WORK
ELEN E3106	SOLID STATE DEVICES-MATERIALS

IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[4]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[5]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[6]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[7]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[8]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

Semester VI

PHYS UN1494 (Track 1) [9]	INTRO TO EXPERIMENTAL PHYS-LAB
ELEN E3401	ELECTROMAGNETICS
ELEN E3701 or CSEE W4119[10]	INTRO TO COMMUNICATION SYSTEMS
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[4]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[5]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[6]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[7]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[8]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

Fourth Year

Semester VII

ELEN E3043	SOLID ST,MICROWAVE,FBR OPT LAB
ELEN E3399	ELECTRICAL ENGINEERING PRACTICE
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[4]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[5]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[6]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[7]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[8]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

Semester VIII

ELEN E3390[11]	EE SENIOR DESIGN PROJECT
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[4]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[5]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[6]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[7]

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[8]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

1 ENGI E1006 INTRO TO COMP FOR ENG/APP SCI may not be offered every semester. See ee.columbia.edu for more discussion about the Computer Science sequences.

2 If possible, these labs should be taken along with their corresponding lecture courses.

3 APMA E2101 INTRO TO APPLIED MATHEMATICS may be replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA.

4 Some of these courses are not offered both semesters. Students with an adequate background can take some of these courses in the sophomore year.
A course such as STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS cannot generally be used to replace IEOR E3658 PROBABILITY FOR ENGINEERS or STAT GU4203 PROBABILITY THEORY.

5 Some of these courses are not offered both semesters. Students with an adequate background can take some of these courses in the sophomore year.
Students who plan to minor in Computer Science should choose COMS W3134 Data Structures in Java or COMS W3137 HONORS DATA STRUCTURES & ALGORITHMS.

6 For details, see ee.columbia.edu

7 See ee.columbia.edu

8 Consisting of more depth or breadth courses, or further options listed at ee.columbia.edu/ee-undergraduate-program.
The total points of technical electives is reduced to 15 if APMA E2101 INTRO TO APPLIED MATHEMATICS has been replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can also apply for this waiver, but the courses must have been at an advanced level for this to be considered.

9 Chemistry lab (CHEM UN1500 GENERAL CHEMISTRY LABORATORY) may be substituted for physics lab, although this is not generally recommended.

10 These courses can be taken in the sophomore year if the prerequisites/corequisites are satisfied.

11 The capstone design course provides ELEN majors with a "culminating design experience." As such, it should be taken near the end of the program and involve a project that draws on material from a range of courses. If special arrangements are made in ELEN E3399 ELECTRICAL ENGINEERING PRACTICE, it is possible to use courses such as ELEN E3998 PROJECTS IN ELEC ENGINEERING, ELEN E4350 VLSI design laboratory, ELEN E4998 INTERMEDIATE PROJECTS, EECS E4340 COMPUTER HARDWARE DESIGN, or CSEE W4840 EMBEDDED SYSTEMS in place of ELEN E3390 EE SENIOR DESIGN PROJECT.

Electrical Engineering Program

Traditional-Starting Students

First Year

Semester I

MATH UN1101	CALCULUS I

Choose one of the following Physics courses depending on track:

PHYS UN1401 (Track 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Track 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Track 3)	ACCELERATED PHYSICS I

Choose a one-semester Chemistry lecture:

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
ELEN E1201 (taken Semester I or II)[1]	INTRO-ELECTRICAL ENGINEERING
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on track:

PHYS UN1402 (Track 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Track 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Track 3)	ACCELERATED PHYSICS II
ELEN E1201 (taken Semester I or II)[1]	INTRO-ELECTRICAL ENGINEERING
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on track:

PHYS UN1403 (Track 1)	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Track 2)	PHYSICS III:CLASS/QUANTUM WAVE
PHYS UN3081 (Track 3)	INTERMEDIATE LABORATORY WORK

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
HUMA UN1121 or UN1123	Art Humanities
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
APMA E2101[3]	INTRO TO APPLIED MATHEMATICS
PHYS UN1494 (Track 1) [4]	INTRO TO EXPERIMENTAL PHYS-LAB

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I, II, III, or IV)[2]	INTRO TO COMP FOR ENG/APP SCI

Third Year

Semester V

ELEN E3106	SOLID STATE DEVICES-MATERIALS
ELEN E3201	CIRCUIT ANALYSIS
ELEN E3801	SIGNALS AND SYSTEMS
ELEN E3081[5]	CIRCUIT ANALYSIS LABORATORY
ELEN E3084[5]	SIGNALS # SYSTEMS LABORATORY
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[6]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[7]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[8]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[9]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[10]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

Semester VI

CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
ELEN E3331	ELECTRONIC CIRCUITS
ELEN E3401	ELECTROMAGNETICS
ELEN E3701 or CSEE W4119	INTRO TO COMMUNICATION SYSTEMS
ELEN E3083[5]	ELECTRONIC CIRCUITS LABORATORY
ELEN E3082[5]	DIGITAL SYSTEMS LABORATORY
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[6]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[7]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[8]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[9]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[10]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

Fourth Year

Semester VII

ELEN E3043	SOLID ST,MICROWAVE,FBR OPT LAB
ELEN E3399	ELECTRICAL ENGINEERING PRACTICE
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[6]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[7]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII)[8]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[9]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[10]

Nontech Electives: Complete 27-point requirement; taken Semester V, VI, VII, or VIII)

Semester VIII

ELEN E3390[11]	EE SENIOR DESIGN PROJECT
IEOR E3658 or STAT GU4203 (taken Semester V, VI, VII, or VIII)[6]	PROBABILITY FOR ENGINEERS

Choose one of the following Other Required Courses (taken Semester V, VI, VII, or VIII):[7]

COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL

EE Depth Tech Electives: At least two technical electives in one depth area. (taken Semester V, VI, VII, or VIII) [8]

The four depth areas are:

(a) photonics, solid-state devices, and electromagnetics;

(b) circuits and electronics;

(c) signals and systems;

(d) communications and networking

Breadth Tech Electives (at least 6 points total) (taken Semester V, VI, VII, or VIII):[9]

At least two technical electives outside the chosen depth area; must be courses with significant engineering content

Other Tech Electives: Additional technical electives as required to bring the total points of technical electives to 18 (taken Semester V, VI, VII, or VIII)[10]

Nontech Electives: Complete 27-point requirement (taken Semester V, VI, VII, or VIII)

1 Transfer students and 3-2 Combined Plan students who have not taken ELEN E1201 INTRO-ELECTRICAL ENGINEERING prior to the junior year are expected to have taken a roughly equivalent course when they start ELEN E3201 CIRCUIT ANALYSIS.

2 ENGI E1006 INTRO TO COMP FOR ENG/APP SCI may not be offered every semester. See ee.columbia.edu for more discussion about the Computer Science sequences.

3 APMA E2101 INTRO TO APPLIED MATHEMATICS may be replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA.

4 Chemistry lab (CHEM UN1500 GENERAL CHEMISTRY LABORATORY) may be substituted for physics lab, although this is not generally recommended.

5 If possible, these labs should be taken along with their corresponding lecture courses.

6 Some of these courses are not offered both semesters. Students with an adequate background can take some of these courses in the sophomore year.
A course such as STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS cannot generally be used to replace IEOR E3658 PROBABILITY FOR ENGINEERS or STAT GU4203 PROBABILITY THEORY

7 Some of these courses are not offered both semesters. Students with an adequate background can take some of these courses in the sophomore year.
Students who plan to minor in Computer Science should choose COMS W3134 Data Structures in Java or COMS W3137 HONORS DATA STRUCTURES & ALGORITHMS.

8 For details, see ee.columbia.edu.

9 See ee.columbia.edu

10 Consisting of more depth or breadth courses, or further options listed at ee.columbia.edu/ee-undergraduate-program.
The total points of technical electives is reduced to 15 if APMA E2101 INTRO TO APPLIED MATHEMATICS has been replaced by MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS (formerly MATH E1210) and either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can also apply for this waiver, but the courses must have been at an advanced level for this to be considered.

11 The capstone design course provides ELEN majors with a “culminating design experience.” As such, it should be taken near the end of the program and involve a project that draws on material from a range of courses. If special arrangements are made in ELEN E3399 ELECTRICAL ENGINEERING PRACTICE, it is possible to use courses such as ELEN E3998 PROJECTS IN ELEC ENGINEERING, ELEN E4350 VLSI design laboratory, ELEN E4998 INTERMEDIATE PROJECTS, EECS E4340 COMPUTER HARDWARE DESIGN, or CSEE W4840 EMBEDDED SYSTEMS in place of ELEN E3390 EE SENIOR DESIGN PROJECT.

Electrical Engineering (BS/MS)

B.S./M.S. Program

The B.S./M.S. degree program is open to a select group of undergraduate students. This double degree program makes possible the earning of both the Bachelor of Science and Master of Science degrees in an integrated fashion. Up to 6 points may be credited to both degrees, and some graduate classes taken in the senior year may count toward the M.S. degree. Interested students can find further information at ee.columbia.edu and can discuss options directly with their faculty adviser. Students must apply by April 30 in their junior year.

Graduate Programs

The Department of Electrical Engineering offers graduate programs leading to the degree of Master of Science (M.S.) and the degrees of Doctor of Engineering Science (Eng.Sc.D.) and Doctor of Philosophy (Ph.D.). The Graduate Record Examination (General Test only) is required of all applicants except special students. An undergraduate grade-point average equivalent to B or better from an institution comparable to Columbia is expected.

Applicants who, for good reasons, are unable to submit GRE test results by the deadline date but whose undergraduate record is clearly superior may file an application without the GRE scores. An explanatory note should be added to ensure that the application will be processed even while incomplete. If the candidate's admissibility is clear, the decision may be made without the GRE scores; otherwise, it may be deferred until the scores are received.

There are no prescribed course requirements in any of the regular graduate degree programs. Students, in consultation with their faculty advisers, design their own programs, focusing on particular fields of electrical engineering. Among the fields of graduate study are Communications, Networking, Internet and Internet of Things; Computer Engineering; Integrated Circuits and Systems and Electronics; Integrated Devices and Photonics; Signals, Information, Data, Learning and Control; Smart Electric Energy; and Systems Biology and Neuroengineering.

Graduate course charts for several focus areas can be found at ee.columbia.edu.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Electrical Engineering (MS) (p. 233)
- Quantum Science and Technology (MS)
- Electrical Engineering (PhD, EngScD) (p. 237)

Electrical Engineering (MS)

Master of Science Degree

Candidates for the M.S. degree in electrical engineering must complete 30 points of credit beyond the bachelor's degree. A minimum of 15 points of credit must be at the 6000 level or higher. No credit will be allowed for undergraduate courses (3000 or lower). At least 15 points must be in electrical engineering, defined as including all courses with an ELEN designator or a joint designator containing electrical engineering as a member, e.g., EECS, CSEE, EEME, ECBM, etc. And it is expected that at least 12 of the first 24 points taken will be in electrical engineering. Flowcharts showing sequencing constraints for most Electrical Engineering graduate courses grouped roughly into seven areas are available in the following page (ee.columbia.edu/course-flowcharts).

Not all technical courses can be applied toward the M.S. degree, and some have restrictions. Up to 6 points of research (such as ELEN E4998 INTERMEDIATE PROJECTS, ELEN E6001 ADVANCED PROJECTS, and ELEN E6002 ADVANCED PROJECTS) can be applied. Up to 1.5 points of fieldwork (ELEN E6999 FIELDWORK) can be used. No more than 3 points of courses that do not contain primarily engineering, math, or science content can be used, subject to the written pre-approval of the department. Any course that is not on the list of standard courses specified at ee.columbia.edu/ms-program-ee requires prior written department approval, including during the summer session.

The general school requirements listed earlier in this bulletin, such as minimum GPA, must also be satisfied. All degree requirements must be completed within five years of the beginning of the first course credited toward the degree.

More details and a requirements checklist for approvals can be found at ee.columbia.edu/ms-program-ee.

Optional M.S. Specializations

Students in the electrical engineering M.S. program often choose to use some of their electives to focus on a particular field. Students may pick one of a number of optional, formal specialization templates or design their own M.S. program in consultation with an adviser. These specializations are not degree requirements. They represent suggestions from the faculty as to how one might fill one's programs so as to focus on a particular area of interest. Students may wish to follow these suggestions, but they need not. The degree requirements are quite flexible and are listed in the Master of Science Degree section, above. All students, whether following a formal specialization template or not, are expected to include breadth in their program. Not all of the elective courses listed here are offered every year. For the latest information on available courses, visit the Electrical Engineering home page at ee.columbia.edu.

AI Engineering

Faculty: Dimitris Anastassiou, Homayoon Beigi, Shih-Fu Chang, Micah Goldblum, Predrag Jelenkovic, Zoran Kostic, Aurel A. Lazar, Nima Mesgarani, John Paisley, John Wright, Xiaofan (Fred) Jiang. AI and its applications are the subject of study by faculty across all research areas in the EE department.

1. Satisfy M.S. degree requirements.	
2. Choose 6 courses from the list of 4000- and 6000-level courses below, and add 4 other courses that satisfy the MS EE credit requirements	
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
ECBM E4060	INTRO-GENOMIC INFO SCI # TECH
ELEN E4720	Machine Learning for Signals, Information and Data
EECS E4764	Artificial Intelligence of Things (AIoT)
ELEN E4903	TOPICS IN EE # CE
ELEN E4904	TOPICS IN EE # CE
ECBM E6070	TPC NEUROSCI # DEEP LEARN

MEEC E6600	Mathematics of Machine Learning, Signals, and Control
MEEE E6620	Applied Acoustics and Signal Recognition
EECS E6690	TOPICS DATA-DRIVEN ANAL # COMP
EECS E6791	Advanced Deep Learning
EECS E6792	Deep Learning on the Edge
EECS E6694	TOPICS DATA-DRIVEN ANAL # COMP
EECS E6699	TOPICS DATA-DRIVEN ANAL # COMP
EECS E6720	BAYESIAN MOD MACHINE LEARNING
ELEN E6772	TOPICS IN NETWORKING
ELEN E6873	Statistical signal processing and learning
ELEN E6908	TOPICS IN ELECTRICAL AND COMPUTER ENGINE
EECS E6892	TOPICS-INFORMATION PROCESSING

Signal Processing and Control

Faculty: Dimitris Anastassiou, Homayoon Beigi, Shih-Fu Chang, Christine Hendon, Javad Ghaderi, Predrag Jelenkovic, Xiaofan (Fred) Jiang, Zoran Kostic, Aurel A. Lazar, Nima Mesgarani, John Paisley, Xiaodong Wang, John Wright

1. Satisfy M.S. degree requirements. 2. Choose one basic course such as:	
2. Choose 6 courses from the list of 4000- and 6000-level courses below, and add 4 other courses that satisfy the MS EE credit requirements	
MEEE E4600	Continuous Control Systems
EEME E4601	DISCRETE CONTROL SYSTEMS
ELEN E4720	Machine Learning for Signals, Information and Data
EECS E4750	Heterogeneous Computing for Signal and Data Processing
ELEN E4810	DIGITAL SIGNAL PROCESSING
ELEN E4815	RANDOM SIGNALS # NOISE
ELEN E4830	Image Processing and Computer Vision
MEEC E6600	Mathematics of Machine Learning, Signals, and Control
MEEE E6610	Nonlinear and Adaptive Control
EEOR E6616	CONVEX OPTIMIZATION
MEEE E6620	Applied Acoustics and Signal Recognition
ELEN E6717	Classical and Quantum Information Theory
ELEN E6820	SPEECH#AUDIO PROC#REC
ELEN E6876	Sparse and Low-Dimensional Models for High-Dimensional Data
EEME E6910-6919 Topics in Control	
ELEN E6873	Statistical signal processing and learning
ELEN E6880-E6889 Topics in Signal Processing	

Data-Driven Analysis and Computation

Advisers: Professors Dimitris Anastassiou, Shih-Fu Chang, Pedrag Jelenkovic, Zoran Kostic, Aurel A. Lazar, Nima Mesgarani, John Paisley, John Wright, Xiaofan (Fred) Jiang

1. Satisfy M.S. degree requirements	
2. Choose at least two courses from the following:	
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
EECS E4764	Artificial Intelligence of Things (AIoT)
ELEN E4810	DIGITAL SIGNAL PROCESSING
ELEN E4720	Machine Learning for Signals, Information and Data
EEOR E6616	CONVEX OPTIMIZATION
EECS E6893	TOPICS-INFORMATION PROCESSING
3. Choose at least one course from the following:	
ECBM E6040	NEUR NET # DEEP LEAR RSRCH
EECS E6720	BAYESIAN MOD MACHINE LEARNING
EECS E6765	IoT - SYS #PHY DATA ANALYTICS
EECS E6895	TOPICS-INFORMATION PROCESSING
4. Choose one course from the following:	
A second course from # 3	
ECBM E4060	INTRO-GENOMIC INFO SCI # TECH
ECBM E4070	Computing with Brain Circuits of Model Organisms
ECBM E6070	TPC NEUROSCI # DEEP LEARN
EECS E6690	TOPICS DATA-DRIVEN ANAL # COMP
ELEN E6876	Sparse and Low-Dimensional Models for High-Dimensional Data
EECS E9601	Seminar in Data-Driven Analysis and Computation

Networking

Advisers: Professors Predrag Jelenkovic, Javad Ghaderi, Ethan Katz-Bassett, Debasis Mitra, Gil Zussman, Xiaofan (Fred) Jiang

1. Satisfy M.S. degree requirements.	
2. Choose one basic networking course from the following:	
ELEN E6761	COMPUTER COMMUNICATNS NETWORKS
CSEE W4119	COMPUTER NETWORKS
3. Choose one basic systems or analytical course from the following:	
CSEE W4140	NETWORKING LABORATORY
COMS W4113	FUND-LARGE-SCALE DIST SYSTEMS
COMS W4118	OPERATING SYSTEMS I
ELEN E6772	TOPICS IN NETWORKING
ELEN E6950	WIRELESS # MOBILE NETWORKING I
CSEE E6180	MODELING # PERFORMNCE EVALUATN
4. Choose three courses from the following (courses cannot be used to fulfill both this requirement and any of the above requirements): [1]	
ELEN E6488	Optical interconnects and interconnection networks
ELEN E6761	COMPUTER COMMUNICATNS NETWORKS
ELEN E6767	INTERNET ECON, ENG # SOCIETY
ELEN E6770	TOPICS IN NETWORKING
ELEN E6772	TOPICS IN NETWORKING
ELEN E6775	TOPICS IN NETWORKING
ELEN E6776	TOPICS IN NETWORKING
ELEN E6950	WIRELESS # MOBILE NETWORKING I
EEOR E4650	CONVEX OPTIMIZATION FOR ENG
EEOR E6616	CONVEX OPTIMIZATION
CSEE W4140	NETWORKING LABORATORY
EECS E4951	
CSEE E6180	MODELING # PERFORMNCE EVALUATN
COMS W4181	SECURITY I
COMS W4995	TOPICS IN COMPUTER SCIENCE
COMS E6181	ADVANCED INTERNET SERVICES
COMS E6998	TOPICS IN COMPUTER SCIENCE

IEOR E6704	QUEUING THEORY # APPLICATIONS
IEOR E4106	STOCHASTIC MODELS
5. At least two of the four courses used to fulfill requirements 3 and 4 must be 6000-level ELEN, EECS, CSEE, or EEOR courses.	

[1] With adviser approval, other relevant advanced topic courses on networking topics, other relevant advanced topic courses on networking topics from ELEN E677 x, COMS W4995 TOPICS IN COMPUTER SCIENCE, COMS E6998 TOPICS IN COMPUTER SCIENCE, or other course numbers may be used to fulfill this requirement.

Wireless and Mobile Communications

Advisers: Professors Gil Zussman, Predrag Jelenkovic, Xiaodong Wang

1. Satisfy M.S. degree requirements.	
2. Choose one basic circuits course from the following:	
ELEN E4312	ANALOG ELECTRONIC CIRCUITS
ELEN E4314	COMMUNICATION CIRCUITS
ELEN E6314	
ELEN E6312	ADV ANALOG INTEGRATED CIRCUITS
3. Choose two communications or networking courses such as:	
CSEE W4119	COMPUTER NETWORKS
ELEN E4702	DIGITAL COMMUNICATIONS
ELEN E4703	WIRELESS COMMUNICATIONS
ELEN E6711	
ELEN E4810	DIGITAL SIGNAL PROCESSING
ELEN E6950	WIRELESS # MOBILE NETWORKING I
EECS E4951	
ELEN E6761	COMPUTER COMMUNICATNS NETWORKS
ELEN E6712	COMMUNICATION THEORY
ELEN E6713	Topics in communications
ELEN E6717	Classical and Quantum Information Theory
ELEN E677X	
4. At least two additional approved courses in wireless communications or a related area.	

Integrated Circuits and Systems

Advisers: Professors Peter Kinget, Harish Krishnaswamy, Mingoo Seok, Kenneth Shepard, Yannis Tsividis, Charles Zukowski

1. Satisfy M.S. degree requirements.	
2. Choose one digital course from the following:	
EECS E4321	DIGITAL VLSI CIRCUITS
EECS E6321	Advanced digital electronic circuits
3. Choose one analog course from the following:	
ELEN E4312	ANALOG ELECTRONIC CIRCUITS
ELEN E6312	ADV ANALOG INTEGRATED CIRCUITS
ELEN E6316	Analog-Digital Interfaces in VLSI
ELEN E4314	COMMUNICATION CIRCUITS
ELEN E6314	
ELEN E6320	MILLIMETER-WAVE IC DESIGN
4. Choose two additional courses such as:	
Other courses from no. 2 and 3	
ELEN E6350	VLSI DESIGN LABORATORY
ELEN E6318	MICROWAVE CIRCUIT DESIGN
ELEN E9303	Seminar in electronic circuits
5. At least one additional approved course in integrated circuits and systems or a related area.	

Smart Electric Energy

Advisers: Professors Matthias Preindl, Xiaofan (Fred) Jiang, Gil Zussman, Kenneth Shepard, Xiaodong Wang

1. Satisfy M.S. degree requirements.	
2. Choose at least two power conversion or power systems courses from the following:	
ELEN E4361	POWER ELECTRONICS
ELEN E4551	Electric Machines
ELEN E4511	POWER SYSTEMS ANALYSIS
EEEL E4220	Energy System Economics and Optimization
ELEN E4510	Grid Modernization # Clean Tech
ELEN E4901	TOPICS IN EE # CE
ELEN E6550	Motor Drive Systems
ELEN E6570	Future Energy: Economics, Systems, Policies
ELEN E6901	TPCS-ELEC # COMPUT ENGINEERING
ELEN E6341	BIPOLAR DEVICE MODELING
ELEN E6590	Topics in Smart Electric Energy
ELEN E6591	Topics in Smart Electric Energy
ELEN E6903	TPCS-ELEC # COMPUT ENGINEERING
3. Choose at least one control or optimization course from the following:	
EEME E4600	Continuous Control Systems
EEOR E4650	CONVEX OPTIMIZATION FOR ENG
ELEN E4620	Numerical Methods for Data Analysis
EECS E4764	Artificial Intelligence of Things (AIoT)
EEME E4601	DISCRETE CONTROL SYSTEMS
CSEE W4840	EMBEDDED SYSTEMS
EEME E6602	MODERN CONTROL THEORY
ELEN E6907	TPCS-ELEC # COMPUT ENGINEERING
EECS E6908	
MEEE E6610	Nonlinear and Adaptive Control
EEOR E6616	CONVEX OPTIMIZATION
4. Choose at least one nonelectric energy class course from the following:	
MECE E4210	ENERGY INFRASTRUCTURE PLANNING
MECE E4211	ENERGY SOURCES AND CONVERSION
MECE E4320	INTRO TO COMBUSTION
MECE E4302	ADVANCED THERMODYNAMICS
MECE E4350	Building Energy Modeling and Simulation
MECE E4430	AUTOMOTIVE DYNAMICS
EAEE E4002	ALTERNATIVE ENERGY RESOURCES
EAEE E4180	ELECTROCHEMICAL ENERGY STORAGE SYSTEMS
EAEE E4257	ENVIR DATA ANALYSIS # MODELING
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
5. Not required, but consider taking one of the following energy policy or market nontechnical elective courses (this course will fill the quota of nontechnical courses on the M.S. Checklist)	
EAEE E4001	INDUST ECOLOGY-EARTH RESOURCES
EAIA W4200	ALTERNATIVE ENERGY RESOURCES
INAF U6057	Electricity Markets
INAF U6072	Energy Systems Fundamentals
SUMA K4135	Energy Analysis for Energy Efficiency

INAF U6065	The Economics of Energy
INAF U6061	Global Energy Policy
INAF U6242	Energy Policy
INAF U6135	Renewable Energy Markets and Policy

Systems Biology and Neuroengineering

Advisers: Professors Dimitris Anastassiou, Christine Hendon, Pedrag Jelenkovic, Aurel A. Lazar, Nima Mesgarani, Kenneth Shepard, Xiaodong Wang

1. Satisfy M.S. degree requirements.	
2. Take both:	
ECBM E4060	INTRO-GENOMIC INFO SCI # TECH
BMEB W4020	Computational neuroscience: circuits in the brain
3. Choose at least one course from the following:	
BMEE E4030	NEURAL CONTROL ENGINEERING
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
ECBM E4070	Computing with Brain Circuits of Model Organisms
ECBM E4090	BRAIN COMPUTER INTERFACES LAB
CBMF W4761	COMPUTATIONAL GENOMICS
ELEN E6010	DESIGN PRIN FOR BIOL CIRCUITS
EEBM E6020	METHODS OF COMPUT NEUROSCIENCE
4. Choose at least one course from the following:	
ECBM E6040	NEUR NET # DEEP LEAR RSRCH
ECBM E6070	TPC NEUROSCI # DEEP LEARN
ELEN E608X:	
EEBM E6091	TPCS IN COMP NEUROSCI/ ENGINEERING
ELEN E6261	
ELEN E6717	Classical and Quantum Information Theory
ELEN E6860	ADV DIGITAL SIGNAL PROCESSING

Lightwave (Photonics) Engineering

Advisers: Professors Keren Bergman, Ioannis (John) Kymissis, Michal Lipson

1. Satisfy M.S. degree requirements.	
2. Take both: [1]	
ELEN E4411	FUNDAMENTALS OF PHOTONICS
ELEN E6412	LIGHTWAVE DEVICES
3. Choose one of the following device/circuits/photonics courses such as:	
ELEN E6413	LIGHTWAVE SYSTEMS
ELEN E6414	PHOTONIC INTEGRATED CIRCUITS
ELEN E4314	COMMUNICATION CIRCUITS
ELEN E4488	OPTICAL SYSTEMS
ELEN E6488	Optical interconnects and interconnection networks
ELEN E4193	MOD DISPLAY SCI # TECHNOLOGY
4. Choose at least two additional approved courses in photonics or a related area. Options also include courses outside EE such as:	
MSAE E4090	NANOTECHNOLOGY
APPH E4100	QUANTUM PHYSICS OF MATTER
APPH E4110	MODERN OPTICS
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
APPH E4112	LASER PHYSICS
APPH E4130	SOLAR ENERGY & STORAGE
APPH E6081	SOLID STATE PHYSICS I
APPH E6091	Magnetism and magnetic materials
MSAE E4202	KINETICS OF TRANSFORMATIONS
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS
MSAE E4207	LATTICE VIBES # CRYSTAL DEFCTS
MSAE E6229	ENERGY/PART-BEAM PROCES-MATRLS

[1] Or an E&M course, such as APPH E4300 APPLIED ELECTRODYNAMICS or PHYS GR6092 ELECTROMAGNETIC THEORY.

Microelectronic Devices

Advisers: Professors Dion Khodagholy, Ioannis (John) Kymissis, Michal Lipson, James Teherani, Wen Wang

1. Satisfy M.S. degree requirements.	
2. Choose one basic course such as:	
ELEN E4411	FUNDAMENTALS OF PHOTONICS
3. Choose one advanced course such as:	
ELEN E4193	MOD DISPLAY SCI # TECHNOLOGY
ELEN E4944	PRNCPLS OF DEVICE MICROFABRCTN
ELEN E6331	PRINCPLS SEMICONDUCTR PHYSCS I
ELEN E6333	Semiconductor device physics
ELEN E6945	DEVICE NANOFABRICATION
4. Choose at least two other approved courses in devices or a related area. Options also include courses outside EE such as:	
MSAE E4090	NANOTECHNOLOGY
APPH E4100	QUANTUM PHYSICS OF MATTER
APPH E4110	MODERN OPTICS
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
APPH E4112	LASER PHYSICS
APPH E4130	SOLAR ENERGY & STORAGE
APPH E6081	SOLID STATE PHYSICS I
APPH E6091	Magnetism and magnetic materials
MSAE E4202	KINETICS OF TRANSFORMATIONS
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS
MSAE E4207	LATTICE VIBES # CRYSTAL DEFCTS
MSAE E6229	ENERGY/PART-BEAM PROCES-MATRLS

1. Satisfy M.S. degree requirements.	
ECBM E4040	NEURAL NETWRKS # DEEP LEARNING
ECBM E4060	INTRO-GENOMIC INFO SCI # TECH
ELEN E4720	Machine Learning for Signals, Information and Data
EECS E4764	Artificial Intelligence of Things (AIoT)
ELEN E4903	TOPICS IN EE # CE
ELEN E4904	TOPICS IN EE # CE
ECBM E6070	TPC NEUROSCI # DEEP LEARN
MEEC E6600	Mathematics of Machine Learning, Signals, and Control
MEEE E6620	Applied Acoustics and Signal Recognition
EECS E6690	TOPICS DATA-DRIVEN ANAL # COMP
EECS E6791	Advanced Deep Learning
EECS E6792	Deep Learning on the Edge
EECS E6694	TOPICS DATA-DRIVEN ANAL # COMP

EECS E6699	TOPICS DATA-DRIVEN ANAL # COMP
EECS E6720	BAYESIAN MOD MACHINE LEARNING
ELEN E6772	TOPICS IN NETWORKING
ELEN E6873	Statistical signal processing and learning
ELEN E6908	TOPICS IN ELECTRICAL AND COMPUTER ENGINE
EECS E6892	TOPICS-INFORMATION PROCESSING

Electrical Engineering (PhD, EngScD)

Doctoral Degree

The requirements for the Ph.D. and Eng.Sc.D. degrees are identical. Both require a dissertation based on the candidate's original research, conducted under the supervision of a faculty member. The work may be theoretical or experimental or both.

Students who wish to become candidates for the doctoral degree in electrical engineering have the option of applying for admission to the Eng.Sc.D. program or the Ph.D. program. Students who elect the Eng.Sc.D. degree register in the School of Engineering and Applied Science; those who elect the Ph.D. degree register in the Graduate School of Arts and Sciences.

Doctoral candidates must obtain a minimum of 60 points of formal course credit beyond the bachelor's degree. A master's degree from an accredited institution may be accepted as equivalent to 30 points. A minimum of 30 points beyond the master's degree must be earned while in residence in the doctoral program.

More detailed information regarding the requirements for the doctoral degree may be obtained in the department office and at ee.columbia.edu.

Industrial Engineering and Operations Research

315 S. W. Mudd, MC 4704
212-854-2941
ieor.columbia.edu

The Department of Industrial Engineering and Operations Research (IEOR) is home to a multi-disciplinary community of researchers and educators who apply mathematical models to improve decision-making in complex environments. Its faculty are widely recognized for their foundational contributions to optimization, statistics, machine learning, and probability, and lead cutting-edge research in healthcare operations, financial engineering, supply chain management, and market design. IEOR faculty work closely with the Data Science Institute, Columbia Business School, and industry partners to ensure that theoretical advances translate into real-world impact.

Research in the department spans five interconnected areas: financial engineering, machine learning and analytics, optimization, operations, and stochastic modeling and simulation. These collectively address some of the most challenging problems in science, engineering, business, and society.

In financial engineering, faculty work on problems at the intersection of mathematics and markets, from reinforcement learning in stochastic control and mean-field games to systemic risk, taking full advantage of the department's New York location through practitioner seminars, research collaborations, and global industry partnerships.

In machine learning and analytics, research spans theoretical and applied topics including learning from interactive data, online learning, and fairness and interpretability of AI systems, with applications in financial technology, energy, pricing, and business analytics.

In optimization, the department advances both discrete and continuous optimization, designing near-optimal algorithms for large-scale problems with provable guarantees and addressing uncertainty through stochastic, robust, and dynamic approaches.

In operations, faculty leverage mathematical models and data to address problems in healthcare scheduling, supply chain management, online retail, energy management, and the sharing economy.

In stochastic modeling and simulation, researchers study complex systems to develop tools for performance evaluation, risk assessment, and real-time decision-making.

Current Research Activities

The department is home to and affiliated with research centers that bring together faculty, students, and industry partners across a broad range of IEOR's core areas:

- The Center for Applied Probability provides an umbrella under which diverse research and educational activities in probability and its applications can be focused and supported.
- The Center for AI in Business Analytics and Financial Technology (FinTech) partners closely with industry and government to pursue transformational change within the financial industry. From hedge funds to real estate and asset management to advanced data analysis, the Center provides world-class faculty, research, and students to take advanced technology from the lab to the market.
- The Center for Digital Finance and Technologies seeks to advance the digital transformation of financial services for higher efficiency and security, increased accessibility, and greater social responsibility.
- The Center for Financial and Business Analytics develops analytical and computational tools to manage risk and to support decisions using the growing volume and variety of data available.
- The Center for Financial Engineering aims to encourage interdisciplinary research on financial engineering and risk management. It also promotes collaboration between Columbia faculty and financial institutions through the organization of research seminars, workshops, and the dissemination of research conducted by members of the center.
- The Center for the Management of Systemic Risk conducts transdisciplinary research to understand systemic failures, examining them not as isolated accidents but through a unifying systems engineering perspective that reveals common breakdown mechanisms and informs better design, control, and management of complex systems.
- Computational Optimization Research Center (CORC) researchers carry out advanced studies in the solution of difficult, large-scale optimization problems, with special focus on state-of-the-art implementation of modern algorithms, targeting problems of practical relevance in collaboration with industry partners.
- The research of the Nie Center for Intelligent Asset Management focuses on the exploration of theoretical underpinnings and modeling

strategies for financial asset management through the introduction of dynamic control and big data analytical techniques.

Chair

- Antonius (Ton) Dieker

Directors of Undergraduate Programs

- Yi Zhang
- Eric Balkanski

Director of Financial Engineering

- Ali Hirsa

Director of Management Science and Engineering

- Hardeep Johar

Director of Business Analytics

- Hardeep Johar

Director of Industrial Engineering

- Fabrizio Lecci

Director of Operations Research

- Fabrizio Lecci

Director of Doctoral Programs

- Henry Lam

Professors

- Vineet Goyal
- Daniel Bienstock
- Agostino Capponi
- Ton Dieker
- Garud Iyengar
- Jay Sethuraman
- Clifford Stein
- David D. Yao
- Xunyu Zhou

Professors of Professional Practice

- Ali Hirsa
- Soulaymane Kachani
- Harry West

Associate Professor of Professional Practice

- Fabrizio Lecci

Associate Professors

- Rachel Cummings
- Adam Elmachtoub
- Yuri Faenza
- Christian Kroer
- Daniel Lacker
- Henry Lam
- Eric Balkanski

Assistant Professors

- Anish Agarwal
- Anran Hu
- Cédric Josz
- Tianyi Lin
- Bento Natura
- Wenpin Tang
- Kaizheng Wang
- Lily Xu
- Yuchen Hu

Teaching Professor

- Hardeep Johar

Senior Lecturer in Discipline

- Yi Zhang

Lecturers in Discipline

- Yaren Kaya
- Eric Stratman
- Uday Menon

Adjunct Faculty

- Amit Arora
- Dave Begun
- Luca Capriotti
- Nicolas Chikhani
- Krzysztof Choromanski
- Naftali Cohen
- Siddhartha Dastidar
- Owen Davis
- Kosrow Dehnad
- David DeRosa
- Sebastien Donadio
- Tony Effik
- Daniel Fernandez
- Michelle Glaser
- Leon S. Gold
- Ken Goodman
- Ebad Jahangir
- Alireza Javaheri
- Gary Kazantsev
- Dave Lerner
- Paul Logston
- Allan Malz
- Gunter Meissner

- Michael Miller
- Amal Moussa
- Gerard Neumann
- Christopher Perez
- Michael Robbins
- Lynn Root
- Ali Sadighian
- Cyril Shmatov
- Andrei Simion
- Rodney Sunada-Wong
- Maya Waisman
- Nadejda Zaets

For up-to-date course offerings, please visit ieor.columbia.edu

Course Descriptions

CEOR E4011 INFRASTRUCTURE SYSTEMS OPTIMIZATION. *3.00 points*.
Lect.: 3.

Prerequisites: Basic linear algebra. Basic probability and statistics. Engineering economic concepts. Basic spreadsheet analysis and programming skills. Subject to instructor's permission. Infrastructure design and systems concepts, analysis, and design under competing/conflicting objectives, transportation network models, traffic assignments, optimization, and the simplex algorithm

Fall 2026: CEOR E4011

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CEOR 4011	001/14468	W 7:00pm - 9:30pm 327 Seeley W. Mudd Building	Xuan Di	3.00	13/30

CSOR E4231 ANALYSIS OF ALGORITHMS I. *3.00 points*.
Prerequisites: (COMS W3134 and COMS W3136) or (COMS W3137 and COMS W3203)
Introduction to the design and analysis of efficient algorithms. Topics include models of computation, efficient sorting and searching, algorithms for algebraic problems, graph algorithms, dynamic programming, probabilistic methods, approximation algorithms, and NP-completeness.

Spring 2026: CSOR E4231

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSOR 4231	001/13263	M W 2:40pm - 3:55pm 303 Uris Hall	Daniel Bienstock	3.00	11/50

CSOR W4246 ALGORITHMS FOR DATA SCIENCE. *3.00 points*.
Prerequisites: COMS W1007 Basic knowledge in programming (e.g. at the level of COMS W1007), a basic grounding in calculus and linear algebra.
Corequisites: COMS W4121
Methods for organizing data, e.g. hashing, trees, queues, lists,priority queues. Streaming algorithms for computing statistics on the data. Sorting and searching. Basic graph models and algorithms for searching, shortest paths, and matching. Dynamic programming. Linear and convex programming. Floating point arithmetic, stability of numerical algorithms, Eigenvalues, singular values, PCA, gradient descent, stochastic gradient descent, and block coordinate descent. Conjugate gradient, Newton and quasi-Newton methods. Large scale applications from signal processing, collaborative filtering, recommendations systems, etc.

Fall 2026: CSOR W4246

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSOR 4246	001/12497	T Th 11:40am - 12:55pm 833 Seeley W. Mudd Building	Eleni Drinea	3.00	86/120
CSOR 4246	002/12498	T Th 1:10pm - 2:25pm 833 Seeley W. Mudd Building	Eleni Drinea	3.00	130/120
CSOR 4246	V01/18101		Eleni Drinea	3.00	0/99

DROM B8000 OPTIMIZATION # SIMULATION BOOTCAMP. *0.00 points*.

DROM B8105 HEALTHCARE ANALYTICS. *1.50 point*.
Course Description: This course will introduce students to the core concepts of health analytics, the types of questions addressed by healthcare analytics departments, and a broad overview of the most common analysis techniques

DROM B8106 Operations Strategy. *3.00 points*.
Prerequisites: DROM B5101 OR DROM B6101
Operations Strategy

Spring 2026: DROM B8106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8106	060/14702	Th 9:00am - 12:15pm 640 Geffen Hall	Medini Singh	3.00	57/65
DROM 8106	062/14703	F 9:00am - 12:15pm 640 Geffen Hall	Medini Singh	3.00	39/65

Summer 2026: DROM B8106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8106	001/11285	M T W Th F 9:00am - 5:00pm 640 Geffen Hall	Medini Singh	3.00	58/65

DROM B8107 Service Operations Management. *3.00 points*.
Prerequisites: DROM B6102 OR DROM B5102

Fall 2026: DROM B8107

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8107	060/16293	Th 9:00am - 12:15pm 890 Kravis Hall	Medini Singh	3.00	45/65

DROM B8116 Risk Management. *3.00 points*.

Spring 2026: DROM B8116

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8116	060/14701	M W 6:00pm - 7:30pm 640 Kravis Hall	Evan Picoult	3.00	49/74

DROM B8123 Demand Analytics. *3.00 points*.
Lect: 3.

Tools to efficiently manage supply and demand networks. Topics include service and inventory trade-offs, stock allocation, pricing, markdown management and contracts, timely product distribution to market while avoiding excess inventory, allocating adequate resources to the most profitable products and selling the right product to the right customer at the right price and at the right time.

DROM B8131 Sports Analytics. *3.00 points*.
Sports analytics refers to the use of data and quantitative methods to measure performance and make decisions to gain advantage in the competitive sports arena. This course builds on the Business Analytics core course and is designed to help students to develop and apply analytical skills that are useful in business, using sports as the application area. These skills include critical thinking, mathematical modeling, statistical analysis, predictive analytics, game theory, optimization and simulation. These skills will be applied to sports in this course, but are equally useful in many areas of business.There will be three main topics in the course: (1) measuring and predicting player and team performance, (2) decision-making and strategy in sports, and (3) fantasy sports and sports betting. Typical questions addressed in sports analytics include: How to rank players or teams? How to predict future performance of players or teams? How much is a player on a team worth? How likely are extreme performances, i.e., streaks? Are there hot-hands in sports performances? Which decision is more likely to lead to a win (e.g., attempt a stolen base or not in baseball, punt or go for it on fourth down in football, dump and chase or not in hockey, pull the goalie or not in hockey)? How to form lineups in daily fantasy sports? How to manage money in sports betting? How to analyze various ``prop'' bets?The main sports discussed in the course will be baseball, football, basketball, hockey, and golf. Soccer, tennis, and other sports will be briefly discussed. Students are welcome to pursue any sport in more detail (e.g., cricket, rugby, auto racing, horse racing, Australian rules football, skiiing, track and field, or even card games such as blackjack, poker, etc.) in a project. Class sessions will involve a mixture of current events, lecture, discussion, and hands-on analysis with computers in class. Each session will typically address a question from a sport using an important analytical idea (e.g., mean reversion) together with a mathematical technique (e.g., regression). Because of the "laboratory" nature of part of the sessions, students should bring their laptops to each class

Spring 2026: DROM B8131

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8131	060/14700	T 6:00pm - 9:00pm 420 Kravis Hall	Luke Beasley	3.00	46/74

Summer 2026: DROM B8131

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8131	001/11268	M T W Th S 9:00am - 5:00pm 420 Geffen Hall	Mark Broadie	3.00	55/74

Fall 2026: DROM B8131

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8131	001/16255	F M 2:20pm - 5:35pm 690 Kravis Hall	Mark Broadie	3.00	74/74

DROM B8153 People Analytics: Creating Business Value from Data. *1.50 point*.

DROM B8510 MANAGERIAL NEGOTIATIONS. *3.00 points*.

DROM B8816 Quantitative Pricing # Revenue. *1.50 point*.
Prerequisites: Familiar with the content covered in the managerial statistics, business analytics, managerial economics and marketing core courses. Knowledge in managerial statistics, probability, probability distributions, expected value calculations, etc
Quantitative pricing and revenue analytics collectively refers to the set of practices and tools that firms in various industries use to quantitatively model consumer preferences, segment their market, and tactically optimize (often in micro targeted or personalized manner) their product assortment, pricing, and promotion strategies. The origins of this field, often referred to as revenue management as it is also called, are in the airline industry during the late 80s. The prototypical question is how a firm should set and update pricing and product availability decisions across its various selling channels in order to maximize its profitability. In the airline industry, as most of us know, tickets for the same flight may be sold at many different fares, the availability of which is changing as a function of purchase restrictions, the forecasted future demand, and the number of unsold seats. The adoption of such systems has transformed the transportation and hospitality industries, and is increasingly important in retail, telecommunications, entertainment, financial services, health care, manufacturing, as well as on-line advertising, online retailing, and online markets. In parallel, pricing and revenue optimization has become a rapidly expanding practice in consulting services, and a growing area of software and IT development. We will be doing a hands-on dive into the above tools in the context of 2-3 case studies and datasets, in conjunction with lectures to set the stage. The case studies will cover markdown pricing for a retailer, demand and inventory data for a self-storage company, customer research data of a mortgage lender, and peak load pricing data for a highway toll booth.Through this course, students will be able to model and identify opportunities for revenue optimization in different business contexts. As the ensuing outline reveals, most of the topics covered in the course are either directly or indirectly related to customer segmentation, demand modeling, and tactical price optimization.TextbookOne recommended book for the course is by Robert Phillips titled "Pricing and Revenue Optimization. This will primarily be done in teams, much of it in class, and with the help of the TA(s) and the professor. Sample code will be shared for various parts of these analyses. Course deliverables align. Apart from class participation (30# of the total grade), the other course deliverables consist of a set of in-class (homework) assignments (40#) and a take-home final exam (30#).Class participation: I will routinely ask that you review some material, or watch some short recor

Fall 2026: DROM B8816

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
DROM 8816	060/16294	F 2:20pm - 5:35pm 670 Kravis Hall	Wei Ke	1.50	74/74

EEOR E4650 CONVEX OPTIMIZATION FOR ENG. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E3801) or ELEN E3801; or instructor's permission. Theory of convex optimization; numerical algorithms; applications in circuits, communications, control, signal processing and power systems

Fall 2026: EEOR E4650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEOR 4650	001/11281	Th 10:10am - 12:40pm 141 Uris Hall	James Anderson	3.00	24/60

EEOR E6616 CONVEX OPTIMIZATION. *3.00 points*.
Lect: 2.5.

Prerequisites: (IEOR E6613) and (EEOR E4650) EEOR E4650 AND IEOR E6613
Convex sets and functions, and operations preserving convexity. Convex optimization problems. Convex duality. Applications of convex optimization problems ranging from signal processing and information theory to revenue management. Convex optimization in Banach spaces. Algorithms for solving constrained convex optimization problems

Spring 2026: EEOR E6616

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEOR 6616	001/13265	M W 4:10pm - 5:25pm 233 Seeley W. Mudd Building	Bento Natura	3.00	17/40
EEOR 6616	V01/19800		Bento Natura	3.00	2/99

ENGI E4300 Design Justice: Human-Centered Design and Social Justice. *3.00 points*.
Prerequisites: IEME E4200 or COMS W4170 Or instructor's permission.
Introduction to Human-Centered Design and Innovation. Unpack the role of design in the market economy for an individual consumer, for a designer/developer and for an enterprise or other organization. Consider how designing in good faith for most can lead to injustice for some. Examine how - to use the PROP framework of the Columbia School of Social Work[1] - power, race, oppression, and privilege can be executed through the design process. Equip students with tools to engage in the design process and to facilitate the engagement of others. Explore strategies for guiding design and innovation towards more just solutions. [1] https://socialwork.columbia.edu/about/dei/dei-mission-statement/

IEME E4200 HUMAN-CENTERED DESIGN AND INNOVATION. *3.00 points*.
Prerequisites: Instructor's permission.
Open to SEAS graduate and advanced undergraduate students, Business School, and GSAPP. Students from other schools may apply. Fast-paced introduction to human-centered design. Students learn the vocabulary of design methods, understanding of design process. Small group projects to create prototypes. Design of simple product, more complex systems of products and services, and design of business

Spring 2026: IEME E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEME 4200	001/13266	W 10:10am - 11:25am Cin Alfred Lerner Hall	Harry West	3.00	58/60
IEME 4200	001/13266	W 11:25am - 12:40pm 430 River Side Church	Harry West	3.00	58/60
IEME 4200	002/17196	W 10:10am - 11:25am Cin Alfred Lerner Hall	Harry West	3.00	59/60
IEME 4200	002/17196	W 4:10pm - 5:25pm 430 River Side Church	Harry West	3.00	59/60

Fall 2026: IEME E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEME 4200	001/14493	T 4:10pm - 6:40pm 545 Seeley W. Mudd Building	Harry West	3.00	43/45

IEME E4810 INTRO-HUMANS IN SPACE FLIGHT. *3.00 points*.
Prerequisites: Department permission and knowledge of MATLAB or equivalent.
Introduction to human spaceflight from a systems engineering perspective. Historical and current space programs and spacecraft. Motivation, cost, and rationale for human space exploration. Overview of space environment needed to sustain human life and health, including physiological and psychological concerns in space habitat. Astronaut selection and training processes, spacewalking, robotics, mission operations, and future program directions. Systems integration for successful operation of a spacecraft. Highlights from current events and space research, Space Shuttle, Hubble Space Telescope, and International Space Station (ISS). Includes a design project to assist International Space Station astronauts

IEOR E1000 Frontiers in Operations Research and Data Analytics. *1.00 point*.
Introductory course for overview of modern approaches and ideas of operations research and data analytics. Through a series of interactive sessions, students engage in activities exploring OR topics with various faculty members from the IEOR department

Spring 2026: IEOR E1000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 1000	001/13267	F 1:30pm - 2:30pm 330 Uris Hall	Yi Zhang	1.00	57/60

Fall 2026: IEOR E1000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 1000	001/14495	F 2:00pm - 4:00pm 702 Hamilton Hall	Yi Zhang, Johanna Levey	1.00	27/80

IEOR E2000 Data Engineering with Python. *3.00 points*.
Prerequisites: ENGI E1006; Or competency in Python.
Introduction to essential data engineering methods. Potential topics include Arrays, Linked Lists, Stacks and Queues, Trees and Graphs, Hash Tables, Search Algorithms and Efficiency, Relational databases, SQL, NoSQL, and Data Wrangling. Practice both theory and applications using Python programming

Spring 2026: IEOR E2000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 2000	001/13268	M W 2:40pm - 3:55pm 303 Seeley W. Mudd Building	Yi Zhang	3.00	57/58

IEOR E2261 ACCOUNTING AND FINANCE. *3.00 points*.
Lect: 3.

Prerequisites: (ECON UN1105) ECON W1105
For undergraduates only. Examines the fundamental concepts of financial accounting and finance, from the perspective of both managers and investors. Key topics covered include principles of accrual accounting; recognizing and recording accounting transactions; preparation and analysis of financial statements; ratio analysis; pro-forma projections; time value of money (present values, future values and interest/discount rates); inflation; discounted-cash-flow (DCF) project evaluation methods; deterministic and probabilistic measures of risk; capital budgeting

Fall 2026: IEOR E2261

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 2261	001/14496	F 1:10pm - 3:40pm 833 Seeley W. Mudd Building	Nadejda Zaets	3.00	105/105

IEOR E3106 STOCHASTIC SYSTEMS AND APPLICATIONS. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3658) and For undergraduates only. Required for all undergraduate students majoring in IE, OR:EMS, OR:FE, and OR. Must be taken during or before the fifth semester.
Corequisites: IEOR E4404
Some of the main stochastic models used in engineering and operations research applications: discrete-time Markov chains, Poisson processes, birth and death processes and other continuous Markov chains, renewal reward processes. Applications: queueing, reliability, inventory, and finance. IEOR E3106 must be completed by the fifth term. Only students with special academic circumstances may be allowed to take these courses in alternative semesters with the consultation of CSA and Departmental advisers.

Fall 2026: IEOR E3106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3106	001/14497	T Th 4:10pm - 5:25pm 329 Pupin Laboratories	Kaizheng Wang	3.00	65/100

IEOR E3402 PRODUCTN-INVENTORY PLAN-CONTRL. *4.00 points*.
Lect: 3. Recit: 1.

Prerequisites: (IEOR E3608) and (IEOR E3658) and IEOR E3608 AND IEOR E3658
For undergraduates only. Required for all undergraduate students majoring in IE, OR:EMS, OR:FE, and OR. Must be taken during (or before) the sixth semester. Inventory management and production planning. Continuous and periodic review models: optimal policies and heuristic solutions, deterministic and probabilistic demands. Material requirements planning. Aggregate planning of production, inventory, and work force. Multi-echelon integrated production-inventory systems. Production scheduling. Term project. Recitation section required

Spring 2026: IEOR E3402

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3402	001/13269	F 11:00am - 12:00pm 142 Uris Hall	Ali Sadighian	4.00	14/90
IEOR 3402	001/13269	M W 8:40am - 9:55am 310 Fayerweather	Ali Sadighian	4.00	14/90

IEOR E3404 SIMULATION MODELING AND ANALYSIS. *4.00 points*.
Prerequisites: Knowledge of a programming language such as Python, C, C++ or Matlab
It is strongly advised that Stochastic modeling (IEOR E3106 or IEOR E4106) be taken before this course. This is an introductory course to simulation, a statistical sampling technique that uses the power of computers to study complex stochastic systems when analytical or numerical techniques do not suffice. The course focuses on discrete-event simulation, a general technique used to analyze a model over time and determine the relevant quantities of interest. Topics covered in the course include the generation of random numbers, sampling from given distributions, simulation of discrete-event systems, output analysis, variance reduction techniques, goodness of fit tests, and the selection of input distributions. The first half of the course is oriented toward the design and implementation of algorithms, while the second half is more theoretical in nature and relies heavily on material covered in prior probability courses. The teaching methodology consists of lectures, recitations, weekly homework, and both in-class and take-home exams. Homework almost always includes a programming component for which students are encouraged to work in teams.

Spring 2026: IEOR E3404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3404	001/13270	M W 5:40pm - 6:55pm 142 Uris Hall	Yi Zhang	4.00	76/90

IEOR E3608 FOUNDATIONS OF OPTIMIZATION. *3.00 points*.
Lect: 3.

Prerequisites: (MATH UN2010)
Corequisites: COMS W3134,COMS W3137
This first course in optimization focuses on theory and applications of linear optimization, network optimization, and dynamic programming.

Fall 2026: IEOR E3608

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3608	001/14498	M W 11:40am - 12:55pm 310 Fayerweather	Eric Balkanski	3.00	84/90

IEOR E3609 ADVANCED OPTIMIZATION. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3608) IEOR E3608
For undergraduates only. Required for all undergraduate students majoring in IE, OR:EMS, OR:FE, and OR. This is a follow-up to IEOR E3608 and will cover advanced topics in optimization, including integer optimization, convex optimization, and optimization under uncertainty, with a strong focus on modeling, formulations, and applications

Spring 2026: IEOR E3609

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3609	001/13271	M W 1:10pm - 2:25pm 602 Hamilton Hall	Bento Natura	3.00	67/80

IEOR E3658 PROBABILITY FOR ENGINEERS. *3.00 points.*
Lect: 3.

Prerequisites: Calculus. For undergraduates only. Required for OR:FE concentration. Must be taken during or before third semester. Students who take IEOR E3658 may not take W4150 due to significant overlap. Recommended: strong mathematical skills.
Introductory course to probability theory and does not assume any prior knowledge of subject. Teaches foundations required to use probability in applications, but course itself is theoretical in nature. Basic definitions and axioms of probability and notions of independence and conditional probability introduced. Focus on random variables, both continuous and discrete, and covers topics of expectation, variance, conditional distributions, conditional expectation and variance, and moment generating functions. Also Central Limit Theorem for sums of random variables. Consists of lectures, recitations, weekly homework, and in-class exams.

Spring 2026: IEOR E3658

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3658	001/13272	M W 10:10am - 11:25am 614 Schermerhorn Hall	Daniel Lacker	3.00	112/115

Fall 2026: IEOR E3658

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3658	001/14499	M W 10:10am - 11:25am 614 Schermerhorn Hall	Lily Xu	3.00	110/110

IEOR E3700 Research Immersion in OR and Data Analytics. *3.00 points.*
Prerequisites: IEOR E3608 AND IEOR E3658 AND IEOR E4307; For IEOR undergraduates only.
An overview of active research areas in Operations Research and Data Analytics, and an introduction to the essential components of research studies. This course helps students develop fundamental research skills, including paper reading, problem formulation, problem-solving, scientific writing, and research presentation. Classes are in seminar format, with students analyzing research papers, developing research projects, and presenting research findings

Spring 2026: IEOR E3700

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3700	001/13273	T 4:10pm - 6:40pm 326 Uris Hall	Adam Elmachtoub	3.00	8/30

IEOR E3900 UNDERGRAD RESEARCH OR PROJECT. *1.00-3.00 points.*
Prerequisites: Approval by a faculty member who agrees to supervise the work.
Independent work involving experiments, computer programming, analytical investigation, or engineering design

Spring 2026: IEOR E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3900	001/13443		Anish Agarwal	1.00-3.00	0/40
IEOR 3900	002/13445		Shipra Agrawal	1.00-3.00	0/40
IEOR 3900	003/13446		Eric Balkanski	1.00-3.00	0/40
IEOR 3900	004/13448		Daniel Bienstock	1.00-3.00	0/40
IEOR 3900	005/13449		Agostino Capponi	1.00-3.00	0/40
IEOR 3900	006/13451		Rachel Cummings	1.00-3.00	0/40
IEOR 3900	007/13453		Antonius Dieker	1.00-3.00	0/40
IEOR 3900	008/13454		Adam Elmachtoub	1.00-3.00	0/40
IEOR 3900	009/13456		Yuri Faenza	1.00-3.00	0/40
IEOR 3900	010/13457		Vineet Goyal	1.00-3.00	0/40
IEOR 3900	011/13458		Ali Hirsa	1.00-3.00	0/40
IEOR 3900	012/13460		Anran Hu	1.00-3.00	0/40
IEOR 3900	013/13462		Garud Iyengar	1.00-3.00	0/40
IEOR 3900	014/13463		Hardeep Johar	1.00-3.00	0/40
IEOR 3900	015/13465		Cedric Josz	1.00-3.00	0/40
IEOR 3900	016/13466		Soulaymane Kachani	1.00-3.00	7/40
IEOR 3900	017/13468		Yaren Kaya	1.00-3.00	2/40
IEOR 3900	018/13469		Christian Kroer	1.00-3.00	0/40
IEOR 3900	019/13471		Daniel Lacker	1.00-3.00	0/40
IEOR 3900	020/13472		Henry Lam	1.00-3.00	0/40
IEOR 3900	021/13474		Fabrizio Lecci	1.00-3.00	0/40
IEOR 3900	022/13475		Tianyi Lin	1.00-3.00	0/40
IEOR 3900	023/13476		Uday Menon	1.00-3.00	0/40
IEOR 3900	024/13477		Bento Natura	1.00-3.00	0/40
IEOR 3900	025/13478		Jay Sethuraman	1.00-3.00	0/40
IEOR 3900	026/13479		Karl Sigman	1.00-3.00	0/40
IEOR 3900	027/13480		Eric Stratman	1.00-3.00	2/40
IEOR 3900	028/13481		Clifford Stein	1.00-3.00	1/40
IEOR 3900	029/13559		Kaizheng Wang	1.00-3.00	0/40
IEOR 3900	030/13482		Wenpin Tang	1.00-3.00	0/40
IEOR 3900	031/13483		Kaizheng Wang	1.00-3.00	0/40
IEOR 3900	032/13484		Lily Xu	1.00-3.00	2/40
IEOR 3900	033/13485		David Yao	1.00-3.00	0/10
IEOR 3900	034/13489		Yi Zhang	1.00-3.00	0/20
IEOR 3900	035/13529		Xunyu Zhou	1.00-3.00	0/20
IEOR 3900	036/13530		Harry West	1.00-3.00	1/20
IEOR 3900	037/13532		Kelly Katsigris	1.00-3.00	0/20

Summer 2026: IEOR E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3900	001/12103		Anish Agarwal	1.00-3.00	0/40
IEOR 3900	002/12104		Shipra Agrawal	1.00-3.00	0/40
IEOR 3900	003/12105		Eric Balkanski	1.00-3.00	0/40
IEOR 3900	004/12106		Daniel Bienstock	1.00-3.00	0/40
IEOR 3900	005/12107		Agostino Capponi	1.00-3.00	0/40
IEOR 3900	006/12108		Rachel Cummings	1.00-3.00	0/40
IEOR 3900	007/12109		Antonius Dieker	1.00-3.00	0/40
IEOR 3900	008/12110		Adam Elmachtoub	1.00-3.00	0/40
IEOR 3900	009/12111		Yuri Faenza	1.00-3.00	0/40

IEOR E3999 FIELDWORK. *1.00-2.00 points*.
1-1.5 pts. (up to 2 pts. summer only)

Prerequisites: Obtained internship and approval from faculty advisor. Only for IEOR undergraduate students who need relevant work experience as part of their program of study.
Final reports are required. This course may not be taken for pass/fail credit or audited

Spring 2026: IEOR E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3999	001/13289		Yi Zhang, Jiaqi Li, Kelly Katsigris	1.00-2.00	3/50

Summer 2026: IEOR E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3999	001/11143		Yi Zhang, Kelly Katsigris, Richelle Roy, Samantha Sudol	1.00-2.00	11/200

Fall 2026: IEOR E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 3999	001/14580		Samantha Sudol, Richelle Roy, Kelly Katsigris, Jiaqi Li, Yi Zhang	1.00-2.00	2/40

IEOR E4003 CORPORATE FINANCE FOR ENGINEERS. *3.00 points*.
Lect: 3.

Prerequisites: Probability theory and linear programming. Required for all undergraduate students majoring in IE, OR:EMS, OR:FE, and OR.
Introduction to the economic evaluation of industrial projects. Economic equivalence and criteria. Deterministic approaches to economic analysis. Multiple projects and constraints. Analysis and choice under risk and uncertainty

Fall 2026: IEOR E4003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4003	001/14500	Th 6:10pm - 8:40pm 702 Hamilton Hall	Daniel Chen	3.00	41/80
IEOR 4003	V01/18114		Daniel Chen	3.00	1/99

IEOR E4004 OPTIMIZATION MODELS AND METHODS. *3.00 points*.
Lect: 3.

Prerequisites: Refer to course syllabus.
A graduate course only for MS#E, IE, and OR students. This is also required for students in the Undergraduate Advanced Track. For students who have not studied linear programming. Some of the main methods used in IEOR applications involving deterministic models: linear programming, the simplex method, nonlinear, integer and dynamic programming

Spring 2026: IEOR E4004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4004	001/13274	M W 1:10pm - 2:25pm 428 Pupin Laboratories	Yaren Kaya	3.00	140/140
IEOR 4004	002/13276	M W 4:10pm - 5:25pm 207 Mathematics Building	Yaren Kaya	3.00	127/147
IEOR 4004	C01/20183		Yaren Kaya	3.00	1/99
IEOR 4004	V01/18275		Yaren Kaya	3.00	1/99

Fall 2026: IEOR E4004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4004	001/14501	M W 10:10am - 11:25am Room TBA	Yaren Kaya	3.00	45/110
IEOR 4004	002/14502	M W 1:10pm - 2:25pm 833 Seeley W. Mudd Building	Yaren Kaya	3.00	110/110
IEOR 4004	003/14503	M W 11:40am - 12:55pm 702 Hamilton Hall	Yuri Faenza	3.00	84/86

IEOR E4007 OPT MODELS # METHODS FOR FE. *3.00 points*.
Lect: 3.

Prerequisites: Linear algebra. This graduate course is only for M.S. Program in Financial Engineering students.
Linear, quadratic, nonlinear, dynamic, and stochastic programming. Some discrete optimization techniques will also be introduced. The theory underlying the various optimization methods is covered. The emphasis is on modeling and the choice of appropriate optimization methods. Applications from financial engineering are discussed

Fall 2026: IEOR E4007

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4007	001/14504	T Th 4:10pm - 5:25pm Cin Alfred Lerner Hall	Jay Sethuraman	3.00	90/120

IEOR E4008 COMPUTATION DISCRETE OPT. *3.00 points*.
Prerequisites: Linear programming, basic probability theory.
Discrete optimization problems. Mathematical techniques and testing strengths and limits in practice on relevant applications. Transportation (travelling salesman and vehicle routing) and matching (online advertisement and school allocation) problems.

IEOR E4011 Agentic AI for Operations Research and Financial Engineering. *3.00 points*.
Prerequisites: Students should be familiar with Python programming. A basic understanding of probability and statistics at the level of IEOR E4150 (or equivalent) is required.
Introduces agentic AI systems for decision-making in operations research and financial engineering. Covers large language models, retrieval-augmented generation, conversational agents, semantic workflows, and streaming architectures. Emphasizes hands-on design and deployment of end-to-end agentic pipelines, integrating forecasting, optimization, and reasoning in operational problems and financial engineering applications. Applications include supply chain risk, energy systems, inventory management, and portfolio management.

Fall 2026: IEOR E4011

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4011	001/15328	M W 10:10am - 11:25am 524 Seeley W. Mudd Building	Agostino Capponi	3.00	55/55
IEOR 4011	V01/18115		Agostino Capponi	3.00	1/99

IEOR E4100 STATISTICS # SIMULATION. *1.50 point*.
Lecture 1.5

Prerequisites: Understanding of single- and multivariable calculus. Probability and simulation. Statistics building on knowledge in probability and simulation. Point and interval estimation, hypothesis testing, and regression. A specialized version of IEOR E4150 for MSE and MSBA students who are exempt from the first half of IEOR E4101. Must obtain waiver for E4101

Fall 2026: IEOR E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4100	001/14506	M W 2:40pm - 3:55pm 214 Pupin Laboratories	Eric Stratman	1.50	0/60

IEOR E4101 PROBABILITY STAT # SIMULATION. *3.00 points*.
Prerequisites: Understanding of single- and multivariable calculus. MSE and MSBA students only.
Basic probability theory, including independence and conditioning, discrete and continuous random variable, law of large numbers, central limit theorem, and stochastic simulation, basic statistics, including point and interval estimation, hypothesis testing, and regression; examples from business applications such as inventory management, medical treatments, and finance. A specialized version of IEOR E4150 for MSE and MSBA students

Fall 2026: IEOR E4101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4101	001/14507	M W 2:40pm - 3:55pm 833 Seeley W. Mudd Building	Eric Stratman	3.00	84/120
IEOR 4101	002/14508	M W 2:40pm - 3:55pm 207 Mathematics Building	Yi Zhang	3.00	80/80
IEOR 4101	003/14509	M W 11:40am - 12:55pm 501 Northwest Corner	Yi Zhang	3.00	120/120

IEOR E4102 STOCHASTIC MODELING FOR MSE. *3.00 points*.
Prerequisites: IEOR E4101
Introduction to stochastic processes and models, with emphasis on applications to engineering and management; random walks, gambler's ruin problem, Markov chains in both discrete and continuous time, Poisson processes, renewal processes, stopping times, Wald's equation, binomial lattice model for pricing risky assets, simple option pricing; simulation of simple stochastic processes, Brownian motion, and geometric Brownian motion. A specialized version of IEOR E4106 for MSE students

Spring 2026: IEOR E4102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4102	001/13275	M W 1:10pm - 2:25pm 142 Uris Hall	Karl Sigman	3.00	84/95

IEOR E4106 STOCHASTIC MODELS. *3.00 points*.
Lect: 3.

Prerequisites: (STAT GU4001) or IEOR E4150 This graduate course is only for IE and OR students. Also required for students in the Undergraduate Advanced Track.
Corequisites: IEOR E4403
Some of the main stochastic models used in engineering and operations research applications: discrete-time Markov chains, Poisson processes, birth and death processes and other continuous Markov chains, renewal reward processes. Applications: queueing, reliability, inventory, and finance.

Spring 2026: IEOR E4106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4106	001/13277	M W 5:40pm - 6:55pm 428 Pupin Laboratories	Antonius Dieker	3.00	132/135
IEOR 4106	C01/20166		Antonius Dieker	3.00	1/99
IEOR 4106	V01/16659		Antonius Dieker	3.00	3/99

Fall 2026: IEOR E4106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4106	001/14510	M W 10:10am - 11:25am 402 Chandler	David Yao	3.00	68/120

IEOR E4108 SUPPLY CHAIN ANALYTICS. *3.00 points*.
Prerequisites: IEOR E3402 or instructor's permission. MS IEOR students only.
Supply chain management, model design of a supply chain network, inventories, stock systems, commonly used inventory models, supply contracts, value of information and information sharing, risk pooling, design for postponement, managing product variety, information technology and supply chain management; international and environmental issues. Note: replaced IEOR E4000 beginning in fall 2018.

Spring 2026: IEOR E4108

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4108	001/13278	T Th 1:10pm - 2:25pm 633 Seeley W. Mudd Building	Elioth Sanabria Buenaventura	3.00	40/47
IEOR 4108	V01/20170		Elioth Sanabria Buenaventura	3.00	2/99

Fall 2026: IEOR E4108

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4108	001/16502	T Th 11:40am - 12:55pm 717 Hamilton Hall	Vineet Goyal	3.00	12/78
IEOR 4108	V01/19963		Vineet Goyal	3.00	2/99

IEOR E4111 OPERATIONS CONSULTING. *3.00 points*.
Prerequisites: Probability and statistics at the level of IEOR E3658 and E4307 or STAT GU4001, and Deterministic Models at the level of IEOR E3608 or IEOR E4004, or instructor permission. For MS-MS&E students only.
Aims to develop and harness the modeling, analytical, and managerial skills of engineering students and apply them to improve the operations of both service and manufacturing firms. Structured as a hands-on laboratory in which students "learn by doing" on real-world consulting projects (October to May). The student teams focus on identifying, modeling, and testing (and sometimes implementing) operational improvements and innovations with high potential to enhance the profitability and/or achieve sustainable competitive advantage for their sponsor companies. The course is targeted toward students planning careers in technical consulting (including operations consulting) and management consulting, or pursuing positions as business analysts in operations, logistics, supply chain and revenue management functions, positions in general management, and future entrepreneurs.

Spring 2026: IEOR E4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4111	001/13279	Th 7:10pm - 9:40pm 501 Northwest Corner	Soulaymane Kachani	3.00	0/90

Fall 2026: IEOR E4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4111	001/14511	Th 7:00pm - 11:00pm 501 Northwest Corner	Soulaymane Kachani	3.00	85/110

IEOR E4150 INTRO-PROBABILITY # STATISTICS. *3.00 points*.
Lect: 3.

Prerequisites: Calculus, including multiple integration.
Covers the following topics: fundamentals of probability theory and statistical inference used in engineering and applied science; Probabilistic models, random variables, useful distributions, expectations, law of large numbers, central limit theorem; Statistical inference: pint and confidence interval estimation, hypothesis tests, linear regression. For IEOR graduate students

Spring 2026: IEOR E4150

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4150	XMT/20709		Christine Chan, Kelly Katsigris	3.00	3/8

Summer 2026: IEOR E4150

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4150	D01/12812		Antonius Dieker	3.00	8/99

Fall 2026: IEOR E4150

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4150	001/14512	M W 11:40am - 12:55pm 209 Havemeyer Hall	Eric Stratman	3.00	97/105
IEOR 4150	002/14513	M W 4:10pm - 5:25pm 833 Seeley W. Mudd Building	Eric Stratman	3.00	62/105
IEOR 4150	V01/18116		Eric Stratman	3.00	6/99
IEOR 4150	XMT/14514			3.00	0/0

IEOR E4177 Think Bigger. *3.00 points*.
Innovative solutions to complex problems that are both novel and useful. Focuses on The Think Bigger Innovation Method, uses decision-making theory, cognitive science, and industry practice to facilitate creativity and innovation. Designed to foster new ideas during the beginning of the semester that will then function as the seeds for entrepreneurially minded. Culminates in a final project with presentation of formal and polished pitch of an innovative idea in front of a distinguished panel of successful minds from across the city

IEOR E4199 MSIEOR Quantitative Bootcamp. *0.00 points*.
Zero-credit course. Primer on quantitative and mathematical concepts. Required for all incoming MSOR and MSIE students

Spring 2026: IEOR E4199

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4199	001/18252			0.00	21/8

Fall 2026: IEOR E4199

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4199	001/14691		Michael Miller	0.00	170/250

IEOR E4207 HUMAN FACTORS: PERFORMANCE. *3.00 points*.
Lect: 3.

Sensory and cognitive (brain) processing considerations in the design, development, and operations of systems, products, and tools. User or operator limits and potential in sensing, perceiving decision making, movement coordination, memory, and motivation.

Fall 2026: IEOR E4207

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4207	001/14692	M 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Leon Gold	3.00	52/52

IEOR E4208 SEM IN HUMAN FACTORS DESIGN. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4207) or IEOR E4207; IEOR E4207 or instructor's permission.
An elective for undergraduate students majoring in IE. An in-depth exploration of the application potential of human factor principles for the design of products and processes. Applications to industrial products, tools, layouts, workplaces, and computer displays. Consideration to environmental factors, training and documentation. Term project

IEOR E4212 Data Analytics # Machine Learning for OR. *3.00 points*.
Surveys tools available in Python for getting (web scraping and APIs) and visualizing data (charts and maps). Introduction to analytics through machine learning (ML algorithms, model evaluation, text analytics, network algorithms, deep learning)

Fall 2026: IEOR E4212

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4212	001/14693	M 1:10pm - 3:40pm 303 Seeley W. Mudd Building	Hardeep Johar	3.00	43/70

IEOR E4213 AI and Algorithms for Analytics. *3.00 points*.
Prerequisites: IEOR E2000 (or sufficient coding background in Python); IEOR 3608 (or CSOR 4231 Analysis of Algorithms I); IEOR E3658 (or another probability course); IEOR E4212 (or machine learning background from other courses
This course explores modern artificial intelligence (AI) algorithms and methods for analytics and operational decision-making. Students will develop a conceptual and methodological understanding of AI tools, with an emphasis on their applications to domains such as healthcare, finance, energy systems, and logistics. Topics include machine learning, neural networks, large language models, reinforcement learning, multi-agent systems, and agentic systems.

IEOR E4307 STATISTICS AND DATA ANALYSIS. *3.00 points*.
Lect: 3.

Prerequisites: probability, linear algebra.
Descriptive statistics, central limit theorem, parameter estimation, sufficient statistics, hypothesis testing, regression, logistic regression, goodness-of-fit tests, applications to operations research models

Fall 2026: IEOR E4307

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4307	001/14694	T Th 10:10am - 11:25am 313 Fayerweather	Fabrizio Lecci	3.00	60/78

IEOR E4399 MSE Quantitative Bootcamp. *0.00 points*.
Zero-credit course. Primer on quantitative and mathematical concepts. Required for all incoming MSOR and MSIE students

Fall 2026: IEOR E4399

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4399	001/14695		Michael Miller	0.00	87/150

IEOR E4402 Corporate Finance, Accounting # Investment Banking. *3.00 points*.
Prerequisites: Covers primary financial theories and alternative theories underlying Corporate Finance, such as CAPM, Miller Modigliani, Fama French factors, Smart Beta, etc.
Interpret financial statements, build cash flow models, value projects, value companies, and make Corporate Finance decisions. Additional topics include: cost of capital, dividend policy, debt policy, impact of taxes, Shareholder/Debtholder agency costs, dual-class shares, using option pricing theory to analyze management behavior, investment banking activities, including equity underwriting, syndicated lending, venture capital, private equity investing and private equity secondaries. Application of theory in real-world situations: analyzing financial activities of companies such as General Electric, Google, Snapchat, Spotify, and Tesla

Spring 2026: IEOR E4402

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4402	001/13280	Th 4:30pm - 7:00pm 303 Seeley W. Mudd Building	Rodney Sunada-Wong	3.00	67/67
IEOR 4402	V01/20158		Rodney Sunada-Wong	3.00	4/99

Fall 2026: IEOR E4402

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4402	001/14696	W 5:40pm - 8:10pm 833 Seeley W. Mudd Building	Rodney Sunada-Wong	3.00	110/110

IEOR E4403 QUANTITATIVE CORPORATE FINANCE. *3.00 points*.
Lect: 3.

Prerequisites: Probability theory and linear programming
Required for students in the Undergraduate Advanced Track. Key measures and analytical tools to assess the financial performance of a firm and perform the economic evaluation of industrial projects. Deterministic mathematical programming models for capital budgeting. Concepts in utility theory, game theory and real options analysis

IEOR E4404 SIMULATION. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3658) and (IEOR E4307) or (STAT GU4001) and Required for all undergraduate students majoring in IE, OR:EMS, OR:FE, and OR. Also required for MSOR.
Corequisites: IEOR E3106,IEOR E4106
Generation of random numbers from given distributions; variance reduction; statistical output analysis; introduction to simulation languages; application to financial, telecommunications, computer, and production systems. Graduate students must register for 3 points. Undergraduate students must register for 4 points. Note: Students who have taken IEOR E4703 Monte Carlo simulation may not register for this course for credit. Recitation section required.

Spring 2026: IEOR E4404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4404	001/13281	T Th 2:40pm - 3:55pm 207 Mathematics Building	Henry Lam	3.00	152/152
IEOR 4404	V01/19799		Henry Lam	3.00	2/99

Fall 2026: IEOR E4404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4404	001/14747	M W 11:40am - 12:55pm 428 Pupin Laboratories	Yuchen Hu	3.00	77/96
IEOR 4404	V01/18117		Yuchen Hu	3.00	1/99

IEOR E4405 PRODUCTION SCHEDULING. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3608) and (IEOR E3658) and IEOR E3608 AND IEOR E3658; Computer programming.
Required for undergraduate students majoring in IE and OR. Job shop scheduling: parallel machines, machines in series; arbitrary job shops. Algorithms, complexity, and worst-case analysis. Effects of randomness: machine breakdowns, random processing time. Term project

Spring 2026: IEOR E4405

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4405	001/13282	T Th 8:40am - 9:55am 633 Seeley W. Mudd Building	Clifford Stein	3.00	14/60

IEOR E4407 GAME THEOR MODELS OF OPERATION. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4004) or (IEOR E3608) and (IEOR E4106) or (IEOR E3106) and Familiarity with differential equations and computer programming; or instructor's permission.
Required for undergraduate students majoring in OR:FE and OR. A mathematically rigorous study of game theory and auctions, and their application to operations management. Topics include introductory game theory, private value auction, revenue equivalence, mechanism design, optimal auction, multiple-unit auctions, combinatorial auctions, incentives, and supply chain coordination with contracts. No previous knowledge of game theory is required.

Fall 2026: IEOR E4407

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4407	001/14697	T Th 2:40pm - 3:55pm 313 Fayerweather	Jay Sethuraman	3.00	32/75
IEOR 4407	V01/18118		Jay Sethuraman	3.00	3/99

IEOR E4213 AI and Algorithms for Analytics. *3.00 points*.
Prerequisites: IEOR E2000 (or sufficient coding background in Python); IEOR 3608 (or CSOR 4231 Analysis of Algorithms I); IEOR E3658 (or another probability course); IEOR E4212 (or machine learning background from other courses
This course explores modern artificial intelligence (AI) algorithms and methods for analytics and operational decision-making. Students will develop a conceptual and methodological understanding of AI tools, with an emphasis on their applications to domains such as healthcare, finance, energy systems, and logistics. Topics include machine learning, neural networks, large language models, reinforcement learning, multi-agent systems, and agentic systems.

IEOR E4418 TRANSPORTATION ANALYTICS # LOGISTICS. *3.00 points*.
Lect: 3.

Prerequisites: A background in optimization and/or algorithms is strongly encouraged and may be obtained concurrently. Background in probability and/or stochastic processes is also strongly encouraged and may be obtained concurrently. Prior coding experience encouraged
Transportation, primarily focused on the movement of people, and logistics, primarily focused on the movement of goods, are two of the most fundamental challenges to modern society. To address many problems in these areas, a wide array of mathematical models and analytics tools have been developed. This class will introduce many of the foundational tools used in transportation and logistics problems, relying on ideas from linear optimization, integer optimization, stochastic processes, statistics, and simulation. We will address problems such as optimizing the routes of cars and delivery trucks, positioning emergency vehicles, and controlling traffic behavior. Moreover, we will discuss modern issues such as bicycle sharing, on-demand car and delivery services, and humanitarian logistics. Concepts will be reinforced with technical content as well as real-world data and examples

IEOR E4420 Introduction to Financial Technology. *3.00 points*.
Prerequisites: Students should have a good background in calculus, probability, and linear algebra. Some basic prior knowledge of finance will be helpful (but not necessary).
Introduction to the foundations and applications of Financial Technology, with a focus on decentralized finance (DeFi) and blockchain systems. Potential topics include blockchain fundamentals, permissioned and permissionless protocols, DeFi primitives such as AMMs, lending, liquidity staking, MEV, and stablecoins, market microstructure and on-chain data analytics, as well as emerging applications including institutional DeFi, real-world asset tokenization, and AI integration. Emphasizes both theoretical concepts and empirical design, giving students practical experience analyzing and working with blockchain and DeFi data.

IEOR E4500 APPLICATIONS PROGRAMMNG FOR FE. *3.00 points*.
Lect: 3.

Prerequisites: Computer programming or instructor's approval. Required for undergraduate students majoring in OR:FE.
We will take a hands-on approach to developing computer applications for Financial Engineering. Special focus will be placed on high-performance numerical applications that interact with a graphical interface. In the course of developing such applications we will learn how to create DLLs, how to integrate VBA with C/C programs, and how to write multithreaded programs. Examples of problems settings that we consider include simulation of stock price evolution, tracking, evaluation and optimization of a stock portfolio; optimal trade execution. In the course of developing these applications, we review topics of interest to OR:FE in a holistic fashion

Fall 2026: IEOR E4500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4500	001/14698	M W 10:10am - 11:25am 329 Pupin Laboratories	Anran Hu	3.00	98/98

IEOR E4501 TOOLS FOR ANALYTICS. *3.00 points*.
Corequisites: IEOR E4523
MS IEOR students only. Introduction programming in Python, tools with the programmer's ecosystem. Python, Data Analysis tools in Python (NumPy, pandas, bokeh), GIT, Bash, SQL, VIM, Linux/Debia, SSH.

IEOR E4502 Python for Analytics. *0.00 points*.
Zero-credit course. Primer on Python for analytics concepts. Required for MSBA students

Fall 2026: IEOR E4502

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4502	001/16336		Samantha Sudol, Kelly Katsigris, Jean Flick	0.00	291/250

IEOR E4505 OPERATION RES IN PUBLIC POLICY. *3.00 points*.
Aims to give the student a broad overview of the role of Operations Research in public policy. The specific areas covered include voting theory, apportionment, deployment of emergency units, location of hazardous facilities, health care, organ allocation, management of natural resources, energy policy, and aviation security. Draws on a variety techniques such as linear and integer programming, statistical and probabilistic methods, decision analysis, risk analysis, and analysis and control of dynamic systems.

Spring 2026: IEOR E4505

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4505	001/13283	M W 11:40am - 12:55pm 717 Hamilton Hall	Eric Stratman	3.00	32/50

IEOR E4506 DESIGN DIGITAL OPERATING MODELS. *3.00 points*.
IEOR students only. Understand digital businesses, apply scientific, engineering thinking to digital economy. Data-driven digital strategies and operating models. Sectors: ecommerce, advertising technology, and marketing technology. Automation of the marketing, sales, and advertising functions. Algorithms, patents, and business models. Business side of the digital ecosytem and the digital economy

Fall 2026: IEOR E4506

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4506	001/14699	M 7:00pm - 9:30pm 141 Uris Hall	Bryan Chong	3.00	60/60

IEOR E4507 HEALTHCARE OPERATIONS MGT. *3.00 points*.
Prerequisites: (IEOR E3608) and (IEOR E3658) and (IEOR E4307) For senior undergraduate Engineering students: SIEO W3600: Introduction to Probability and Statistics and IEOR E3608: Introduction to Mathematical Programming; For Engineering graduate students (MS or PhD): Probability and Statistics at the level of SIEO W4150, and Deterministic Models at the level of IEOR E4004. For Healthcare Management students: P8529: Analytic Methods for Health Services Management.
Prerequisite(s): for senior undergraduate Engineering students: IEOR E3608, E3658, and E4307; for Engineering graduate students (M.S. or Ph.D.): Probability and statistics at the level of IEOR E4150, and deterministic models at the level of IEOR E4004; for healthcare management students: P8529 Analytical methods for health services management. Develops modeling, analytical, and managerial skills of engineering and health care management students. Enables students to master an array of fundamental operations management tools adapted to the management of health care systems. Through real-world business cases, students learn to identify, model, and analyze operational improvements and innovations in a range of health care contexts.

Fall 2026: IEOR E4507

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4507	001/14700	M W 4:10pm - 5:25pm 303 Seeley W. Mudd Building	Yaren Kaya	3.00	23/55

IEOR E4510 PROJECT MANAGEMENT. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4004) or (IEOR E3608) IEOR E4004 OR IEOR E3608 Management of complex projects and the tools that are available to assist managers with such projects. Topics include project selection, project teams and organizational issues, project monitoring and control, project risk management, project resource management, and managing multiple projects

Spring 2026: IEOR E4510

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4510	001/13284	F 10:10am - 12:40pm 517 Hamilton Hall	David Begun	3.00	25/80

IEOR E4511 Industry Projects in Analytics # Operations Research. *3.00 points*.
Teams of students work on real-world projects in analytics. Focus on three aspects of analytics: identifying client analytical requirements; assembling, cleaning and organizing data; identifying and implementing analytical techniques (e.g., statistics and/or machine learning); and delivering results in a client-friendly format. Each project has a defined goal and pre-identified data to analyze in one semester. Client facing class. Class requires 10 hours of time per week and possible client visits on Fridays

Spring 2026: IEOR E4511

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4511	001/13285	M 9:00am - 11:30am Cin Alfred Lerner Hall	Kelly Katsigris, Christine Chan, Michael Robbins	3.00	53/150

Fall 2026: IEOR E4511

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4511	001/14701	M 9:00am - 11:30am Room TBA	Michael Robbins	3.00	70/100
IEOR 4511	002/15509	M 4:10pm - 6:40pm 310 Fayerweather	Michael Robbins, Robert Kramer	3.00	54/90
IEOR 4511	V01/18119		Michael Robbins	3.00	0/99

IEOR E4520 APPLIED SYSTEMS ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: B.S. in engineering or applied sciences; professional experience recommended; calculus, probability and statistics, linear algebra.
Introduction to fundamental methods used in systems engineering. Rigorous process that translates customer needs into a structured set of specific requirements; synthesizes a system architecture that satisfies those requirements and allocates them in a physical system, meeting cost, schedule, and performance objectives throughout the product life-cycle. Sophisticated modeling of requirements optimization and dependencies, risk management, probabilistic scenario scheduling, verification matrices, and systems-of-systems constructs are synthesized to define the meta-workflow at the top of every major engineering project

IEOR E4521 SYSTEM ENGI TOOLS/METHODS. *3.00 points*.
Prerequisites: B.S. in engineering or applied sciences; probability and statistics, optimization, linear algebra, and basic economics.
Applications of SE tools and methods in various settings. Encompasses modern complex system development environments, including aerospace and defense, transportation, energy, communications, and modern software-intensive systems

IEOR E4523 Data Analytics and Machine Learning. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4501) Prior exposure to some programming language is helpful, and you should either have taken or be concurrently registered in the IEOR E4501 Tools for Analytics class.
IEOR students only; priority to MSBA students. Practical survey of Python tools for acquiring, cleaning, and analyzing data. Techniques for obtaining data from files, web scraping, and APIs (CSV, HTML, JSON, XML); performing core data-cleaning tasks; and using data analysis, machine learning, and visualization libraries (NumPy, Pandas, Matplotlib, Seaborn, TensorFlow/Keras). Introduces foundational machine learning and deep learning concepts, including backpropagation, gradient descent, and implementation of neural networks with TensorFlow/Keras. Covers text mining using word, sentence, and document embeddings. Includes a group project requiring students to collect, store, and analyze a dataset of their choice and build a predictive model.

Spring 2026: IEOR E4523

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4523	001/13286	T Th 4:10pm - 5:25pm 833 Seeley W. Mudd Building	Uday Menon	3.00	11/100

Fall 2026: IEOR E4523

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4523	001/14702	T Th 2:40pm - 3:55pm 702 Hamilton Hall	Uday Menon	3.00	85/85
IEOR 4523	002/14703	T Th 4:10pm - 5:25pm 702 Hamilton Hall	Uday Menon	3.00	72/85
IEOR 4523	003/14704	T Th 5:40pm - 6:55pm 602 Hamilton Hall	Uday Menon	3.00	75/85

IEOR E4524 ANALYTICS IN PRACTICE. *3.00 points*.
Lect: 3.

MSBA students only. Groups of students will work on real world projects in analytics, focusing on three aspects: identifying client analytical requirements; assembling, cleaning, and organizing data; identifying and implementing analytical techniques (statistics, OR, machine learning); and delivering results in a client-friendly format. Each project has a well-defined goal, comes with sources of data preidentified, and has been structured so that it can be completed in one semester. Client-facing class with numerous on-site client visits; students should keep Fridays clear for this purpose.

Spring 2026: IEOR E4524

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4524	001/13287	Th 7:10pm - 9:40pm 301 Pupin Laboratories	Hardeep Johar	3.00	255/260
IEOR 4524	002/13288	T 4:10pm - 6:40pm 327 Seeley W. Mudd Building	Yaren Kaya	3.00	21/30

IEOR E4525 MACHINE LEARNING FE # OPR. *3.00 points*.
Prerequisites: Optimization, applied probability, statistics, and knowledge of or experience in computer programming.
MS IEOR students only. Introduction to machine learning, practical use of ML algorithms and applications to financial engineering and operations. Supervised learning: regression, classification, resampling methods, regularization, support vector machines (SVMs), and deep learning. Unsupervised learning: dimensionality reduction, matrix decomposition, and clustering algorithms

Spring 2026: IEOR E4525

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4525	001/13290	M 4:10pm - 5:25pm 142 Uris Hall	Daniel Bienstock	3.00	40/68

Fall 2026: IEOR E4525

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4525	002/16882	M W 1:10pm - 2:25pm 501 Schermerhorn Hall	Daniel Bienstock	3.00	56/100

IEOR E4526 ANALYTICS ON THE CLOUD. *3.00 points*.
Prerequisites: IEOR E4501 and IEOR E4523 IEOR E4501 AND IEOR E4523 To introduce students to programming issues around working with clouds for data analytics. Class will learn how to work with infrastructure of cloud platforms, and discussion about distributed computing, focus of course is on programming. Topics covered include MapReduce, parallelism, rewriting of algorithms (statistical, OR, and machine learning) for the cloud, and basics of porting applications so that they run on the cloud

Fall 2026: IEOR E4526

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4526	001/14706	M 10:10am - 12:40pm 303 Seeley W. Mudd Building	Hardeep Johar	3.00	53/60

IEOR E4530 TOPICS IN OPERATIONS RESEARCH. *3.00 points*.
Prerequisites: A course in probability and statistics 4101/4150 or equivalent, basic python programming.
This course will cover the basics of game theory and market design, with a focus on how AI and optimization enables large-scale game solving and markets. We will cover the core ideas behind recent superhuman AIs for games such as Poker. Then, we will discuss how AI and game theory ideas are used in marketplaces such as internet advertising, fair course seat allocation, and spectrum reallocation. This is intended to be an advanced MS level and senior undergraduate course for students in Operations Research and Financial Engineering

IEOR E4532 Visualization and Storytelling with Data. *1.50 point*.
Data visualization and how to build a story with data. Using complex data or statistics to communicate results effectively. Learn to present analysis and results conscisely and effectively

Spring 2026: IEOR E4532

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4532	001/13291	F 9:00am - 5:00pm 313 Fayerweather	Michelle Glaser	1.50	59/60

Fall 2026: IEOR E4532

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4532	001/14707	F 9:00am - 5:00pm 633 Seeley W. Mudd Building		1.50	60/60

IEOR E4533 Performance, Objectives, # Results Using Data Analytics. *1.50 point*.
OKR framework and different variations. Measurement techniques (A/B testing, validation, correlation, etc.) Identifying what to measure in product experience and business initiatives. Data-driven decision making

Spring 2026: IEOR E4533

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4533	001/13292	F Sa S 9:00am - 5:00pm 313 Fayerweather	Nicolas Chikhani	1.50	61/65

Fall 2026: IEOR E4533

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4533	001/14708	F Sa S 9:00am - 5:00pm 633 Seeley W. Mudd Building	Nicolas Chikhani	1.50	65/65

IEOR E4534 Applied Analytics: from Data to Decisions. *3.00 points*.
Applied Analytics focus querying and transforming data with SQL, defining and visualizing metrics, measuring impact of products / processes. Tools and techniques to convert raw data to business decisions, statistical analysis. Be able to apply these techniques to real-world datasets

Spring 2026: IEOR E4534

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4534	001/13293	T Th 10:10am - 11:25am 702 Hamilton Hall	Fabrizio Lecci	3.00	80/80

Fall 2026: IEOR E4534

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4534	001/14709	T Th 11:40am - 12:55pm 602 Hamilton Hall	Fabrizio Lecci	3.00	75/75

IEOR E4535 Analytics Engineering. *3.00 points*.
Introduction to the foundations and applications of Analytics Engineering, bridging Data Engineering and Data Analysis. Potential topics include SQL fundamentals, data warehouse setup and maintenance (Snowflake), version control with GitHub, data ingestion and integration (Fivetran), data cleaning and transformations (dbt), data visualization (Preset), and orchestrating modern data architectures. Emphasizes both theoretical understanding and hands-on practice, giving students practical experience building, managing, and analyzing data pipelines and models in real-world scenarios

IEOR E4540 DATA MINING. *3.00 points*.
Prerequisites: Linear Algebra, Calculus, Probability, and some basic programming.
Course covers major statistical learning methods for data mining under both supervised and unsupervised settings. Topics covered include linear regression and classification, model selection and regularization, tree-based methods, support vector machines, and unsupervised learning. Students learn about principles underlying each method, how to determine which methods are most suited to applied settings, concepts behind model fitting and parameter tuning, and how to apply methods in practice and assess their performance. Emphasizes roles of statistical modeling and optimization in data mining

Spring 2026: IEOR E4540

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4540	001/13294	W 7:00pm - 9:30pm 310 Fayerweather	Krzysztof Choromanski	3.00	46/60

Fall 2026: IEOR E4540

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4540	001/14710	W 7:10pm - 9:40pm 313 Fayerweather	Krzysztof Choromanski	3.00	70/70
IEOR 4540	V01/18120		Krzysztof Choromanski	3.00	0/99

IEOR E4544 Statistical Methods for Analytics. *3.00 points*.
Focus on advanced statistical techniques for a career in data science or business analytics. Covers the use of writing probabilistic models for data-generating processes, using Bayesian Methods/MCMC to solve such problems. Emphasizes problem identification and general problem-solving tools. Special Topics: Survival Analysis, Missing Data, Robust Statistics, Sequential Analysis, Multiple Testing. Assignments are case-based

IEOR E4561 LAUNCH YOUR STARTUP: TECH. *3.00 points*.
Tools and knowledge to develop a comprehensive new venture that is scalable, repeatable, and capital efficient. Covers customer discovery, market sizing, pricing, competition, distribution, funding, developing a minimal viable product, and other facets of creating new ventures. A company blueprint and final investor pitch are deliverables

IEOR E4562 Innovate Using Design Thinking. *3.00 points*.
How Design Thinking can enhance innovation activities, market impact, value creation, and speed. Topics include: conceptual and practical understanding of design thinking, creative solutions, develop robust practices to lead interdisciplinary teams. Course aims to strengthen individuals and collaborative capabilities to identify customer needs, indirect and qualitative research, create concept hypotheses, develop prototype, defined opportunities into actionable innovation possibilities, and recommendations for client organizations

IEOR E4563 Technology Breakthroughs. *1.50 point*.
Technological breakthroughs driven change, disruption, and transformation of the business landscape/society. Course covers overview of deep learning and neural networks; AI and robotics; imaging and vision; photonics; blockchain; smart/digital cities; and the application of these technologies for creating new products and services

IEOR E4564 Strategic Impact through Analytics. *1.50 point*.
Prerequisites: Prior knowledge in quantitative and analytical methods, such as operations research (e.g., optimization or stochastic processes), business analytics (e.g., data analysis or statistical modeling), or machine learning.
Explores how analytics and AI drive strategy, business models, and organizational transformation. Develops students as “analytics translators” who bridge technical models and business execution using leadership, communication, and change management alongside analytical expertise. Covers frameworks for value creation, organizational design, systems thinking, complexity, innovation, and behavioral barriers such as cognitive biases and resistance to change. Examines how firms integrate analytics into strategy and operations within evolving digital and knowledge-driven economies

Fall 2026: IEOR E4564

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4564	001/15332	F Sa 10:00am - 1:00pm 142 Uris Hall	Hardeep Johar	1.50	59/120

IEOR E4570 TOPICS IN OPERATIONS RESEARCH. *3.00 points*.
1.5 points

Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; or instructor's permission.
Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit. or Special topics arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit. Consult the department for section assignment

Spring 2026: IEOR E4570

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4570	001/13295	M W 4:10pm - 5:25pm 829 Seeley W. Mudd Building	Karl Sigman	3.00	2/40

Fall 2026: IEOR E4570

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4570	001/14775	Th 6:10pm - 8:40pm 833 Seeley W. Mudd Building	Robert Kramer, Devon Peticolas	3.00	101/100

IEOR E4571 TOPICS IN OPERATIONS RESEARCH. *3.00 points*.
Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission.
Special topics arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit. Consult the department for section assignment

Spring 2026: IEOR E4571

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4571	001/16808	F 3:00pm - 5:30pm 331 Uris Hall	Gary Kazantsev	3.00	10/50

Fall 2026: IEOR E4571

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4571	001/14711	W 1:10pm - 3:40pm 1024 Seeley W. Mudd Building	Khosrow Dehnad, Robert Kramer	3.00	42/50
IEOR 4571	V01/18121		Robert Kramer, Khosrow Dehnad	3.00	1/99

IEOR E4572 TOPICS IN OPERATIONS RESEARCH. *3.00 points*.
Lect: 3.,Points: 1.5

Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; or instructor's permission.
Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit

Fall 2026: IEOR E4572

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4572	001/14773	F 10:10am - 12:40pm 627 Seeley W. Mudd Building	Perry Beaumont, Robert Kramer	3.00	35/50

IEOR E4573 TOPICS IN OR. *1.50 point*.
Points: 1.5

Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission.
Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit

Spring 2026: IEOR E4573

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4573	001/17836	W 5:40pm - 8:10pm 601 Fairchild Life Sciences Bldg	Mahir Yavuz	1.50	11/55

Fall 2026: IEOR E4573

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4573	001/14772	M 7:00pm - 9:30pm 644 Seeley W. Mudd Building	Robert Kramer, Andi Cupallari	1.50	13/45

IEOR E4574 TOPICS IN OR. *3.00 points*.
Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission.
Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit

Spring 2026: IEOR E4574

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4574	001/13297	T Th 11:40am - 12:55pm 702 Hamilton Hall	Fabrizio Lecci	3.00	60/60

IEOR E4575 TOPICS IN OPERATIONS RESEARCH. *1.50 point*.
Note to students: 1.5 credits

Prerequisites: IEOR E4004IEOR E4106IEOR E4150 or instructor's permission. Probability and statistics, Basic optimization (e.g., familiarity with linear and convex optimization, gradient descent, basic algorithm design constructs), familiarity with Programming in python (or experience with programming in other languages like C/C++/Matlab and willingness to learn python). Knowledge of machine learning is not required, but some basic familiarity may help.
This course introduces engineering undergraduates to the essential concepts, tools, and skills required to create and manage a successful technology-driven business. Students will learn through a mix of lectures, case studies, assignments, and a final business plan project, guided by a professor with an engineering background and over three decades of real-world startup experience. Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit

Spring 2026: IEOR E4575

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4575	001/13298	M 1:10pm - 3:40pm 331 Uris Hall	Grace Lin	1.50	33/45

IEOR E4576 TOPICS IN OPERATIONS RESEARCH. *3.00 points*.
1.5 pts

Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission.
Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit. or Special topics arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit. Consult the department for section assignment

Spring 2026: IEOR E4576

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4576	001/13299	M 7:00pm - 9:30pm 516 Hamilton Hall	Devon Peticolas	3.00	50/45

Fall 2026: IEOR E4576

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4576	001/14712	M 7:10pm - 9:40pm 627 Seeley W. Mudd Building	Charles Pehlivanian	3.00	15/52

IEOR E4577 TOPICS IN OPERATIONS RESEARCH. *1.50 point*.
Points: 1.5

Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission
Special topics arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit. Consult the department for section assignment

Spring 2026: IEOR E4577

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4577	001/13300	F 1:00pm - 4:00pm 326 Uris Hall	Casandra Campbell	1.50	8/50

Fall 2026: IEOR E4577

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4577	001/14713	M 7:10pm - 9:40pm 303 Uris Hall	Amit Arora	1.50	27/60
IEOR 4577	002/14820	Th 5:25pm - 7:55pm 633 Seeley W. Mudd Building	Robert Kramer, Mahir Yavuz	1.50	65/60
IEOR 4577	003/14821	W 1:10pm - 3:40pm 616 Martin Luther King Building	Hugh Thomas	1.50	5/50
IEOR 4577	004/14822	T Th 1:10pm - 2:25pm 614 Schermerhorn Hall	Hugh Thomas, Robert Kramer	1.50	37/50
IEOR 4577	005/14853	Sa 11:00am - 1:30pm 633 Seeley W. Mudd Building	Ciro Greco, Robert Kramer	1.50	57/55
IEOR 4577	006/14854	F 1:00pm - 4:00pm 633 Seeley W. Mudd Building	Casandra Campbell, Robert Kramer	1.50	18/60
IEOR 4577	007/15329	M 7:00pm - 9:30pm 616 Martin Luther King Building	Kenneth Goodman	1.50	2/50
IEOR 4577	008/15412	T 6:10pm - 8:40pm 331 Uris Hall	Owen Davis	1.50	11/50

IEOR E4578 TOPICS IN OPERATION RESEARCH. *1.50 point*.
Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission.
Each offering of this course is devoted to a particular sector of Operations Research and its contemporary research, practice, and approaches. If topics are different, then course can be taken more than once for credit. or Special topics arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit. Consult the department for section assignment

Spring 2026: IEOR E4578

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4578	001/11557	Th 7:00pm - 9:30pm 702 Hamilton Hall	Syed Haider	1.50	42/80

IEOR E4579 TOPICS IN OR. *3.00 points*.
Prerequisites: IEOR E4004 AND IEOR E4106 AND IEOR E4150; IEOR E4150, IEOR E4004, and IEOR E4106, or instructor's permission.
Special topics arranged as the need and availability arises. Topics are usually offered on a one-time basis. Since the content of this course changes each time it is offered, it may be repeated for credit. Consult the department for section assignment

Spring 2026: IEOR E4579

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4579	001/13301	T 5:40pm - 8:10pm 413 Kent Hall	Gary Kazantsev	3.00	55/70

IEOR E4599 MSBA Quantitative Bootcamp. *0.00 points*.
Primer on quantitative and mathematical concepts. Required for all incoming MSBA students

Fall 2026: IEOR E4599

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4599	001/14717		Michael Miller	0.00	204/250

IEOR E4601 DYNAMIC PRICING/REVENUE MGMT. *3.00 points*.
Lect: 3.

Prerequisites: (STAT GU4001) and (IEOR E4004) IEOR E4004 AND STAT W4001
Focus on capacity allocation, dynamic pricing and revenue management. Perishable and/or limited product and pricing implications. Applications to various industries including service, airlines, hotel, resource rentals, etc

Spring 2026: IEOR E4601

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4601	001/13302	M W 11:40am - 12:55pm 415 Schapiro Cepser	Vineet Goyal	3.00	27/30

IEOR E4602 QUANTITATIVE RISK MANAGEMENT. *3.00 points*.
Lect: 3.

Prerequisites: (STAT GU4001) and (IEOR E4106) IEOR E4106 AND STAT W4001
Risk management models and tools; measure risk using statistical and stochastic methods, hedging and diversification. Examples include insurance risk, financial risk, and operational risk. Topics covered include VaR, estimating rare events, extreme value analysis, time series estimation of extremal events; axioms of risk measures, hedging using financial options, credit risk modeling, and various insurance risk models

Fall 2026: IEOR E4602

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4602	001/14718	M W 11:40am - 12:55pm 1127 Seeley W. Mudd Building	Agostino Capponi	3.00	60/60
IEOR 4602	V01/18122		Agostino Capponi	3.00	0/99

IEOR E4620 PRICING MODELS FOR FIN ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4700) IEOR E4700
Required for undergraduate students majoring in OR:FE. Characteristics of commodities or credit derivatives. Case study and pricing of structures and products. Topics covered include swaps, credit derivatives, single tranche CDO, hedging, convertible arbitrage, FX, leverage leases, debt markets, and commodities

Fall 2026: IEOR E4620

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4620	001/14719	T 4:10pm - 6:40pm 633 Seeley W. Mudd Building	Michael Miller	3.00	47/70
IEOR 4620	V01/18123		Michael Miller	3.00	2/99

IEOR E4630 ASSET ALLOCATION. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4700) IEOR E4700
Models for pricing and hedging equity, fixed-income, credit-derivative securities, standard tools for hedging and risk management, models and theoretical foundations for pricing equity options (standard European, American equity options, Asian options), standard Black-Scholes model (with multiasset extension), asset allocation, portfolio optimization, investments over longtime horizons, and pricing of fixed-income derivatives (Ho-Lee, Black-Derman-Toy, Heath-Jarrow-Morton interest rate model)

Spring 2026: IEOR E4630

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4630	001/16977	T 2:40pm - 5:10pm 303 Seeley W. Mudd Building	Christopher Perez	3.00	53/60

IEOR E4650 BUSINESS ANALYTICS. *3.00 points*.
Prerequisites: A solid background in probability and statistics is strongly encouraged. An optimization background is also strongly encouraged and may be obtained concurrently. Prior coding experience is encouraged. This course focuses on how to identify, evaluate, and capture business analytic opportunities that create value. The course covers basic analytic methods alongside case studies on organizations that successfully deployed these techniques. The first part of the course is on using data to develop insights and predictive capabilities with machine learning techniques. The second part focuses on the use of A/B testing, causal inference, ethics, and optimization to support decision-making

Spring 2026: IEOR E4650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4650	001/13303	T Th 2:40pm - 3:55pm 833 Seeley W. Mudd Building	Uday Menon	3.00	40/86

Fall 2026: IEOR E4650

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4650	001/14720	T Th 11:30am - 12:45pm 303 Seeley W. Mudd Building	Uday Menon	3.00	55/73
IEOR 4650	V01/18124		Uday Menon	3.00	1/99

IEOR E4700 INTRO TO FINANCIAL ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E3106) or (IEOR E4106)
Prerequisite(s): IEOR E4106 or E3106. Required for undergraduate students majoring in OR:FE. Introduction to investment and financial instruments via portfolio theory and derivative securities, using basic operations research/engineering methodology. Portfolio theory, arbitrage; Markowitz model, market equilibrium, and the capital asset pricing model. General models for asset price fluctuations in discrete and continuous time. Elementary introduction to Brownian motion and geometric Brownian motion. Option theory; Black-Scholes equation and call option formula. Computational methods such as Monte Carlo simulation.

Spring 2026: IEOR E4700

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4700	001/13304	M W 11:40am - 12:55pm 614 Schermerhorn Hall	Anran Hu	3.00	95/100
IEOR 4700	V01/16661		Anran Hu	3.00	3/99

Fall 2026: IEOR E4700

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4700	001/14721	M W 1:10pm - 2:25pm 209 Havemeyer Hall	Xunyu Zhou	3.00	47/100
IEOR 4700	V01/18125		Xunyu Zhou	3.00	0/99

IEOR E4701 STOCHASTIC MODELS FOR FIN ENG. *3.00 points*.
Lect: 3.

Prerequisites: (STAT GU4001) STAT W4001
This graduate course is only for M.S. Program in Financial Engineering students, offered during the summer session. Review of elements of probability theory, Poisson processes, exponential distribution, renewal theory, Wald's equation. Introduction to discrete-time Markov chains and applications to queueing theory, inventory models, branching processes

Fall 2026: IEOR E4701

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4701	001/14722	M W 8:40am - 9:55am 428 Pupin Laboratories	David Yao	3.00	90/140

IEOR E4703 MONTE CARLO SIMULATION METHODS. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4701) IEOR E4701
This graduate course is only for M.S. Program in Financial Engineering students. Multivariate random number generation, bootstrapping, Monte Carlo simulation, efficiency improvement techniques. Simulation output analysis, Markov-chain Monte Carlo. Applications to financial engineering. Introduction to financial engineering simulation software and exposure to modeling with real financial data. Note: Students who have taken IEOR E4404 Simulation may not register for this course for credit

Spring 2026: IEOR E4703

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4703	001/13305	T Th 8:40am - 9:55am 501 Schermerhorn Hall	Ali Hirsa	3.00	154/160

IEOR E4704 Foundations of Financial Technology. *3.00 points*.
Prerequisites: Students should have a good background in calculus, probability and linear algebra. Some basic prior knowledge on finance will be helpful (but not necessary).
Introduces emerging area of Financial Technology (FinTech) within decentralized finance (DeFi) and blockchains. Topics: blockchain fundamentals: major (permissionless) blockchain protocols, permissioned blockchains, and their applications; DeFi fundamentals: Layer-2 primitives (AMMs, lending, liquidity staking, MEV, etc) and stablecoins; markets and trading: market microstructure and on-chain data analytics; and emerging applications: institutional DeFi, real-world asset tokenizations (RWAs), and AI integration. Emphasis on both mathematical foundations and empirical designs.

Spring 2026: IEOR E4704

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4704	001/16948	T Th 4:10pm - 5:25pm 602 Hamilton Hall	Wenpin Tang	3.00	42/50

IEOR E4706 FOUNDATIONS FR FINANCIAL ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4701) and (IEOR E4702) and Linear algebra
Corequisites: IEOR E4709
This graduate course is only for M.S. Program in Financial Engineering students, offered during the summer session. Discrete-time models of equity, bond, credit, and foreign-exchange markets. Introduction to derivative markets. Pricing and hedging of derivative securities. Complete and incomplete markets. Introduction to portfolio optimization and the capital asset pricing model.

Fall 2026: IEOR E4706

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4706	001/14723	T Th 11:40am - 12:55pm 428 Pupin Laboratories	Wenpin Tang	3.00	90/140

IEOR E4707 FE CONTINUOUS TIME MODELS. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4701)
Corequisites: IEOR E4709
This graduate course is only for MS program in FE students. Modeling, analysis, and computation of derivative securities. Applications of stochastic calculus and stochastic differential equations. Numerical techniques: finite-difference, binomial method, and Monte Carlo.

Spring 2026: IEOR E4707

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4707	001/13306	M W 2:40pm - 3:55pm 301 Uris Hall	Xunyu Zhou	3.00	152/160
IEOR 4707	V01/19646		Xunyu Zhou	3.00	2/99

IEOR E4709 STATISTICAL ANALYSIS AND TIME SERIES. *3.00 points*.
Lect: 3.

Prerequisites: IEOR E4702 Probability
Corequisites: IEOR E4706,IEOR E4707
This graduate course is only for M.S. Program in Financial Engineering students. Empirical analysis of asset prices: heavy tails, test of the predictability of stock returns. Financial time series: ARMA, stochastic volatility, and GARCH models. Regression models: linear regression and test of CAPM, non-linear regression and fitting of term structures.

Spring 2026: IEOR E4709

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4709	001/13307	M W 11:40am - 12:55pm 501 Schermerhorn Hall	Agostino Capponi	3.00	153/163

IEOR E4711 GLOBAL CAPITAL MARKETS. *3.00 points*.
Prerequisites: Refer to course syllabus.
An introduction to capital markets and investments providing an overview of financial markets and tools for asset valuation. Topics covered include the pricing of fixed-income securities (treasury markets, interest rate swaps futures, etc.), discussions on topics in credit, foreign exchange, sovereign ad securitized markets—private equity and hedge funds, etc

Fall 2026: IEOR E4711

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4711	001/14724	M 6:00pm - 8:30pm 326 Uris Hall	Siddhartha Ghosh Dastidar	3.00	69/70

IEOR E4718 INTRO-IMPLIED VOLATILITY SMILE. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4706) and IEOR E4706; Knowledge of derivatives valuation models.
During the past 15 years the behavior of market options prices have shown systematic deviations from the classic Black-Scholes model. Examines the empirical behavior of implied volatilities, in particular the volatility smile that now characterizes most markets, the mathematics and intuition behind new models that can account for the smile, and their consequences for hedging and valuation

Spring 2026: IEOR E4718

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4718	001/13308	Th 7:00pm - 9:30pm 313 Fayerweather	Amal Moussa	3.00	78/80

IEOR E4720 TOPICS IN QUANT FINANCE. *3.00 points*.
Prerequisites: (IEOR E4700) and IEOR E4700; Additional prerequisites will be announced depending on offering
Selected topics of interest in the area of quantitative finance. Offerings vary each year; some topics include energy derivatives, experimental finance, foreign exchange and related derivative instruments, inflation derivatives, hedge fund management, modeling equity derivatives in Java, mortgage-backed securities, numerical solutions of partial differential equations, quantitative portfolio management, risk management, trade and technology in financial markets

IEOR E4721 TOPICS IN QUANT FINANCE. *1.50 point*.
Prerequisites: IEOR E4700; Additional prerequisites will be announced depending on offering
This graduate-level course provides a rigorous foundation in quantitative portfolio construction, bridging theory with practical implementation. It develops a systematic framework for constructing optimal portfolios, beginning with the classical Markowitz model and enhancing it to address real-world portfolio objectives and constraints. Students learn how forecasts of asset returns, risk, and market impact are formulated in the optimizer objectives and constraints, and how estimation error affects portfolio construction and performance. They also study the robust estimation of key optimizer inputs such as risk models using modern statistical and econometric methods that handle noise and time-varying dynamics. Students gain hands-on experience constructing portfolios using industry-standard datasets, tools, and risk models. The course also provides a brief introduction to advanced topics such as random matrix theory, multiperiod optimization, and the use of modern machine learning methods, which represent emerging directions in quantitative portfolio research

Spring 2026: IEOR E4721

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4721	001/13309	W 4:10pm - 6:40pm 633 Seeley W. Mudd Building	Sridhar Gollamudi	1.50	22/50

IEOR E4722 TOPICS IN QUANT FINANCE. *3.00 points*.
Prerequisites: IEOR E4700 Additional prerequisites announced depending on offering.
Stochastic control has broad applications in almost every walk of life, including finance, revenue management, energy, health care and robotics. Classical, model-based stochastic control theory assumes that the system dynamics and reward functions are known and given, whereas modern, model-free stochastic control problems call for reinforcement learning to learn optimal policies in an unknown environment. This course covers model-based stochastic control and model-free reinforcement learning, both in continuous time with continuous state space and possibly continuous control (action) space. It includes the following topics: Shortest path problem, calculus of variations and optimal control; formulation of stochastic control; maximum principle and backward stochastic differential equations; dynamic programming and Hamilton-Jacobi-Bellman (HJB) equation; linear-quadratic control and Riccati equations; applications in high-frequency trading; exploration versus exploitation in reinforcement learning; policy evaluation and martingale characterization; policy gradient; q-learning; applications in diffusion models for generative AI.

IEOR E4723 TOPICS IN QUANTATIVE FINANCE. *1.50 point*.
Course Points: 1.5

Prerequisites: IEOR E4700; Additional Prerequisites will be announced depending on offering
The course examines how large language models are transforming investment management practice. It opens with a grounding in core AI techniques (prompting strategies, Retrieval-Augmented Generation, and agentic frameworks) before mapping these onto institutional investment and wealth management workflows. The bulk of the course explores specific applications: extracting and monitoring risk factors from equity data and unstructured text using AI, building real-time news monitoring systems that score sentiment and flag portfolio-relevant events, and using LLMs to generate stress-test scenarios. Later sessions cover multi-agent systems for automated research and trading, including agent roles, guardrails, and human oversight, and how these techniques can enhance classical portfolio construction methods (risk parity, mean-variance optimization, Black-Litterman). The course includes guest lectures by industry practitioners discussing the industry's AI adoption trends

Fall 2026: IEOR E4723

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4723	001/14771	T 7:10pm - 9:40pm 627 Seeley W. Mudd Building	Cyril Shmatov	1.50	47/50

IEOR E4724 TOPICS IN QUANTATIVE FINANCE. *3.00 points*.
Prerequisites: IEOR E4700; Additional prerequisites will be announced depending on offering
In this course, we will cover the basics of mathematical modeling of interest rates and credit derivatives. In the first part, we will cover basic interest rate derivatives, the Heath-Jarrow-Morton (HJM) framework, classic short rate models (for both interest rates and default intensities), and the numerical techniques used in practice for their calibration. In the second part, we will cover the basics of single-name derivatives modeling, and we will discuss pricing simple credit derivatives. We will also discuss correlation products and the most common techniques used for their pricing. In the third part, we will discuss some recent research papers addressing the use of adjoint algorithmic differentiation for the calculation of risk for interest rate and credit derivatives

IEOR E4725 Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation. *3 points*.
Lect: 3.

Prerequisites: (IEOR E4700) Additional Prerequisites will be announced depending on offering
Networks are ubiquitous in our modern society. Economic and social networks have been used extensively to model a variety of situations, in which individual decision-makers are affected by the choices of their peers in the network. This course will introduce the main mathematical models for the study of these networks. It will discuss game theoretical and dynamic optimization techniques, which can be used to analyze a wide variety of these networks, including their resilience to shocks, the diffusion of information leading to social contagion, and how the strategic behavior of agents shapes the performance of the network

IEOR E4728 TOPICS IN QUANTITATIVE FINANCE. *1.50 point*.
Prerequisites: IEOR E4700; Additional prerequisites will be announced depending on offering
The search for better performance has led investors to explore Alternative Investments that are outside the traditional categories of exchange traded equities, Treasury Bonds, and other investment-grade fixed income products. The field of Alternative Investments covers a wide range of products such as convertible bonds, Preferred Shares, Hedge Funds, Venture Capital, and Cryptocurrencies. There is a growing need in the market for students with knowledge of these products and the practical and theoretical know how of valuing and risk managing these investments given that each product has it own nuances and anomalies. This course presents and studies some major Alternative Investment products and ways to evaluate and risk manage them

Spring 2026: IEOR E4728

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4728	001/16950	T 1:10pm - 3:40pm 413 Kent Hall	Khosrow Dehnad	1.50	11/50

Fall 2026: IEOR E4728

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4728	001/14725	Th 1:10pm - 3:40pm 616 Martin Luther King Building	Khosrow Dehnad	1.50	50/50

IEOR E4729 TOPICS IN QUANTATIVE FINANCE. *1.50 point*.
NOTE: If you have previously completed IEOR 4733 Algorithmic Trading or IEOR 4729 Model Based Trading, please note that while this version of 4729 has many new elements, it materially overlaps with these two classes and is intended to replace both.

Prerequisites: IEOR E4700 Additional prerequisites will be announced depending on offering.
Selected topics of interest in the area of quantitative finance. Offerings vary each year; some topics include energy derivatives, experimental finance, foreign exchange and related derivative instruments, inflation derivatives, hedge fund management, modeling equity derivatives in Java, mortgage-backed securities, numerical solutions of partial differential equations, quantitative portfolio management, risk management, trade and technology in financial markets.

IEOR E4731 CREDIT RISK/CREDIT DERIVATIVES. *3.00 points*.
Lect: 3.

Prerequisites: (IEOR E4701) and (IEOR E4707) IEOR E4701 AND IEOR E4707
Introduction to quantitative modeling of credit risk, with a focus on the pricing of credit derivatives. Focus on the pricing of single-name credit derivatives (credit default swaps) and collateralized debt obligations (CDOs). Detail topics include default and credit risk, multiname default barrier models and multiname reduced form models

IEOR E4732 COMPUT METHODS IN FINANCE. *3.00 points*.
Prerequisites: (IEOR E4700) IEOR E4700
MS IEOR students only. Application of various computational methods/techniques in quantitative/computational finance. Transform techniques: fast Fourier transform for data de-noising and pricing, finite difference methods for partial differential equations (PDE), partial integro-differential equations (PIDE), Monte-Carlo simulation techniques in finance, and calibration techniques, filtering and parameter estimation techniques. Computational platform will be C /Java/Python/Matlab/R

Spring 2026: IEOR E4732

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4732	001/13310	Th 7:10pm - 9:40pm 545 Seeley W. Mudd Building	Alireza Javaheri	3.00	23/40
IEOR 4732	V01/16662		Alireza Javaheri	3.00	2/99

IEOR E4733 ALGORITHMIC TRADING. *3.00 points*.
Prerequisites: IEOR E4700
Large and amorphous collection of subjects ranging from the study of market microstructure, to the analysis of optimal trading strategies, to the development of computerized, high-frequency trading strategies. Analysis of these subjects, the scientific and practical issues they involve, and the extensive body of academic literature they have spawned. Attempt to understand and uncover the economic and financial mechanisms that drive and ultimately relate them.

Spring 2026: IEOR E4733

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4733	001/16978	T 7:00pm - 9:30pm 833 Seeley W. Mudd Building	Charles Pehlivanian	3.00	86/100
IEOR 4733	V01/19981		Charles Pehlivanian	3.00	3/99

IEOR E4734 FOR EXCH/RELATD DERIVATVS INST. *1.50 point*.
1.5.

Prerequisites: (IEOR E4700) IEOR E4700
Foreign exchange market and its related derivative instruments—the latter being forward contracts, futures, options, and exotic options. What is unusual about foreign exchange is that although it can rightfully claim to be the largest of all financial markets, it remains an area where very few have any meaningful experience. Virtually everyone has traded stocks, bonds, and mutual funds. Comparatively few individuals have ever traded foreign exchange. In part that is because foreign exchange is an interbank market. Ironically the foreign exchange markets may be the best place to trade derivatives and to invent new derivatives—given the massive two-way flow of trading that goes through bank dealing rooms virtually 24 hours a day. And most of that is transacted at razor-thin margins, at least comparatively speaking, a fact that makes the foreign exchange market an ideal platform for derivatives. The emphasis is on familiarizing the student with the nature of the foreign exchange market and those factors that make it special among financial markets, enabling the student to gain a deeper understanding of the related market for derivatives on foreign exchange

Fall 2026: IEOR E4734

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4734	001/14726	T 7:10pm - 9:40pm 330 Uris Hall	David DeRosa	1.50	60/60

IEOR E4735 STRUCTURED#HYBRID PRODUCTS. *3.00 points*.
Prerequisites: Recommended: IEOR E4700
Conceptual and practical understanding of structured and hybrid products from the standpoint of relevant risk factors, design goals and characteristics, pricing, hedging, and risk management. Detailed analysis of the underlying cash-flows, embedded derivative instruments, and various structural features of these transactions, both from the investor and issuer perspectives, and analysis of the impact of the prevailing market conditions and parameters on their pricing and risk characteristics. Numerical methods for valuing and managing risk of structured/hybrid products and their embedded derivatives and their application to equity, interest rates, commodities and currencies, inflation, and credit-related products. Conceptual and mathematical principles underlying these techniques, and practical issues that arise in their implementations in Python and other programming environments. Special contractual provisions encountered in structured and hybrid transactions, and incorporation of yield curves, volatility smile, and other features of the underlying processes into pricing and implementation framework for these products

Fall 2026: IEOR E4735

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4735	001/14727	Th 7:10pm - 9:40pm 329 Pupin Laboratories	Alireza Javaheri	3.00	100/100
IEOR 4735	V01/18126		Alireza Javaheri	3.00	0/99

IEOR E4737 AI Applications in Finance. *3.00 points*.
Prerequisites: Proficiency in Python & Tensor, good understanding of calculus, knowledge of linear/matrix algebra, and basic knowledge of statistics
Data, models, visuals; various facets of AI, applications in finance; areas: fund, manager, security selection, asset allocation, risk management within asset management; fraud detection and prevention; climate finance and risk; data-driven real estate finance; cutting-edge techniques: machine learning, deep learning in computational, quantitative finance; concepts: explainability, interpretability, adversarial machine learning, resilience of AI systems; industry utilization

Spring 2026: IEOR E4737

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4737	001/13311	F Sa 9:00am - 5:00pm 207 Mathematics Building	Ali Hirsa	3.00	93/88

Summer 2026: IEOR E4737

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4737	001/11141	T W Th F 9:00am - 5:00pm 428 Pupin Laboratories	Ali Hirsa	3.00	68/80
IEOR 4737	V01/11876		Ali Hirsa	3.00	6/99

IEOR E4741 Programming for Financial Engineering. *3.00 points*.
Covers C programming language, applications, and features for financial engineering, and quantitative finance applications. Note: restricted to IEOR MS FE students only

Fall 2026: IEOR E4741

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4741	001/14728	W 7:10pm - 9:40pm 633 Seeley W. Mudd Building	Sebastien Donadio	3.00	60/60

IEOR E4742 Deep Learning for OR and FE. *3.00 points*.
Selected topics of interest in area of quantitative finance. Some topics include energy derivatives, experimental finance, foreign exchange and related derivative instruments, inflation derivatives, hedge fund management, modeling equity derivatives in Java, mortgage-backed securities, numerical solutions of partial differential equations, quantitative portfolio management, risk management, trade and technology in financial markets. Note: open to IEOR students only

Fall 2026: IEOR E4742

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4742	001/14729	F Sa 9:00am - 6:00pm 428 Pupin Laboratories	Ali Hirsa	3.00	128/130

IEOR E4745 Applied Financial Risk Management. *3.00 points*.
Prerequisites: Probability and statistics, instruments of the financial markets, and asset pricing models

Prerequisites: see notes re: points probability and statistics, instruments of the financial markets, and asset pricing models.
Introduces risk management principles, practical implementation and applications, standard market, liquidity, and credit risk measurement techniques, and their drawbacks and limitations. Note: restricted to IEOR students only

Fall 2026: IEOR E4745

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4745	001/14730	T 7:00pm - 9:00pm 614 Schermerhorn Hall	Allan Malz	3.00	110/110
IEOR 4745	V01/18127		Allan Malz	3.00	0/99

IEOR E4798 Financial Engineering Practitioners Seminar Series. *0.00 points*.
Prerequisites: First year MSFE Students
Degree requirement for all MSFE first-year students. Topics in Financial Engineering. Past seminar topics include Evolving Financial Intermediation, Measuring and Using Trading Algorithms Effectively, Path-Dependent Volatility, Artificial Intelligence and Data Science in modern financial decision making, Risk-Based Performance Attribution, and Financial Machine Learning. Meets select Monday evenings

Spring 2026: IEOR E4798

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4798	001/13312	M 7:00pm - 9:00pm 501 Schermerhorn Hall	Ali Hirsa, Jiaqi Li, Jean Flick, Samantha Sudol	0.00	0/158

Fall 2026: IEOR E4798

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4798	001/14731	M 7:00pm - 9:00pm 501 Northwest Corner	Ali Hirsa	0.00	98/140

IEOR E4797 Summer Seminar on IEOR Topics. *0.00 points*.
Prerequisites: Permission of the instructor
This seminar series exposes IEOR students to emerging research areas, applications, and interdisciplinary methods shaping the field of IEOR today. Students will engage with topics such as financial engineering, machine learning, artificial intelligence, reinforcement learning, operations analytics, and other advanced techniques. Content varies each year based on faculty expertise and emerging trends. The course encourages discussion, critical reading of recent literature, and hands-on exploration of modern methods.

IEOR E4799 MSFE Quantitative and Computational Bootcamp. *0.00 points*.

Primer on quantitative and mathematical concepts. Required of all incoming MSFE students

Fall 2026: IEOR E4799

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4799	001/16322		Ali Hirsa, Sebastien Donadio, Michael Miller	0.00	99/140

IEOR E4900 MASTERS RESEARCH OR PROJECT. *1.00-3.00 points*.

Prerequisites: *approval by a faculty member who agrees to supervise the work.*

Prerequisite(s): Approval by a faculty member who agrees to supervise the work. Independent work involving experiments, computer programming, analytical investigation, or engineering design

Spring 2026: IEOR E4900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4900	001/13560		Anish Agarwal	1.00-3.00	0/40
IEOR 4900	002/13561		Shipra Agrawal	1.00-3.00	0/40
IEOR 4900	003/13562		Eric Balkanski	1.00-3.00	0/40
IEOR 4900	004/13563		Daniel Bienstock	1.00-3.00	0/40
IEOR 4900	005/13564		Agostino Capponi	1.00-3.00	0/40
IEOR 4900	006/13565		Rachel Cummings	1.00-3.00	0/40
IEOR 4900	007/13566		Antonius Dieker	1.00-3.00	0/40
IEOR 4900	008/13567		Adam Elmachtoub	1.00-3.00	0/40
IEOR 4900	009/13568		Yuri Faenza	1.00-3.00	0/40
IEOR 4900	010/13569		Vineet Goyal	1.00-3.00	0/40
IEOR 4900	011/13570		Ali Hirsa	1.00-3.00	4/40
IEOR 4900	012/13571		Anran Hu	1.00-3.00	0/40
IEOR 4900	013/13572		Garud Iyengar	1.00-3.00	0/40
IEOR 4900	014/13573		Hardeep Johar	1.00-3.00	0/40
IEOR 4900	015/13574		Cedric Josz	1.00-3.00	0/40
IEOR 4900	016/13575		Soulaymane Kachani	1.00-3.00	0/40
IEOR 4900	017/13576		Yaren Kaya	1.00-3.00	0/40
IEOR 4900	018/13577		Christian Kroer	1.00-3.00	0/40
IEOR 4900	019/13578		Daniel Lacker	1.00-3.00	0/40
IEOR 4900	020/13579		Henry Lam	1.00-3.00	0/40
IEOR 4900	021/13580		Fabrizio Lecci	1.00-3.00	0/40
IEOR 4900	022/13581		Tianyi Lin	1.00-3.00	0/40
IEOR 4900	023/13582		Uday Menon	1.00-3.00	0/40
IEOR 4900	024/13583		Bento Natura	1.00-3.00	0/40
IEOR 4900	025/13584		Jay Sethuraman	1.00-3.00	0/40
IEOR 4900	026/13585		Karl Sigman	1.00-3.00	0/40
IEOR 4900	027/13586		Eric Stratman	1.00-3.00	0/40
IEOR 4900	028/13587		Clifford Stein	1.00-3.00	0/40
IEOR 4900	029/13588		Wenpin Tang	1.00-3.00	0/40
IEOR 4900	030/13589		Kaizheng Wang	1.00-3.00	0/40
IEOR 4900	031/13590		Lily Xu	1.00-3.00	0/40
IEOR 4900	032/13591		David Yao	1.00-3.00	0/40
IEOR 4900	033/13592		Yi Zhang	1.00-3.00	0/20
IEOR 4900	034/13593		Xunyu Zhou	1.00-3.00	0/20
IEOR 4900	035/13594		Christine Chan	1.00-3.00	0/20
IEOR 4900	036/13595		Chris Lee	1.00-3.00	0/20

Summer 2026: IEOR E4900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4900	001/12066		Anish Agarwal	1.00-3.00	0/40
IEOR 4900	002/12067		Shipra Agrawal	1.00-3.00	0/40
IEOR 4900	003/12068		Eric Balkanski	1.00-3.00	0/40
IEOR 4900	004/12069		Daniel Bienstock	1.00-3.00	0/40
IEOR 4900	005/12070		Agostino Capponi	1.00-3.00	0/40
IEOR 4900	006/12071		Rachel Cummings	1.00-3.00	0/40
IEOR 4900	007/12072		Antonius Dieker	1.00-3.00	0/40
IEOR 4900	008/12073		Adam Elmachtoub	1.00-3.00	0/40
IEOR 4900	009/12074		Yuri Faenza	1.00-3.00	0/40
IEOR 4900	010/12075		Vineet Goyal	1.00-3.00	0/40

IEOR E4998 MANAG TECH INNOV # ENTREPRENEURSHIP. *3.00 points*.
Lect: 3.

A required course for undergraduate students majoring in OR:EMS. Focus on the management and consequences of technology-based innovation. Explores how new industries are created, how existing industries can be transformed by new technologies, the linkages between technological development and the creation of wealth and the management challenges of pursuing strategic innovation

Spring 2026: IEOR E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4998	001/13313	M 7:00pm - 9:30pm 313 Fayerweather	Brandon Procak	3.00	46/45

IEOR E4999 FIELDWORK. *1.00-1.50 points*.
Prerequisites: Obtained internship and approval from faculty adviser. Only for IEOR graduate students who need relevant work experience as part of their program of study. Final reports required. May not be taken for pass/fail credit or audited

Spring 2026: IEOR E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4999	001/13323		Ali Hirsa, Jiaqi Li, Richelle Roy, Samantha Sudol	1.00-1.50	2/150
IEOR 4999	002/13324		Hardeep Johar, Jiaqi Li, Richelle Roy, Samantha Sudol	1.00-1.50	9/150
IEOR 4999	003/13325		Jiaqi Li, Fabrizio Lecci, Richelle Roy, Samantha Sudol	1.00-1.50	4/150

Summer 2026: IEOR E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4999	001/11144		Samantha Sudol, Richelle Roy, Jiaqi Li, Ali Hirsa	1.00-1.50	46/600
IEOR 4999	002/11145		Samantha Sudol, Richelle Roy, Jiaqi Li, Hardeep Johar	1.00-1.50	119/600
IEOR 4999	003/11146		Samantha Sudol, Richelle Roy, Kelly Katsigris, Fabrizio Lecci	1.00-1.50	49/600

Fall 2026: IEOR E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 4999	001/14733		Ali Hirsa	1.00-1.50	1/300
IEOR 4999	002/14734		Hardeep Johar	1.00-1.50	26/300
IEOR 4999	003/14748		Jiaqi Li, Fabrizio Lecci, Kelly Katsigris, Richelle Roy, Samantha Sudol	1.00-1.50	9/300

IEOR E6608 INTEGER PROGRAMMING. *3.00 points*.
N/A

IEOR E6613 Optimization, I. *4.5 points*.
Prerequisites: Linear algebra
Theory and geometry of linear programming. The simplex method. Duality theory, sensitivity analysis, column generation and decomposition. Interior point methods. Introduction to nonlinear optimization: convexity, optimality conditions, steepest descent and Newton's method, active set and barrier methods.

Fall 2026: IEOR E6613

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 6613	001/14735	T Th 10:10am - 11:25am 327 Seeley W. Mudd Building	Vineet Goyal	4.5	4/35

IEOR E6614 OPTIMIZATION II. *4.50 points*.
Lect: 3.

Prerequisites: Linear algebra
An introduction to combinatorial optimization, network flows and discrete algorithms. Shortest path problems, maximum flow problems. Matching problems, bipartite and cardinality nonbipartite. Introduction to discrete algorithms and complexity theory: NP-completeness and approximation algorithms

Spring 2026: IEOR E6614

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 6614	001/13314	T Th 10:10am - 11:25am 825 Seeley W. Mudd Building	Clifford Stein	4.50	16/40

IEOR E6617 Machine Learning and High-Dimensional Data Analysis in Operations Research. *3.00 points*.
Discusses recent advances in fields of machine learning: kernel methods, neural networks (various generative adversarial net architectures), and reinforcement learning (with applications in robotics). Quasi Monte Carlo methods in the context of approximating RBF kernels via orthogonal transforms (instances of the structured technique). Will discuss techniques such as TD(0), TD(λ), LSTDQ, LSPI, DQN

Fall 2026: IEOR E6617

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 6617	001/14736	M 7:10pm - 9:40pm 524 Seeley W. Mudd Building	Krzysztof Choromanski	3.00	25/30
IEOR 6617	V01/18128		Krzysztof Choromanski	3.00	5/99

IEOR E6711 STOCHASTIC MODELING I. *4.50 points*.
Prerequisites: (STAT GU4001) or STAT W4001; STAT GU4001 or equivalent.
Advanced treatment of stochastic modeling in the context of queueing, reliability, manufacturing, insurance risk, financial engineering and other engineering applications. Review of elements of probability theory; exponential distribution; renewal theory; Wald’s equation; Poisson processes. Introduction to both discrete and continuous-time Markov chains; introduction to Brownian motion

Fall 2026: IEOR E6711

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 6711	001/14737	M W 2:40pm - 3:55pm 415 Schapiro Cepser	Henry Lam	4.50	12/40

IEOR E6712 STOCHASTIC MODELING II. *4.50 points*.
Prerequisites: (IEOR E6711) or equivalent.
Continuation of IEOR E6711, covering further topics in stochastic modeling in the context of queueing, reliability, manufacturing, insurance risk, financial engineering, and other engineering applications. Topics from among generalized semi-Markov processes; processes with a non-discrete state space; point processes; stochastic comparisons; martingales; introduction to stochastic calculus.

Spring 2026: IEOR E6712

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 6712	001/13315	T Th 2:40pm - 3:55pm 415 Schapiro Cepser	David Yao	4.50	19/30

IEOR E8100 ADVANCED TOPICS IN IEOR. *3.00 points*.
Prerequisites: Faculty adviser's permission.
Selected topics in IEOR. Content varies from year to year. May be repeated for credit

Spring 2026: IEOR E8100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 8100	001/13316	M W 11:40am - 12:55pm 327 Seeley W. Mudd Building	Lily Xu	3.00	9/26
IEOR 8100	002/13317	M W 2:40pm - 3:55pm 253 Engineering Terrace	Daniel Lacker	3.00	18/28
IEOR 8100	003/13318	T Th 4:10pm - 5:25pm 253 Engineering Terrace	Kaizheng Wang	3.00	22/25
IEOR 8100	004/13319	M W 10:10am - 11:25am 415 Schapiro Cepser	Vineet Goyal	3.00	8/20
IEOR 8100	005/13320	T Th 11:40am - 12:55pm 337 Seeley W. Mudd Building	Wenpin Tang	3.00	13/20
IEOR 8100	006/19647	Th 2:40pm - 5:10pm 233 Seeley W. Mudd Building	Rachel Cummings	3.00	4/20

Fall 2026: IEOR E8100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 8100	001/14738	T 2:40pm - 5:10pm 414 Schapiro Cepser	Xunyu Zhou	3.00	16/30
IEOR 8100	002/14739	T Th 2:40pm - 3:55pm 233 Seeley W. Mudd Building	Clifford Stein	3.00	8/30
IEOR 8100	003/14740	M W 10:10am - 11:25am 825 Seeley W. Mudd Building	Yuri Faenza	3.00	10/30
IEOR 8100	004/14741	T 10:10am - 11:25am 415 Schapiro Cepser	Jay Sethuraman	3.00	5/30

IEOR E9101 RESEARCH. *1.00-6.00 points*.
Before registering, the student must submit an outline of the proposed work for approval by the supervisor and the chair of the Department. Advanced study in a specialized field under the supervision of a member of the department staff. May be repeated for credit

Spring 2026: IEOR E9101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 9101	001/13596		Anish Agarwal	1.00-6.00	1/20
IEOR 9101	002/13597		Shipra Agrawal	1.00-6.00	0/20
IEOR 9101	003/13598		Eric Balkanski	1.00-6.00	1/20
IEOR 9101	004/13599		Daniel Bienstock	1.00-6.00	0/20
IEOR 9101	005/13600		Agostino Capponi	1.00-6.00	3/20
IEOR 9101	006/13601		Rachel Cummings	1.00-6.00	0/20
IEOR 9101	007/13602		Antonius Dieker	1.00-6.00	0/20
IEOR 9101	008/13603		Adam Elmachtoub	1.00-6.00	1/20
IEOR 9101	009/13604		Yuri Faenza	1.00-6.00	0/20
IEOR 9101	010/13605		Vineet Goyal	1.00-6.00	0/20
IEOR 9101	011/13606		Ali Hirsa	1.00-6.00	0/20
IEOR 9101	012/13607		Anran Hu	1.00-6.00	0/20
IEOR 9101	013/13608		Garud Iyengar	1.00-6.00	0/20
IEOR 9101	014/13609		Hardeep Johar	1.00-6.00	0/20
IEOR 9101	015/13610		Cedric Josz	1.00-6.00	0/20
IEOR 9101	016/13611		Soulaymane Kachani	1.00-6.00	0/20
IEOR 9101	017/13612		Yaren Kaya	1.00-6.00	0/20
IEOR 9101	018/13613		Christian Kroer	1.00-6.00	3/20
IEOR 9101	019/13614		Daniel Lacker	1.00-6.00	0/20
IEOR 9101	020/13615		Henry Lam	1.00-6.00	2/20
IEOR 9101	021/13616		Fabrizio Lecci	1.00-6.00	0/20
IEOR 9101	022/13617		Tianyi Lin	1.00-6.00	0/20
IEOR 9101	023/13618		Uday Menon	1.00-6.00	0/20
IEOR 9101	024/13619		Bento Natura	1.00-6.00	1/20
IEOR 9101	025/13620		Jay Sethuraman	1.00-6.00	0/20
IEOR 9101	026/13621		Karl Sigman	1.00-6.00	0/20
IEOR 9101	027/13622		Eric Stratman	1.00-6.00	0/20
IEOR 9101	028/13623		Clifford Stein	1.00-6.00	1/20
IEOR 9101	029/13624		Wenpin Tang	1.00-6.00	2/20
IEOR 9101	030/13625		Kaizheng Wang	1.00-6.00	1/20
IEOR 9101	031/13626		Lily Xu	1.00-6.00	2/20
IEOR 9101	032/13627		David Yao	1.00-6.00	0/20
IEOR 9101	033/13628		Yi Zhang	1.00-6.00	0/20
IEOR 9101	034/13629		Xunyu Zhou	1.00-6.00	1/20
IEOR 9101	035/13630		Christine Chan	1.00-6.00	0/20
IEOR 9101	036/13631		Winsor Yang	1.00-6.00	2/20

Summer 2026: IEOR E9101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEOR 9101	001/12030		Anish Agarwal	1.00-6.00	0/20
IEOR 9101	002/12031		Shipra Agrawal	1.00-6.00	0/20
IEOR 9101	003/12032		Eric Balkanski	1.00-6.00	0/20
IEOR 9101	004/12033		Daniel Bienstock	1.00-6.00	0/20
IEOR 9101	005/11953		Agostino Capponi	1.00-6.00	1/20
IEOR 9101	006/12034		Rachel Cummings	1.00-6.00	0/20
IEOR 9101	007/12035		Antonius Dieker	1.00-6.00	0/20
IEOR 9101	008/12036		Adam Elmachtoub	1.00-6.00	0/20
IEOR 9101	009/12037		Yuri Faenza	1.00-6.00	0/20
IEOR 9101	010/12038		Vineet Goyal	1.00-6.00	0/20
IEOR 9101	011/12039		Ali Hirsa	1.00-6.00	0/20

IEOR E9800 DOCTORAL RESEARCH INSTRUCTION. *3.00-12.00 points*.

MEIE E4810 INTRO TO HUMAN SPACE FLIGHT. *3.00 points*.
Prerequisites: Department permission and knowledge of MATLAB or equivalent.
Introduction to human spaceflight from a systems engineering perspective. Historical and current space programs and spacecraft. Motivation, cost, and rationale for human space exploration. Overview of space environment needed to sustain human life and health, including physiological and psychological concerns in space habitat. Astronaut selection and training processes, spacewalking, robotics, mission operations, and future program directions. Systems integration for successful operation of a spacecraft. Highlights from current events and space research, Space Shuttle, Hubble Space Telescope, and International Space Station (ISS). Includes a design project to assist International Space Station astronauts

MRKT B8623 Intro To Product Management. *1.50 point*.

ORCA E2500 FOUNDATIONS OF DATA SCIENCE. *3.00 points*.
Prerequisites: MATH UN1101 and MATH UN1102 MATH V1101 AND MATH V1102; Some familiarity with programming.
Designed to provide an introduction to data science for sophomore SEAS majors. Combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? Teaches critical concepts and skills in computer programming, statistical inference, and machine learning, in conjunction with hands-on analysis of real-world datasets such as economic data, document collections, geographical data, and social networks. At least one project will address a problem relevant to New York City

Spring 2026: ORCA E2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCA 2500	001/13321	F 10:10am - 12:40pm 329 Pupin Laboratories	Daniel Fernandez	3.00	69/75

Fall 2026: ORCA E2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCA 2500	001/14744	F 10:10am - 12:40pm 833 Seeley W. Mudd Building	Daniel Fernandez	3.00	73/90

ORCA E4500 FOUNDATIONS OF DATA SCIENCE. *3.00 points*.
Prerequisites: MATH V1101 AND MATH V1102; Some familiarity with programming
Designed to provide an introduction to data science for sophomore SEAS majors. Combines three perspectives: inferential thinking, computational thinking, and real-world applications. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? Teaches critical concepts and skills in computer programming, statistical inference, and machine learning, in conjunction with hands-on analysis of real-world datasets such as economic data, document collections, geographical data, and social networks

ORCS E4200 Data-driven Decision Modeling. *3.00 points*.
Introduction to modeling, estimating, and solving decision-making problems in the context of artificial intelligence and analytics. Potential topics include choice models, quantity models, online learning using multi-armed bandits, dynamic decision modeling, dynamic games, and Bayesian learning theory. Practice both theory and applications using Python programming

Fall 2026: ORCS E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4200	001/14745	T Th 4:10pm - 5:25pm 303 Seeley W. Mudd Building	Lily Xu	3.00	75/75

ORCS E4201 Policy for Privacy Technologies. *3.00 points*.
Introduction to privacy technologies, their use in practice, and privacy regulations. Potential topics include anonymization, differential privacy, cryptography, secure multi-party computation, and legislation. Course material will be abased in real-world use cases of these tools

Spring 2026: ORCS E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4201	001/17127	T Th 11:40am - 12:55pm 633 Seeley W. Mudd Building	Rachel Cummings	3.00	32/30

Fall 2026: ORCS E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4201	001/14879	M W 4:10pm - 5:25pm Cin Alfred Lerner Hall	Rachel Cummings	3.00	25/40

ORCS E4529 Reinforcement Learning. *3.00 points*.
Prerequisites: Probability and statistics, basic optimization e.g., familiarity with linear and convex optimization, gradient descent, basic algorithm design constructs, familiarity with programming in python. Markov Decision Processes (MDP) and Reinforcement Learning (RL) problems. Reinforcement Learning algorithms including Q-learning, policy gradient methods, actor-critic method. Reinforcement learning while doing exploration-exploitation dilemma, multi-armed bandit problem. Monte Carlo Tree Search methods, Distributional, Multi-agent, and Causal Reinforcement Learning

Fall 2026: ORCS E4529

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ORCS 4529	001/14746	M W 1:10pm - 2:25pm 614 Schermerhorn Hall	Shipra Agrawal	3.00	90/90

Undergraduate Programs

The Department of Industrial Engineering and Operations Research (IEOR) is dedicated to advancing multidisciplinary applied sciences by applying mathematical and computer models to enhance decision-making within complex environments. Renowned for our pivotal contributions to fields such as optimization, statistics, machine learning, and probability, the IEOR department stands at the forefront of pioneering research in healthcare operations, financial engineering, supply chain management, and market design.

MAJORS

The department offers five majors. Students in all five majors complete a set of common requirements, building up strong foundations in mathematics, computer programming, and operations research methods. They then complete the major requirements and electives for their specialization.

Industrial Engineering (All Class Years)

Strong emphasis on quantitative, economic, and computer-aided approaches to design, production, and service management problems. Offers a robust foundation in contemporary industrial engineering concepts and methods.

Operations Research (All Class Years)

Strong focus on mathematics applications. Prepares students for advanced studies and professional employment as operations research analysts in areas such as professional services, financial services, and large technology organizations.

Operations Research: Analytics (Class of 2027 & Class of 2028)

Trains students to leverage advanced quantitative models, algorithms, and data science for making actionable decisions to improve social operations.

Operations Research: Engineering Management Systems (Class of 2027 & Class of 2028)

Provides understanding for contemporary technology and management. Designed for students interested in a technical management background rather than one in a traditional engineering field.

Operations Research: Financial Engineering (Class of 2027 & Class of 2028)

Trains students to apply engineering methodologies and quantitative methods to finance.

Decision Science & Data Analytics (Class of 2029 & Class of 2030)

Equips students with advanced quantitative modeling techniques, algorithmic problem-solving skills, and state-of-the-art data analytics tools to support strategic, data-driven decision-making in complex organizational environments. By integrating technical expertise with managerial insight, this major prepares students to analyze large datasets, optimize processes, and design actionable solutions that directly improve business performance.

Quantitative Finance & Financial Technology (Class of 2029 & Class of 2030)

Exposes students to rigorous mathematical modeling skills, computational techniques, and advanced financial analytics tools to address complex challenges in modern finance. Students learn to develop and implement quantitative models for pricing, risk management, portfolio optimization, and algorithmic trading, while also gaining expertise in emerging financial technologies such as blockchain, digital payments, and decentralized finance.

MINORS

The IEOR Department is home to three undergraduate minors:

- Industrial Engineering
- Operations Research
- Entrepreneurship and Innovation

These minors are described in the Undergraduate Minors section (p. 325).

IEOR program students are encouraged to consider minors in Economics, Applied Math, or Computer Science. In addition, students pursuing majors in Operations Research (including Operations Research, Analytics, Financial Engineering, and Engineering Management Systems) may elect to minor in Industrial Engineering. Conversely, students majoring in Industrial Engineering may elect to minor in Operations Research. However, students cannot minor in both Industrial Engineering and Operations Research. They may choose either Industrial Engineering or Operations Research, in addition to Entrepreneurship and Innovation.**

The department does not offer minors in Analytics, Engineering Management Systems, or Financial Engineering.

- Decision Science and Data Analytics (BS)
- Industrial Engineering (BS) (p. 264)
- Operations Research (BS) (p. 268)
- Quantitative Finance and Financial Technology (BS)
- Undergraduate Advanced Track
- Industrial Engineering Minor (p. 331)
- Operations Research Minor (p. 332)
- Entrepreneurship and Innovation Minor (p. 330)

Industrial Engineering (BS)

The undergraduate program is designed to develop the technical skills and intellectual discipline needed by our graduates to become leaders in industrial engineering and related professions. The program is distinctive in its emphasis on quantitative, economic, computer-aided approaches to production and service management problems. It is focused on providing an experimental and mathematical problem-formulating and problem-solving framework for industrial engineering work. The curriculum provides a broad foundation in the current ideas, models, and methods of industrial engineering. It also includes a substantial component in the humanities and social sciences to help students understand the societal implications of their work.

The industrial engineering program objectives are:

1. To provide students with the requisite analytical and computational skills to assess practical situations and academic problems, formulate models of the problems represented or embedded therein, design potential solutions, and evaluate their impact;
2. To prepare students for the workplace by fostering their ability to participate in teams, understand and practice interpersonal and organizational behaviors, and communicate their solutions and recommendations effectively through written, oral, and electronic presentations;
3. To familiarize students with the historical development of industrial engineering tools and techniques and with the contemporary state of the art, and to instill the need for lifelong learning within their profession; and
4. To instill in our students an understanding of ethical issues and professional and managerial responsibilities.

Industrial Engineering Program

Students must compete a total of 128 points to graduate. An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1101	CALCULUS I
Choose one of the following Physics courses depending on sequence:	
PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I
Choose one of the following Chemistry courses (taken Semester I or II):	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ECON UN1105 & ECON UN1155 (taken Semester I or II)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II
Choose one of the following Physics courses depending on sequence:	
PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II
Choose one of the following Chemistry courses (taken Semester I or II):	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ECON UN1105 & ECON UN1155 (taken Semester I or II)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001	MULTV. CALC. FOR ENGI # APP SCI
Choose one of the following Chemistry or Physics labs: (Sequences 1, 2, and 3)	
PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081	INTERMEDIATE LABORATORY WORK
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN1507	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN3085	PHYSICL-ANALYTICL LABORATORY I
Choose one of the following Required Nontechnical Electives:	
HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
HUMA UN1121 or UN1123 (taken Semester III or IV)	Art Humanities
IEOR E3658 (taken Semester III or IV)	PROBABILITY FOR ENGINEERS

Semester IV

Linear algebra[1]	
Choose one of the following Required Nontechnical Electives:	
HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
HUMA UN1121 or UN1123 (taken Semester III or IV)	Art Humanities
IEOR E3658 (taken Semester III or IV)	PROBABILITY FOR ENGINEERS
IEOR E2000[3]	Data Engineering with Python

Third Year

Semester V

Required courses:[4]	
IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E4307	STATISTICS AND DATA ANALYSIS
Nontech Electives: (Students must complete the 27-point requirement. Please refer to https://bulletin-next.columbia.edu/columbia-engineering/undergraduate-studies/undergraduate-programs/first-year-sophomore-program/) (taken Semester V, VI, VII, or VIII)	
Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]	
Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]	

Semester VI

Required courses:[4]	
IEOR E3402	PRODUCTN-INVENTORY PLAN-CONTRL
IEOR E3404	SIMULATION MODELING AND ANALYSIS
IEOR E3609	ADVANCED OPTIMIZATION

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

Fourth Year

Semester VII

Required courses:[4]

IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

Semester VIII

Required courses:[4]

IEOR E4405	PRODUCTION SCHEDULING

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

1 The linear algebra requirement may be filled by either MATH UN2010 LINEAR ALGEBRA or APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or COMS W3251 COMPUTATIONAL LINEAR ALGEBRA.

2 ENGI E1006 INTRO TO COMP FOR ENG/APP SCI can be replaced by COMS W1004 PROGRAMMING IN JAVA.

3 IEOR E2000 Data Engineering with Python can be replaced by COMS W3134 Data Structures in Java and COMS W4111 INTRODUCTION TO DATABASES. Students cannot get credit for IEOR E2000 Data Engineering with Python if IEOR E2000 Data Engineering with Python is taken after COMS W3134 Data Structures in Java and COMS W4111 INTRODUCTION TO DATABASES.

4 Taking required courses later than the prescribed semester is not permitted.

5 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available below.

6 3 points total. Cannot double-count non-technical electives. The complete list is available below.

IEOR Technical Electives

IEOR E3402	PRODUCTN-INVENTORY PLAN-CONTRL
IEOR E3700	Research Immersion in OR and Data Analytics
IEOR E3900	UNDERGRAD RESEARCH OR PROJECT
IEOR E4008	COMPUTATION DISCRETE OPT
IEOR E4108	SUPPLY CHAIN ANALYTICS
ORCS E4200	Data-driven Decision Modeling
IEOR E4212	Data Analytics # Machine Learning for OR
CSOR E4231	ANALYSIS OF ALGORITHMS I
CSOR W4231	ANALYSIS OF ALGORITHMS I
IEOR E4405	PRODUCTION SCHEDULING
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4418	TRANSPORTATION ANALYTICS # LOGISTICS
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4525	MACHINE LEARNING FE # OPR
IEOR E4526	ANALYTICS ON THE CLOUD
IEOR E4530	TOPICS IN OPERATIONS RESEARCH
ORCS E4529	Reinforcement Learning ((Cannot take 4529 with 6529))
or ORCS E6529	Advanced Reinforcement Learning
IEOR E4540	DATA MINING
IEOR E4544	Statistical Methods for Analytics
IEOR E4545	Causal Analysis for Data Analytics and OR
IEOR E4572	TOPICS IN OPERATIONS RESEARCH
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4620	PRICING MODELS FOR FIN ENGIN
IEOR E4630	ASSET ALLOCATION
IEOR E4650	BUSINESS ANALYTICS
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
IEOR E4709	STATISTICAL ANALYSIS AND TIME SERIES
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4737	AI Applications in Finance
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4742	Deep Learning for OR and FE
IEOR E4745	Applied Financial Risk Management
IEOR E6613	Optimization, I
IEOR E6614	OPTIMIZATION II
EEOR E6616	CONVEX OPTIMIZATION
IEOR E6711	STOCHASTIC MODELING I
IEOR E6712	STOCHASTIC MODELING II
IEOR E4524	ANALYTICS IN PRACTICE
IEOR E4010	Artificial Intelligence for OR and FE
IEOR E4704	Foundations of Financial Technology
CSOR W4223	Networks, Crowds, and the Web
ORCS E6529	Advanced Reinforcement Learning
IEOR E6604	Advanced Combinatorial Optimization

Non-IEOR Technical Electives

APMA E3102	APPLIED MATHEMATICS II: PDE'S
APMA E4100	Applied Analysis
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
APMA E4204	FUNCTNS OF A COMPLEX VARIABLE
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
BMCS E4575	High-dimensional statistics for biomedical data
COMS W3107	Software Quality and Design
COMS W3157	ADVANCED PROGRAMMING
COMS W3203	DISCRETE MATHEMATICS
COMS W3261	COMPUTER SCIENCE THEORY
COMS W4111	INTRODUCTION TO DATABASES
COMS W4113	FUND-LARGE-SCALE DIST SYSTEMS
COMS W4115	PROGRAMMING LANG # TRANSLATORS
COMS W4118	OPERATING SYSTEMS I

COMS W4153	Cloud Computing
COMS W4156	Advanced Software Engineering
COMS W4160	COMPUTER GRAPHICS
COMS W4167	COMPUTER ANIMATION
COMS W4170	USER INTERFACE DESIGN
COMS W4232	Advanced Algorithms
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
COMS W4261	INTRO TO CRYPTOGRAPHY
COMS W4281	INTRO TO QUANTUM COMPUTING
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4731	Computer Vision I: First Principles
COMS W4732	Computer Vision II: Learning
COMS W4733	COMPUTATIONAL ASPECTS OF ROBOTICS
COMS W4735	VISUAL INTERFACES TO COMPUTERS
COMS W4762	Machine Learning for Functional Genomics
COMS W4773	Machine Learning Theory
COMS W4774	Unsupervised Learning
COMS W4775	Causal Inference
COMS W4776	Neural Networks # Deep Learning
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
CSEE W4119	COMPUTER NETWORKS
EAEE E4257	ENVIR DATA ANALYSIS # MODELING
ECON GU4020	ECON OF UNCERTAINTY # INFORMTN
ECON GU4211	ADVANCED MICROECONOMICS
ECON GU4213	ADVANCED MACROECONOMICS
ECON GU4251	INDUSTRIAL ORGANIZATION
ECON GU4260	MARKET DESIGN
ECON GU4301	ECONOMIC GROWTH # DEVELOPMNT I
ECON GU4412	ADVANCED ECONOMETRICS
ECON GU4413	Econometrics of Time Series and Forecasting
ECON GU4415	GAME THEORY
ECON UN3025	FINANCIAL ECONOMICS
ECON UN3211	INTERMEDIATE MICROECONOMICS
ECON UN3213	INTERMEDIATE MACROECONOMICS
ECON UN3412	INTRODUCTION TO ECONOMETRICS
EECS E6792	Deep Learning on the Edge
ELEN E4620	Numerical Methods for Data Analysis
MATH BC2006	COMBINATORICS
MATH GU4041	INTRO MODERN ALGEBRA I
MATH GU4042	INTRO MODERN ALGEBRA II
MATH GU4051	TOPOLOGY
MATH GU4061	INTRO MODERN ANALYSIS I
MATH GU4062	INTRO MODERN ANALYSIS II
MATH UN2030	ORDINARY DIFFERENTIAL EQUATIONS
MATH UN3020	NUMBER THEORY AND CRYPTOGRAPHY
MATH UN3386	DIFFERENTIAL GEOMETRY
ORCA E2500	FOUNDATIONS OF DATA SCIENCE
STAT GU4205	LINEAR REGRESSION MODELS
STAT GU4221	TIME SERIES ANALYSIS
STAT GU4224	BAYESIAN STATISTICS

Management Electives

CHEN E2100	Material and Energy Balances
CIEN E3000	THE ART OF STRUCTURAL DESIGN
CIEN E3129	PROJECT MGMT FOR CONSTRUCTION
CIEN E4132	PREV#RESOL OF CONSTR DISPUTES
CIEN E4138	REAL ESTATE FIN/CONST MANAG
COMS W4460	PRIN-INNOVATN/ENTREPRENEURSHIP
ECIA W4100	MGMT # DEVPT OF WATER SYSTEMS
ECON GU4230	ECONOMICS OF NEW YORK CITY
ECON GU4321	ECONOMIC DEVELOPMENT
ECON GU4370	POLITICAL ECONOMY
ECON GU4400	LABOR ECONOMICS
ECON GU4438	ECONOMICS OF RACE IN THE U.S.
ECON GU4465	PUBLIC ECONOMICS
ECON GU4480	GENDER # APPLIED ECONOMICS
ECON GU4500	INTERNATIONAL TRADE
ECON GU4505	INTERNATIONAL MACROECONOMICS
ECON GU4625	ECONOMICS OF THE ENVIRONMENT
ECON GU4700	FINANCIAL CRISES
ECON GU4710	FINANCE AND THE REAL ECONOMY
ECON GU4750	GLOBALIZATION # ITS RISKS
ECON GU4840	BEHAVIORAL ECONOMICS
ECON GU4850	COGNITIVE MECH # ECON BEHAVIOR
ECON GU4860	BEHAVIORAL FINANCE
ECON UN2105	THE AMERICAN ECONOMY
ECON UN2257	THE GLOBAL ECONOMY
ECON UN3265	MONEY AND BANKING
ECON UN3901	ECONOMICS OF EDUCATION
ECON UN3952	MACROECONOMICS#FORMATION OF EXPECTATIONS
ENGI E4100	RESEARCH TO REVENUE
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEME E4810	INTRO-HUMANS IN SPACE FLIGHT
IEOR E2261	ACCOUNTING AND FINANCE
IEOR E4207	HUMAN FACTORS: PERFORMANCE
IEOR E4505	OPERATION RES IN PUBLIC POLICY
IEOR E4506	DESIGN DIGITAL OPERATING MODELS
IEOR E4507	HEALTHCARE OPERATIONS MGT
IEOR E4510	PROJECT MANAGEMENT
IEOR E4520	APPLIED SYSTEMS ENGINEERING
IEOR E4521	SYSTEM ENGI TOOLS/METHODS
IEOR E4711	GLOBAL CAPITAL MARKETS
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
ORCS E4201	Policy for Privacy Technologies
SOCI W3490	Mistake, Misconduct, Disaster
SOCI UN3675	ORGANIZING INNOVATION
Corporate Finance (Can only take one):	
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS
IEOR E4402	Corporate Finance, Accounting # Investment Banking
IEOR E4403	QUANTITATIVE CORPORATE FINANCE

Operations Research (BS)

The operations research program is one of several applied science programs offered at the School. At the undergraduate level, it offers basic courses in probability, statistics, applied mathematics, simulation, and optimization as well as more professionally oriented operations research courses. The curriculum is well suited for students with an aptitude for mathematics applications.

It prepares graduates for professional employment as operations research analysts, e.g., with management consultant and financial service organizations, as well as for graduate studies in operations research or business. It is flexible enough to be adapted to the needs of future medical and law students.

There is the BSOR major program, along with three additional track options. Please view the Degree Track for each option.

**The major has three tracks available for students in the Class of 2027 and Class of 2028. Students in the Class of 2029 must consult their IEOR academic advisor if interested in pursuing a track off of BSOR. Tracks are not available for students in Class of 2030.*

Operations Research: Analytics

The analytics concentration within the operations research program seeks to train students to leverage advanced quantitative models, algorithms, and data for making actionable decisions to improve business operations. Examples include staffing and scheduling at hospitals, ride matching and pricing for on-demand car services, personalized promotions in online retail, and smarter energy consumption. Students are provided with a rigorous exposure to optimization and stochastic modeling, as well as machine learning and data analysis tools for predictive modeling and prescriptive analytics. Electives in the areas of healthcare, marketing, transportation, deep learning, and many others further enrich students with domain expertise, and provide many opportunities to work directly with data on real-world problems.

**This track is available for students in the Class of 2027 or Class of 2028. Students in the Class of 2029 must consult their IEOR academic advisor if interested in pursuing the major. Not available for student in Class of 2030.*

Operations Research: Engineering Management Systems

This operations research option is designed to provide students with an understanding of contemporary technology and management. It is for students who are interested in a technical-management background rather than one in a traditional engineering field. It consists of required courses in industrial engineering and operations research, economics, business, and computer science, intended to provide a foundation for dealing with engineering and management systems problems. Elective courses are generally intended to provide a substantive core in at least one technology area and at least one management area.

Due to the flexibility of this option, it can incorporate the varied educational needs of preprofessional students interested in law, medicine, business, and finance. In addition, most students are encouraged to add a minor in economics or computer science to their standard course schedules.

**This track is available for students in the Class of 2027 or Class of 2028. Students in the Class of 2029 must consult their IEOR academic advisor if interested in pursuing the major. Not available for student in Class of 2030.*

Operations Research: Financial Engineering

The operations research concentration in financial engineering is designed to provide students with an understanding of the application of engineering methodologies and quantitative methods to finance. Financial engineering is a multidisciplinary field integrating financial theory with economics, methods of engineering, tools of mathematics, and practice of programming. Students graduating with this concentration are prepared to enter careers in securities, banking, financial management, and consulting industries, and fill quantitative roles in corporate treasury and finance departments of general manufacturing and service firms.

Students who are interested in pursuing the rigorous concentration in financial engineering must demonstrate proficiency in calculus, computer programming, linear algebra, ordinary differential equations, probability, and statistics.

**This track is available for students in the Class of 2027 or Class of 2028. Students in the Class of 2029 must consult their IEOR academic advisor if interested in pursuing the major. Not available for student in Class of 2030.*

Operations Research Program

Students must complete a total of 128 points to graduate. An overview of the degree track in PDF format can be found here.

First and Second Year Degree Track: All IEOR Degree Programs

First Year

Semester I

MATH UN1101	CALCULUS I
Choose one of the following Physics courses depending on sequence:	
PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I
Choose one of the following Chemistry courses (taken Semester I or II):	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ECON UN1105 & ECON UN1155 (taken Semester I or II)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES

ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on sequence:

PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II

Choose one of the following Chemistry courses (taken Semester I or II):

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY

ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ECON UN1105 & ECON UN1155 (taken Semester I or II)	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I or II)[2]	INTRO TO COMP FOR ENG/APP SCI
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Chemistry or Physics labs:

PHYS UN1494	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081	INTERMEDIATE LABORATORY WORK
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN1507	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN3085	PHYSICL-ANALYTICL LABORATORY I

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester III or IV)	Art Humanities
IEOR E3658 (taken Semester III or IV)	PROBABILITY FOR ENGINEERS

Semester IV

Linear algebra[1]

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester III or IV)	Art Humanities
IEOR E3658 (taken Semester III or IV)	PROBABILITY FOR ENGINEERS
IEOR E2000[3]	Data Engineering with Python

[1] The linear algebra requirement may be filled by either MATH UN2010 LINEAR ALGEBRA or APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or COMS W3251 COMPUTATIONAL LINEAR ALGEBRA.

[2] ENGI E1006 INTRO TO COMP FOR ENG/APP SCI can be replaced by COMS W1004 PROGRAMMING IN JAVA.

[3] IEOR E2000 Data Engineering with Python can be replaced by COMS W3134 Data Structures in Java and COMS W4111 INTRODUCTION TO DATABASES. Students cannot get credit for IEOR E2000 Data Engineering with Python if IEOR E2000 Data Engineering with Python is taken after COMS W3134 Data Structures in Java and COMS W4111 INTRODUCTION TO DATABASES.

Third and Fourth Year Degree Track: Operations Research

Third Year

Semester V

Required courses:[1]

IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E4307	STATISTICS AND DATA ANALYSIS

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[3]

Semester VI

Required courses:[1]

IEOR E3402	PRODUCTN-INVENTORY PLAN-CONTRL
IEOR E3404	SIMULATION MODELING AND ANALYSIS
IEOR E3609	ADVANCED OPTIMIZATION

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[3]

Fourth Year

Semester VII

Required courses:[4]

IEOR E4407	GAME THEOR MODELS OF OPERATION

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

Semester VIII

Required courses:[4]

IEOR E4405	PRODUCTION SCHEDULING

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

1 Taking required courses later than the prescribed semester is not permitted.
2 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
3 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.

Third and Fourth Year Degree Track: Operations Research: Analytics *(Class of 2027 & Class of 2028)*

Third Year

Semester V

Required courses:[1]

IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E4307	STATISTICS AND DATA ANALYSIS
IEOR E4212	Data Analytics # Machine Learning for OR

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[3]

Semester VI

Required courses:[1]

IEOR E3404	SIMULATION MODELING AND ANALYSIS
IEOR E3609	ADVANCED OPTIMIZATION
IEOR E4650	BUSINESS ANALYTICS
ORCS E4201	Policy for Privacy Technologies

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[3]

Fourth Year

Semester VII

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

Semester VIII

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

1 Taking required courses later than the prescribed semester is not permitted.
2 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
3 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.

Third and Fourth Year Degree Track: Operations Research: Engineering Management Systems *(Class of 2027 & Class of 2028)*

Third Year

Semester V

Required courses:[1]

IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E4307	STATISTICS AND DATA ANALYSIS

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (12 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (6 points) (taken Semester V, VI, VII, or VIII)[3]

Semester VI

Required courses:[1]

IEOR E3402	PRODUCTN-INVENTORY PLAN-CONTRL
IEOR E3404	SIMULATION MODELING AND ANALYSIS
IEOR E3609	ADVANCED OPTIMIZATION

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (12 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (6 points) (taken Semester V, VI, VII, or VIII)[3]

Fourth Year

Semester VII

Required courses:[1]

IEOR E4003	CORPORATE FINANCE FOR ENGINEERS

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (12 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (6 points) (taken Semester V, VI, VII, or VIII)[6]

Semester VIII

Required courses:[1]

IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (12 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (6 points) (taken Semester V, VI, VII, or VIII)[6]

[1] Taking required courses later than the prescribed semester is not permitted.

[2] 12 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.

[3] 6 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.

Third and Fourth Year Degree Track: Operations Research: Financial Engineering *(Class of 2027 & Class of 2028)*

Third Year

Semester V

Required courses:[4]

IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS
IEOR E4307	STATISTICS AND DATA ANALYSIS

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[3]

Semester VI

Required courses:[1]

IEOR E3404	SIMULATION MODELING AND ANALYSIS
IEOR E3609	ADVANCED OPTIMIZATION
IEOR E4700	INTRO TO FINANCIAL ENGINEERING

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[2]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[3]

Fourth Year

Semester VII

Required courses:[1]

IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

Semester VIII

Nontech Electives: (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)

Tech Electives (15 points) (taken Semester V, VI, VII, or VIII)[5]

Management Electives (3 points) (taken Semester V, VI, VII, or VIII)[6]

[1] Taking required courses later than the prescribed semester is not permitted.

[2] 15 points total. At least 3 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.

[3] 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.

IEOR Technical Electives

CSOR W4231	ANALYSIS OF ALGORITHMS I
CSOR E4231	ANALYSIS OF ALGORITHMS I
CSOR W4223	Networks, Crowds, and the Web
EEOR E6616	CONVEX OPTIMIZATION
IEOR E3402	PRODUCTN-INVENTORY PLAN-CONTRL
IEOR E3700	Research Immersion in OR and Data Analytics
IEOR E4008	COMPUTATION DISCRETE OPT
IEOR E4010	Artificial Intelligence for OR and FE
IEOR E4108	SUPPLY CHAIN ANALYTICS
IEOR E4212	Data Analytics # Machine Learning for OR
IEOR E4405	PRODUCTION SCHEDULING
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4418	TRANSPORTATION ANALYTICS # LOGISTICS
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4525	MACHINE LEARNING FE # OPR
IEOR E4526	ANALYTICS ON THE CLOUD
IEOR E4530	TOPICS IN OPERATIONS RESEARCH
IEOR E4540	DATA MINING
IEOR E4544	Statistical Methods for Analytics
IEOR E4544	Statistical Methods for Analytics
IEOR E4572	TOPICS IN OPERATIONS RESEARCH
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4620	PRICING MODELS FOR FIN ENGIN
IEOR E4630	ASSET ALLOCATION
IEOR E4650	BUSINESS ANALYTICS
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
IEOR E4704	Foundations of Financial Technology
IEOR E4709	STATISTICAL ANALYSIS AND TIME SERIES
IEOR E4709	STATISTICAL ANALYSIS AND TIME SERIES
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4735	STRUCTURED#HYBRID PRODUCTS
IEOR E4737	AI Applications in Finance
IEOR E4742	Deep Learning for OR and FE
IEOR E4745	Applied Financial Risk Management
IEOR E6604	Advanced Combinatorial Optimization
IEOR E6613	Optimization, I
IEOR E6614	OPTIMIZATION II
IEOR E6711	STOCHASTIC MODELING I
IEOR E6712	STOCHASTIC MODELING II
ORCS E4200	Data-driven Decision Modeling
ORCS E4529	Reinforcement Learning
ORCS E6529	Advanced Reinforcement Learning

Capstone: Only up to 3 credits can be applied. If the major has a capstone requirement, the capstone cannot be used as a technical elective.

IEOR E3900	UNDERGRAD RESEARCH OR PROJECT
IEOR E4524	ANALYTICS IN PRACTICE

Non-IEOR Technical Elective

APMA E3102	APPLIED MATHEMATICS II: PDE'S
or MATH UN3028	PARTIAL DIFFERENTIAL EQUATIONS
APMA E4100	Applied Analysis
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
APMA E4204	FUNCTNS OF A COMPLEX VARIABLE
or MATH UN3007	COMPLEX VARIABLES
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
BMCS E4575	High-dimensional statistics for biomedical data
COMS W3107	Software Quality and Design
COMS W3157	ADVANCED PROGRAMMING
COMS W3203	DISCRETE MATHEMATICS
COMS W3261	COMPUTER SCIENCE THEORY
COMS W4111	INTRODUCTION TO DATABASES
COMS W4113	FUND-LARGE-SCALE DIST SYSTEMS
COMS W4115	PROGRAMMING LANG # TRANSLATORS
COMS W4118	OPERATING SYSTEMS I
COMS W4153	Cloud Computing
COMS W4156	Advanced Software Engineering
COMS W4160	COMPUTER GRAPHICS
COMS W4167	COMPUTER ANIMATION
COMS W4170	USER INTERFACE DESIGN
COMS W4232	Advanced Algorithms
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
COMS W4261	INTRO TO CRYPTOGRAPHY
COMS W4281	INTRO TO QUANTUM COMPUTING
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4731	Computer Vision I: First Principles
COMS W4732	Computer Vision II: Learning
COMS W4733	COMPUTATIONAL ASPECTS OF ROBOTICS
COMS W4735	VISUAL INTERFACES TO COMPUTERS
COMS W4762	Machine Learning for Functional Genomics
COMS W4773	Machine Learning Theory
COMS W4774	Unsupervised Learning
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MATH GU4062	INTRO MODERN ANALYSIS II
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ORCA E2500	FOUNDATIONS OF DATA SCIENCE
STAT GU4205	LINEAR REGRESSION MODELS
STAT GU4221	TIME SERIES ANALYSIS
STAT GU4224	BAYESIAN STATISTICS

Management Elective

CHEN E2100	Material and Energy Balances
CIEN E3000	THE ART OF STRUCTURAL DESIGN
CIEN E3129	PROJECT MGMT FOR CONSTRUCTION
CIEN E4132	PREV#RESOL OF CONSTR DISPUTES
CIEN E4138	REAL ESTATE FIN/CONST MANAG
COMS W4460	PRIN-INNOVATN/ENTREPRENEURSHIP
ECIA W4100	MGMT # DEVPT OF WATER SYSTEMS
ECON GU4230	ECONOMICS OF NEW YORK CITY
ECON GU4321	ECONOMIC DEVELOPMENT
ECON GU4370	POLITICAL ECONOMY
ECON GU4400	LABOR ECONOMICS
ECON GU4438	ECONOMICS OF RACE IN THE U.S.
ECON GU4465	PUBLIC ECONOMICS
ECON GU4480	GENDER # APPLIED ECONOMICS
ECON GU4500	INTERNATIONAL TRADE
ECON GU4505	INTERNATIONAL MACROECONOMICS
ECON GU4625	ECONOMICS OF THE ENVIRONMENT
ECON GU4700	FINANCIAL CRISES
ECON GU4710	FINANCE AND THE REAL ECONOMY
ECON GU4750	GLOBALIZATION # ITS RISKS
ECON GU4840	BEHAVIORAL ECONOMICS
ECON GU4850	COGNITIVE MECH # ECON BEHAVIOR
ECON GU4860	BEHAVIORAL FINANCE
ECON UN2105	THE AMERICAN ECONOMY
ECON UN2257	THE GLOBAL ECONOMY
ECON UN3265	MONEY AND BANKING
ECON UN3901	ECONOMICS OF EDUCATION
ECON UN3952	MACROECONOMICS#FORMATION OF EXPECTATIONS
ENGI E4100	RESEARCH TO REVENUE
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEME E4810	INTRO-HUMANS IN SPACE FLIGHT

IEOR E2261	ACCOUNTING AND FINANCE
IEOR E4207	HUMAN FACTORS: PERFORMANCE
IEOR E4505	OPERATION RES IN PUBLIC POLICY
IEOR E4506	DESIGN DIGITAL OPERATING MODELS
IEOR E4507	HEALTHCARE OPERATIONS MGT
IEOR E4510	PROJECT MANAGEMENT
IEOR E4520	APPLIED SYSTEMS ENGINEERING
IEOR E4521	SYSTEM ENGI TOOLS/METHODS
IEOR E4711	GLOBAL CAPITAL MARKETS
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
ORCS E4201	Policy for Privacy Technologies
SOCI W3490	Mistake, Misconduct, Disaster
SOCI UN3675	ORGANIZING INNOVATION
Corporate Finance (Can only take one):	
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS
IEOR E4402	Corporate Finance, Accounting # Investment Banking
IEOR E4403	QUANTITATIVE CORPORATE FINANCE

Graduate Programs

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

Master of Science Programs

The Department of Industrial Engineering and Operations Research offers courses and M.S. programs in

1. Financial engineering on a full-time basis only;
2. Management science and engineering on a full-time basis only;
3. Business analytics on a full-time basis only;
4. Industrial engineering on either a full- or part-time basis; and
5. Operations research on either a full- or part-time basis.

Both the Department's M.S. programs in Business Analytics and Management Science and Engineering are offered in conjunction with Columbia Business School.

All degree program applicants are required to take the Aptitude Tests of the Graduate Record Examination (GRE). A minimum grade-point average of 3.0 (B) or its equivalent in an undergraduate engineering program is required for admission to the M.S. programs. At a minimum, students are expected, on entry, to have completed courses in ordinary differential equations, linear algebra, probability, and a programming language such as C, Java, or Python.

The Department requires that M.S. students achieve grades of B– or higher in each of the fundamental core courses in the discipline of study. Poor performance in core courses is indicative of inadequate preparation and is very likely to lead to serious problems in completing the program. As a result, students failing to meet this criterion may be asked to withdraw.

Courses taken at the School of Professional Studies will not be counted toward the M.S. degree in the IEOR Department (e.g., courses with the following prefixes: ACTU, BUSI, COPR, IKNS, SUMA, FUND, and more). Please consult with your academic adviser regarding electives offered in other departments and schools, prior to registration.

- Business Analytics (MS) (p. 274)
- Financial Engineering (MS) (p. 277)
- Management Science and Engineering (MS) (p. 278)
- Industrial Engineering (MS) (p. 281)
- Operations Research (MS) (p. 283)
- Industrial Engineering (PhD), Operations Research (PhD) (p. 285)
- Industrial Engineering (Joint MS and MBA)

Business Analytics (MS)

The Master of Science in Business Analytics (MSBA) is a 36-credit, STEM-designated program offered by the IEOR Department in partnership with Columbia Business School. Developed through extensive collaboration with industry leaders, alumni, and students, the program bridges advanced quantitative analysis with strategic business insights. The curriculum emphasizes data-driven decision-making, utilizing statistical modeling, optimization, and predictive analytics to resolve complex operational challenges and improve business performance.

Students receive rigorous exposure to optimization and stochastic modeling, along with in-depth coverage of practical analytics applications. As data becomes central to global infrastructure, this program equips graduates to lead innovation across business, healthcare, government, and numerous other sectors of the economy.

Graduate studies in Business Analytics consist of 36 credits, assuming adequate student preparation in probability and statistics.

To graduate, students must earn a minimum of 18 credits within IEOR and a minimum of 15 credits from Columbia Business School. With department approval, additional elective credits can be taken from Columbia Business School or Columbia's other graduate schools, including the School of International and Public Affairs or the Graduate School of Arts and Sciences.

Additional details are available on the MSBA website at msba.engineering.columbia.edu/content/curriculum.

Required Core Courses (18 Credits)

NOTE: To satisfy the degree requirements, students must complete 12 credits of core courses within IEOR and 6 credits within Columbia Business School (CBS).

IEOR E4101	PROBABILITY STAT # SIMULATION (First Fall Semester)
IEOR E4523	Data Analytics and Machine Learning (First Fall Semester)
DROM B8101	Business Analytics I (Full Term)
MRKT B9651	MS Marketing Analytics (Marketing Analytics, First Fall Semester)
IEOR E4524	ANALYTICS IN PRACTICE (Spring Semester)
IEOR E4004	OPTIMIZATION MODELS AND METHODS (Spring Semester)
IEOR E4502	Python for Analytics (0 credits, First Fall Semester)
IEOR E4598	Business Analytics Practitioners Seminar (0 credits, First Year)
IEOR E4599	MSBA Quantitative Bootcamp (0 credits,First Fall Semester)

Columbia Business School Electives (Minimum 9 Credits)

When combined with the 6 credits of Columbia Business School (CBS) core coursework, students will satisfy the requirement to earn a minimum of 15 CBS credits by taking at least 9 elective credits. Refer to the MSBA website for the pre-approved listing from CBS.

Remaining Electives (0-9 Credits)

To complete the 36-credit graduation requirement, remaining elective credits may be chosen from IEOR, CBS, or approved graduate schools and departments across the University.

IEOR/CBS Pre-Approved Elective Courses

NOTE: Courses not listed below must be pre-approved by IEOR advising prior to the add/drop date of the semester.

IEOR Elective Courses

Industrial Engineering and Operations Research (IEOR) Elective Courses

CSOR E4231	ANALYSIS OF ALGORITHMS I
CSOR W4246	ALGORITHMS FOR DATA SCIENCE
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEOR E4008	COMPUTATION DISCRETE OPT
IEOR E4010	Artificial Intelligence for OR and FE
IEOR E4011	Agentic AI for Operations Research and Financial Engineering
IEOR E4106	STOCHASTIC MODELS
IEOR E4108	SUPPLY CHAIN ANALYTICS
IEOR E4207	HUMAN FACTORS: PERFORMANCE
IEOR E4402	Corporate Finance, Accounting # Investment Banking
or IEOR E4403	QUANTITATIVE CORPORATE FINANCE
IEOR E4404	SIMULATION
IEOR E4405	PRODUCTION SCHEDULING
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4418	TRANSPORTATION ANALYTICS # LOGISTICS
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4505	OPERATION RES IN PUBLIC POLICY
IEOR E4506	DESIGN DIGITAL OPERATING MODELS
IEOR E4507	HEALTHCARE OPERATIONS MGT
IEOR E4510	PROJECT MANAGEMENT
IEOR E4520	APPLIED SYSTEMS ENGINEERING
IEOR E4521	SYSTEM ENGI TOOLS/METHODS
IEOR E4525	MACHINE LEARNING FE # OPR
IEOR E4526	ANALYTICS ON THE CLOUD
IEOR E4530	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4532	Visualization and Storytelling with Data
IEOR E4533	Performance, Objectives, # Results Using Data Analytics
IEOR E4534	Applied Analytics: from Data to Decisions
IEOR E4535	Analytics Engineering
IEOR E4540	DATA MINING
IEOR E4544	Statistical Methods for Analytics
IEOR E4501	TOOLS FOR ANALYTICS
IEOR E4564	Strategic Impact through Analytics
IEOR E4570	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4571	TOPICS IN OPERATIONS RESEARCH
IEOR E4572	TOPICS IN OPERATIONS RESEARCH
IEOR E4573	TOPICS IN OR (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4574	TOPICS IN OR (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4575	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4576	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4577	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4578	TOPICS IN OPERATION RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4579	TOPICS IN OR (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4620	PRICING MODELS FOR FIN ENGIN
IEOR E4630	ASSET ALLOCATION
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
IEOR E4704	Foundations of Financial Technology
IEOR E4711	GLOBAL CAPITAL MARKETS
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4720	TOPICS IN QUANT FINANCE
IEOR E4721	TOPICS IN QUANT FINANCE
IEOR E4722	TOPICS IN QUANT FINANCE
IEOR E4723	TOPICS IN QUANTATIVE FINANCE
IEOR E4724	TOPICS IN QUANTATIVE FINANCE
IEOR E4725	Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation
IEOR E4726	TOPICS IN QUANTATIVE FINANCE
IEOR E4727	TOPICS IN QUANTATIVE FINANCE
IEOR E4728	TOPICS IN QUANTITATIVE FINANCE
IEOR E4729	TOPICS IN QUANTATIVE FINANCE
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4734	FOR EXCH/RELATD DERIVATVS INST
IEOR E4735	STRUCTURED#HYBRID PRODUCTS
IEOR E4737	AI Applications in Finance
IEOR E4741	Programming for Financial Engineering
IEOR E4742	Deep Learning for OR and FE
IEOR E4745	Applied Financial Risk Management
IEOR E4900	MASTERS RESEARCH OR PROJECT
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
IEOR E4999	FIELDWORK
ORCS E4200	Data-driven Decision Modeling
ORCS E4201	Policy for Privacy Technologies
ORCS E4529	Reinforcement Learning
or ORCS E6529	Advanced Reinforcement Learning
IEOR E6711	STOCHASTIC MODELING I
IEOR E6614	OPTIMIZATION II
IEOR E6712	STOCHASTIC MODELING II
IEOR E6613	Optimization, I
IEOR E8100	ADVANCED TOPICS IN IEOR
EEOR E6616	CONVEX OPTIMIZATION

CBS Electives

Columbia Business School (CBS) Elective Courses	
Course Codes may include DROMBxxxx, MRKTBxxxx, MGMTBxxxx, ACCTBxxxx or FINCBxxxx. Please refer to the MSBA website for pre-approved CBS listings. Courses not listed below must be pre-approved by IEOR advising prior to the add/drop date of the semester.	
ACCT B8008	Earnings Quality # Fundamental
ACCT B8029	Mergers # Acquisitions Transactions
BUEC B8211	The Digital Economy: Regulatory Conflicts and Opportunities
BUEC B8216	ECONOMICS OF STRATEGIC BEHAVIOR
BUEC B8251	Financial Markets and the Macroeconomy
BUEC B8498	Mergers # Acquisitions in Medi
DROM B8103	Business Analytics II Half Term
DROM B8106	Operations Strategy
DROM B8107	Service Operations Management
DROM B8110	Game-Theoretic Business Strategy
DROM B8116	Risk Management
DROM B8117	Business Analytics III: Modern AI, Deep Learning, and Generative AI
DROM B8131	Sports Analytics
DROM B8148	The Analytics Advantage
DROM B8159	Digital Marketplaces
DROM B8510	MANAGERIAL NEGOTIATIONS
FINC B8306	Capital Markets # Investments
FINC B8307	Advanced Corporate Finance
FINC B8325	Mergers # Acquisitions
FINC B8331	Real Estate Finance
FINC B8377	Value Investing
MGMT B8518	Foundations of Entrepreneurship
MGMT B8577	Think Bigger
MRKT B8604	Frontiers in Retailing
MRKT B8607	Strategic Consumer Insights
MRKT B8609	Generative AI for Business (Half-Term)
MRKT B8632	Digital Product Management Lab
MRKT B8636	Product Management (Full-Term)
MRKT B8649	Pricing Strategies
MRKT B8662	Innovate Using Design Thinking
MRKT B8663	Social Innovation using Data-Driven Design
MRKT B8679	Digital Marketing in the AI Era (Full-Term)
MRKT B8680	Digital Marketing in the AI Era (Half Term)
MRKT B9655	MS Digital Marketing
Please note: Programming courses from CBS are not approved.	

Optional Elective Concentrations (9 Credits)

Financial Analytics & Financial Technology (FinTech)

Choose nine credits from the following:

- IEOR E4106 STOCHASTIC MODELS
- IEOR E4500 APPLICATIONS PROGRAMMNG FOR FE
- IEOR E4525 MACHINE LEARNING FE # OPR
- IEOR E4574 TOPICS IN OR *(1.5 points)*
- IEOR E4742 Deep Learning for OR and FE
- IEOR E4725 Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation
- *MRKT B8649 Pricing strategies*[1]
- DROM B8106 Operations Strategy
- DROM B8116 Risk Management
- DROM B8510 MANAGERIAL NEGOTIATIONS/*MGMT B8510 Managerial negotiations*[1]
- MRKT B8776 *Foundations of innovation*[1]
- DROM B8816 Quantitative Pricing # Revenue
- *DROM B9122 Computing for business research*[1]

[1] Information on courses administered by Columbia Business School can be found here.

Marketing Analytics

Choose nine credits from the following:

- IEOR E4407 GAME THEOR MODELS OF OPERATION
- IEOR E4506 DESIGN DIGITAL OPERATING MODELS
- IEOR E4312 Application of OR # AI Techniques in Marketing
- IEOR E4562 Innovate Using Design Thinking
- IEOR E4601 DYNAMIC PRICING/REVENUE MGMT
- *DROM B8122 Game-theoretic business strategy*[1]
- DROM B8123 Demand Analytics
- DROM B8131 Sports Analytics
- DROM B8510 MANAGERIAL NEGOTIATIONS/*MGMT B8510 Managerial negotiations*[1]
- *MRKT B8607 Strategic consumer insights*[1]
- *MRKT B8608 New product development*[1]
- *MRKT B8617 Marketing research and analytics*[1]
- *MRKT B8623 Intro to product management (1.5)*[1]
- *MRKT B8625 Winning strategic capabilities*[1]
- *MRKT B8679 Digital marketing*[1]
- *MRKT B8681 Advanced marketing strategy*[1]
- *MRKT B8683 Marketing models*[1]
- *DROM B9122 Computing for business research*[1]
- *DROM B9127 Online marketplaces*[1]

- *MRKT B9613 Mathematical models in marketing*[1]
- *MRKT B9656 Customer management: concepts and tools (1.5)*[1]

[1] Information on courses administered by Columbia Business School can be found here.

Healthcare Analytics

Choose nine credits from the following:

- IEOR E4108 SUPPLY CHAIN ANALYTICS/DROM B8108 Supply chain management
- IEOR E4405 PRODUCTION SCHEDULING
- IEOR E4505 OPERATION RES IN PUBLIC POLICY
- IEOR E4507 HEALTHCARE OPERATIONS MGT
- IEOR E4520 APPLIED SYSTEMS ENGINEERING
- IEOR E4521 SYSTEM ENGI TOOLS/METHODS
- IEOR E4540 DATA MINING
- *DROM B8105 Healthcare analytics (1.5)*[1]
- DROM B8107 Service Operations Management
- *DROM B8128 Healthcare investment and entrepreneurship HCIT and services*[1]
- *DROM B8132 Digital health care systems*[1]
- DROM B8510 MANAGERIAL NEGOTIATIONS*/MGMT B8510 Managerial negotiations*[1]
- *MRKT B8692 Pharmaceutical drug commercialization: strategy & practice (1.5)*[1]
- *DROM B8832 U.S. health care system*[1]
- *MRKT B9656 Customer management: concepts and tools (1.5)*[1]

[1] Information on courses administered by Columbia Business School can be found here.

Analytics Algorithms & Methodology

Choose nine credits from the following:

- IEOR E4008 COMPUTATION DISCRETE OPT
- COMS W4111 INTRODUCTION TO DATABASES
- CSOR W4231 ANALYSIS OF ALGORITHMS I
- IEOR E4407 GAME THEOR MODELS OF OPERATION
- IEOR E4418 TRANSPORTATION ANALYTICS # LOGISTICS
- IEOR E4525 MACHINE LEARNING FE # OPR
- IEOR E4526 ANALYTICS ON THE CLOUD
- IEOR E4540 DATA MINING
- DROM B8110 Game-Theoretic Business Strategy
- *DROM B8111 Analytics for business research*[1]
- *DROM B8127 Big immersion seminar—big data (1.5 pts)*[1]
- *DROM B8130 Applied statistics and data analytics*[1]
- *MRKT B9160 Applied multivariate statistics*[1]
- *MRKT B9608 Experimental design & analysis for behavioral research*[1]
- *MRKT B9616 Bayesian modeling & computation*[1]
- *MRKT B9652 MS marketing models*[1]
- *MRKT B9653 MS machine learning (1.5)*[1]
- *MRKT B9654 MS artificial intelligence*[1]

[1] Information on courses administered by Columbia Business School can be found here.

Financial Engineering (MS)

The M.S. program in Financial Engineering is offered on a full time basis only. Financial Engineering is intended to provide a unique technical background for students interested in pursuing career opportunities in financial analysis and risk management. In addition to the basic requirements for graduate study, students are expected, on entry, to have attained a high level of mathematical and computer programming skills, particularly in probability, statistics, linear algebra, and the use of a programming language such as C, Python, or Java. Previous professional experience is highly desirable but not required.

Graduate studies in Financial Engineering consists of 36 points (12 courses), starting the fall semester. Students may complete the program in May, August, or December of the following year. The requirements include six required core courses and additional elective courses chosen from a variety of departments or schools at Columbia.

Financial Engineering

Required Core Courses

Required Core Courses	
IEOR E4007	OPT MODELS # METHODS FOR FE
IEOR E4701	STOCHASTIC MODELS FOR FIN ENG
IEOR E4703	MONTE CARLO SIMULATION METHODS
IEOR E4706	FOUNDATIONS FR FINANCIAL ENGIN
IEOR E4707	FE CONTINUOUS TIME MODELS
IEOR E4709	STATISTICAL ANALYSIS AND TIME SERIES
IEOR E4798	Financial Engineering Practitioners Seminar Series (0 credits) [1]
IEOR E4799	MSFE Quantitative and Computational Bootcamp (0 credits)

[1] Students are required to attend IEOR E4798 Financial Engineering Practitioners Seminar Series and submit learning journals.

A sample schedule is available in the Department office and on the IEOR website at ieor.columbia.edu. Students select electives from a group of

specialized offerings in both the fall and spring terms. They may select from a variety of approved electives from the Department, Columbia Business School, and the Graduate School of Arts and Sciences.

Financial Engineering [1]

Sample Plan (36 points)

Fall Semester	
Choose nine points from the following required core courses: [2]	
IEOR E4007	OPT MODELS # METHODS FOR FE
IEOR E4701	STOCHASTIC MODELS FOR FIN ENG
IEOR E4706	FOUNDATIONS FR FINANCIAL ENGIN
IEOR E4798	Financial Engineering Practitioners Seminar Series (0 credits)
IEOR E4799	MSFE Quantitative and Computational Bootcamp (0 credits)
Plus Financial Engineering electives, 3-6 points [3]	
Spring Semester	
Required core courses (9 points): [2]	
IEOR E4703	MONTE CARLO SIMULATION METHODS
IEOR E4707	FE CONTINUOUS TIME MODELS
IEOR E4709	STATISTICAL ANALYSIS AND TIME SERIES
Plus Financial Engineering electives, 3–6 points [3]	
Summer and/or Fall Semester	
(For remaining credits) [2]	
CSOR E4231	ANALYSIS OF ALGORITHMS I
CSOR W4246	ALGORITHMS FOR DATA SCIENCE
IEOR E4402	Corporate Finance, Accounting # Investment Banking
or IEOR E4403	QUANTITATIVE CORPORATE FINANCE
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4525	MACHINE LEARNING FE # OPR
IEOR E4530	TOPICS IN OPERATIONS RESEARCH
IEOR E4540	DATA MINING
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4630	ASSET ALLOCATION
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4704	Foundations of Financial Technology
IEOR E4720	TOPICS IN QUANT FINANCE
IEOR E4721	TOPICS IN QUANT FINANCE
IEOR E4722	TOPICS IN QUANT FINANCE
IEOR E4723	TOPICS IN QUANTATIVE FINANCE
IEOR E4724	TOPICS IN QUANTATIVE FINANCE
IEOR E4725	Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation
IEOR E4726	TOPICS IN QUANTATIVE FINANCE
IEOR E4727	TOPICS IN QUANTATIVE FINANCE
IEOR E4728	TOPICS IN QUANTITATIVE FINANCE
IEOR E4729	TOPICS IN QUANTATIVE FINANCE
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4734	FOR EXCH/RELATD DERIVATVS INST
IEOR E4735	STRUCTURED#HYBRID PRODUCTS
IEOR E4737	AI Applications in Finance
IEOR E4741	Programming for Financial Engineering
IEOR E4742	Deep Learning for OR and FE
IEOR E4745	Applied Financial Risk Management
IEOR E4900	MASTERS RESEARCH OR PROJECT
IEOR E4999	FIELDWORK
ORCS E4529	Reinforcement Learning
or ORCS E6529	Advanced Reinforcement Learning
IEOR E6711	STOCHASTIC MODELING I
IEOR E6614	OPTIMIZATION II
IEOR E6712	STOCHASTIC MODELING II
IEOR E6613	Optimization, I
IEOR E8100	ADVANCED TOPICS IN IEOR
EEOR E6616	CONVEX OPTIMIZATION
Some pre-approved CBS electives that may satisfy MSFE electives	
DROM B8116	Risk Management
FINC B8307	Advanced Corporate Finance
FINC B8308	DEBT MARKETS
FINC B8309	Derivatives (Half-Term)
FINC B8310	Advanced Blockchain and Smart Contracts Course
FINC B8323	ASSET MANAGEMENT
FINC B8325	Mergers # Acquisitions
FINC B8326	Capital Markets Regulation
FINC B8343	Private Equity Finance
FINC B8347	Financial Crises, Regulatory Responses
FINC B8348	Emerging Financial Markets
FINC B8352	Financing Energy Infrastructure
FINC B8354	Personal Finance
Additional Financial Engineering electives will be offered [3]	

[1] Students may conclude the program in May, August, or December. Please visit the departmental website at msfe.ieor.columbia.edu for more information.

[2] All courses listed are for 3 points, unless stated otherwise.

[3] The list of Financial Engineering electives can be found at ieor.columbia.edu/msfe-curriculum.

Financial Engineering has seven concentrations:

1. Asset Management;
2. Computation and Programming;
3. Computational Finance and Trading Systems;
4. Derivatives;
5. Finance and Economics;
6. Financial Technology; and
7. Machine Learning for Financial Engineering.

Management Science and Engineering (MS)

The Master of Science in Management Science and Engineering (MS&E) is a 36-credit, STEM-designated program offered by Columbia Engineering in partnership with Columbia Business School, with a three-semester

curriculum designed for those who want to focus on management and engineering perspectives in solving problems of complex systems.

A defining feature of the curriculum is the year-long Operations Consulting course. This immersive capstone allows students to immediately bridge theory and practice by partnering with industry clients to solve high-stakes business and operational problems. Working in teams, students select from an array of active consulting projects, gaining invaluable, real-world experience alongside their advanced academic coursework.

Students must earn a minimum of 18 credits within the IEOR Department, and a minimum of 9 credits from Columbia Business School.

To graduate, students must also satisfy the minimum credit allocations for each designated semi-core requirement. With department approval, additional elective credits can be taken within IEOR, Columbia Business School, or at Columbia's other graduate schools, including the School of Engineering, the School of International and Public Affairs, the Law School, or the Departments of Economics, Mathematics, and Statistics.

Students in residence during the summer term can take two to four Business School courses in their third semester to complete their program.

Additional details regarding these electives are available on the MS&E website at ieor.columbia.edu/mse-curriculum.

Management Science and Engineering (36 credits)

Required Core Courses (12 credits)

IEOR E4004	OPTIMIZATION MODELS AND METHODS (first fall semester)
IEOR E4101	PROBABILITY STAT # SIMULATION (first fall semester)
IEOR E4102	STOCHASTIC MODELING FOR MSE (spring semester)
IEOR E4111	OPERATIONS CONSULTING (starts fall semester, year-long course)
IEOR E4399	MSE Quantitative Bootcamp
DROM B8000	OPTIMIZATION # SIMULATION BOOTCAMP

Semi-Core (18 credits)

Decision, Risk, and Operations Electives (9 credits minimum)

For a full list of DROM course schedules, visit course.business.columbia.edu.

Choose nine points from the following:

Please note that course may not be up to date. Please see the IEOR website and Columbia Business School directory for the most up to date approved courses available	
DROM B8101	Business Analytics I (Full Term)
DROM B8102	Process Improvement and Growth
DROM B8103	Business Analytics II Half Term
DROM B8105	HEALTHCARE ANALYTICS
DROM B8106	Operations Strategy
DROM B8107	Service Operations Management
DROM B8108	Supply chain management
or DROM B8109	Supply Chain Management
DROM B8110	Game-Theoretic Business Strategy
DROM B8112	QUANT FIN: MODELS # COMPUTATN
DROM B8114	Applied Regression Analysis
DROM B8115	Leading Sustainable Operations
DROM B8116	Risk Management
DROM B8117	Business Analytics III: Modern AI, Deep Learning, and Generative AI
DROM B8123	Demand Analytics
DROM B8128	Healthcare Venture Capital And Private Equity
DROM B8131	Sports Analytics
DROM B8132	Digital Health Startups
DROM B8143	Foundations of AI for Business
DROM B8145	Applying Digital Health
DROM B8146	Analytics in Action (Master Cl
DROM B8148	The Analytics Advantage
DROM B8153	People Analytics: Creating Business Value from Data
DROM B8159	Digital Marketplaces
DROM B8510	MANAGERIAL NEGOTIATIONS
DROM B8816	Quantitative Pricing # Revenue
DROM B8823	The U.S. Healthcare Industry
DROM B9122	COMPUTING FOR BUSINESS RESRCH

Analysis and Management Electives (9 credits minimum)

Analysis Group (3 credits minimum, up to 6 credits)

Choose one to four of the following:	
CSOR E4231	ANALYSIS OF ALGORITHMS I
EEOR E6616	CONVEX OPTIMIZATION
IEOR E4008	COMPUTATION DISCRETE OPT
IEOR E4010	Artificial Intelligence for OR and FE
IEOR E4011	Agentic AI for Operations Research and Financial Engineering
IEOR E4405	PRODUCTION SCHEDULING
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4418	TRANSPORTATION ANALYTICS # LOGISTICS
IEOR E4501	TOOLS FOR ANALYTICS
IEOR E4507	HEALTHCARE OPERATIONS MGT
IEOR E4520	APPLIED SYSTEMS ENGINEERING
IEOR E4521	SYSTEM ENGI TOOLS/METHODS
IEOR E4523	Data Analytics and Machine Learning
IEOR E4525	MACHINE LEARNING FE # OPR
IEOR E4526	ANALYTICS ON THE CLOUD
IEOR E4530	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4532	Visualization and Storytelling with Data
IEOR E4533	Performance, Objectives, # Results Using Data Analytics
IEOR E4534	Applied Analytics: from Data to Decisions
IEOR E4535	Analytics Engineering
IEOR E4540	DATA MINING
IEOR E4544	Statistical Methods for Analytics
IEOR E4564	Strategic Impact through Analytics

IEOR E4571	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4575	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4577	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4579	TOPICS IN OR (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4650	BUSINESS ANALYTICS
IEOR E4742	Deep Learning for OR and FE
ORCS E4529	Reinforcement Learning
Management Group (3 credits minimum, up to 6 credits)	
Choose one to four of the following:	
IEOR E4402	Corporate Finance, Accounting # Investment Banking
or IEOR E4403	QUANTITATIVE CORPORATE FINANCE
IEOR E4505	OPERATION RES IN PUBLIC POLICY
IEOR E4506	DESIGN DIGITAL OPERATING MODELS
IEOR E4510	PROJECT MANAGEMENT
IEOR E4570	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4575	TOPICS IN OPERATIONS RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4578	TOPICS IN OPERATION RESEARCH (Refer to IEOR website for list of approved topics titles and sections)
IEOR E4711	GLOBAL CAPITAL MARKETS
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
Pre-approved CBS courses that can count as Management Electives:	
FINC B8306	Capital Markets # Investments
FINC B8307	Advanced Corporate Finance
FINC B8310	Advanced Blockchain and Smart Contracts Course
FINC B8335	Private Equity Allocation
FINC B8357	Activist Value Investing for Small Cap Companies
FINC B8389	Hedge Funds
FINC B8416	Private Equity Leverage
FINC B8417	Private Equity Deals
FINC B8429	Digital Investing
MGMT B8500	MS Lead: People, Team, Organizations
MGMT B8502	MS Strategy Formulation
MGMT B8511	Turnaround Management
MGMT B8515	Top Management Process
MGMT B8518	Foundations of Entrepreneurship
MGMT B8519	Launch Your Startup
MGMT B8521	Foundations of Family Enterprise
MGMT B8524	Managerial Decision Making (Full-Ter)
MGMT B8527	Social Venture Incubator
MGMT B8531	Power # Influence
MGMT B8532	Food Entrepreneurship (Half-Term)
MGMT B8533	Family Office Management
MGMT B8534	Global Enterprise Management
MGMT B8536	Strategy and Competition in Ph
MGMT B8538	The Leader's Voice: Communicat
MGMT B8545	High Performing Nonprofits
MGMT B8551	Future of Work: Strategy # Leadership
MGMT B8553	Managerial Decision Making (Half-Term)
MGMT B8561	Entrepreneurial Law for Start-
MGMT B8573	Global Philanthropy
MGMT B8575	Governance
MGMT B8577	Think Bigger
MGMT B8578	Public Policy and the Healthca
MGMT B8579	Navigating Dynamics and Conflicts in Family Enterprise
MGMT B8581	Modern Political Economy
MGMT B8582	Food Entrepreneurship (Full-Term)
MGMT B8586	Entrepreneurial Strategy
MGMT B8587	Business Strategies for Solvin
MGMT B8590	People Analytics and Strategy
MGMT B8591	NYC Immersion Seminar: Food Service
MGMT B8592	Immersive Teamwork
MGMT B8618	Strategies For Long-Term Growth
MRKT B9620	MS Advanced Market Strategy
MRKT B8506	Launch Your Startup II
MRKT B8604	Frontiers in Retailing
MRKT B8608	Tech Ethics
MRKT B8618	Integrated Marketing Strategy
MRKT B8619	Behav Econ # Decision Making
MRKT B8623	Intro To Product Management
MRKT B8627	Urban Retail Placemaking
MRKT B8632	Digital Product Management Lab
MRKT B8636	Product Management (Full-Term)
MRKT B8649	Pricing Strategies
MRKT B8651	Systematic Creativity in Busin
MRKT B8662	Innovate Using Design Thinking

Breadth Electives (6 credits)

ACCT B8008	Earnings Quality # Fundamental
BUEC B8251	Financial Markets and the Macroeconomy
CSOR W4246	ALGORITHMS FOR DATA SCIENCE
FINC B8377	Value Investing
IEOR E4207	HUMAN FACTORS: PERFORMANCE
IEOR E4404	SIMULATION
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4573	TOPICS IN OR
IEOR E4574	TOPICS IN OR
IEOR E4576	TOPICS IN OPERATIONS RESEARCH
IEOR E4577	TOPICS IN OPERATIONS RESEARCH
IEOR E4578	TOPICS IN OPERATION RESEARCH
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4620	PRICING MODELS FOR FIN ENGIN
IEOR E4630	ASSET ALLOCATION
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
IEOR E4704	Foundations of Financial Technology
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4720	TOPICS IN QUANT FINANCE

IEOR E4721	TOPICS IN QUANT FINANCE
IEOR E4722	TOPICS IN QUANT FINANCE
IEOR E4723	TOPICS IN QUANTATIVE FINANCE
IEOR E4724	TOPICS IN QUANTATIVE FINANCE
IEOR E4725	Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation
IEOR E4728	TOPICS IN QUANTITATIVE FINANCE
IEOR E4729	TOPICS IN QUANTATIVE FINANCE
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4734	FOR EXCH/RELATD DERIVATVS INST
IEOR E4735	STRUCTURED#HYBRID PRODUCTS
IEOR E4737	AI Applications in Finance
IEOR E4741	Programming for Financial Engineering
IEOR E4745	Applied Financial Risk Management
IEOR E4900	MASTERS RESEARCH OR PROJECT
IEOR E4999	FIELDWORK
MRKT B8680	Digital Marketing in the AI Era (Half Term)
MRKT B9655	MS Digital Marketing

Management Science and Engineering Concentrations

In addition to the core and semi-core requirements, Management Science and Engineering has seven concentrations:

1. Operations and Analytics
2. Pricing and Revenue Management
3. Entrepreneurship and Innovation
4. Logistics and Supply Chain Management
5. Financial Technology (Fin Tech)
6. Healthcare Management
7. Product Management

Additional details regarding these concentrations are available on the MS&E website at ieor.columbia.edu/mse-curriculum.

Graduates of this program are expected to assume positions as analysts and associates in consulting firms, business analysts in logistics, supply chain, operations, or revenue management departments of large corporations, and as financial analysts in various functions (e.g., risk management) of investment banks, hedge funds, credit-card companies, and insurance firms.

Management Science and Engineering (36 credits) can be completed in a single calendar year, in three semesters. Students enter in the Fall term and can either finish their coursework in the Summer or the following Fall term.

Industrial Engineering (MS)

Graduate studies in Industrial Engineering is for students who want to enhance their training in special fields, such as scheduling, production planning, inventory control, and industrial economics. Students may complete the studies on a full time (12 points per term) or part time basis for a total of 30 STEM credits. Students may start in the Fall or Spring.

Industrial Engineers are required to satisfy a core program of graduate courses in production management, probability theory, statistics, simulation, and operations research.

All students must take at least 18 points of graduate work in Industrial Engineering and at least 30 points total of graduate studies at Columbia.

Industrial Engineering:

Required Core Courses (12 points)

IEOR E4150	INTRO-PROBABILITY # STATISTICS (For Fall Admits)
or STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
IEOR E4004	OPTIMIZATION MODELS AND METHODS
IEOR E4106	STOCHASTIC MODELS
IEOR E4108	SUPPLY CHAIN ANALYTICS
IEOR E4199	MSIEOR Quantitative Bootcamp (0 credits)

Approved IEOR Elective List (18 points)

IEOR Electives

Refer to IEOR website for list of approved topics titles and sections.

CSOR W4231	ANALYSIS OF ALGORITHMS I
CSOR W4246	ALGORITHMS FOR DATA SCIENCE
EEOR E6616	CONVEX OPTIMIZATION
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEOR E4008	COMPUTATION DISCRETE OPT
IEOR E4010	Artificial Intelligence for OR and FE
IEOR E4011	Agentic AI for Operations Research and Financial Engineering
IEOR E4207	HUMAN FACTORS: PERFORMANCE
IEOR E4402	Corporate Finance, Accounting # Investment Banking
or IEOR E4403	QUANTITATIVE CORPORATE FINANCE
IEOR E4404	SIMULATION
IEOR E4405	PRODUCTION SCHEDULING
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4418	TRANSPORTATION ANALYTICS # LOGISTICS
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4501	TOOLS FOR ANALYTICS
IEOR E4505	OPERATION RES IN PUBLIC POLICY
IEOR E4506	DESIGN DIGITAL OPERATING MODELS
IEOR E4507	HEALTHCARE OPERATIONS MGT
IEOR E4510	PROJECT MANAGEMENT
IEOR E4511	Industry Projects in Analytics # Operations Research
IEOR E4520	APPLIED SYSTEMS ENGINEERING
IEOR E4521	SYSTEM ENGI TOOLS/METHODS
IEOR E4523	Data Analytics and Machine Learning
IEOR E4525	MACHINE LEARNING FE # OPR

IEOR E4526	ANALYTICS ON THE CLOUD
IEOR E4530	TOPICS IN OPERATIONS RESEARCH
IEOR E4532	Visualization and Storytelling with Data
IEOR E4533	Performance, Objectives, # Results Using Data Analytics
IEOR E4534	Applied Analytics: from Data to Decisions
IEOR E4535	Analytics Engineering
IEOR E4540	DATA MINING
IEOR E4544	Statistical Methods for Analytics
IEOR E4564	Strategic Impact through Analytics
IEOR E4570	TOPICS IN OPERATIONS RESEARCH
IEOR E4571	TOPICS IN OPERATIONS RESEARCH
IEOR E4572	TOPICS IN OPERATIONS RESEARCH
IEOR E4573	TOPICS IN OR
IEOR E4574	TOPICS IN OR
IEOR E4575	TOPICS IN OPERATIONS RESEARCH
IEOR E4576	TOPICS IN OPERATIONS RESEARCH
IEOR E4577	TOPICS IN OPERATIONS RESEARCH
IEOR E4578	TOPICS IN OPERATION RESEARCH
IEOR E4579	TOPICS IN OR
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4620	PRICING MODELS FOR FIN ENGIN
IEOR E4630	ASSET ALLOCATION
IEOR E4650	BUSINESS ANALYTICS
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
IEOR E4704	Foundations of Financial Technology
IEOR E4711	GLOBAL CAPITAL MARKETS
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4720	TOPICS IN QUANT FINANCE
IEOR E4721	TOPICS IN QUANT FINANCE
IEOR E4722	TOPICS IN QUANT FINANCE
IEOR E4723	TOPICS IN QUANTATIVE FINANCE
IEOR E4724	TOPICS IN QUANTATIVE FINANCE
IEOR E4725	Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation
IEOR E4726	TOPICS IN QUANTATIVE FINANCE
IEOR E4727	TOPICS IN QUANTATIVE FINANCE
IEOR E4728	TOPICS IN QUANTITATIVE FINANCE
IEOR E4729	TOPICS IN QUANTATIVE FINANCE
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4734	FOR EXCH/RELATD DERIVATVS INST
IEOR E4735	STRUCTURED#HYBRID PRODUCTS
IEOR E4737	AI Applications in Finance
IEOR E4741	Programming for Financial Engineering
IEOR E4742	Deep Learning for OR and FE
IEOR E4745	Applied Financial Risk Management
IEOR E4900	MASTERS RESEARCH OR PROJECT
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
IEOR E4999	FIELDWORK
IEOR E6711	STOCHASTIC MODELING I
IEOR E6614	OPTIMIZATION II
IEOR E6712	STOCHASTIC MODELING II
IEOR E6613	Optimization, I
IEOR E8100	ADVANCED TOPICS IN IEOR
ORCS E4200	Data-driven Decision Modeling
ORCS E4201	Policy for Privacy Technologies
ORCS E4529	Reinforcement Learning
ORCS E6529	Advanced Reinforcement Learning

Additional Electives

APMA E4200	PARTIAL DIFFERENTIAL EQUATIONS
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4775	Causal Inference
ECON GU4415	GAME THEORY
ECON GU4860	BEHAVIORAL FINANCE
MATH GU4061	INTRO MODERN ANALYSIS I
MATH GR5010	INTRO TO THE MATH OF FINANCE
MATH GR5450	Credit Analytics
MATH GR6151	ANALYSIS # PROBABILITY I
STAT GU4243	
STAT GU4224	BAYESIAN STATISTICS

Columbia Business School Electives

Course codes may include DROM Bxxxx, MRKT Bxxxx, ACCT Bxxxx, or FINC Bxxxx. Please refer to the MSIE website for pre-approved CBS listings. Courses not listed below must be pre-approved by IEOR advising prior to the add/drop date of the semester.

Please note: Programming courses from CBS are not approved.

ACCT B8029	Mergers # Acquisitions Transactions
BUEC B8211	The Digital Economy: Regulatory Conflicts and Opportunities
BUEC B8216	ECONOMICS OF STRATEGIC BEHAVIOR
BUEC B8498	Mergers # Acquisitions in Medi
DROM B8103	Business Analytics II Half Term
DROM B8106	Operations Strategy
DROM B8107	Service Operations Management
DROM B8116	Risk Management
DROM B8117	Business Analytics III: Modern AI, Deep Learning, and Generative AI
DROM B8131	Sports Analytics
DROM B8159	Digital Marketplaces
DROM B8510	MANAGERIAL NEGOTIATIONS
FINC B8307	Advanced Corporate Finance
FINC B8325	Mergers # Acquisitions
FINC B8331	Real Estate Finance
FINC B9325	(PhD)Fincl Econometrics I
MGMT B8518	Foundations of Entrepreneurship
MGMT B8577	Think Bigger
MRKT B8604	Frontiers in Retailing
MRKT B8607	Strategic Consumer Insights
MRKT B8609	Generative AI for Business (Half-Term)
MRKT B8632	Digital Product Management Lab
MRKT B8636	Product Management (Full-Term)
MRKT B8662	Innovate Using Design Thinking
MRKT B8663	Social Innovation using Data-Driven Design
MRKT B8679	Digital Marketing in the AI Era (Full-Term)
or MRKT B8680	Digital Marketing in the AI Era (Half Term)

Industrial Engineering may include concentrations in:

1. Healthcare Management;
2. Regulated Industries; and
3. Systems Engineering.

Additional details regarding these concentrations and electives are available in the Departmental office and on the IEOR website at https://ieor.columbia.edu/msie-curriculum.

Operations Research (MS)

Operations Research is an applied science that is concerned with quantitative decision problems that generally involve the allocation and control of limited resources. Such problems arise, for example, in the operations of industrial firms, financial institutions, health care organizations, transportation systems, energy and resources, and government.

Graduate studies in Operations Research enables students to concentrate their studies in methodological areas such as mathematical programming, stochastic models, and simulation. Students may complete the studies on a full time (12 points per term) or part time basis for a total of 30 STEM credits. Students may start in the Fall or Spring.

Operation Research Engineers are required to satisfy a core program of graduate courses in simulation, probability theory, statistics, stochastic models, and operations research.

All students must take at least 18 points of graduate work in IEOR and at least 30 points of graduate studies at Columbia.

Operations Research

Required Core Courses (12 points):

Required Core Courses (12 points):	
IEOR E4150	INTRO-PROBABILITY # STATISTICS (For Fall Admits) [1]
or STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
IEOR E4004	OPTIMIZATION MODELS AND METHODS
IEOR E4106	STOCHASTIC MODELS
IEOR E4404	SIMULATION
IEOR E4199	MSIEOR Quantitative Bootcamp

[1] STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS will not count toward the 18 IEOR point requirement.

IEOR Approved Electives (18 points):

IEOR Electives

Refer to IEOR website for list of approved topics titles and sections.

CSOR E4231	ANALYSIS OF ALGORITHMS I
CSOR W4246	ALGORITHMS FOR DATA SCIENCE
EEOR E6616	CONVEX OPTIMIZATION
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEOR E4008	COMPUTATION DISCRETE OPT
IEOR E4010	Artificial Intelligence for OR and FE
IEOR E4011	Agentic AI for Operations Research and Financial Engineering
IEOR E4108	SUPPLY CHAIN ANALYTICS
IEOR E4207	HUMAN FACTORS: PERFORMANCE
IEOR E4402	Corporate Finance, Accounting # Investment Banking
IEOR E4405	PRODUCTION SCHEDULING
IEOR E4407	GAME THEOR MODELS OF OPERATION
IEOR E4418	TRANSPORTATION ANALYTICS # LOGISTICS
IEOR E4500	APPLICATIONS PROGRAMMNG FOR FE
IEOR E4501	TOOLS FOR ANALYTICS
IEOR E4505	OPERATION RES IN PUBLIC POLICY
IEOR E4506	DESIGN DIGITAL OPERATING MODELS
IEOR E4507	HEALTHCARE OPERATIONS MGT
IEOR E4510	PROJECT MANAGEMENT
IEOR E4511	Industry Projects in Analytics # Operations Research
IEOR E4520	APPLIED SYSTEMS ENGINEERING
IEOR E4521	SYSTEM ENGI TOOLS/METHODS
IEOR E4523	Data Analytics and Machine Learning
IEOR E4525	MACHINE LEARNING FE # OPR
IEOR E4526	ANALYTICS ON THE CLOUD
IEOR E4530	TOPICS IN OPERATIONS RESEARCH
IEOR E4532	Visualization and Storytelling with Data
IEOR E4533	Performance, Objectives, # Results Using Data Analytics
IEOR E4534	Applied Analytics: from Data to Decisions
IEOR E4535	Analytics Engineering
IEOR E4540	DATA MINING
IEOR E4544	Statistical Methods for Analytics
IEOR E4564	Strategic Impact through Analytics
IEOR E4570	TOPICS IN OPERATIONS RESEARCH
IEOR E4571	TOPICS IN OPERATIONS RESEARCH
IEOR E4572	TOPICS IN OPERATIONS RESEARCH
IEOR E4573	TOPICS IN OR
IEOR E4574	TOPICS IN OR
IEOR E4575	TOPICS IN OPERATIONS RESEARCH
IEOR E4576	TOPICS IN OPERATIONS RESEARCH
IEOR E4577	TOPICS IN OPERATIONS RESEARCH
IEOR E4578	TOPICS IN OPERATION RESEARCH
IEOR E4579	TOPICS IN OR
IEOR E4601	DYNAMIC PRICING/REVENUE MGMT
IEOR E4602	QUANTITATIVE RISK MANAGEMENT
IEOR E4620	PRICING MODELS FOR FIN ENGIN
IEOR E4630	ASSET ALLOCATION
IEOR E4650	BUSINESS ANALYTICS
IEOR E4700	INTRO TO FINANCIAL ENGINEERING
IEOR E4704	Foundations of Financial Technology
IEOR E4711	GLOBAL CAPITAL MARKETS
IEOR E4718	INTRO-IMPLIED VOLATILITY SMILE
IEOR E4720	TOPICS IN QUANT FINANCE
IEOR E4721	TOPICS IN QUANT FINANCE
IEOR E4722	TOPICS IN QUANT FINANCE
IEOR E4723	TOPICS IN QUANTATIVE FINANCE
IEOR E4724	TOPICS IN QUANTATIVE FINANCE

IEOR E4725	Topics in Quantitative Finance: Numerical Solutions of Partial Differential Equation
IEOR E4726	TOPICS IN QUANTATIVE FINANCE
IEOR E4727	TOPICS IN QUANTATIVE FINANCE
IEOR E4728	TOPICS IN QUANTITATIVE FINANCE
IEOR E4729	TOPICS IN QUANTATIVE FINANCE
IEOR E4731	CREDIT RISK/CREDIT DERIVATIVES
IEOR E4732	COMPUT METHODS IN FINANCE
IEOR E4733	ALGORITHMIC TRADING
IEOR E4734	FOR EXCH/RELATD DERIVATVS INST
IEOR E4735	STRUCTURED#HYBRID PRODUCTS
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IEOR E4745	Applied Financial Risk Management
IEOR E4900	MASTERS RESEARCH OR PROJECT
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
IEOR E4999	FIELDWORK
IEOR E6711	STOCHASTIC MODELING I
IEOR E6614	OPTIMIZATION II
IEOR E6712	STOCHASTIC MODELING II
IEOR E6613	Optimization, I
IEOR E8100	ADVANCED TOPICS IN IEOR
ORCS E4200	Data-driven Decision Modeling
ORCS E4201	Policy for Privacy Technologies
ORCS E4529	Reinforcement Learning
ORCS E6529	Advanced Reinforcement Learning

Non-IEOR Electives

APMA E4200	PARTIAL DIFFERENTIAL EQUATIONS
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4775	Causal Inference
ECON GU4415	GAME THEORY
ECON GU4860	BEHAVIORAL FINANCE
MATH GU4061	INTRO MODERN ANALYSIS I
MATH GR5010	INTRO TO THE MATH OF FINANCE
MATH GR5450	Credit Analytics
MATH GR6151	ANALYSIS # PROBABILITY I
STAT GU4224	BAYESIAN STATISTICS
STAT GU4243	
STAT GU4224	BAYESIAN STATISTICS

CBS Electives

Course codes may include DROM Bxxxx, MRKT Bxxxx, MGMT Bxxxx, ACCT Bxxxx, or FINC Bxxxx. Please refer to the MSOR website for pre-approved CBS listings. Courses not listed below must be pre-approved by IEOR advising prior to the add/drop date of the semester.

Please note: Programming courses from CBS are not approved.

ACCT B8029	Mergers # Acquisitions Transactions
BUEC B8211	The Digital Economy: Regulatory Conflicts and Opportunities
BUEC B8216	ECONOMICS OF STRATEGIC BEHAVIOR
BUEC B8498	Mergers # Acquisitions in Medi
DROM B8103	Business Analytics II Half Term
DROM B8106	Operations Strategy
DROM B8107	Service Operations Management
DROM B8116	Risk Management
DROM B8117	Business Analytics III: Modern AI, Deep Learning, and Generative AI
DROM B8131	Sports Analytics
DROM B8159	Digital Marketplaces
DROM B8510	MANAGERIAL NEGOTIATIONS
FINC B8307	Advanced Corporate Finance
FINC B8325	Mergers # Acquisitions
FINC B8331	Real Estate Finance
FINC B9325	(PhD)Fincl Econometrics I
MGMT B8518	Foundations of Entrepreneurship
MGMT B8577	Think Bigger
MRKT B8604	Frontiers in Retailing
MRKT B8607	Strategic Consumer Insights
MRKT B8609	Generative AI for Business (Half-Term)
MRKT B8632	Digital Product Management Lab
MRKT B8636	Product Management (Full-Term)
MRKT B8662	Innovate Using Design Thinking
MRKT B8663	Social Innovation using Data-Driven Design
MRKT B8679	Digital Marketing in the AI Era (Full-Term)
or MRKT B8680	Digital Marketing in the AI Era (Half Term)

Operations Research has eight areas of concentrations, including:

1. Analytics;
2. Stochastic Modeling;
3. Entrepreneurship and Innovation;
4. Finance and Management;
5. Healthcare Management;
6. Logistics and Supply Chain Management;
7. Machine Learning and Artificial Intelligence; and
8. Optimization.

Students may select from a variety of approved electives from the Department, Columbia Business School, and the Graduate School of Arts and Sciences. Additional details regarding these concentrations and electives are available in the Departmental office and on IEOR's website at https://ieor.columbia.edu/msor-curriculum.

Industrial Engineering (Joint MS and MBA)

Joint M.S. and M.B.A.

The Department and Columbia Business School offer a joint M.S. program in Industrial Engineering. Prospective students for this special program must submit separate applications to Columbia Engineering and Columbia Business School and be admitted to both schools for entrance into the joint program.

Admissions requirements are the same as those for the regular M.S. program in Industrial Engineering and for the M.B.A. This joint program is coordinated so that both degrees can be obtained after five terms of full-time study (30 points in two terms while registered in Columbia Engineering and 45 points in three terms while registered in Columbia Business School).

Students in the joint program must complete certain courses by the end of their first year of study. If a substantial equivalent has been completed during undergraduate studies, students should consult with a faculty adviser in order to obtain exemption from a required course.

Industrial Engineering (PhD), Operations Research (PhD)

Ph.D. Program

The IEOR Department offers two Ph.D. programs in

1. Industrial Engineering; and
2. Operations Research.

The requirements for the Ph.D. in Industrial Engineering and Ph.D. in Operations Research are identical. Both programs require the student to complete the qualifying procedure, fulfill the coursework requirements, and defend a dissertation based on the candidate's original research. The dissertation must be conducted under the supervision of an IEOR faculty advisor and may be theoretical or computational or both.

Qualifying Procedure

The qualifying procedure consists of two components:

1. complete the four Ph.D. core courses during the first year with an average GPA of 3.66 or above; and
2. conduct research during the first summer (ideally starting in Spring or earlier), submit a 3-5 page extended abstract, and present the work in a department seminar at the beginning of the second academic year.

Students will be reviewed after each component. Students who fail to complete component (1) may be asked to withdraw from the program at the end of the first year. Students who successfully complete component (1) will typically move on to summer research advised by a faculty member in the IEOR department.

In the rare instance that the PhD Committee is dissatisfied with a student's performance in component (2), the student may be asked to withdraw from the program during their second year.

Coursework Requirements

Doctoral students are also required to take four additional Ph.D. level courses during the program. Students can consider courses from other departments including Mathematics, Computer Science, Statistics, Economics, and Decision, Risk and Operations. Ph.D. Research credits (IEOR E9101 RESEARCH) do not count toward this requirement.

Doctoral candidates must obtain a minimum of 60 points of formal course credit beyond the bachelor's degree. A master's degree from an accredited institution may be accepted as equivalent to 30 points. A minimum of 30 points beyond the master's degree must be earned while in residence in the doctoral program. Detailed information regarding the requirements for the doctoral degree may be obtained in the Department office and on the IEOR website at ieor.columbia.edu.

Thesis Proposal and Dissertation Defense

Each student is expected to submit a research proposal and present it to a committee of three IEOR faculty members before the end of year 4. The committee considers the scope of the proposed research, its suitability for doctoral research and the appropriateness of the research plan. The committee may approve the proposal without reservation or may recommend modifications.

In accordance with regulations of the Graduate School of Arts and Sciences, each student is expected to submit a final thesis and defend it before a committee of five faculty, one of whom holds a primary appointment in another department, school or university.

MS/Ph.D. Track

Students admitted to the Ph.D. program without a master's degree in a related discipline are expected to fulfill additional requirements to earn a Master of Science after the first year, including:

- enroll full-time each semester
- complete a minimum of 30.0 credits in the first year, including the Ph.D. core courses
- receive passing letter grades for all classes

Students who successfully complete these requirements will receive the respective MS degree at the end of the first year. Those who also fulfill the qualifying requirements may continue on to the Ph.D. program. Those who do not meet the qualifying requirements will be dismissed from the program.

Materials Science and Engineering Program

Program in the Department of Applied Physics and Applied Mathematics, sharing teaching and research with the faculty of the Henry Krumb School of Mines.

200 S. W. Mudd, MC 4701
212-854-4457
apam.columbia.edu
matsci.apam.columbia.edu

Materials Science and Engineering (MSE) focuses on understanding, designing, and producing technology-enabling materials by analyzing the relationships among the synthesis and processing of materials, their properties, and their detailed structure. This includes a wide range of materials such as metals, polymers, ceramics, and semiconductors.

The undergraduate and graduate programs in materials science and engineering are coordinated through the MSE Program in the Department of Applied Physics and Applied Mathematics. This program promotes the interdepartmental nature of the discipline and involves the Departments of Applied Physics and Applied Mathematics, Chemical Engineering and Applied Chemistry, Electrical Engineering, and Earth and Environmental Engineering in the Henry Krumb School of Mines (HKSM) with advisory input from the Departments of Chemistry and Physics.

Students interested in materials science and engineering enroll in the materials science and engineering program in the Department of Applied

Physics and Applied Mathematics. The faculty listed constitute but a small fraction of those participating in materials research.

Materials science and engineering uses optical, electron, and scanning probe microscopy and diffraction techniques to reveal details of structure, ranging from the atomic to the macroscopic scale—details essential to understanding the relationship between materials synthesis and processing and materials properties, including electronic, magnetic, mechanical, optical, and thermal properties. These studies also give insight into problems of the deterioration of materials in service, enabling designers to prolong the useful life of their products. Materials science and engineering also focuses on new ways to synthesize and process materials, from bulk samples to ultrathin films to epitaxial heterostructures to nanocrystals and soft nanomaterials. This involves techniques such as UHV sputtering; molecular beam epitaxy; plasma etching; laser ablation, chemistry, and recrystallization; nanoscale self-assembly processes and other nonequilibrium processes. The widespread use of new materials and the new uses of existing materials in electronics, communications, and computers have intensified the demand for a systematic approach to the problem of relating properties to structure and have necessitated a multidisciplinary approach.

Materials science and solid-state and soft-matter science science use techniques such as transport measurements, X-ray photoelectron spectroscopy, X-ray scattering, X-ray and electron microscopy tomography, ferromagnetic resonance, inelastic light scattering, luminescence, and nonlinear optics to understand electrical, optical, and magnetic properties on a quantum mechanical level. Such methods are used to investigate exciting new types of structures, such as epitaxial metals, two-dimensional transition metal dichalcogenides, three-dimensional self-assembly nanomaterials, superconductors, and semiconductor surfaces and nanocrystals.

Current Research Activities

Current research activities in the materials science and engineering program at Columbia focus on thin films, electronic and magnetic materials, materials at high pressures, materials for advanced batteries, and the structure of soft nanomaterials and nanoparticle-based materials. Specific topics under investigation include interfaces, stresses, and grain boundaries in thin films; lattice defects and electrical properties of metals and semiconductors; laser processing and ultrarapid solidification of thin films; nucleation in condensed systems; magnetic and electrical properties of semiconductors and metals; synthesis of nanocrystals, two-dimensional materials, and nanotechnology-related materials; deposition, in situ characterization, electronic testing, and ultrafast spectroscopy of magnetoelectronic ultrathin films and heterostructures. In addition, there is research in first-principles electronic structure computation.

Laboratory Facilities

Facilities exist within the Materials Science Laboratory, which also serve as shared facilities for Materials Structural and Mechanical Characterization. Facilities and research opportunities also exist within the interdepartmental Columbia Nanotechnology Initiative (CNI). Modern clean room facilities with optical and e-beam lithography, thin film deposition, and surface analytical probes (STM, SPM, XPS), small-angle X-ray scattering as well as electron microscopes (SEM, S/TEM) are available. More specialized equipment exists in individual research groups in solid-state engineering and materials science and engineering. The research facilities in solid-state science and engineering are listed in the sections for each host department.

Program Chair

Professor William E. Bailey
1140 S. W. Mudd

Committee on Materials Science and Engineering

William E. Bailey
Associate Professor of Materials Science

Siu-Wai Chan
Professor of Materials Science

Aravind Devarakonda
Assistant Professor of Applied Physics and Applied Mathematics

Alexander L. Gaeta
David M. Rickey Professor of Applied Physics and Materials Science and Professor of Electrical Engineering

Oleg Gang
Professor of Chemical Engineering and Applied Physics and Materials Science

James S. Im
Professor of Materials Science

Chris A. Marianetti
Associate Professor of Materials Science

Ismail C. Noyan
Professor of Materials Science

Michele Simoncelli
Assistant Professor of Applied Physics and Applied Mathematics

Renata Wentzcovitch
Professor of Materials Science and Applied Physics, and Earth and Environmental Science

Yuan Yang
Associate Professor of Materials Science

Nanfang Yu
Associate Professor of Applied Physics

Course Descriptions

For related courses, see also Applied Physics and Applied Mathematics, Chemical Engineering, Earth and Environmental Engineering, Electrical Engineering, and Mechanical Engineering.

MSAE E3010 FOUNDATIONS OF MATERIALS SCIENCE. *3.00 points*.
Lect.: 3

Prerequisites: CHEM UN1404 and PHYS UN1011
Introduction to quantum mechanics: atoms, electron shells, bands, bonding; introduction to group theory: crystal structures, symmetry, crystallography; introduction to materials classes: metals, ceramics, polymers, liquid crystals, nanomaterials; introduction to polycrystals and disordered materials; noncrystalline and amorphous structures; grain boundary structures, diffusion; phase transformations; phase diagrams, time-temperature transformation diagrams; properties of single crystals: optical properties, electrical properties, magnetic properties, thermal properties, mechanical properties, and failure of polycrystalline and amorphous materials.

Fall 2026: MSAE E3010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3010	001/14148	T Th 10:10am - 11:25am 829 Seeley W. Mudd Building	Renata Wentzcovitch	3.00	14/30

MSAE E3012 LABORATORY IN MATERIALS SCI I. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3010) MSAE E3010
Lectures and hands-on experiments on the characterization of microstructure in crystalline and amorphous solids. Optical, scanning and transmission electron microscopy. Metallography, sample preparation and analysis. Stereology. Crystal structure determination with x-ray diffraction. Elemental analysis using energy-dispersive x-ray analysis. Atomic force microscopy

Fall 2026: MSAE E3012

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3012	001/14150	M 1:00pm - 5:00pm 214 Seeley W. Mudd Building	Yuan Yang	3.00	4/10

MSAE E3013 LABORATORY IN MATERIALS SCI II. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3011) MSAE E3012
Metallographic sample preparation, optical microscopy, quantitative metallography, hardness and tensile testing, plastic deformation, annealing, phase diagrams, brittle fracture of glass, temperature and strain-rate dependent deformation of polymers; written and oral reports. This is the second of a two-semester sequence materials laboratory course

Spring 2026: MSAE E3013

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3013	001/12989		Ismail Noyan	3.00	6/15

MSAE E3100 Crystallography. *3.00 points*.
Prerequisites: CHEM UN1403 or PHYS UN1403 or APMA E2101 Or equivalent
A first course in crystallography, crystal symmetry, Bravais lattices, point groups and space groups. Diffraction and diffracted intensities. Exposition of typical crystal structures in engineering materials, including metals, ceramics and semiconductors. Crystalline anisotropy.

Fall 2026: MSAE E3100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3100	001/14154	T Th 11:40am - 12:55pm 1024 Seeley W. Mudd Building	William Bailey	3.00	6/23

MSAE E3111 THERMO/KINETIC THRY/STAT MECH. *3.00 points*.
Lect: 3.

An introduction to the basic thermodynamics of systems, including concepts of equilibrium, entropy, thermodynamic functions, and phase changes. Basic kinetic theory and statistical mechanics, including diffusion processes, concept of phase space, classical and quantum statistics, and applications thereof

Fall 2026: MSAE E3111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3111	001/14153	T Th 4:10pm - 5:25pm 101 Knox Hall	Michele Simoncelli	3.00	19/35

MSAE E3156 DESIGN PROJECT. *3.00 points*.
Prerequisites: Senior standing. Written permission from instructor and approval from adviser.
E3156: a design problem in materials science or metallurgical engineering selected jointly by the student and a professor in the department. The project requires research by the student, directed reading, and regular conferences with the professor in charge. E3157: completion of the research, directed reading, and conferences, culminating in a written report and an oral presentation to the department

Fall 2026: MSAE E3156

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3156	001/14152		Yuan Yang	3.00	3/10

MSAE E3157 DESIGN PROJECT. *3.00 points*.
Prerequisites: Senior standing. Written permission from instructor and approval from adviser.
E3156: a design problem in materials science or metallurgical engineering selected jointly by the student and a professor in the department. The project requires research by the student, directed reading, and regular conferences with the professor in charge. E3157: completion of the research, directed reading, and conferences, culminating in a written report and an oral presentation to the department

Spring 2026: MSAE E3157

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3157	001/12992		Yuan Yang	3.00	6/10

MSAE E3201 Materials Thermodynamics and Phase Diagrams. *3.00 points*.
Prerequisites: MSAE E3010 Or equivalent or permission of the instructor
Review of laws of thermodynamics, thermodynamic variables and relations, free energies and equilibrium in thermodynamic systems. Unary, binary, and ternary phase diagrams, compounds and intermediate phases, solid solutions and Hume-Rothery rules, relationship between phase diagrams and metastability, defects in crystals. Thermodynamics of surfaces and interfaces, effect of particle size on phase equilibria, adsorption isotherms, grain boundaries, surface energy, electrochemistry.
Note: MSAE E4201 shares lectures and meeting times with E3201 and therefore, may not be taken in other semesters.

Spring 2026: MSAE E3201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3201	001/12997	T Th 11:40am - 12:55pm 627 Seeley W. Mudd Building	Renata Wentzcovitch	3.00	7/10

MSAE E3900 UNDERGRAD RES IN MATERIALS SCI. *0.00-4.00 points*.
0 to 4 pts.

Prerequisites: Written permission from instructor and approval from adviser.
May be repeated for credit, but no more than 6 points of this course may be counted toward the satisfaction of the B.S. degree requirements. Candidates for the B.S. degree may conduct an investigation in materials science or carry out a special project under the supervision of the staff. Credit for the course is contingent upon the submission of an acceptable thesis or final report

Spring 2026: MSAE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3900	004/20338		Siu-Wai Chan	0.00-4.00	1/5
MSAE 3900	007/18335		Michele Simoncelli	0.00-4.00	1/5
MSAE 3900	012/20394		Yuan Yang	0.00-4.00	1/5

Summer 2026: MSAE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 3900	001/11370		Siu-Wai Chan	0.00-4.00	1/5
MSAE 3900	002/11476		Nanfang Yu	0.00-4.00	0/2

MSAE E4090 NANOTECHNOLOGY. *3.00 points*.
Lect: 3.

Prerequisites: (APPH E3100) and (MSAE E3010) or their equivalents with instructor's permission.
The science and engineering of creating materials, functional structures and devices on the nanometer scale. Carbon nanotubes, nanocrystals, quantum dots, size dependent properties, self-assembly, nanostructured materials. Devices and applications, nanofabrication. Molecular engineering, bionanotechnology. Imaging and manipulating at the atomic scale. Nanotechnology in society and industry. Offered in alternate years.

Spring 2026: MSAE E4090

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4090	001/13006	M W 2:40pm - 3:55pm 415 Schapiro Cepser	Yuan Yang	3.00	33/42
MSAE 4090	V01/16667		Yuan Yang	3.00	3/99

MSAE E4100 CRYSTALLOGRAPHY. *3.00 points*.
Lect: 3

Prerequisites: (CHEM UN1403) and (PHYS UN1403) and (APMA E2101) or APMA E2101 AND CHEM W1403 AND PHYS W1403; or equivalent.
A first course on crystallography. Crystal symmetry, Bravais lattices, point groups, space groups. Diffraction and diffracted intensities. Exposition of typical crystal structures in engineering materials, including metals, ceramics, and semiconductors. Crystalline anisotropy

Fall 2026: MSAE E4100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4100	001/14155	T Th 11:40am - 12:55pm 1024 Seeley W. Mudd Building	William Bailey	3.00	16/28
MSAE 4100	V01/18132		William Bailey	3.00	1/99

MSAE E4102 SYNTHESIS # PROCESSING OF MATERIALS. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3010) or equivalent or instructors permission
A course on synthesis and processing of engineering materials. Established and novel methods to produce all types of materials (including metals, semiconductors, ceramics, polymers, and composites). Fundamental and applied topics relevant to optimizing the microstructure of the materials with desired properties. Synthesis and processing of bulk, thin-film, and nano materials for various mechanical and electronic applications.

Spring 2026: MSAE E4102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4102	001/13005	T Th 2:40pm - 3:55pm 1024 Seeley W. Mudd Building	Siu-Wai Chan	3.00	20/25
MSAE 4102	V01/18012		Siu-Wai Chan	3.00	1/99

MSAE E4105 Ceramic Nanomaterials. *3.00 points*.
Lect: 3.

Prerequisites: (CHEM UN1404) or or equivalent undergraduate thermodynamics.
Ceramic nanomaterials and nanostructures: synthesis, characterization, size-dependent properties, and applications; surface energy, surface tension and surface stress; effect of ligands, surfactants, adsorbents, isoelectric point, and surface charges; supersaturation and homogenous nucleation for monodispersity.

MSAE E4200 THEORY CRYSTALLIN MAT: PHONONS. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E4100) or MSAE E4100; or instructor's permission.
Phenomenological theoretical understanding of vibrational behavior of crystalline materials; introducing all key concepts at classical level before quantizing the Hamiltonian. Basic notions of Group Theory introduced and exploited: irreducible representations, Great Orthogonality Theorem, character tables, degeneration, product groups, selection rules, etc. Both translational and point symmetry employed to block diagonalize the Hamiltonian and compute observables related to vibrations/phonons. Topics include band structures, density of states, band gap formation, nonlinear (anharmonic) phenomena, elasticity, thermal conductivity, heat capacity, optical properties, ferroelectricty. Illustrated using both minimal model Hamiltonians in addition to accurate Hamiltonians for real materials (e.g., Graphene)

Fall 2026: MSAE E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4200	001/14158	T Th 1:10pm - 2:25pm 545 Seeley W. Mudd Building	Chris Marianetti	3.00	11/35
MSAE 4200	V01/18133		Chris Marianetti	3.00	1/99

MSAE E4201 MATERIALS THERMODYN/PHASE DIAG. *3.00 points*.
Lect.: 3

Prerequisites: (MSAE E3010) or equivalent or instructor's permission.
Review of laws of thermodynamics, thermodynamic variables and relations, free energies and equilibrium in thermodynamic system. Statistical thermodynamics. Unary, binary, and ternary phase diagrams, compounds and intermediate phases, solid solutions and Hume-Rothery rules, relationship between phase diagrams and metastability, defects in crystals. Thermodynamics of surfaces and interfaces, effect of particle size on phase equilibria, adsorption isotherms, grain boundaries, surface energy, electrochemistry, statistical mechanics.

Spring 2026: MSAE E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4201	001/13001	T Th 11:40am - 12:55pm 627 Seeley W. Mudd Building	Renata Wentzcovitch	3.00	5/20
MSAE 4201	V01/16668		Renata Wentzcovitch	3.00	1/99

MSAE E4202 KINETICS OF TRANSFORMATIONS. *3.00 points*.
Lect: 3.

Prerequisites: (MSAE E4201) MSAE E4201
Review of thermodynamics, irreversible thermodynamics, diffusion in crystals and noncrystalline materials, phase transformations via nucleation and growth, overall transformation analysis and time-temperature-transformation (TTT) diagrams, precipitation, grain growth, solidification, spinodal and order-disorder transformations, martensitic transformation

Spring 2026: MSAE E4202

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4202	001/13009	W 4:10pm - 6:40pm 610 Martin Luther King Building	James Im	3.00	22/25
MSAE 4202	V01/16792		James Im	3.00	2/99

MSAE E4203 THEORY CRYSTALL MAT: ELECTRONS. *3.00 points*.
Prerequisites: MSAE E4200 Or instructor's permission
Phenomenological theoretical understanding of electrons in crystalline materials. Both translational and point symmetry employed to block diagonalize the Schrödinger equation and compute observables related to electrons. Topics include nearly free electrons, tight-binding, electron-electron interactions, transport, magnetism, optical properties, topological insulators, spin-orbit coupling, and superconductivity. Illustrated using both minimal model Hamiltonians in addition to accurate Hamiltonians for real materials.

Spring 2026: MSAE E4203

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4203	001/13013	T Th 1:10pm - 2:25pm 1024 Seeley W. Mudd Building	Chris Marianetti	3.00	18/25
MSAE 4203	V01/16795		Chris Marianetti	3.00	0/99

MSAE E4206 ELEC # MAGNETIC PROP OF SOLIDS. *3.00 points*.
Prerequisites: PHYS W1401 AND PHYS C1402 AND PHYS W1403; or equivalent.
A survey course on the electronic and magnetic properties of materials, oriented towards materials for solid state devices. Dielectric and magnetic properties, ferroelectrics and ferromagnets. Conductivity and superconductivity. Electronic band theory of solids: classification of metals, insulators, and semiconductors. Materials in devices: examples from semiconductor lasers, cellular telephones, integrated circuits, and magnetic storage devices. Topics from physics are introduced as necessary

MSAE E4215 MECH BEHAVIOR OF MATERIALS. *3.00 points*.
Lect: 3.

Prerequisites: (MSAE E3010) Recommended preparation: a course in mechanics of materials.
Review of states of stress and strain and their relations in elastic, plastic, and viscous materials. Dislocation and elastic-plastic concepts introduced to explain work hardening, various materials-strengthening mechanisms, ductility, and toughness. Macroscopic and microstructural aspects of brittle and ductile fracture mechanics, creep and fatigue phenomena. Case studies used throughout, including flow and fracture of structural alloys, polymers, hybrid materials, composite materials, ceramics, and electronic materials devices. Materials reliability and fracture prevention emphasized.

Spring 2026: MSAE E4215

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4215	001/13016	M W 10:10am - 11:25am 1127 Seeley W. Mudd Building	William Bailey	3.00	16/35
MSAE 4215	V01/16670		William Bailey	3.00	1/99

Fall 2026: MSAE E4215

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4215	001/14159	M W 10:10am - 11:25am 1024 Seeley W. Mudd Building	Ismail Noyan	3.00	19/35
MSAE 4215	V01/18134		Ismail Noyan	3.00	1/99

MSAE E4250 CERAMICS # COMPOSITES. *3.00 points*.
Lect: 3.

Prerequisites: (MSAE E3010) and (MSAE E3013) Or instructor's permission.
Corequisites: MSAE E3013,MSAE E3010
Will cover some of the fundamental processes of atomic diffusion, sintering and microstructural evolution, defect chemistry, ionic transport, and electrical properties of ceramic materials. Following this, we will examine applications of ceramic materials, specifically, ceramic thick and thin film materials in the areas of sensors and energy conversion/storage devices such as fuel cells, and batteries. The coursework level assumes that the student has already taken basic courses in the thermodynamics of materials, diffusion in materials, and crystal structures of materials.

Fall 2026: MSAE E4250

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4250	001/14163	W 7:00pm - 9:30pm 644 Seeley W. Mudd Building		3.00	7/35

MSAE E4260 ELECTROCHEM MATLS # DEVS. *3.00 points*.
Lect: 3.

Prerequisites: (CHEM UN1403) and (MSAE E3010) or CHEM W1403 AND MSAE E3010; or equivalents or instructor's permission.
Overview of electrochemical processes and applications from perspectives of materials and devices. Thermodynamics and principles of electrochemistry, methods to characterize electrochemical processes, application of electrochemical materials and devices, including batteries, supercapacitors, fuel cells, electrochemical sensor, focus on link between material structure, composition, and properties with electrochemical performance.

Fall 2026: MSAE E4260

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4260	001/14160	M W 11:40am - 12:55pm 1024 Seeley W. Mudd Building	Yuan Yang	3.00	25/35
MSAE 4260	V01/18135		Yuan Yang	3.00	1/99

MSAE E4301 MATERIALS SCIENCE LABORATORY. *3.00 points*.
Prerequisites: Introductory materials course or equivalent or instructor's permission.
General experimental techniques in materials science, including X-ray diffraction, scanning electron microscopies, atomic force microscopy, materials synthesis and thermodynamics, characterization of material properties (mechanical, electrochemical, magnetic, electronic). Additional experiments at discretion of instructor

Fall 2026: MSAE E4301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4301	001/14161	M 1:00pm - 5:00pm 214 Seeley W. Mudd Building	Yuan Yang	3.00	9/20

MSAE E4990 SPEC TOPICS:MATERIAL SCI # ENGIN. *1.00-3.00 points*.
Prerequisites: Instructor's permission.
May be repeated for credit. Topics and instructors change from year to year. For advanced undergraduate students and graduate students in engineering, physical sciences, and other fields

MSAE E4999 SUPERVISED INTERNSHIP. *1.00-3.00 points*.
Prerequisites: Internship and approval from adviser must be obtained in advance.
Only for master's students in the Department of Applied Physics and Applied Mathematics who may need relevant work experience as part of their program of study. Final report required. May not be taken for pass/fail or audited

Summer 2026: MSAE E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 4999	001/11471		Yuan Yang	1.00-3.00	2/5

MSAE E6085 COMP ELEC STRUCT-COMPLX MTRS. *3.00 points*.
Prerequisites: (APPH E3100) or APPH E3100; or equivalent.
Basics of density functional theory (DFT) and its application to complex materials. Computation of electronics and mechanical properties of materials. Group theory, numerical methods, basis sets, computing, and running open source DFT codes. Problem sets and a small project

MSAE E6100 TRANSMISSION ELEC MICROSCOPY. *3.00 points*.
Lect.: 3

Prerequisites: Instructor's permission.
Course Fee: $600. Theory and practice of transmission electron microscopy (TEM): principles of electron scattering, diffraction, and microscopy; analytical techniques used to determine local chemistry; introduction to sample preparation; laboratory and in-class remote access demonstrations, several hours of hands-on laboratory operation of the microscope; the use of simulation and analysis software; guest lectures on cryomicroscopy for life sciences and high resolution transmission electron microscopy for physical sciences; and, time permitting, a visit to the electron microscopy facility in the Center for Functional Nanomaterials (CFN) at the Brookhaven National Laboratory (BNL).

MSAE E6251 THIN FILMS AND LAYERS. *3.00 points*.
Lect: 3.

Vacuum basics, deposition methods, nucleation and growth, epitaxy, critical thickness, defects properties, effect of deposition procedure, mechanical properties, adhesion, interconnects, and electromigration

MSAE E6273 MATERIALS SCIENCE REPORTS. *0.00-6.00 points*.
0 to 6 pts.

Prerequisites: Written permission from instructor and approval from adviser.
Formal written reports and conferences with the appropriate member of the faculty on a subject of special interest to the student but not covered in the other course offerings

Spring 2026: MSAE E6273

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 6273	002/20080		William Bailey	0.00-6.00	1/5
MSAE 6273	008/20403		James Im	0.00-6.00	3/5
MSAE 6273	012/20095		Yuan Yang	0.00-6.00	4/8

Summer 2026: MSAE E6273

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 6273	001/11474		Siu-Wai Chan	0.00-6.00	1/5

Fall 2026: MSAE E6273

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 6273	008/19985		Michele Simoncelli	0.00-6.00	0/10

MSAE E8235 SELECTED TPCS IN MATERIALS SCI. *3.00 points*.
Lect: 3.

May be repeated for credit. Selected topics in materials science. Topics and instructors change from year to year. For students in engineering, physical sciences, biological sciences, and related fields

MSAE E9000 MATERIALS SCIENCE COLLOQUIUM. *0.00 points*.
0 pts.

Speakers from universities, national laboratories, and industry are invited to speak on the recent impact of materials science and engineering innovations

MSAE E9301 DOCTORAL RESEARCH. *0.00-15.00 points*.
0-15 pts.

Prerequisites: Qualifying examination for the doctorate.
Required of doctoral candidates

Spring 2026: MSAE E9301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 9301	001/17801		William Bailey	0.00-15.00	1/6
MSAE 9301	002/17770		James Hone, Katayun Barmak	0.00-15.00	4/5
MSAE 9301	003/17776		Aravind Devarakonda	0.00-15.00	1/5
MSAE 9301	008/17771		James Im	0.00-15.00	3/5
MSAE 9301	009/17772		Chris Marianetti	0.00-15.00	2/5
MSAE 9301	011/17773		Renata Wentzcovitch	0.00-15.00	0/5
MSAE 9301	012/17774		Yuan Yang	0.00-15.00	3/8
MSAE 9301	013/17775		Nanfang Yu	0.00-15.00	2/5

Fall 2026: MSAE E9301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MSAE 9301	001/15045		William Bailey	0.00-15.00	1/10
MSAE 9301	003/15040		Aravind Devarakonda	0.00-15.00	1/10
MSAE 9301	006/15041		James Im	0.00-15.00	0/10
MSAE 9301	007/15042		Chris Marianetti	0.00-15.00	1/10
MSAE 9301	009/15039		Renata Wentzcovitch	0.00-15.00	1/10
MSAE 9301	010/15043		Yuan Yang	0.00-15.00	2/10
MSAE 9301	011/15044		Nanfang Yu	0.00-15.00	0/10

Undergraduate Programs

- Materials Science (BS) (p. 291)
- Materials Science Minor (p. 332)

Materials Science (BS)

Undergraduate Program in Material Science

The objectives of the undergraduate program in the Materials Science Program of the Department of Applied Physics and Applied Mathematics are as follows:

1. Professional employment in industry, including materials production, automotive, aerospace, microelectronics, information storage, medical devices, energy production, storage and conversion, and in engineering consulting firms.
2. Graduate studies in materials science and engineering or related fields.

The undergraduate curriculum is designed to provide the basis for developing, improving, and understanding materials and processes for application in engineered systems. It draws from physics, chemistry and other disciplines to provide a coherent background for immediate application in engineering or for subsequent advanced study. The emphasis is on fundamentals relating atomic-to-microscopic-scale phenomena to materials properties and processing, including design and control of industrially important materials processes. Core courses and electives combine rigor with flexibility and provide opportunities for focusing on such areas as nanomaterials, materials for green energy, materials for infrastructure and manufacturing, materials for health and biotechnology, and materials for next generation electronics.

The unifying theme of understanding and interrelating materials synthesis, processing, structure, and properties forms the basis of our program and is evident in the undergraduate curriculum and in faculty research activities. These activities include work on polycrystalline silicon for flat panel displays; semiconductors for lasers and solar cell applications, magnetic heterostructures for information storage and novel computation architectures; electronic ceramics for batteries, gas sensors and fuel cells; electrodeposition and corrosion of metals; and the analysis and design of high-temperature reactors and first principles calculations. Through involvement with our research groups, students gain valuable hands-on experience and are often engaged in joint projects with industrial and government laboratories.

Students are strongly encouraged to take courses in the order specified in the course tables; implications of deviations should be discussed with a departmental adviser before registration. The first two years provide a strong grounding in the physical and chemical sciences, materials fundamentals, and mathematics. This background is used to provide a unique physical approach to the study of materials. The last two years of the undergraduate program provide substantial exposure to modern materials science and include courses in processing, structure and properties of materials that extend the work of the first two years. Graduates of the program are equipped for employment in industry. Graduates are prepared for graduate study in materials science and engineering and related fields.

Required Materials Science Courses

Students are required to take 13 Materials Science courses for a total of 37 points. The required courses are:

MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE
MSAE E3012	LABORATORY IN MATERIALS SCI I
MSAE E3013	LABORATORY IN MATERIALS SCI II
MSAE E3100	Crystallography
MSAE E3156	DESIGN PROJECT
MSAE E3157	DESIGN PROJECT
MSAE E3201	Materials Thermodynamics and Phase Diagrams
MSAE E4102	SYNTHESIS # PROCESSING OF MATERIALS
MSAE E4202	KINETICS OF TRANSFORMATIONS
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS
MSAE E4215	MECH BEHAVIOR OF MATERIALS
MSAE E4250	CERAMICS # COMPOSITES

one MSAE 3000-, 4000-, or 6000-level elective (excluding MSAE E4999)

Technical Elective Requirements

Students are required to take nine technical electives (27 points) from the list given below, which offers significant flexibility in allowing students to tailor their degree program to their interests.

1. All 3000-level or higher courses in the Materials Science program of the Department of Applied Physics and Applied Mathematics, except those MSAE courses that are required.
2. All 3000-level or higher courses in Applied Physics or Applied Math Programs of the Department of Applied Physics and Applied Mathematics.
3. All 3000-level or higher courses in the Department of Biomedical Engineering, Civil Engineering and Engineering Mechanics program, Department of Chemical Engineering, Department of Computer Science, Department of Earth and Environmental Engineering, Department of Electrical Engineering, Department of Industrial Engineering and Operations Research, and Department of Mechanical Engineering, except for courses that require graduate standing.
4. ORCA E2500 FOUNDATIONS OF DATA SCIENCE
5. Courses in the Department of Chemistry listed in the Focus Areas below.

Elective Specializations for technical electives are listed below. Students may choose from any one area if they so choose. They are not required to do so.

Nanomaterials

APPH E3100	INTRO TO QUANTUM MECHANICS [y]
CHEM GU4071	INORGANIC CHEMISTRY [x]
MSAE E4090	NANOTECHNOLOGY [y]
APPH E4100	QUANTUM PHYSICS OF MATTER [x]
CHEM GU4168	[x]
ELEN E4193	MOD DISPLAY SCI # TECHNOLOGY [x]
MECE E4212	MICROELECTROMECHANICAL SYSTEMS [x,y]
BMEN E4550	MICRO/NANO STRUCT CELL ENG [y]
ELEN E4944	PRNCPLS OF DEVICE MICROFABRCTN [x]

y A y following the course number means that the course meets in the spring semester.
x An x following the course number means that the course meets in the fall semester.

Materials for Next Generation Electronics

APPH E3100	INTRO TO QUANTUM MECHANICS [y]
ELEN E3106	SOLID STATE DEVICES-MATERIALS [x]
APPH E4100	QUANTUM PHYSICS OF MATTER [x]
ELEN E4301	[y]
ELEN E4944	PRNCPLS OF DEVICE MICROFABRCTN [x]

y A y following the course number means that the course meets in the spring semester.
x An x following the course number means that the course meets in the fall semester.

Materials for Green Energy

EAEE E3103	ENERGY,MINERALS,MATERIALS SYST [x]
EAEE E4004	[x]
CHEE E4050	[x]
CHEM GU4071	INORGANIC CHEMISTRY [x]
APPH E4130	SOLAR ENERGY & STORAGE
EAEE E4190	PHOTOVOLTAIC SYSTEMS ENGIN [x]
EAIA E4200	Alternative energy resources [y]
MECE E4210	ENERGY INFRASTRUCTURE PLANNING [x]
MECE E4211	ENERGY SOURCES AND CONVERSION [y]
EAEE E4550	CATALYSIS OF EMISSIONS CONTROL [x]

y A y following the course number means that the course meets in the spring semester.
x An x following the course number means that the course meets in the fall semester.

Materials for 21st Century Infrastructure and Manufacturing

EACE E3255	ENVIRONMENTAL CONTROL AND POLLUTION REDUCTION
CIEE E3260	ENGINEERING FOR COMMUNITY DEVELOPMENT [y]
ENME E3114	EXPERIMENTAL MECH OF MATERIALS [y]
MECE E3610	MATERIALS/PROCESSES IN MANUFAC [y]
ENME E4113	ADVANCED MECHANICS OF SOLIDS [x]
ENME E4114	MECHANCS OF FRACTURE # FATIGUE [y]
ENME E4115	MICROMECH OF COMPOSITE MAT [y]
CIEN E4226	ADV DESIGN OF STEEL STRUCTURES [y]
CHEE E4530	CORROSION OF METALS [x]

y A y following the course number means that the course meets in the spring semester.
x An x following the course number means that the course meets in the fall semester.

Materials for Health and Biotechnology

CHEM UN2443	ORGANIC CHEMISTRY I-LECTURES [x]
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES [y]
APPH E3400	PHYSICS OF THE HUMAN BODY [y]
CHEM GU4168	[x]
BMEN E4210	DRIVING FORCES OF BIOLOGICAL SYSTEMS [y]
BMEN E4301	[x]
BMEN E4310	SOLID BIOMECHANICS [x,y]
BMEN E4550	MICRO/NANO STRUCT CELL ENG [y]
BMEN E4501	Biomaterials and Scaffold Design [x]
CHEE E4530	CORROSION OF METALS [y]
BMEN E4550	MICRO/NANO STRUCT CELL ENG [x]

**Note that* BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC[x] *and* BIOL UN2006 INTRO BIO II:CELL BIO,DEV/PHYS[y] *are prerequisites for a number of courses in this track.*

x An x following the course number means that the course meets in the fall semester.
y A y following the course number means that the course meets in the spring semester.

Materials Chemistry/Soft Materials

CHEM UN2443	ORGANIC CHEMISTRY I-LECTURES [x]
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES [y]
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
CHEE E4252	INTRO-SURFACE AND COLLOID SCI
CHEN E4620	INTRO-POLYMERS/SOFT MATERIALS
CHEN E4640	

x An x following the course number means that the course meets in the fall semester.

y A y following the course number means that the course meets in the spring semester.

Nontechnical Elective Requirements

All materials science students are also expected to register for nontechnical electives, both those specifically required by the School of Engineering and Applied Science and those needed to meet the 27-point total of nontechnical electives required for graduation.

Transfer Students

Combined Plan 3-2/Transfer students and students transferring from another SEAS department into the Materials Science Program in the junior year (upon approval of the Materials Science Undergraduate Transfer Committee) will take the following courses to satisfy the degree requirements:

MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE
MSAE E3012	LABORATORY IN MATERIALS SCI I
MSAE E3013	LABORATORY IN MATERIALS SCI II
MSAE E3100	Crystallography
MSAE E3156	DESIGN PROJECT
MSAE E3157	DESIGN PROJECT
MSAE E3201	Materials Thermodynamics and Phase Diagrams
MSAE E4102	SYNTHESIS # PROCESSING OF MATERIALS
MSAE E4202	KINETICS OF TRANSFORMATIONS
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS
MSAE E4215	MECH BEHAVIOR OF MATERIALS
MSAE E4250	CERAMICS # COMPOSITES
one MSAE 3000-, 4000-, or 6000-level elective	

Combined Plan 3-2/Transfer Students will be guided by their academic advisers to avoid duplication of courses previously taken. The course tables describe the four-semester program schedule of courses leading to the bachelor's degree in the Materials Science Program of the Department of Applied Physics and Applied Mathematics.

Materials Science Program

An overview of the degree track in PDF format can be found here.

First Year

Semester I

MATH UN1101	CALCULUS I
Choose one of the following Physics courses depending on sequence:	
PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I
Choose one of the following Chemistry courses (taken Semester I or II):	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
Choose one of the following Required Labs (taken Semester I or II):	
PHYS UN1493	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081	INTERMEDIATE LABORATORY WORK
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN1507	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN3085	PHYSICL-ANALYTICL LABORATORY I
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]	
HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)[1]	Art Humanities
Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]	
HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155 (taken Semester I, II, III, or IV)	PRINCIPLES OF ECONOMICS
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Semester II

MATH UN1102	CALCULUS II
Choose one of the following Physics courses depending on sequence:	
PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II
Choose one of the following Chemistry courses (taken Semester I or II):	

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)

Choose one of the following Required Labs (taken Semester I or II):

PHYS UN1493	INTRO TO EXPERIMENTAL PHYS-LAB
PHYS UN3081	INTERMEDIATE LABORATORY WORK
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN1507	INTENSVE GENERAL CHEMISTRY-LAB
CHEM UN3085	PHYSICL-ANALYTICL LABORATORY I

ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)[1]	Art Humanities

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	

ECON UN1105 or UN1155 (taken Semester I, II, III, or IV)[1]	PRINCIPLES OF ECONOMICS
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on sequence:

PHYS UN1403 (Sequence 1)	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Sequences 2 and 3)	PHYSICS III:CLASS/QUANTUM WAVE

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123[1]	Art Humanities

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	

ECON UN1105 & ECON UN1155 (taken Semester I, II, III, or IV)[1]	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI
MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
APMA E2101	INTRO TO APPLIED MATHEMATICS

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	

HUMA UN1121 or UN1123 (taken Semester I, II, III, or IV)[1]	Art Humanities

Choose one of the following Required Nontechnical Electives (taken Semester I, II, III, or IV):[1]

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	

ECON UN1105 & ECON UN1155 (taken Semester I, II, III, or IV)[1]	PRINCIPLES OF ECONOMICS
ENGI E1006 (taken Semester I, II, III, or IV)	INTRO TO COMP FOR ENG/APP SCI

Third Year

Semester V

MSAE E3012[2]	LABORATORY IN MATERIALS SCI I
MSAE E3100	Crystallography
MSAE E4102	SYNTHESIS # PROCESSING OF MATERIALS

Technical Electives (Students must complete 27 units of Technical Electives.) (taken Semester V, VI, VII, or VIII)

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[3]

Semester VI

MSAE E3013[2]	LABORATORY IN MATERIALS SCI II
MSAE E3201	Materials Thermodynamics and Phase Diagrams
MSAE E4250	CERAMICS # COMPOSITES

Technical Electives (Students must complete 27 units of Technical Electives.) (taken Semester V, VI, VII, or VIII)

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[3]

Fourth Year

Semester VII

MSAE E3156	DESIGN PROJECT
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS

one MSAE 3000-, 4000-, or 6000-level elective

Technical Electives (Students must complete 27 units of Technical Electives.) (taken Semester V, VI, VII, or VIII)

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[3]

Semester VIII

MSAE E3157	DESIGN PROJECT
MSAE E4202	KINETICS OF TRANSFORMATIONS
MSAE E4215	MECH BEHAVIOR OF MATERIALS

Technical Electives (Students must complete 27 units of Technical Electives.) (taken Semester V, VI, VII, or VIII)

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[3]

1 Some nontech courses can be postponed to junior or senior year, so lab courses MSAE E3012 LABORATORY IN MATERIALS SCI I and MSAE E3013 LABORATORY IN MATERIALS SCI II can be taken along with MSAE E3010 FOUNDATIONS OF MATERIALS SCIENCE

2 Motivated students are highly encouraged to take MSAE E3012 LABORATORY IN MATERIALS SCI I and MSAE E3103 ELEMENTS OF MATERIALS SCIENCE in the sophomore year to obtain practical understanding of material covered in the junior and senior years.

3 See Nontechnical Electives (p. 8) for details (administered by the advising dean).

Materials Science (Transfer Students)

Third Year

Semester V

MSAE E3010	FOUNDATIONS OF MATERIALS SCIENCE
MSAE E3012	LABORATORY IN MATERIALS SCI I
MSAE E4102	SYNTHESIS # PROCESSING OF MATERIALS

Technical Electives (Students must complete 27 or 24 units of Technical Electives.) (taken V, VI, VII, or VIII)[1]

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[2]

Semester VI

MSAE E3013	LABORATORY IN MATERIALS SCI II
MSAE E3201	Materials Thermodynamics and Phase Diagrams
MSAE E4250	CERAMICS # COMPOSITES

Technical Electives (Students must complete 27 or 24 units of Technical Electives.) (taken V, VI, VII, or VIII)[1]

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[2]

Fourth Year

Semester VII

MSAE E3156	DESIGN PROJECT
MSAE E3100	Crystallography
MSAE E4206	ELEC # MAGNETIC PROP OF SOLIDS

one MSAE 3000-, 4000-, or 6000-level elective

Technical Electives (Students must complete 27 or 24 units of Technical Electives.) (taken V, VI, VII, or VIII)[1]

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[2]

Semester VIII

MSAE E3157	DESIGN PROJECT
MSAE E4202	KINETICS OF TRANSFORMATIONS
MSAE E4215	MECH BEHAVIOR OF MATERIALS

Technical Electives (Students must complete 27 or 24 units of Technical Electives.) (taken V, VI, VII, or VIII)[1]

Nontechnical Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[2]

1 Students transferring from another SEAS department into the Materials Science program in the junior year must complete the 27 units of technical elective requirement; Combined Plan 3/2 transfer students must complete 24 units of technical electives.

2 Students transferring from another SEAS department into the Materials Science program in the junior year must complete the 27-point requirement; see Nontechnical Electives (p. 8) for details (administered by the advising dean). Combined Plan 3/2 transfer students do not need nontechnical electives.

Graduate Programs

Graduate Programs in Materials Science and Engineering

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Materials Science and Engineering (MS) (p. 296)
- Materials Science and Engineering (EngScD, PhD) (p. 297)

Materials Science and Engineering (MS)

Master of Science Degree

Candidates for the Master of Science degree in Materials Science and Engineering will follow a program of study formulated in consultation with and approved by a faculty adviser. Thirty points of credit (typically ten three-point courses) are required for the degree. The requirements include:

- Eighteen (18) points, MSAE 4000-, 6000-, 8000- level courses (max three points of research)[1]
- Six (6) points, approved electives (see following list) which may not include research points, e.g. MSAE E6273 MATERIALS SCIENCE REPORTS
- Six (6) points, general electives (which may include three additional points of research.), except APMA E4901 SEM-PROBLEMS IN APPLIED MATH, APMA E4903 SEM-PROBLEMS IN APPLIED MATH, APPH E4901 SEM-PROBLMS IN APPLIED PHYSICS, and APPH E4903 SEM-PROBLMS IN APPLIED PHYSICS.

Of the 30 points of credit required for the MS degree, 18 points of MSAE 4000-, 6000-, or 8000-level courses must be included. Only three points of research (MSAE E6273 MATERIALS SCIENCE REPORTS or other research course) may be used to satisfy the MSAE point requirement. A minimum of six points of MSAE courses must be taken in the first semester. Furthermore, it is expected that 15 of the first 24 points taken will be in MSAE courses; any exceptions must be approved by a faculty adviser.

Six points of restricted electives may be chosen from the following list of approved electives; a course not on the approved list can be counted only with prior, written approval. Research units may not be included.

Six points of electives may be chosen freely. These electives may include MSAE courses, approved electives, other electives, or an additional three points of research. As a reminder, no undergraduate courses (3000-level or below) may be counted toward the degree.

Students who do not have an undergraduate degree in Materials Science and Engineering may be required to take MSAE E4301 MATERIALS SCIENCE LABORATORY in the first semester. Students will be informed whether they are required to take this course based on a review of their undergraduate transcripts, no later than the first week of classes. The three credits for this course will be counted against the six points of general electives, and not against the six points of restricted electives or eighteen points of MSAE courses.

Students interested in a specific focus in metallurgy or other areas in materials science and engineering should consult their faculty adviser for relevant course listings.

Electives

MSAE E4000-, 6000- or 8000-level courses [2]	
APCH E4080	SOFT CONDENSED MATTER
APMA E4007	APPLIED LINEAR ALGEBRA
APMA E4008	Advanced and Applied Linear Algebra
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
APMA E4200	PARTIAL DIFFERENTIAL EQUATIONS
APMA E4204	FUNCTNS OF A COMPLEX VARIABLE
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
APMA E4301	NUMERICAL METHODS/PDE'S
APPH E4100	QUANTUM PHYSICS OF MATTER
APPH E4110	MODERN OPTICS
APPH E4112	LASER PHYSICS
APPH E4200	PHYSICS OF FLUIDS
APPH E4300	APPLIED ELECTRODYNAMICS
APPH E4990	SPEC TOPICS IN APPLIED PHYSICS
APPH E6081	SOLID STATE PHYSICS I
BMEN E4300	SOLID BIOMECHANICS
BMEN E4580	FOUND OF NANOBIOSCI/NANOBIOTECH
CHAP E4120	STATISTICAL MECHANICS AND COMP METHODS
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
CHEN E4620	INTRO-POLYMERS/SOFT MATERIALS
CHEN E4630	TOPICS IN SOFT MATERIALS
CHEN E4650	POLYMER PHYSICS
CHEN E4880	ATOMISTIC SIMULATIONS FOR SCIENCE AND EN
CHEE E4252	INTRO-SURFACE AND COLLOID SCI
CIEN E4021	ELAS/PLAS ANALYSIS-STRUCTURES
CIEE E4116	Energy Harvesting
ELEN E4106	Advanced Solid State Devices and Materials
ELEN E4193	MOD DISPLAY SCI # TECHNOLOGY
ELEN E4411	FUNDAMENTALS OF PHOTONICS
ELEN E4944/E6945	PRNCPLS OF DEVICE MICROFABRCTN
ELEN E6412	LIGHTWAVE DEVICES
ELEN E6331/E6333	PRINCPLS SEMICONDUCTR PHYSCS I
ENME E4113	ADVANCED MECHANICS OF SOLIDS
ENME E4114	MECHANCS OF FRACTURE # FATIGUE
IEOR E4150	INTRO-PROBABILITY # STATISTICS
MECE E4212	MICROELECTROMECHANICAL SYSTEMS
MECE E4213	Lab-on-a-Chip and Microrobotic Devices
MECE E4214	MEMS Sensors and Systems
MECE E4610	ADV MANUFACTURING PROCESSES
MECE E6137	NANOSCALE ACTUATION # SENSING
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS

[1] Except MSAE E4999 SUPERVISED INTERNSHIP

[2] Except MSAE E6273 MATERIALS SCIENCE REPORTS and MSAE E4999 SUPERVISED INTERNSHIP

All degree requirements must be completed within five years. A candidate is required to maintain at least a 2.5 GPA.

Professional Degree; Metallurgical Engineer

The program is designed for engineers who wish to do advanced work beyond the level of the M.S. degree but who do not desire to emphasize research. Admissions requirements include the undergraduate engineering degree, minimum 3.0 GPA, and GRE.

Candidates must complete at least 30 credits of graduate work beyond the M.S., or 60 points of graduate work beyond the B.S. No thesis is required. All degree requirements must be completed within five years of the beginning of the first course credited toward the degree.

Coursework includes five core required courses and five elective courses from a pre-approved list of choices.

Core Courses	
EAEE E4001	INDUST ECOLOGY-EARTH RESOURCES
EAEE E4009	GIS-RES,ENVIR,INFRASTRUCTR MGT
EAEE E4160	SOLID # HAZARDOUS WASTE MGMT
EAEE E4900	APP TRANSP/CHEM RATE PHENOMENA
EAEE E6255 & EAEE E6256	and

Elective courses must be five courses at the 4000 or higher level from within the Earth and Environmental Engineering Department, the Chemical Engineering Department, Materials Science Program, or others as approved by the adviser. These include but are not limited to:

EAEE E4150	AIR POLLUTION PREVENTION/CONTR
CHEE E4252	INTRO-SURFACE AND COLLOID SCI
EACE E4252	Foundations of Environmental Engineering
EAEE E4256	
EAEE E4257	ENVIR DATA ANALYSIS # MODELING
EAEE E6208	

Although it is not required, interested students may choose to complete up to six credits in MSAE E9259 -MSAE E9260 .

Materials Science and Engineering (EngScD, PhD)

Doctoral Program

At the end of the first year of graduate study in the doctoral program, candidates are required to take a comprehensive written qualifying examination, which is designed to test the ability of the candidate to apply coursework in problem solving and creative thinking. The standard is first-year graduate level. There are two three-hour examinations over a two-day period.

Candidates in the program must take the oral examination by the end of the spring semester of their second year. Candidates must submit a written proposal and defend it orally before a Thesis Proposal Defense Committee consisting of three members of the faculty, including the adviser, in the spring semester of their third year. Doctoral candidates must submit a thesis to be defended before a Dissertation Defense Committee consisting of five faculty members, including two professors from outside the doctoral program. Requirements for the Eng. Sc.D. (administered by the School of Engineering and Applied Science) and the Ph.D. (administered by the Graduate School of Arts and Sciences) can be found on the Doctoral Degrees page. (p. 20)

Areas of Research

Materials science and engineering is concerned with synthesis, processing, structure, and properties of metals, ceramics, and other materials, with emphasis on understanding and exploiting relationships among structure, properties, and applications requirements. Our graduate research programs encompass research areas as diverse as polycrystalline silicon, electronic ceramics grain boundaries and interfaces, microstructure and stresses in microelectronics thin films, oxide thin films for novel sensors and fuel cells, optical diagnostics of thin-film processing, ceramic nanocomposites, electrodeposition and corrosion processes, structure, properties, and transmission electron microscopy and crystal orientation mapping, magnetic thin films for spintronic applications, chemical synthesis of nanoscale materials, nanocrystals, two-dimensional materials, nanostructure analysis using X-ray and neutron diffraction techniques, and electronic structure calculation of materials using density functional and dynamical mean-field theories. Application targets for polycrystalline silicon are thin film transistors for active matrix displays and silicon-on-insulator structures for ULSI devices. Novel applications are being developed for oxide thin films, including uncooled IR focal plane arrays and integrated fuel cells for portable equipment.

Thin film synthesis and processing in this program include evaporation, sputtering, electrodeposition, and plasma and laser processing. For analyzing materials structures and properties, faculty and students employ electron microscopy, scanning probe microscopy, photoluminescence, magnetotransport measurements, and X-ray diffraction techniques. Faculty members have research collaborations with IBM, and other New York area research and manufacturing centers, as well as major international research centers. Scientists and engineers from these institutions also serve as adjunct faculty members at Columbia. The National Synchrotron Light Source at Brookhaven National Laboratory is used for high-resolution X-ray diffraction and absorption measurements.

Entering students typically have undergraduate degrees in materials science, metallurgy, physics, chemistry, or other science and engineering disciplines. First-year graduate courses provide a common base of knowledge and technical skills for more advanced courses and for research. In addition to coursework, students usually begin an association with a research group, individual laboratory work, and participation in graduate seminars during their first year.

Mechanical Engineering

220 S. W. Mudd, MC 4703
212-854-0661
me.columbia.edu

Mechanical engineering is a diverse subject that derives its breadth from the need to design and manufacture everything from small individual parts/devices (e.g., micro-scale sensors, inkjet printer nozzles) to large systems (e.g., spacecraft and machine tools). The role of a mechanical engineer is to take a product from an idea to the marketplace. In order

to accomplish this, a broad range of skills are needed. The particular skills in which the mechanical engineer acquires deeper knowledge are the ability to understand the forces and the thermal environment that a product, its parts, or its subsystems will encounter; design them for functionality, aesthetics, and the ability to withstand the forces and the thermal environment they will be subjected to; determine the best way to manufacture them and ensure they will operate without failure. Perhaps the one skill that is the mechanical engineer's exclusive domain is the ability to analyze and design objects and systems with motion.

Since these skills are required for virtually everything that is made, mechanical engineering is perhaps the broadest and most diverse of engineering disciplines. Hence mechanical engineers play a central role in such industries as automotive (from the car chassis to its every subsystem—engine, transmission, sensors); aerospace (airplanes, aircraft engines, control systems for airplanes and spacecraft); biotechnology (implants, prosthetic devices, fluidic systems for pharmaceutical industries); computers and electronics (disk drives, printers, cooling systems, semiconductor tools); microelectromechanical systems, or MEMS (sensors, actuators, micro power generation); energy conversion (gas turbines, wind turbines, solar energy, fuel cells); environmental control (HVAC, air-conditioning, refrigeration, compressors); automation (robots, data/image acquisition, recognition, and control); manufacturing (machining, machine tools, prototyping, microfabrication).

To put it simply, mechanical engineering deals with anything that moves. Mechanical engineers learn about materials, solid and fluid mechanics, thermodynamics, heat transfer, control, instrumentation, design, and manufacturing to realize/ understand mechanical systems. Specialized mechanical engineering subjects include biomechanics, cartilage tissue engineering, energy conversion, laser-assisted materials processing, combustion, MEMS, microfluidic devices, fracture mechanics, nanomechanics, mechanisms, micropower generation, tribology (friction and wear), and vibrations. The American Society of Mechanical Engineers (ASME) currently lists thirty-six technical divisions, from advanced energy systems and aerospace engineering to safety engineering and tribology.

The breadth of the mechanical engineering discipline allows students a variety of career options beyond some of the industries listed above. Regardless of the particular future path they envision for themselves after they graduate, their education would have provided them with the creative thinking that allows them to design an exciting product or system, the analytical tools to achieve their design goals, the ability to meet several sometimes conflicting constraints, and the teamwork needed to design, market, and produce a system. These skills also prove to be valuable in other endeavors and can launch a career in medicine, law, consulting, management, banking, finance, and so on.

For those interested in applied scientific and mathematical aspects of the discipline, graduate study in mechanical engineering can lead to a career of research and teaching.

Current Research Activities

Current research activities in the Department of Mechanical Engineering are in the areas of controls and robotics, energy and micropower generation, fluid mechanics, heat/mass transfer, mechanics of materials, manufacturing, material processing, MEMS, nanotechnology, and biomechanics and biofluids.

Biomechanics, Biofluids, and Mechanics of Materials

Some of the current research in biomechanics is concerned with the application of continuum theories of mixtures to problems of electromechanical behavior of soft biological tissues, contact mechanics, lubrication of diarthrodial joints, and cartilage tissue engineering. (Ateshian)

The Kysar group studies the mechanics and mechanical properties of small-scale structures and materials. Examples of material systems include two-dimensional materials such as graphene, nanoporous metal thin films, metallic and polymeric composites containing nanoscale strengthening agents, single crystal metals, and the ear's round Window Membrane, among several others. The work is experimental, theoretical, and computational in nature. The ultimate goal is to understand and predict the mechanical behavior based on fundamental physics and chemistry through the development of multiple length scale models.

At the Kasza Living Materials Lab we are interested in how cells self-organize to build tissues and organs with mechanical properties that are required for proper function. A major focus is to uncover fundamental mechanical and biological mechanisms that coordinate the behaviors of cells in developing tissues. To do this, we study morphogenesis in developing embryos of model organisms and combine approaches such as *in vivo* imaging, optogenetics, and biomechanical measurements. We are leveraging this knowledge to design and build novel cell-based tissue structures and systems. Our goals are to shed light on human health and disease and learn how to better build functional tissues in the lab.

Other areas of biomechanics include characterizing the structure-function behavior of the cervix during the remodeling events of pregnancy and characterizing the mechanical properties of the eye-wall in relation to glaucoma. Research in our lab includes the mechanical testing of biological soft tissues, the biochemical analysis of tissue microstructure, and material modeling based on structure-mechanical property relationships. In collaboration with clinicians, our goal is to understand the etiologies of tissue pathology and disease. (Myers)

A surgically implantable pediatric valve device that can 'grow with the child' would revolutionize current treatment for neonates born with valve disease. In close collaboration with Dr. David Kalfa, who is a pediatric heart surgeon at Columbia University Medical Center, and Dr. Haim Waisman from the Civil Engineering department, the Kysar and Vedula groups are involved in a multidisciplinary NIH-funded project to develop an expendable biostable polymeric valved conduit. The device would be implanted surgically to reconstruct the right ventricular outflow tract in neonates and then expanded by successive transcatheter procedures to reach the adult size. This project involves material design and characterization of the growth potential of a viscoplastic polymer, numerically model the fluid-structure interaction of the valved conduit, optimization for valve competence at every stage of expansion, and assess the biocompatibility and durability in animal models. (Kysar, Vedula)

Control, Robotics, Design, and Manufacturing

Control research emphasizes iterative learning control (ILC) and repetitive control (RC). ILC creates controllers that learn from previous experience performing a specific command, such as robots on an assembly line, aiming for high-precision mechanical motions. RC learns to cancel repetitive disturbances, such as precision motion through gearing, machining, satellite precision pointing, particle accelerators, etc. Time optimal control of robots is being studied for increased productivity on assembly lines through dynamic motion planning. Research is also being conducted on improved system identification, making mathematical models from input-output data. The results can be the starting point for

designing controllers, but they are also studied as a means of assessing damage in civil engineering structures from earthquake data. (Longman)

Robotics research focuses on design of novel rehabilitation machines and training algorithms for functional rehabilitation of neural impaired adults and children. The research also aims to design intelligent machines using nonlinear system theoretic principles, computational algorithms for planning, and optimization.

Robotic Systems Engineering (ROSE) Lab develops technology capable of solving difficult design problems, such as cable-actuated systems, under-actuated systems, and others. Robotics and Rehabilitation (ROAR) Lab focuses on developing new and innovative technologies to improve the quality of care and patient outcomes. The lab designs novel exoskeletons for upper and lower limbs training of stroke patients, and mobile platforms to improve socialization in physically impaired infants. (Agrawal)

The Robotic Manipulation and Mobility (ROAM) Lab focuses on versatile manipulation and mobility in robotics, aiming for robotic applications pervasive in everyday life. Research areas include manipulation and grasping, interactive or Human-in-the-Loop robotics, dynamic simulators and virtual environments, machine perception and modeling, and many more. We are interested in application domains such as versatile automation in manufacturing and logistics, assistive and rehabilitation robotics in healthcare, space robotics, and mobile manipulation in unstructured environments. (Ciocarlie)

At the Creative Machines Lab (CreativeMachines.org) we are interested in robots that create and robots that are themselves creative. We develop novel autonomous systems that can design and make other machines —automatically. We are working on a self-replicating robots, self-aware robots, robots that improve themselves over time, and robots that compete and cooperate with other robots. We build robots that paint art, cook food, build bridges and fabricate other robots. Our work is inspired from biology, as we seek new biological concepts for engineering and new engineering insights into biology. (Lipson)

In the area of advanced manufacturing processes and systems, current research concentrates on laser materials processing. Investigations are being carried out in laser micromachining; laser forming of sheet metal; microscale laser shock-peening, material processing using improved laser-beam quality. Both numerical and experimental work is conducted using state-of-the-art equipment, instruments, and computing facilities. Close ties with industry have been established for collaborative efforts. (Yao)

Energy, Fluid Mechanics, and Heat/Mass Transfer

In the area of energy, one effort is in energy systems with an eye toward cost-effective decarbonization using technologies that are at hand or near-ready. The interaction of the electric grid, with buildings, transportation, gas networks, storage and electrofuels is being studied. Another effort addresses the integration of thermal storage into HVAC systems for efficient use of variable renewable energy. The development of measurement, monitoring and control systems using IoT devices for use in micrositing and operation of microgrids and enabling flexibility or demand response of load. (Modi)

In the area of energy, demand estimation and prediction of interest using utility data, satellite imagery and lean, robust field data capture. (Modi)

In the area of nanoscale thermal transport, our research efforts center on the enhancement of thermal radiation transport across interfaces separated by a nanoscale gap. The scaling behavior of nanoscale radiation transport is measured using a novel heat transfer measurement technique based on the deflection of a bimaterial atomic force microscope cantilever. Numerical simulations are also performed to confirm these measurements. The measurements are also used to infer extremely small variations of van der Waals forces with temperature. This enhancement of radiative transfer will ultimately be used to improve the power density of thermophotovoltaic energy conversion devices. (Narayanaswamy)

Also in the area of energy, research is being performed to improve the thermochemical models used in accelerating development of cleaner, more fuel-efficient engines through computational design. In particular, data-driven approaches to creating high-accuracy, uncertainty-quantified thermochemicals models are being developed that utilize both theoretical and experimental data. Special emphasis is placed on the generation and analysis of data across the full range of relevant scales—from the small-scale electronic behavior that governs molecular reactivity to the large-scale turbulent, reactive phenomena that govern engine performance. (Burke)

The Vedula group aims to advance clinical management of cardiovascular disease using computational modeling. We are developing novel computational techniques for performing patient-specific modeling of the cardiovascular system aimed at understanding the role of biomechanical factors in disease and development, device design, and 'virtual' surgery planning. Computational modeling combined with machine learning and data-mining strategies provides unprecedented opportunities to not only examine acute response to treatment, but also predict and risk stratify patients susceptible to long-term remodeling and dysfunction. (Vedula)

The Vedula group is involved in developing multiscale-multiphysics models of the heart coupling cardiac electrophysiology, tissue mechanics, blood flow and valvular interactions, thereby creating an integrated heart model, that could be used to study a variety of cardiac and valvular pediatric and adult cardiovascular disease. A few applications that we are particularly interested in include cardiomyopathies, valvular calcifications and device design, remodeling and dysfunction in congenital heart disease. (Vedula)

In the area of energy, the Building Physics and Energy Systems Laboratory aims to develop new modeling techniques to understand the dynamics of energy demand necessary to facilitate decarbonization in buildings. Research focuses on developing new modeling and simulation methods to provide more accurate estimates of time-vary demand, model-based control system to enable demand flexibility, and hybrid physics and statistical modeling approaches to provide accurate estimates of the timing of demand at the urban scale. (Howard)

MEMS and Nanotechnology

In these areas, research activities focus on power generation systems, nanostructures for photonics, fuel cells and photovoltaics, and microfabricated adaptive cooling skin and sensors for flow, shear, and wind speed. Basic research in fluid dynamics and heat/mass transfer phenomena at small scales also support these activities. (Hone, Kysar, Lin, Modi, Narayanaswamy)

We study the dynamics of microcantilevers and atomic force microscope cantilevers to use them as microscale thermal sensors based on the resonance frequency shifts of vibration modes of the cantilever. Bimaterial microcantilever-based sensors are used to determine the thermophysical properties of thin films. (Narayanaswamy)

Research in the area of nanotechnology focuses on nanomaterials such as
nanotubes and nanowires and their applications, especially in nanoelectromechanical systems (NEMS). A laboratory is available for the synthesis of graphene and other two-dimensional materials using chemical vapor deposition (CVD) techniques and to build devices using electron-beam lithography and various etching techniques. This effort will seek to optimize the fabrication, readout, and sensitivity of these devices for numerous applications, such as sensitive detection of mass, charge, and magnetic resonance. (Hone, Kysar, Modi)

Research in BioMEMS aims to design and create MEMS and micro/nanofluidic systems to control the motion and measure the dynamic behavior of biomolecules in solution. Current efforts involve modeling and understanding the physics of micro/nanofluidic devices and systems, exploiting polymer structures to enable micro/nanofluidic manipulation, and integrating MEMS sensors with microfluidics for measuring physical properties of biomolecules. (Lin)

The Schuck group aims to characterize, understand, and control nanoscale light-matter interactions, with a primary focus on sensing, engineering, and exploiting novel optoelectronic phenomena emerging from nanostructures and interfaces. This offers unprecedented opportunities for developing innovative devices that rely on the dynamic manipulation of single photons and charge carriers. We are continuously developing new multimodal and multidimensional spectroscopic methods that provide unique access to optical, electrical, and structural properties at relevant length scales in real environments encountered in energy and biological applications. (Schuck)

Biological Engineering and Biotechnology

Active areas of research in the musculoskeletal biomechanics laboratory include theoretical and experimental analysis of articular cartilage mechanics; theoretical and experimental analysis of cartilage lubrication, cartilage tissue engineering, and bioreactor design; growth and remodeling of biological tissues; cell mechanics; and mixture theory for biological tissues with experiments and computational analysis. (Ateshian)

The Hone laboratory studies two-dimensional (2D) materials such as graphene, with efforts spanning synthesis of single crystals and thin films; device nanofabrication; and testing of electronic, optical, mechanical, and other properties. The group develops methods to combine 2D materials into layered heterostructures, which are used to explore fundamental properties, achieve new functionality, and enable applications in electronics, photonics, sensing, and other areas. (Hone)

The Hone group uses nanofabrication techniques to create tools for studying the role of mechanical forces and geometry in cellular biology. These investigations seek to understand how cells sense the mechanical properties or physical shape of their surroundings, a process that plays a major role in maintaining healthy cellular and tissue function. (Hone)

Microelectromechanical systems (MEMS) are being exploited to enable and facilitate the characterization and manipulation of biomolecules. MEMS technology allows biomolecules to be studied in well-controlled micro/nanoenvironments of miniaturized, integrated devices, and may enable novel biomedical investigations not attainable by conventional techniques. The research interests center on the development of MEMS devices and systems for label-free manipulation and interrogation of biomolecules. Current research efforts primarily involve microfluidic devices that exploit specific and reversible, stimulus-dependent binding between biomolecules and receptor molecules to enable selective purification, concentration, and label-free detection of nucleic acid, protein, and small molecule analytes; miniaturized instruments for label-free characterization of thermodynamic and other physical properties of biomolecules; and subcutaneously implantable MEMS affinity biosensors for continuous monitoring of glucose and other metabolites. (Kysar, Lin)

The Kysar group has a project to design and develop a method to deliver therapeutics into the inner ear through the Round Window Membrane (RWM) that serves as a portal for acoustic energy between the middle ear and inner ear. This involves the design and fabrication of arrays of microneedles, the measurements of diffusive flux of chemical species across a perforated RWM, and the design, delivery, and testing of surgical tools, all in close collaboration with Anil K. Lalwani, M.D., at Columbia University Medical Center. (Kysar)

The Schuck group is involved in engineering novel near-infrared (NIR) upconverting nanoparticles (UCNPs) and UCNP-based microdevices for large-scale sensing applications, including deployment in projects aimed at deep-tissue imaging and the control of neural function deep within brain tissue. UCNPs have the potential to overcome nearly all limitations of current optical probes and sensors, which have run into fundamental chemical and photophysical incompatibilities with living systems. (Schuck)

Mass radiological triage is critical after a large-scale radiological event because of the need to identify those individuals who will benefit from medical intervention as soon as possible. The goal of the ongoing NIH-funded research project is to design a prototype of a fully automated, ultra high throughput biodosimetry. This prototype is supposed to accommodate multiple assay preparation protocols that allow the determination of the levels of radiation exposure that a patient received. The input to this fully autonomous system is a large number of capillaries filled with blood of patients collected using finger sticks. These capillaries are processed by the system to distill the micronucleus assay in lymphocytes, with all the assays being carried out in situ in multiwell plates. The research effort on this project involves the automation system design and integration including hierarchical control algorithms, design and control of custom built robotic devices, and automated image acquisition and processing for sample preparation and analysis. (Yao)

A technology that couples the power of multidimensional microscopy (three spatial dimensions, time, and multiple wavelengths) with that of DNA array technology is investigated in an NIH-funded project. Specifically, a system is developed in which individual cells selected on the basis of optically detectable multiple features at critical time points in dynamic processes can be rapidly and robotically micromanipulated into reaction chambers to permit amplified DNA synthesis and subsequent array analysis. Customized image processing and pattern recognition techniques are developed, including Fisher's linear discriminant preprocessing with neural net, a support vector machine with improved training, multiclass cell detection with error correcting output coding, and kernel principal component analysis. (Yao)

Facilities for Teaching and Research

The undergraduate laboratories, occupying an area of approximately 6,000 square feet of floor space, are the site of experiments ranging in complexity from basic instrumentation and fundamental exercises to advanced experiments in such diverse areas as automatic controls, heat transfer, fluid mechanics, stress analysis, vibrations, microcomputer-based data acquisition, and control of mechanical systems.

Equipment includes microcontrollers and microprocessors, analog-to-digital and digital-to-analog converters, a tensile testing system equipped

with digital image correlation (DIC) capabilities, a subsonic wind tunnel, and 3D printers as well as laser cutters. The undergraduate laboratory also houses experimental setups for the understanding and performance evaluation of a small steam power generation system, a heat exchanger, a compressor, a car suspension simulator, a torsion tester, and a hydrogen fuel cell. Part of the undergraduate laboratory is a staffed machine shop with machining tools such as CNC vertical milling machines, a CNC lathe, standard vertical milling machines, engine and bench lathes, surface grinder, band saw, drill press, tool grinders, a horizontal bandsaw, several other mills used for light machining and circuit board fabrication.

A mechatronics laboratory affords the opportunity for hands-on experience with microcomputer-embedded control of electromechanical systems. Facilities for the construction and testing of analog and digital electronic circuits aid the students in learning the basic components of the microcomputer architecture. The laboratory is divided into work centers for two-person student laboratory teams. Each work center is equipped with a mixed signal oscilloscope, several power supplies (for low-power electronics and higher power control), a function generator, a multimeter, a protoboard for building circuits, a microcomputer circuit board (which includes the microcomputer and peripheral components), a microcomputer programmer, and a personal computer that contains a data acquisition board. The data acquisition system serves as an oscilloscope, additional function generator, and spectrum analyzer for the student team. The computer also contains a complete microcomputer software development system, including editor, assembler, simulator, debugger, and C compiler. The laboratory is also equipped with a portable oscilloscope, an EPROM eraser (to erase microcomputer programs from the erasable chips), a logic probe, and an analog filter bank that the student teams share, as well as a stock of analog and digital electronic components.

The CAD Lab is a modern computer-aided design laboratory equipped with 30 Dell Precision 5820 workstations. Machines have software for design, CAD, FEM, and CFD, including Altair Analysis Suite, AutoCAD, COMSOL Multiphysics, Matlab, RStudio, Solidworks, Wolfram Mathematica. The research facilities are located within within individual or group research laboratories in the department, and these facilities are being continually upgraded. To view the current research capabilities please visit the various laboratories within the research section of the department website. The students and staff of the department can, by prior arrangement, use much of the equipment in these research facilities. Through their participation in the NSF-MRSEC center, the faculty also have access to shared instrumentation and the clean room located in the Schapiro Center for Engineering and Physical Science Research. Columbia University's extensive library system has superb scientific and technical collections.

Email and computing services are maintained by Columbia University Information Technology (CUIT). For more information visit https://www.cuit.columbia.edu/.

Chair

Hod Lipson
248 S. W. Mudd

Director of Finance and Administration

Sara McDonald

220 S.W. Mudd

Professors

Sunil Agrawal

Gerard A. Ateshian

Mary C. Boyce

Sami Haddadin

James Hone

Jeffrey W. Kysar

Qiao Lin

Hod Lipson

Vijay Modi

Associate Professors

Michael P. Burke

Matei Ciocarlie

Julia Di

Karen Kasza

Kristin Myers

Arvind Narayanaswamy

P. James Schuck

Adrian Buganza Tepole

Assistant Professors

Bianca Howard

Cody Paige

Vijay Vedula

Chaoqun Dong

Professors of Professional Practice

Homayoon Beigi

Michael J. Massimino

Harry West

Lecturers in Discipline

Sinisa Vukelic

Yevgeniy Yesilevskiy

Adjunct Faculty

Jonathan Blutinger

Joshua Browne

Nicholas Chbat

Changyao Chen

Ali Dadgar

Anthony Genova

J. P. Hilton

Evan Lerner

Peter LeVoci

David Tew

Enrico Zordan

Marc Zuluaga

Manager of Instructional Laboratories

Daniela Duron Garcia

Course Descriptions

AEME E4304 Turbomachinery. *3.00 points*.
Introduction to basics of theory, design, analysis, and selection of turbomachinery. Turbomachines are widely used in myriad engineering applications such as energy conversion, HVAC, and propulsion, in the forms of pumps, compressors, gas turbines, jet engines, wind turbines, etc. Variety of such applications used as examples to illustrate important concepts

Spring 2026: AEME E4304

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AEME 4304	001/20208	Sa 12:00pm - 2:30pm 415 Schapiro Cepser	Sean Nolan	3.00	13/40

AEME E4305 Propulsion. *3.00 points*.
Prerequisites: (MECE E3301)
Introduction to aerospace propulsion, including traditional and emerging aircraft and rocket propulsion systems — and energy storage approaches. Introduction to the design and thermodynamic performance analysis of such systems and their major components.

Fall 2026: AEME E4305

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AEME 4305	001/14489	Th 4:10pm - 6:40pm 327 Seeley W. Mudd Building	David Tew	3.00	27/35

AEME E4306 Intro to Aerodynamics. *3.00 points*.
Principles of flight, incompressible flows, compressible regimes. Inviscid compressible aerodynamics in nozzles (wind tunnels, jet engines), around wings (aircraft, space shuttle) and around blunt bodies (rockets, reentry vehicles). Physics of normal shock waves, oblique shock waves, and explosion waves

AERO E3420 Aerospace Engineering Design I. *3.00 points*.
First semester of a senior capstone sequence for students interested in aerospace engineering. Focused on the technical design, prototyping, simulation, and validation of aerospace systems. Students work in teams to develop projects incorporating mechanical, electrical, and aerospace subsystems, progressing from concept to functional prototype. Emphasis is placed on 3D design, subsystem integration, critical testing, and mission-driven specifications and design reviews. Involves brainstorming concept generation, literature review, incorporation of multiple constraints, adherence to appropriate engineering codes and standards, and the production of a layout drawing of the proposed capstone design project in a Computer Aided Design (CAD) software tools. Business and product framing activities will support the technical work with market and mission relevance

AERO E3430 Aerospace Engineering Design II. *3.00 points*.
Second semester of a senior capstone sequence for students interested in aerospace engineering focused on system-level integration, manufacturability, and launch readiness of aerospace systems. Students carry forward validated prototypes from Design I and advance them through pre-production and manufacturing sprints. Final deliverables include system demonstrations, validation reports, go-to-market strategies, and public-facing showcase materials. Students will adhere to appropriate engineering codes and standards and incorporate realistic design and manufacturing constraints

AERO E4431 Spaceflight Mechanics. *3.00 points*.
Prerequisites: ENME E3105
Two-body orbital motion, Newtonian and Keplerian mechanics, energy and angular momentum conservation, Vis-Viva equation, Kepler's Equation, Euclidean geometry, vector mathematics, conic sections. Trajectory design using analytical and software-based methods. Systems Tool Kit Astrogator for simulation of Earth-Moon and interplanetary missions.

Fall 2026: AERO E4431

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4431	001/11863	T 1:10pm - 3:40pm 227 Seeley W. Mudd Building	Anthony Genova	3.00	20/40

AERO E4432 Space Resource and Planetary Protection. *3.00 points*.
Prerequisites: (ENME E3105) Above Prerequisites OR Instructor's Permission
Corequisites: MECE E4431
Planetary defense against asteroids and comets; astronaut rescue and emergency response; satellite constellations and orbital congestion; space debris and long-term sustainability; space law, treaties, and Artemis Accords; planetary protection, cislunar competition, and future international strategies. Weekly case studies on national doctrines, commercial actors, and modern enforcement challenges. Systems Tool Kit Astrogator software used to model satellite constellations, cislunar surveillance orbits, lunar frozen orbits, and defense scenarios connecting spaceflight mechanics with law and policy.

Spring 2026: AERO E4432

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4432	001/18316	M 1:10pm - 3:40pm 829 Seeley W. Mudd Building	Anthony Genova	3.00	20/40

AERO E4440 Rapid Prototyping for Aerospace Products. *3.00 points*.
Prerequisites: (MECE E1008 and MECE E3408 and ELEN E1201)
Graduate-level design course focused on the rapid prototyping, integration, testing, and validation of aerospace systems. Students work in teams to design and build engineering models of aerospace systems (e.g., drones, CubeSat subsystems, ground systems, balloon payloads, or related aerospace hardware). Projects progress from concept to pre-production functional prototype through iterative sprint cycles emphasizing scoping, design, build, and test. Deliverables include mission-driven specifications and design reviews, working prototypes, and supporting documentation. Involves brainstorming concept generation, literature review, production of layout drawing(s) in Computer Aided Design (CAD) software tools, incorporation of multiple constraints, and adherence to appropriate engineering codes and standards. Business and product framing activities will support the technical work with market and mission relevance.

Spring 2026: AERO E4440

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4440	001/18317	W 4:10pm - 6:40pm 294 Engineering Terrace	Evan Lerner	3.00	26/30

AERO E4450 Microgravity Experiment Design. *3.00 points*.
Rapid prototyping and engineering skills for experiments operating in altered gravity environments. Topics include parabolic flight mechanics, human physiology in reduced gravity, the space environment, mechanical and electrical design for flight hardware, data acquisition, experiment operations, safety analysis, fault tree methods, and payload integration requirements. Team-based development of a flight-ready microgravity experiment concept culminating in a Payload Integration Package (PIP), Critical Design Review (CDR), and Technical Readiness Review (TRR), with emphasis on flight readiness, safety procedures, and payload integration

Fall 2026: AERO E4450

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4450	001/18267	Th 1:10pm - 3:40pm 304 Hamilton Hall	Cody Paige	3.00	10/40

AERO E4810 Introduction to Human Spaceflight. *3.00 points*.
Prerequisites: Permission of Instructor – All students interested must join the waitlist and fill out a questionnaire when registering for the class in order to be considered. The link to the questionnaire is provided in the notes for the class on Vergil.
Introduction to human spaceflight from a systems engineering perspective. Historical and current space programs and spacecraft. Motivation, cost, and rationale for human space exploration. Overview of space environment needed to sustain human life and health, including physiological and psychological concerns in space habitat. Astronaut selection and training processes, spacewalking, robotics, mission operations, and future program directions. Systems integration for successful operation of a spacecraft. Highlights from current events and space research, Space Shuttle, Hubble Space Telescope, and International Space Station (ISS). Includes team design project.

Spring 2026: AERO E4810

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4810	001/18260	F 1:10pm - 3:40pm 325 Pupin Laboratories	Michael Massimino	3.00	18/20

AERO E4811 Aerospace Human Factors Engineering. *3.00 points*.
Prerequisites: Permission of Instructor – All students interested must join the waitlist and fill out a questionnaire when registering for the class in order to be considered. The link to the questionnaire is provided in the notes for the class on Vergil.
Engineering fundamentals and experimental methods of human factors design and evaluation for spacecraft and aircraft which incorporate human-in-the-loop control. Develop understanding of human factors specific to spacecraft and aircraft design with human-in-the-loop control. Design of human factors experiments utilizing task analysis and user testing with quantitative evaluation metrics to develop a sate and high-performing operational space system. Human-centered design, functional allocation and automation, human sensory performance in the space environment, task analysis, human factors experimental methods and statistics, space vehicle displays and controls, situation awareness, workload, usability, manual piloting and handling qualities, human error analysis and prevention, and anthropometrics. Includes team design project.

Fall 2026: AERO E4811

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
AERO 4811	001/11862	F 1:10pm - 3:40pm 327 Seeley W. Mudd Building	Michael Massimino	3.00	24/25

EEME E3601 Introduction to Continuous Control Systems. *3.00 points*.
Lect: 3.

Prerequisites: (MATH UN2030 and APMA E3101)
Introduction to continuous systems with the treatment of classical and state-space formulations. Mathematical concepts, complex variables, integral transforms and their inverses, differential equations, and relevant linear algebra. Classical feedback control, time/frequency domain design, stability analysis, Laplace transform formulation and solutions, block diagram simplification and manipulation, signal flow graphs, modeling physical systems and linearization. state-space formulation and modeling, in parallel with classical single-input single-output formulation, connections between the two formulations. Transient and steady state analysis, methods of stability analysis, such as root locus methods, Nyquist stability criterion, Routh Hurwitz criterion, pole/zero placement, Bode plot analysis, Nichols chart analysis, phase lead and lag compensators, controllability, observability, realization of canonical forms, state estimation in multivariable systems, time-variant systems. Introduction to advanced stability analysis such as Lyapunov stability and simple optimal control formulation. May not take for credit if already received credit for EEME E4600.

Fall 2026: EEME E3601

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEME 3601	001/11349	W 4:10pm - 6:40pm 142 Uris Hall	Homayoon Beigi	3.00	76/105

EEME E4601 DISCRETE CONTROL SYSTEMS. *3.00 points*.
Lect: 3.

Prerequisites: (EEME E3601) or (EEME E6601)
The course studies control strategies and their implementation in the discrete domain. Introduction with examples; review of continuous control and Laplace Transforms; review of continuous state-space representation and Solutions; review of difference equations, discretization in time and frequency, the WKS (aka Shannon) sampling theorem, windowing, filters, Transforms: Fourier series, Fourier transform, z-transform and their inverses; Ideal sampler, Sample-and-hold devices, zero, one, polygonal, and slewer hold; Transfer functions, block diagrams, and signal flow graphs for discrete systems; Discrete State-Space transformation, controllabililty, observability, and stability in the state-space domain. Discrete time and z domain analysis, steady state analysis, discrete-time root-locus, and pole-zero placement; Discrete Nyquist stability criterion, Bode plot, Gain and Phase Margin analysis, Nichols chart, bandwidth and sensitivity analysis; Design criteria, self-tuning regulator, Kalman filter, and simulation, followed by advanced stability analysis such as Lyapunov stability; Overview of the discrete Euler-Lagrange equations, discrete maximum and minimum principle, optimal linear discrete regulator design, optimality and dynamic programming.

Spring 2026: EEME E4601

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
EEME 4601	001/12106	W 4:10pm - 6:40pm 1127 Seeley W. Mudd Building	Homayoon Beigi	3.00	24/50
EEME 4601	V01/16657		Homayoon Beigi	3.00	4/99

EEME E6602 MODERN CONTROL THEORY. *3.00 points*.
Lect: 3.

Singular value decomposition. ARX model and state space model system identification. Recursive least squares filters and Kalman filters. LQR, H**∞,** linear robust control, predictive control, adaptive control. Liapunov and Popov stability. Nonlinear adaptive control, nonlinear robust control, sliding mode control.

EEME E8601 ADV TOPICS IN CONTROL THEORY. *3.00 points*.
Lect: 3.

Prerequisites: (EEME E4601 and EEME E6601) or instructor's permission. May be taken more than once, since the content changes from year to year, electing different topics from control theory such as learning and repetitive control, adaptive control, system identification, Kalman filtering, etc.

ENGI E4300 Design Justice: Human-Centered Design and Social Justice. *3.00 points*.
Prerequisites: IEME E4200 or COMS W4170 Or instructor's permission.
Introduction to Human-Centered Design and Innovation. Unpack the role of design in the market economy for an individual consumer, for a designer/developer and for an enterprise or other organization. Consider how designing in good faith for most can lead to injustice for some. Examine how - to use the PROP framework of the Columbia School of Social Work[1] - power, race, oppression, and privilege can be executed through the design process. Equip students with tools to engage in the design process and to facilitate the engagement of others. Explore strategies for guiding design and innovation towards more just solutions.
[1] https://socialwork.columbia.edu/about/dei/dei-mission-statement/

ENME E3105 MECHANICS. *4.00 points*.
Lect: 4.

Corequisites: ENME E3106,ENME E3113
Elements of statics; dynamics of a particle and systems of particles.

Spring 2026: ENME E3105

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3105	001/12107	M W 11:40am - 12:55pm 310 Fayerweather	Jeffrey Kysar	4.00	88/96
ENME 3105	001/12107	F 1:10pm - 2:25pm 310 Fayerweather	Jeffrey Kysar	4.00	88/96

Fall 2026: ENME E3105

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENME 3105	001/14594	M W F 11:40am - 12:55pm 603 Hamilton Hall	Addis Kidane	4.00	43/54

IEME E4200 HUMAN-CENTERED DESIGN AND INNOVATION. *3.00 points*.
Prerequisites: Instructor's permission.
Open to SEAS graduate and advanced undergraduate students, Business School, and GSAPP. Students from other schools may apply. Fast-paced introduction to human-centered design. Students learn the vocabulary of design methods, understanding of design process. Small group projects to create prototypes. Design of simple product, more complex systems of products and services, and design of business

Spring 2026: IEME E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEME 4200	001/13266	W 10:10am - 11:25am Cin Alfred Lerner Hall	Harry West	3.00	58/60
IEME 4200	001/13266	W 11:25am - 12:40pm 430 River Side Church	Harry West	3.00	58/60
IEME 4200	002/17196	W 10:10am - 11:25am Cin Alfred Lerner Hall	Harry West	3.00	59/60
IEME 4200	002/17196	W 4:10pm - 5:25pm 430 River Side Church	Harry West	3.00	59/60

Fall 2026: IEME E4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
IEME 4200	001/14493	T 4:10pm - 6:40pm 545 Seeley W. Mudd Building	Harry West	3.00	43/45

IEME E4810 INTRO-HUMANS IN SPACE FLIGHT. *3.00 points*.
Prerequisites: Department permission and knowledge of MATLAB or equivalent.
Introduction to human spaceflight from a systems engineering perspective. Historical and current space programs and spacecraft. Motivation, cost, and rationale for human space exploration. Overview of space environment needed to sustain human life and health, including physiological and psychological concerns in space habitat. Astronaut selection and training processes, spacewalking, robotics, mission operations, and future program directions. Systems integration for successful operation of a spacecraft. Highlights from current events and space research, Space Shuttle, Hubble Space Telescope, and International Space Station (ISS). Includes a design project to assist International Space Station astronauts

MACH E4320 Intro to Combustion. *3.00 points*.
Prerequisites: (MECE E3301)
Thermodynamics and kinetics of reacting flows; chemical kinetic mechanisms for fuel oxidation and pollutant formation; transport phenomena; conservation equations for reacting flows; laminar nonpremixed flames (including droplet vaporization and burning); laminar premixed flames; flame stabilization, quenching, ignition, extinction, and other limit phenomena; detonations; flame aerodynamics and turbulent flames.

Fall 2026: MACH E4320

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MACH 4320	001/19696	Th 1:10pm - 3:40pm 337 Seeley W. Mudd Building	Michael Burke	3.00	26/30

MEBM E4439 MODELING # ID OF DYNAMIC SYST. *3.00 points*.
Prerequisites: (APMA E2101) and (ELEN E3801) or APMA E2101 AND ELEN E3801; EEME E3601; APMA E2101, ELEN E3801, or corequisite EEME E3601, or permission of instructor.
Corequisites: EEME E3601
Generalized dynamic system modeling and simulation. Fluid, thermal, mechanical, diffusive, electrical, and hybrid systems are considered. Nonlinear and high order systems. System identification problem and Linear Least Squares method. State-space and noise representation. Kalman filter. Parameter estimation via prediction-error and subspace approaches. Iterative and bootstrap methods. Fit criteria. Wide applicability: medical, energy, others. MATLAB and Simulink environments

MEBM E4710 MORPHOGENESIS:BIOL MAT SHP/STR. *3.00 points*.
Prerequisites: Courses in mechanics, thermodynamics, and ordinary differential equations at the undergraduate level or instructor's permission.
Introduction to how shape and structure are generated in biological materials using engineering approach emphasizing application of fundamental physical concepts to a diverse set of problems. Mechanisms of pattern formation, self-assembly, and self-organization in biological materials, including intracellular structures, cells, tissues, and developing embryos. Structure, mechanical properties, and dynamic behavior of these materials. Discussion of experimental approaches and modeling. Course uses textbook materials as well as collection of research papers

MECE E1008 INTRO TO MACHINING. *1.00 point*.
Introduction to the manual machine operation, CNC fabrication and usage of basic hand tools, band/hack saws, drill presses, grinders and sanders

Spring 2026: MECE E1008

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 1008	001/12109	F 9:10am - 11:00am 294 Engineering Terrace	Robert Stark, Daniela Duron Garcia	1.00	8/8
MECE 1008	002/12110	F 11:05am - 12:55pm 294 Engineering Terrace	Robert Stark, Daniela Duron Garcia	1.00	9/8
MECE 1008	003/12111	F 2:10pm - 4:00pm 294 Engineering Terrace	Robert Stark, Daniela Duron Garcia	1.00	9/8
MECE 1008	004/12112	F 9:10am - 11:00am 294 Engineering Terrace	Robert Stark, Daniela Duron Garcia	1.00	7/8
MECE 1008	005/12113	F 11:05am - 12:55pm 294 Engineering Terrace	Daniela Duron Garcia, Robert Stark	1.00	8/8
MECE 1008	006/12114	F 2:10pm - 4:00pm 294 Engineering Terrace	Robert Stark, Daniela Duron Garcia	1.00	8/8

Fall 2026: MECE E1008

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 1008	001/15020	T 2:10pm - 4:00pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	002/16481	T 4:10pm - 6:00pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	003/16482	Th 1:40pm - 3:30pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	004/16483	Th 3:40pm - 5:30pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	005/16484	T 2:10pm - 4:00pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	006/16485	T 4:10pm - 6:00pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	007/16486	Th 1:40pm - 3:30pm 294 Engineering Terrace	James Hone	1.00	0/12
MECE 1008	008/16487	Th 3:40pm - 5:30pm 294 Engineering Terrace	James Hone	1.00	0/12

MECE E1304 NAVAL SHIP SYSTEMS. *3.00 points*.
Students are strongly advised to consult with the ME Department prior to registering for this course. A study of ship characteristics and types including ship design, hydrodynamic forces, stability, compartmentation, propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control; theory and design of steam, gas turbine, and nuclear propulsion; shipboard safety and firefighting. This course is part of the Naval ROTC program at Columbia but will be taught at SUNY Maritime. Enrollment may be limited; priority is given to students participating in Naval ROTC. Will not count as a technical elective. Students should see a faculty adviser as well as Columbia NROTC staff (nrotc@columbia.edu) for more information

MECE E3018 MECHANICAL ENGINEERING LAB I. *3.00 points*.
Lect: 3.

Experiments in instrumentation and measurement: optical, pressure, fluid flow, temperature, stress, and electricity; viscometry, cantilever beam, digital data acquisition. Probability theory: distribution, functions of random variables, tests of significance, correlation, ANOVA, linear regression

Fall 2026: MECE E3018

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3018	001/14539	T 1:10pm - 2:00pm Room TBA	James Hone	3.00	80/130
MECE 3018	R01/14538	T 2:10pm - 4:00pm 273 Engineering Terrace	James Hone	3.00	21/22
MECE 3018	R02/14542	T 4:10pm - 6:00pm 273 Engineering Terrace	James Hone	3.00	14/22
MECE 3018	R03/14543	Th 11:40am - 1:30pm 273 Engineering Terrace	James Hone	3.00	21/22
MECE 3018	R04/14544	Th 1:40pm - 3:30pm 273 Engineering Terrace	James Hone	3.00	23/22
MECE 3018	R05/14545	Th 3:40pm - 5:30pm 273 Engineering Terrace	James Hone	3.00	3/22

MECE E3028 MECHANICAL ENGINEERING LAB II. *3.00 points*.
Lect: 3.

Experiments in engineering and physical phenomena: aerofoil lift and drag in wind tunnels, laser Doppler anemometry in immersed fluidic channels, supersonic flow and shock waves, Rankine thermodynamical cycle for power generation, and structural truss mechanics and analysis

Spring 2026: MECE E3028

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3028	001/12115	T Th 1:10pm - 3:40pm 209 Havemeyer Hall	Bianca Howard	3.00	84/100

MECE E3100 INTRO TO MECHANCIS OF FLUIDS. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3105) ENME E3105
Basic continuum concepts. Liquids and gases in static equilibrium. Continuity equation. Two-dimensional kinematics. Equation of motion. Bernoulli's equation and applications. Equations of energy and angular momentum. Dimensional analysis. Two-dimensional laminar flow. Pipe flow, laminar, and turbulent. Elements of compressible flow

Fall 2026: MECE E3100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3100	001/11353	T Th 10:10am - 11:25am Room TBA	Karen Kasza	3.00	87/130
MECE 3100	R01/11354	F 10:00am - 11:00am 301 Pupin Laboratories	Karen Kasza	3.00	2/130

MECE E3102 Fluids Recitation. *0.00 points*.
Recitation course to accompany MECE E3100 INTRO TO MECHANCIS OF FLUIDS. Only students registered for MECE E3100 can register for this course

MECE E3301 THERMODYNAMICS. *3.00 points*.
Lect: 3.

Classical thermodynamics. Basic properties and concepts, thermodynamic properties of pure substances, equation of state, work, heat, the first and second laws for flow and nonflow processes, energy equations, entropy, and irreversibility. Introduction to power and refrigeration cycles

Fall 2026: MECE E3301

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3301	001/11355	T Th 8:40am - 9:55am 428 Pupin Laboratories	Arvind Narayanaswamy	3.00	95/130
MECE 3301	R01/11356	F 9:00am - 10:00am 833 Seeley W. Mudd Building	Arvind Narayanaswamy	3.00	3/120

MECE E3302 Thermodynamics Recitation. *0.00 points*.
Recitation course to accompany MECE E3301 Thermodynamics. Only students registered for MECE E3301 can register for this course

MECE E3311 HEAT TRANSFER. *3.00 points*.
Lect: 3.

Steady and unsteady heat conduction. Radiative heat transfer. Internal and external forced and free convective heat transfer. Change of phase. Heat exchangers

Spring 2026: MECE E3311

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3311	001/12116	T Th 10:10am - 11:25am 203 Mathematics Building	Vijay Vedula	3.00	111/110
MECE 3311	R01/12117	F 1:00pm - 2:00pm 142 Uris Hall	Vijay Vedula	3.00	6/90

MECE E3312 Heat Transfer Recitation. *0.00 points*.
Recitation course to accompany MECE E3311 Heat Transfer. Only students registered for MECE E3311 can register for this course

MECE E3401 MECHANICS OF MACHINES. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3105) and (MECE E3408) ENME E3105 AND MECE E3408
Introduction to mechanisms and machines, analytical and graphical synthesis of mechanism, displacement analysis, velocity analysis, acceleration analysis of linkages, dynamics of mechanism, cam design, gear and gear trains, and computer-aided mechanism design

MECE E3408 COMPUTER GRAPHICS # DESIGN. *3.00 points*.
Lect: 3.

Introduction to drafting, engineering graphics, computer graphics, solid modeling, and mechanical engineering design. Interactive computer graphics and numerical methods applied to the solution of mechanical engineering design problems

Spring 2026: MECE E3408

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3408	001/12118	M W 8:40am - 9:55am 252 Engineering Terrace	Sinisa Vukelic	3.00	27/28
MECE 3408	002/12119	M W 10:10am - 11:25am 252 Engineering Terrace	Sinisa Vukelic	3.00	26/28

Fall 2026: MECE E3408

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3408	001/14462	M W 8:40am - 9:55am 1224 Seeley W. Mudd Building	Sinisa Vukelic	3.00	0/47
MECE 3408	002/14463	M W 10:10am - 11:25am 1224 Seeley W. Mudd Building	Sinisa Vukelic	3.00	0/47

MECE E3409 MACHINE DESIGN. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3408) MECE E3408
Computer-aided analysis of general loading states and deformation of machine components using singularity functions and energy methods. Theoretical introduction to static failure theories, fracture mechanics, and fatigue failure theories. Introduction to conceptual design and design optimization problems. Design of machine components such as springs, shafts, fasteners, lead screws, rivets, welds. Modeling, analysis, and testing of machine assemblies for prescribed design problems. Problems will be drawn from statics, kinematics, dynamics, solid modeling, stress analysis, and design optimization

Fall 2026: MECE E3409

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3409	001/11357	T Th 10:10am - 11:25am 310 Fayerweather	Yevgeniy Yesilevskiy	3.00	85/90

MECE E3411 REVIEW OF FUNDMNTLS MECE ENGR. *1.00 point*.
Lect: 3.

Prerequisites: Senior standing.
Review of core courses in mechanical engineering, including mechanics, strength of materials, fluid mechanics, thermodynamics, heat transfer, materials and processing, control, and mechanical design and analysis. Review of additional topics, including engineering economics and ethics in engineering. The course culminates with a comprehensive examination, similar to the Fundamentals of Engineering examination. Meets the first 4.5 weeks only

MECE E3414 Mechanics of Solids for Mechanical Engineers. *3.00 points*.
Prerequisites: Mechanics, linear algebra, ordinary differential equations
Introduction to the mechanics of solids with an emphasis on mechanical engineering applications. Stress tensor, principal stresses, maximum shear stress, stress equilibrium, infinitesimal strain tensor, Hooke's law, boundary conditions. Introduction to the finite element method for stress analysis. Static failure theories, safety factors, fatigue failure. Assignments include finite element stress analyses using university-provided commercial software

Fall 2026: MECE E3414

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3414	001/11358	M W 11:40am - 12:55pm Cin Alfred Lerner Hall	Kristin Myers	3.00	90/130

MECE E3420 ENG DES-CONCPT/DESIGN GENERATN. *3.00 points*.
Prerequisites: Senior standing.
Corequisites: MECE E3409
A preliminary design for an original project is a prerequisite for the capstone design course. Will focus on the steps required for generating a preliminary design concept. Included will be a brainstorming concept generation phase, a literature search, incorporation of multiple constraints, adherence to appropriate engineering codes and standards, and the production of a layout drawing of the proposed capstone design project in a Computer Aided Design (CAD) software package. Note: MECE students only.

Fall 2026: MECE E3420

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3420	001/11359	M W 1:10pm - 3:40pm 717 Hamilton Hall	Yevgeniy Yesilevskiy	3.00	84/86

MECE E3430 ENGINEERING DESIGN. *3.00 points*.
Lect: 2. Lab: 4.

Prerequisites: (MECE E3420) MECE E3420
Building on the preliminary design concept, the detailed elements of the design process are completed: systems synthesis, design analysis optimization, incorporation of multiple constraints, compliance with appropriate engineering codes and standards, and Computer Aided Design (CAD) component part drawings. Execution of a project involving the design, fabrication, and performance testing of an actual engineering device or system

Spring 2026: MECE E3430

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3430	001/12120	T Th 9:00am - 11:30am 614 Schermerhorn Hall	Yevgeniy Yesilevskiy	3.00	85/85

MECE E3450 COMPUTER AIDED DESIGN. *3.00 points*.
Lect: 3

Prerequisites: (ENME E3105) and (ENME E3113) and (MECE E3408) and (MECE E3311) ENME E3105 AND ENME E3113 AND MECE E3311 AND MECE E3408
Introduction to numerical methods and their applications to rigid body mechanics for mechanisms and linkages. Introduction to finite element stress analysis for deformable bodies. Computer-aided mechanical engineering design using established software tools and verifications against analytical and finite difference solutions

MECE E3610 MATERIALS/PROCESSES IN MANUFAC. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3113) or the equivalent.
Introduction to microstructures and properties of metals, polymers, ceramics and composites; typical manufacturing processes: material removal, shaping, joining, and property alteration; behavior of engineering materials in the manufacturing processes.

Spring 2026: MECE E3610

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3610	001/12122	M W 1:10pm - 2:25pm 614 Schermerhorn Hall	Sinisa Vukelic	3.00	107/120

MECE E3899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: MECE E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3899	001/20299		Matei Ciocarlie	0.00	1/15
MECE 3899	002/20300		Bianca Howard	0.00	0/5
MECE 3899	003/20301		Chaoqun Dong	0.00	1/3

Summer 2026: MECE E3899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3899	001/11836		Chaoqun Dong	0.00	0/5
MECE 3899	002/12146		Hod Lipson	0.00	0/5
MECE 3899	004/11319		Sinisa Vukelic	0.00	0/5
MECE 3899	008/11314		Harry West	0.00	0/5

MECE E3900 HONORS TUTORIAL IN MECH ENGIN. *1.00-3.00 points*.
Lect: 3.

Prerequisites: 3.2 or higher GPA.
Individual study; may be selected after the first term of the junior year by students maintaining a 3.2 grade-point average. Course format may vary from individual tutorial to laboratory work to seminar instruction under faculty supervision. Projects requiring machine-shop use must be approved by the laboratory supervisor. Students may count up to 6 points toward degree requirements. Students must submit both a project outline prior to registration and a final project write up at the end of the semester

Summer 2026: MECE E3900

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3900	001/11951		Sinisa Vukelic	1.00-3.00	1/2

MECE E3901 HONORS TUTORIAL IN MECH ENGIN. *3.00 points*.
Lect: 3.

Prerequisites: 3.2 or higher GPA.
Individual study; may be selected after the first term of the junior year by students maintaining a 3.2 grade-point average. Course format may vary from individual tutorial to laboratory work to seminar instruction under faculty supervision. Projects requiring machine-shop use must be approved by the laboratory supervisor. Students may count up to 6 points toward degree requirements. Students must submit both a project outline prior to registration and a final project write up at the end of the semester

Spring 2026: MECE E3901

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3901	001/20284		Gerard Ateshian	3.00	0/2
MECE 3901	002/20285		Arvind Narayanaswamy	3.00	0/2
MECE 3901	003/20286		Vijay Vedula	3.00	0/2
MECE 3901	004/20287		James Hone	3.00	0/2
MECE 3901	005/20288		Kristin Myers	3.00	1/2
MECE 3901	006/20289		Jeffrey Kysar	3.00	0/2
MECE 3901	007/20290		Vijay Modi	3.00	0/2
MECE 3901	009/20291		Matei Ciocarlie	3.00	1/2
MECE 3901	011/20292		Sunil Agrawal	3.00	0/2
MECE 3901	015/20293		Yevgeniy Yesilevskiy	3.00	0/2
MECE 3901	016/20294		Hod Lipson	3.00	1/2
MECE 3901	019/20295		Mary Boyce	3.00	0/2

MECE E3998 PROJECTS IN MECH ENGINEERING. *1.00-3.00 points*.
Prerequisites: Approval by faculty member who agrees to supervise the work.
Independent project involving theoretical, computational, experimental, or engineering design work. May be repeated, but no more than 3 points may be counted toward degree requirements. Projects requiring machine-shop use must be approved by the laboratory supervisor. Students must submit both a project outline prior to registration and a final project write-up at the end of the semester

Spring 2026: MECE E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3998	001/12448		Gerard Ateshian	1.00-3.00	3/5
MECE 3998	002/12449		Arvind Narayanaswamy	1.00-3.00	1/5
MECE 3998	003/12450		Vijay Vedula	1.00-3.00	2/5
MECE 3998	004/12451		James Hone	1.00-3.00	0/5
MECE 3998	005/12452		Kristin Myers	1.00-3.00	5/5
MECE 3998	006/12453		Jeffrey Kysar	1.00-3.00	0/5
MECE 3998	007/12454		Vijay Modi	1.00-3.00	0/5
MECE 3998	008/12455		P Schuck	1.00-3.00	0/5
MECE 3998	009/12457		Qiao Lin	1.00-3.00	1/5
MECE 3998	010/12458		Matei Ciocarlie	1.00-3.00	3/5
MECE 3998	011/12460		Michael Massimino	1.00-3.00	1/5
MECE 3998	012/12461		Michael Burke	1.00-3.00	1/5
MECE 3998	013/12462		Sunil Agrawal	1.00-3.00	1/5
MECE 3998	014/12463		Sinisa Vukelic	1.00-3.00	5/5
MECE 3998	015/12464		Bianca Howard	1.00-3.00	0/5
MECE 3998	016/12465		Harry West	1.00-3.00	1/5
MECE 3998	017/12466		Yevgeniy Yesilevskiy	1.00-3.00	1/10
MECE 3998	018/12467		Hod Lipson	1.00-3.00	5/5
MECE 3998	019/12468		Karen Kasza	1.00-3.00	0/5
MECE 3998	020/12469		Mary Boyce	1.00-3.00	1/5
MECE 3998	021/12470		Homayoon Beigi	1.00-3.00	0/5
MECE 3998	022/12497		Chaoqun Dong	1.00-3.00	1/5
MECE 3998	023/12498		Adrian Buganza Tepole	1.00-3.00	0/5
MECE 3998	024/18277		Anthony Genova	1.00-3.00	4/5

Summer 2026: MECE E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3998	005/11320		Sinisa Vukelic	1.00-3.00	0/5
MECE 3998	006/11307		Hod Lipson	1.00-3.00	2/15
MECE 3998	010/11315		Harry West	1.00-3.00	0/5
MECE 3998	011/12870		Kristin Myers	1.00-3.00	0/5

Fall 2026: MECE E3998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3998	001/14931		Sunil Agrawal	1.00-3.00	0/5
MECE 3998	002/14932		P Schuck	1.00-3.00	0/5
MECE 3998	003/14933		Gerard Ateshian	1.00-3.00	0/5
MECE 3998	004/14934		Michael Burke	1.00-3.00	0/5
MECE 3998	005/14935		Vijay Vedula	1.00-3.00	0/5
MECE 3998	006/14936		Matei Ciocarlie	1.00-3.00	0/10
MECE 3998	007/14937		James Hone	1.00-3.00	0/5
MECE 3998	008/14938		Jeffrey Kysar	1.00-3.00	1/5
MECE 3998	009/14939		Qiao Lin	1.00-3.00	0/5
MECE 3998	010/14940		Bianca Howard	1.00-3.00	0/5
MECE 3998	011/14941		Vijay Modi	1.00-3.00	0/5
MECE 3998	012/14942		Kristin Myers	1.00-3.00	0/5
MECE 3998	013/14943		Arvind Narayanaswamy	1.00-3.00	0/5
MECE 3998	014/14944		Harry West	1.00-3.00	0/5
MECE 3998	015/14945		Sinisa Vukelic	1.00-3.00	0/5

MECE E3999 FIELDWORK. *1.00-2.00 points*.
Prerequisites: Obtained internship and approval from a faculty adviser. May be repeated for credit, but no more than 3 total points may be used toward the 128-credit degree requirement. Only for MECE undergraduate students who include relevant on-campus and off-campus work experience as part of their approved program of study. Final report and letter of evaluation required. Fieldwork credits may not count toward any major core, technical, elective, and nontechnical requirements. May not be taken for pass/fail credit or audited

Spring 2026: MECE E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3999	001/20395		Kristin Myers	1.00-2.00	0/5

Fall 2026: MECE E3999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 3999	001/19969		Arvind Narayanaswamy	1.00-2.00	0/5

MECE E4058 MECHATRONICS # EMBEDDED MICRO. *3.00 points*.
Lect: 3.

Prerequisites: (ELEN E1201) ELEN E1201; Recommended: ELEN E3000. Enrollment limited to 12 students. Mechatronics is the application of electronics and microcomputers to control mechanical systems. Systems explored include on/off systems, solenoids, stepper motors, DC motors, thermal systems, magnetic levitation. Use of analog and digital electronics and various sensors for control. Programming microcomputers in Assembly and C. Lab required

Spring 2026: MECE E4058

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4058	001/12124	Th 4:10pm - 6:40pm 330 Uris Hall	Enrico Zordan	3.00	17/40
MECE 4058	001/12124	Th 7:00pm - 9:30pm 273 Engineering Terrace	Enrico Zordan	3.00	17/40

Fall 2026: MECE E4058

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4058	001/11360	Th 4:10pm - 6:10pm 825 Seeley W. Mudd Building	Enrico Zordan	3.00	40/40
MECE 4058	001/11360	Th 7:00pm - 9:30pm 273 Engineering Terrace	Enrico Zordan	3.00	40/40

MECE E4078 Internet of (Mechanical) Things. *3.00 points*.
Hands-on, project-oriented course covering foundations of Internet of Things (IoT) technologies as they relate to the physical world. Projects utilizing Arduino and Raspberry Pi platforms. End-to-end IoT including sensors, basic controls, embedded systems programming, networking, IoT protocols, power consumption/optimization, and cloud connectivity. Build real IoT devices and systems in two team-based projects

MECE E4100 MECHANICS OF FLUIDS. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3100) MECE E3100; or equivalent.
Fluid dynamics and analyses for mechanical engineering and aerospace applications: boundary layers and lubrication, stability and turbulence, and compressible flow. Turbomachinery as well as additional selected topics

MECE E4211 ENERGY SOURCES AND CONVERSION. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3301) MECE E3301
Energy sources such as oil, gas, coal, gas hydrates, hydrogen, solar, and wind. Energy conversion systems for electrical power generation, automobiles, propulsion and refrigeration. Engines, steam and gas turbines, wind turbines; devices such as fuel cells, thermoelectric converters, and photovoltaic cells. Specialized topics may include carbon-dioxide sequestration, cogeneration, hybrid vehicles and energy storage devices

Fall 2026: MECE E4211

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4211	001/11361	M 4:10pm - 6:40pm 415 Schapiro Cepser		3.00	40/40

MECE E4212 MICROELECTROMECHANICAL SYSTEMS. *3.00 points*.
MEMS markets and applications; scaling laws; silicon as a mechanical material; Sensors and actuators; micromechanical analysis and design; substrate (bulk) and surface micromachining; computer aided design; packaging; testing and characterization; microfluidics

Fall 2026: MECE E4212

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4212	001/11362	Th 1:10pm - 3:40pm 825 Seeley W. Mudd Building	P Schuck	3.00	35/35

MECE E4213 Lab-on-a-Chip and Microrobotic Devices. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3100) and (MECE E3311) MECE E3100 AND MECE E3311; course in transport phenomena, or instructor's permission.
Introduction to lab-on-a-chip and microrobotic devices with a focus on biomedical applications. Microfabrication techniques. Basics of micro- and nanoscale transport phenomena. Microsensors and microactuators. Microfluidic devices. Lab-on-a-chip systems. Microrobots

Fall 2026: MECE E4213

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4213	001/11363	W 4:10pm - 6:40pm C01 80 Claremont	Qiao Lin	3.00	26/25

MECE E4214 MEMS Sensors and Systems. *3.00 points*.
Prerequisites: (MECE E4212) MECE E4212
Connects basic MEMS transduction elements to applications by analyzing the analog signal chain, sensor packaging, and sensor integration into larger systems. Underlying concepts of analog instrumentation such as filtering and digitization covered. Hands-on projects involve off-the-shelf sensors and single-board computers to create self-contained sensor systems that demonstrate relevant issues.

Spring 2026: MECE E4214

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4214	001/12125	M 7:00pm - 9:30pm 337 Seeley W. Mudd Building	John Hilton	3.00	19/25

MECE E4300 Graduate Design. *3.00 points*.
Team-based iterative design sequence to create a novel invention made to meet a well-defined need. Students will identify a need through research, develop a novel (in a patent sense) solution, create a proof-of-concept low-fidelity prototype, and finally create a refined prototype. Students will utilize theory, simulation, and experimentation to validate key design choices. The course will include ideation techniques, intellectual property, standards, advanced 3D modeling, rapid prototyping, kinematics, dynamic simulation, finite element analysis, optimization, and experimental design

Spring 2026: MECE E4300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4300	001/18319	T 1:10pm - 3:40pm 703 Hamilton Hall	Yevgeniy Yesilevskiy	3.00	9/30

MECE E4302 ADVANCED THERMODYNAMICS. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3301) MECE E3301
Advanced classical thermodynamics. Availability, irreversibility, generalized behavior, equations of state for nonideal gases, mixtures and solutions, phase and chemical behavior, combustion. Thermodynamic properties of ideal gases. Applications to automotive and aircraft engines, refrigeration and air conditioning, and biological systems

Spring 2026: MECE E4302

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4302	001/12126	T 1:10pm - 3:40pm 407 Mathematics Building	Michael Burke	3.00	19/25

Summer 2026: MECE E4302

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4302	D01/11960		Sinisa Vukelic	3.00	3/99

MECE E4304 TURBOMACHINERY. *3.00 points*.
Introduces the basics of theory, design, selection and applications of turbomachinery. Turbomachines are widely used in many engineering applications such as energy conversion, power plants, air-conditioning, pumping, refrigeration and vehicle engines, as there are pumps, blowers, compressors, gas turbines, jet engines, wind turbines, etc. Applications are drawn from energy conversion technologies, HVAC and propulsion. Provides a basic understanding of the different kinds of turbomachines

MECE E4305 MECH # THERMODYNAMICS OF PROPULSION. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3301) and (MECE E4306) or instructor approval
Principles of propulsion. Thermodynamic cycles of air breathing propulsion systems including ramjet, scramjet, turbojet, and turbofan engine and rocket propulsion system concepts. Turbine engine and rocket performance characteristics. Component and cycle analysis of jet engines and turbomachinery. Advanced propulsion systems. Columbia Engineering interdisciplinary course.

MECE E4306 INTRO TO AERODYNAMICS. *3.00 points*.
Principles of flight, incompressible flows, compressible regimes. Inviscid compressible aerodynamics in nozzles (wind tunnels, jet engines), around wings (aircraft, space shuttle) and around blunt bodies (rockets, reentry vehicles). Physics of normal shock waves, oblique shock waves, and explosion waves.

Spring 2026: MECE E4306

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4306	001/12127	M 4:10pm - 6:40pm 633 Seeley W. Mudd Building	Peter LeVoci	3.00	43/60

MECE E4312 SOLAR THERMAL ENGINEERING. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3311)
Fundamentals of solar energy transport: radiation heat transfer, convention, conduction and phase change processes. Heat exchangers and solar collectors: basic methods of thermal design, flow arrangements, effects of variable conditions, rating procedures. Solar energy concentration. Piping Systems: series and parallel arrangements, fluid movers. Thermal response and management of photovoltaic energy conversion. Solar energy storage. Solar cooling, solar thermal power and cogeneration. Applications to the design of solar thermal engineering systems.

MECE E4313 Decarbonizing Buildings Studio: Energy system retrofits at speed and scale. *3.00 points*.
Historical co-evolution of building energy systems and fuels. Classifying existing buildings into typologies that are a prevalent combination of building size, age, fuels, equipment, distribution and zoning controls. Fuels, electricity, furnaces, boilers, heat pumps. Overview of common heat and hot water distribution systems. Case-study based approach to evaluate retrofit options for each typology. Considerations of location, staging upgrades, envelope efficiency, retrofit cost structure, paybacks with a view towards decarbonization

Spring 2026: MECE E4313

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4313	001/12128	Th 1:10pm - 3:40pm 337 Seeley W. Mudd Building	Marc Zuluaga	3.00	30/34

MECE E4314 ENERGY DYNAMICS OF GREEN BLDGS. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3301) and (MECE E3311) MECE E3301 AND MECE E3311
Introduction to analysis and design of heating, ventilating and air-conditioning systems. Heating and cooling loads. Humidity control. Solar gain and passive solar design. Global energy implications. Green buildings. Building-integrated photovoltaics. Roof-mounted gardens and greenhouses. Financial assessment tools and case studies. Open to Mechanical Engineering graduate students only

MECE E4330 THERMOFLUID SYSTEMS DESIGN. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3100) and (MECE E3301) and (MECE E3311) MECE E3100 AND MECE E3301 AND MECE E3311
Theoretical and practical considerations, and design principles, for modern thermofluids systems. Topics include boiling, condensation, phase change heat transfer, multimode heat transfer, heat exchangers, and modeling of thermal transport systems. Emphasis on applications of thermodynamics, heat transfer, and fluid mechanics to modeling actual physical systems. Term project on conceptual design and presentation of a thermofluid system that meets specified criteria

Summer 2026: MECE E4330

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4330	D01/11961		Sinisa Vukelic	3.00	2/99

MECE E4350 Building Energy Modeling and Simulation. *3.00 points*.
Review of building energy modeling techniques for simulating time-varying demand. Detailed Physics-based models, gray-box and black-box modeling. Static and dynamic models of building energy systems. Deterministic and Stochastic occupancy modeling. Modeling of control and dispatch of HVAC and local energy systems. Implementation of models in Energyplus and Modelica platforms. Modeling of low and net-zero carbon buildings and local energy systems

Fall 2026: MECE E4350

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4350	001/11365	T 1:10pm - 3:40pm 415 Schapiro Cepser	Bianca Howard	3.00	21/40

MECE E4401 Introduction to Kinematics of Machines and Robots. *3.00 points*.
Prerequisites: (ENME E3105 and APMA E3101) or (MATH UN2010 and APMA E3101) College level mechanics and linear algebra.
Introduction to kinematic analysis and design of machines and robots. Analytical and graphical synthesis of four-bar linkages. Planar displacements of rigid bodies. Spherical displacements of rigid bodies. Spatial displacements of rigid bodies. Rigid body velocities and wrenches. Concepts of kinematics of open-chain linkages.

Spring 2026: MECE E4401

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4401	001/12129	T 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Qiao Lin	3.00	23/34

MECE E4430 AUTOMOTIVE DYNAMICS. *3.00 points*.
Lect: 3.

Prerequisites: (ENME E3105) or or equivalent.
Recommended: ENME E3100 or E3106. Reviews fundamentals of vehicle dynamics. A systems-based engineering approach to explore areas of: tire characteristics, aerodynamics, stability and control, wheel loads, ride and roll rates, suspension geometry, and dampers. A high-performance vehicle (racecar) platform used as an example to review topics.

MECE E4461 Materials Selection for Mechanical Design. *3.00 points*.
Prerequisites: MECE E3414
Understanding the properties and behavior of materials is critical to the mechanical design and subsequent function of any product or part – including wide-ranging applications from aircraft fuselage to robotic manipulators to flexures to telescope mirrors to flywheels to sports equipment to thermal insulators. This course provides a fundamental understanding of the microstructure of a range of materials (metals, polymers, ceramics, composites, hybrid) and the connection to design-determining or limiting properties including stiffness, expansion, thermal expansion, strength, energy storage and dissipation, toughness, and fatigue. Objective functions which are used to determine a "material index" for the selection of the best materials for use in a particular mechanical design are developed, underscoring the combined role of material properties and loading conditions in optimizing for materials selection. For example, take the case of determining a material index for selecting a best set of materials for a lightweight, stiff beam – how do the material density and elastic modulus together with the beam geometry and loading conditions factor in to determining the material index for materials selection? Note that the resulting material index for selecting best materials for a lightweight stiff beam (bending) is different than that for a lightweight stiff rod (tension). The material indices provide the framework for construction and use of materials selection charts to rapidly compare the effectiveness of wide-ranging materials for different applications.

Fall 2026: MECE E4461

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4461	001/11367	M W 11:40am - 12:55pm 415 Schapiro Cepser	Mary Boyce	3.00	40/40

MECE E4520 DATA SCIENCE FOR MECHANICAL SYSTEMS. *3.00 points*.
Lec: 3.

Prerequisites: Knowledge of basic computer programming e.g. Java, MATLAB, Python, or Instructor's permission
Introduction to the practical application of data science, machine learning, and artificial intelligence and their application in Mechanical Engineering. A review of relevant programming tools necessary for applying data science is provided, as well as a detailed review of data infrastructure and database construction for data science. A series of industry case studies from experts in the field of data science will be presented

Fall 2026: MECE E4520

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4520	001/11369	T Th 10:10am - 11:25am 717 Hamilton Hall	Changyao Chen	3.00	90/86

MECE E4602 INTRODUCTION TO ROBOTICS. *3.00 points*.
Lect: 3.

Overview of robot applications and capabilities. Linear algebra, kinematics, statics, and dynamics of robot manipulators. Survey of sensor technology: force, proximity, vision, compliant manipulators. Motion planning and artificial intelligence; manipulator programming requirements and languages

Fall 2026: MECE E4602

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4602	001/11370	T 4:10pm - 6:40pm 833 Seeley W. Mudd Building	Sunil Agrawal	3.00	120/120
MECE 4602	V01/19962		Sunil Agrawal	3.00	1/99

MECE E4604 PRODUCT DESIGN FOR MFG. *3.00 points*.
Lect: 3.

Prerequisites: Manufacturing process, computer graphics, engineering design, mechanical design.
General review of product development process; market analysis and product system design; principles of design for manufacturing; strategy for material selection and manufacturing process choice; component design for machining; casting; molding; sheet metal working and inspection; general assembly processes; product design for manual assembly; design for robotic and automatic assembly; case studies of product design and improvement

MECE E4606 DIGITAL MANUFACTURING. *3.00 points*.
Prerequisites: Basic programming in any language.
Additive manufacturing processes, CNC, Sheet cutting processes, Numerical control, Generative and algorithmic design. Social, economic, legal, and business implications. Course involves both theoretical exercises and a hands-on project

Spring 2026: MECE E4606

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4606	001/12156	T 6:10pm - 8:40pm 517 Hamilton Hall	Jonathan Blutinger	3.00	61/85

MECE E4609 COMPUTER AIDED MANUFACTURING. *3.00 points*.
Lect: 3.

Prerequisites: Introductory course on manufacturing processes and knowledge of computer-aided design, and mechanical design or instructor's permission.
Computer-aided design, free-form surface modeling, tooling and fixturing, computer numeric control, rapid prototyping, process engineering, fixed and programmable automation, industrial robotics

MECE E4610 ADV MANUFACTURING PROCESSES. *3.00 points*.
Lect: 3.

Prerequisites: Introductory course on manufacturing processes, and heat transfer, knowledge of engineering materials, or instructor's permission. Principles of nontraditional manufacturing, nontraditional transport and media. Emphasis on laser assisted materials processing, laser material interactions with applications to laser material removal, forming, and surface modification. Introduction to electrochemical machining, electrical discharge machining and abrasive water jet machining

Fall 2026: MECE E4610

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4610	001/11371	W 4:10pm - 6:40pm 627 Seeley W. Mudd Building	Sinisa Vukelic	3.00	41/50
MECE 4610	V01/19690		Sinisa Vukelic	3.00	1/99

MECE E4611 ROBOTICS STUDIO. *3.00 points*.
Prerequisites: Knowledge of basic computer programming e.g., Java, Matlab, Python or instructor's permission.
Hands-on studio class exposing students to practical aspects of the design, fabrication, and programming of physical robotic systems. Students experience entire robot creation process, covering conceptual design, detailed design, simulation and modeling, digital manufacturing, electronics and sensor design, and software programming

Fall 2026: MECE E4611

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4611	001/11372	W 11:40am - 12:55pm 833 Seeley W. Mudd Building	Hod Lipson	3.00	120/120
MECE 4611	V01/19932		Hod Lipson	3.00	0/99

MECE E4612 SUSTAINABLE MANUFACTURING. *3.00 points*.
Prerequisites: Introductory course in engineering materials and manufacturing processes or instructor's permission.
Fundamentals of sustainable design and manufacturing, metrics of sustainability, analytical tools, principles of life cycle assessment, manufacturing tools, processes and systems energy assessment and minimization in manufacturing, sustainable manufacturing automation, sustainable manufacturing systems, remanufacturing, recycling and reuse

Spring 2026: MECE E4612

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4612	001/12157	M W 1:10pm - 2:25pm 627 Seeley W. Mudd Building	Chaoqun Dong	3.00	23/50

MECE E4613 Industrial Automation. *3.00 points*.
Introduction to industrial automation technologies. Recognizing, modeling and integration of industrial automation problems. Hands-on experiments with robots, computer vision, data management and programming. Sensors engineering and measurement tools; process control; automation hardware and software architectures; programmable logic controllers

Spring 2026: MECE E4613

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4613	001/12162	Th 4:10pm - 6:40pm 415 Schapiro Cepser	Ali Dadgar	3.00	36/42

MECE E4899 Research Training. *0.00 points*.
Prerequisites: Instructor's permission.
Research training course. Recommended in preparation for laboratory related research

Spring 2026: MECE E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4899	001/20302		Matei Ciocarlie	0.00	1/10
MECE 4899	002/20250		Michael Burke	0.00	2/2
MECE 4899	003/20303		Chaoqun Dong	0.00	2/3
MECE 4899	004/20337		Homayoon Beigi	0.00	1/4
MECE 4899	005/20580		P Schuck	0.00	1/1

Summer 2026: MECE E4899

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4899	001/11837		Chaoqun Dong	0.00	2/5
MECE 4899	002/12147		Hod Lipson	0.00	4/5
MECE 4899	003/12837		Michael Burke	0.00	1/5
MECE 4899	004/11322		Sinisa Vukelic	0.00	0/5
MECE 4899	005/11313		Homayoon Beigi	0.00	0/5
MECE 4899	006/11962		Cody Paige	0.00	2/2
MECE 4899	007/11316		Harry West	0.00	0/5
MECE 4899	008/12869		P Schuck	0.00	0/2

MECE E4990 SPECIAL TOPICS IN ME. *3.00 points*.
Lect: 3.

Prerequisites: Permission of the Instructor
Prerequisite(s): Permission of the instructor. Topics and Instructors change from year to year. For advanced undergraduate students and graduate students in engineering, physical sciences, and other fields

Spring 2026: MECE E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4990	001/18310	W 4:10pm - 6:40pm 273 Engineering Terrace	Sinisa Vukelic	3.00	15/20
MECE 4990	002/18320	T F 9:10am - 10:25am 829 Seeley W. Mudd Building	Leonard Imas	3.00	18/24

Fall 2026: MECE E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4990	002/19824	Th 10:10am - 12:40pm 1224 Seeley W. Mudd Building		3.00	0/36

MECE E4998 MS PROJECTS IN MECH ENGINEER. *1.00-3.00 points*.
1-3

Prerequisites: Instructor's permission.
Master's level independent project involving theoretical, computational, experimental, or engineering design work. May be repeated, subject to Master's Program guidelines. Students must submit both a project outline prior to registration and a final project write-up at the end of the semester

Spring 2026: MECE E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4998	001/12472		Gerard Ateshian	1.00-3.00	1/5
MECE 4998	002/12473		Arvind Narayanaswamy	1.00-3.00	0/5
MECE 4998	003/12474		Vijay Vedula	1.00-3.00	2/5
MECE 4998	004/12475		James Hone	1.00-3.00	0/5
MECE 4998	005/12476		Kristin Myers	1.00-3.00	1/5
MECE 4998	006/12477		Jeffrey Kysar	1.00-3.00	0/5
MECE 4998	007/12478		Vijay Modi	1.00-3.00	1/5
MECE 4998	008/12479		P Schuck	1.00-3.00	0/5
MECE 4998	009/12480		Qiao Lin	1.00-3.00	1/5
MECE 4998	010/12481		Matei Ciocarlie	1.00-3.00	3/5
MECE 4998	011/12482		Michael Massimino	1.00-3.00	0/5
MECE 4998	012/12483		Michael Burke	1.00-3.00	2/5
MECE 4998	013/12485		Sunil Agrawal	1.00-3.00	2/10
MECE 4998	014/12486		Sinisa Vukelic	1.00-3.00	4/10
MECE 4998	015/12487		Bianca Howard	1.00-3.00	1/5
MECE 4998	016/12488		Harry West	1.00-3.00	1/5
MECE 4998	017/12490		Yevgeniy Yesilevskiy	1.00-3.00	0/5
MECE 4998	018/12491		Hod Lipson	1.00-3.00	17/20
MECE 4998	019/12492		Karen Kasza	1.00-3.00	0/5
MECE 4998	020/12493		Mary Boyce	1.00-3.00	2/5
MECE 4998	021/12495		Homayoon Beigi	1.00-3.00	5/10
MECE 4998	022/12500		Chaoqun Dong	1.00-3.00	2/5
MECE 4998	023/12502		Adrian Buganza Tepole	1.00-3.00	1/5
MECE 4998	024/18278		Anthony Genova	1.00-3.00	1/5

Summer 2026: MECE E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4998	001/11965		Chaoqun Dong	1.00-3.00	1/5
MECE 4998	003/11308		Matei Ciocarlie	1.00-3.00	0/10
MECE 4998	004/11310		Sunil Agrawal	1.00-3.00	0/10
MECE 4998	005/11323		Sinisa Vukelic	1.00-3.00	0/5
MECE 4998	006/11309		Hod Lipson	1.00-3.00	4/15
MECE 4998	007/12838		Michael Burke	1.00-3.00	1/5
MECE 4998	008/12881		Adrian Buganza Tepole	1.00-3.00	0/5
MECE 4998	009/11312		Homayoon Beigi	1.00-3.00	2/5
MECE 4998	010/11317		Harry West	1.00-3.00	0/5
MECE 4998	011/11466		Vijay Modi	1.00-3.00	1/5

Fall 2026: MECE E4998

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4998	001/14890		Sunil Agrawal	1.00-3.00	0/10
MECE 4998	002/14891		Gerard Ateshian	1.00-3.00	0/5
MECE 4998	003/14892		Michael Burke	1.00-3.00	0/5
MECE 4998	004/14893		Matei Ciocarlie	1.00-3.00	0/10
MECE 4998	005/14894		James Hone	1.00-3.00	0/5
MECE 4998	006/14895		Bianca Howard	1.00-3.00	0/5
MECE 4998	007/14896		Vijay Modi	1.00-3.00	0/5

MECE E4999 FIELDWORK. *1.00 point*.
Prerequisites: Instructor's written permission.
Only for ME graduate students who need relevant off-campus work experience as part of their program of study as determined by the instructor. Written application must be made prior to registration outlining proposed study program. Final reports required. May not be taken for pass/fail credit or audited. International students must consult with the International Students and Scholars Office

Spring 2026: MECE E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4999	001/20396		Michael Burke	1.00	0/15

Fall 2026: MECE E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 4999	001/19818		Michael Burke	1.00	0/15

MECE E6100 ADVANCED MECHANICS OF FLUIDS. *3.00 points*.
Prerequisites: MATH UN2030 and MECE E3100
Corequisites: MECE E6313
Eulerian and Lagrangian descriptions of motion. Stress and strain rate tensors, vorticity, integral and differentialequations of mass, momentum, and energy conservation. Potential flow.

Fall 2026: MECE E6100

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6100	001/11374	W 1:10pm - 3:40pm 644 Seeley W. Mudd Building	Gerard Ateshian	3.00	25/40

MECE E6102 COMPUTATNL HEAT TRANSF-FL FLOW. *3.00 points*.
Prerequisites: MECE E3100 AND MECE E3311
Mathematical description of pertinent physical phenomena. Basics of finite-difference methods of discretization, explicit and implicit schemes, grid sizes, stability, and convergence. Solution of algebraic equations, relaxation. Heat conduction. Incompressible fluid flow, stream function-vorticity formulation. Forced and natural convection. Use of primitive variables, turbulence modeling, and coordinate transformations

MECE E6106 Finite Element Method for Fluid Flow and Fluid-Structure Interactions. *3.00 points*.
Prerequisites: MECE E4100 or MECE E6100 or ENME E4332 or equivalents, or instructor's permission and high-level programming language Fortran, C, C++, Python, MATLAB, etc.
Solving convection-dominated phenomena using finite element method (FEM), including convection-diffusion equation, Navier-Stokes, equation for incompressible viscous flows, and nonlinear fluid-structure interactions (FSI). Foundational concepts of FEM include function spaces, strong and weak forms, Galerkin FEM, isoparametric discretization, stability analysis, and error estimates. Mixed FEM for Stokes flow, incompressibility and inf-sup conditions. Stabilization approaches, including residue-based variational multiscale methods. Arbitrary Lagrangian-Eulerian (ALE) formulation for nonlinear FSI, and selected advanced topics of research interest.

Fall 2026: MECE E6106

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6106	001/15659	M 4:10pm - 6:40pm 337 Seeley W. Mudd Building	Vijay Vedula	3.00	17/30

MECE E6137 NANOSCALE ACTUATION # SENSING. *3.00 points*.
Lect: 3.

Prerequisites: (PHYS UN1402) or (PHYS UN1602) or equivalent, or instructor's permission.
Interaction of light with nanoscale materials and structures for purpose of inducing movement and detecting small changes in strain, temperature, and chemistry within local environments. Methods for concentrating and manipulating light at length scales below the diffraction limit. Plasmonics and metamaterials, as well as excitons, phonos, and polaritons and their advantages for mechanical and chemical sensing, and controlling displacement at nanometer length scales. Applications to nanophotonic devices and recently published progress in nanomechanics and related fields.

Spring 2026: MECE E6137

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6137	001/12163	Th 1:10pm - 3:40pm 627 Seeley W. Mudd Building	P Schuck	3.00	23/50

MECE E6168 Two-dimensional Materials. *3.00 points*.
Prerequisites: Permission of instructor
Introduction to two-dimensional (2D) materials. Crystal structure. Synthesis and characterization. Mechanical behavior. Waves in 2D lattices, and phonon bandstructure. Basic concepts of quantum mechanics. Electronic bandstructure of graphene. Electrical transport in graphene. Optics of 2D semiconductors. Advanced topics include quantum Hall effects; topology; and 'twisted' 2D heterostructures.

Spring 2026: MECE E6168

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6168	001/18318	T 4:10pm - 6:40pm 304 Uris Hall	James Hone	3.00	13/20

MECE E6200 TURBULENCE. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E6100) MECE E6100
Introductory concepts and statistical description. Kinematics of random velocity fields, dynamics of vorticity, and scalar quantities. Transport processes in a turbulent medium. Turbulent shear flows: deterministic and random structures. Experimental techniques, prediction methods, and simulation.

MECE E6313 ADVANCED HEAT TRANSFER. *3.00 points*.
Lect: 3.

Prerequisites: MECE E3311
Corequisites: MECE E6100
Application of analytical techniques to the solution of multidimensional steady and transient problems in heat conduction and convection. Lumped, integral, and differential formulations. Topics include use of sources and sinks, laminar/turbulent forced convection, and natural convection in internal and external geometries.

Spring 2026: MECE E6313

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6313	001/12164	M 4:10pm - 6:40pm 1127 Seeley W. Mudd Building	David Tew	3.00	22/30
MECE 6313	V01/18196		David Tew	3.00	2/99

MECE E6400 ADVANCED MACHINE DYNAMICS. *3.00 points*.
Lect: 3.

Prerequisites: (MECE E3401) MECE E3401
Review of classical dynamics, including Lagrange's equations. Analysis of dynamic response of high-speed machine elements and systems, including mass-spring systems, cam-follower systems, and gearing; shock isolation; introduction to gyrodynamics

Spring 2026: MECE E6400

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6400	001/12166	F 4:10pm - 6:40pm 829 Seeley W. Mudd Building	Anthony Genova	3.00	19/30
MECE 6400	V01/19997	F 4:10pm - 6:40pm Online Only	Anthony Genova	3.00	3/99

MECE E6422 INTRO-THEORY OF ELASTICITY I. *3.00 points*.
Lect: 3.

Prerequisites: APMA E4200
Corequisites: APMA E4200.
Analysis of stress and strain. Formulation of the problem of elastic equilibrium. Torsion and flexure of prismatic bars. Problems in stress concentration, rotating disks, shrink fits, and curved beams; pressure vessels, contact and impact of elastic bodies, thermal stresses, propagation of elastic waves

Summer 2026: MECE E6422

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6422	D01/11885		Jeffrey Kysar	3.00	4/99

Fall 2026: MECE E6422

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6422	001/11375	M 9:10am - 11:30am 253 Engineering Terrace	Adrian Buganza Tepole	3.00	25/25

MECE E6423 INTRO-THEORY OF ELASTICITY II. *3.00 points*.
Lect: 3.

Corequisites: APMA E4200
Analysis of stress and strain. Formulation of the problem of elastic equilibrium. Torsion and flexure of prismatic bars. Problems in stress concentration, rotating disks, shrink fits, and curved beams; pressure vessels, contact and impact of elastic bodies, thermal stresses, propagation of elastic waves.

MECE E6432 SMALL-SCALE MECH BEHAVIOR. *3.00 points*.
Prerequisites: APMA E4200 AND ENME E3113; ENME E3113 or equivalent; APMA E4200 or equivalent.
Mechanics of small-scale materials and structures require nonlinear kinematics and/or nonlinear stress vs. strain constitutive relations to predict mechanical behavior. Topics include variational calculus, deformation and vibration of beam, strings, plates, and membranes; fracture, delamination, bulging, buckling of thin films, among others. Thermodynamics of solids will be reviewed to provide the basis for a detailed discussion of nonlinear elastic behavior as well as the study of the equilibrium and stability of surfaces

Fall 2026: MECE E6432

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6432	001/20107	T 4:10pm - 6:40pm Room TBA	Jeffrey Kysar	3.00	0/20

MECE E6460 Mechanics of Elastomeric and Elastomeric-Like Materials. *3.00 points*.
Prerequisites: (MECE E3414 and MECE E6422)
Mechanics of nonlinear mechanical behavior of elastomeric and elastomeric-like solids. Overview of structure and behavior of elastomers. Kinematics of large deformation. Constitutive models for equilibrium stress-strain behavior, using invariant measures of deformation and statistical mechanics of molecular networks. Automated Constitutive Model Discovery via Neural Networks. Hysteretic aspects of structure and behavior due to time dependence and structural evolution with deformation. Review of experimental data and models to capture and predict observations. Time permitting: behavior of particle-filled, thermoplastic and biomacromolecular elastomers.

Spring 2026: MECE E6460

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 6460	001/20340	W 10:10am - 12:40pm 253 Engineering Terrace	Mary Boyce	3.00	18/25

MECE E6612 Robotics Studio (Advanced). *3.00 points*.
Hands-on studio class exposing students to practical aspects of the design, fabrication, and training of physical robotic systems. Students experience the entire robot creation process, covering conceptual design, detailed design, simulation and modeling, digital manufacturing, electronics and sensor design, software programming. This advanced version of Robotics Studio involves using Machine Learning instead of manual programming of the robot. This course is an advanced version of MECE 4611; only one of these versions can be taken

MECE E6614 ADV TPC:ROBOTICS/MECH SYNTHES. *3.00 points*.
Lect: 3.

Recommended: MECE E3401 or instructor's permission. Kinematic modeling methods for serial, parallel, redundant, wire-actuated robots and multifingered hands with discussion of open research problems. Introduction to screw theory and line geometry tools for kinematics. Applications of homotopy continuation methods and symbolic-numerical methods for direct kinematics of parallel robots and synthesis of mechanisms. Course uses textbook materials as well as a collection of recent research papers.

MECE E8020 MASTERS THESIS. *1.00-3.00 points*.
Research in an area of mechanical engineering culminating in a verbal presentation and a written thesis document approved by the thesis adviser. Must obtain permission from a thesis adviser to enroll. Recommended enrollment for two terms, one of which can be the summer. A maximum of 6 points of master's thesis may count toward an M.S. degree, and additional research points cannot be counted. On completion of all master's thesis credits, the thesis adviser will assign a single grade. Students must use a department-recommended format for thesis writing

Spring 2026: MECE E8020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 8020	002/20246		Arvind Narayanaswamy	1.00-3.00	1/5
MECE 8020	010/20391		Matei Ciocarlie	1.00-3.00	1/5

MECE E8501 ADVNCD CONTINUUM BIOMECHANICS. *3.00 points*.
Prerequisites: Instructor's permission.
The essentials of finite deformation theory of solids and fluids needed to describe mechanical behavior of biological tissue: kinematics of finite deformations, balance laws, principle of material objectivity, theory of constitutive equations, concept of simple solids and simple fluids, approximate constitutive equations, some boundary-value problems. Topics include one- and two-point tensor components with respect to generalized coordinates; finite deformation tensors, such as right and left Cauchy-Green tensors; rate of deformation tensors, such as Rivlin-Ericksen tensors; various forms of objective time derivatives, such as corotational and convected derivatives of tensors; viscometric flows of simple fluids; examples of rate and integral type of constitutive equations

MECE E9000 GRADUATE RESEARCH AND STUDY I. *1.00-6.00 points*.
Theoretical or experimental study or research in graduate areas in mechanical engineering and engineering science

Fall 2026: MECE E9000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 9000	001/14911		Gerard Ateshian	1.00-6.00	3/5
MECE 9000	002/14912		Arvind Narayanaswamy	1.00-6.00	0/2
MECE 9000	003/14913		Bianca Howard	1.00-6.00	1/2
MECE 9000	004/14914		James Hone	1.00-6.00	5/10
MECE 9000	005/14915		Kristin Myers	1.00-6.00	5/5
MECE 9000	006/14916		Jeffrey Kysar	1.00-6.00	0/5
MECE 9000	007/14917		Michael Burke	1.00-6.00	3/5
MECE 9000	008/14918		Vijay Modi	1.00-6.00	5/5
MECE 9000	009/14919		Qiao Lin	1.00-6.00	2/5
MECE 9000	010/14920		Matei Ciocarlie	1.00-6.00	2/5
MECE 9000	011/14921		Vijay Vedula	1.00-6.00	3/5
MECE 9000	012/14922		Sunil Agrawal	1.00-6.00	2/10
MECE 9000	013/14923		Sinisa Vukelic	1.00-6.00	0/2
MECE 9000	014/14924		P Schuck	1.00-6.00	1/5
MECE 9000	015/14925		Karen Kasza	1.00-6.00	0/5
MECE 9000	016/14926		Hod Lipson	1.00-6.00	3/10
MECE 9000	017/14929		Mary Boyce	1.00-6.00	0/2
MECE 9000	018/14927		Adrian Buganza Tepole	1.00-6.00	2/3
MECE 9000	019/14928		Chaoqun Dong	1.00-6.00	2/5

MECE E9001 GRADUATE RESEARCH AND STUDY II. *1.00-6.00 points*.
Theoretical or experimental study or research in graduate areas in mechanical engineering and engineering science

Spring 2026: MECE E9001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 9001	001/12695		Gerard Ateshian	1.00-6.00	4/5
MECE 9001	002/12696		Arvind Narayanaswamy	1.00-6.00	0/5
MECE 9001	003/12697		Vijay Vedula	1.00-6.00	4/5
MECE 9001	004/12698		James Hone	1.00-6.00	6/5
MECE 9001	005/12699		Kristin Myers	1.00-6.00	5/5
MECE 9001	006/12700		Jeffrey Kysar	1.00-6.00	0/5
MECE 9001	007/12701		Vijay Modi	1.00-6.00	4/5
MECE 9001	008/12702		P Schuck	1.00-6.00	3/5
MECE 9001	009/12704		Qiao Lin	1.00-6.00	2/5
MECE 9001	010/12705		Matei Ciocarlie	1.00-6.00	5/5
MECE 9001	011/12706		Michael Massimino	1.00-6.00	0/5
MECE 9001	012/12707		Michael Burke	1.00-6.00	3/5
MECE 9001	013/12708		Sunil Agrawal	1.00-6.00	7/10
MECE 9001	014/12709		Sinisa Vukelic	1.00-6.00	1/10
MECE 9001	015/12710		Bianca Howard	1.00-6.00	2/5
MECE 9001	016/12711		Harry West	1.00-6.00	2/5
MECE 9001	017/12712		Yevgeniy Yesilevskiy	1.00-6.00	0/5
MECE 9001	018/12713		Hod Lipson	1.00-6.00	1/10
MECE 9001	019/12715		Karen Kasza	1.00-6.00	1/5
MECE 9001	020/12716		Mary Boyce	1.00-6.00	0/5
MECE 9001	021/12717		Chaoqun Dong	1.00-6.00	2/5
MECE 9001	022/12718		Adrian Buganza Tepole	1.00-6.00	3/5

MECE E9500 GRADUATE SEMINAR. *0.00 points*.
0 pts.

All doctoral students are required to complete successfully four semesters of the mechanical engineering seminar MECE E9500

Spring 2026: MECE E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 9500	001/12429	F 11:00am - 12:00pm 829 Seeley W. Mudd Building		0.00	22/35

Fall 2026: MECE E9500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 9500	001/14930	F 11:00am - 12:00pm 415 Schapiro Cepser	Matei Ciocarlie	0.00	18/35

MECE E9800 DOCTORAL RESEARCH INSTRUCTION. *3.00-12.00 points*.
3, 6, 9 or 12 pts.

A candidate for the Eng.Sc.D. degree in mechanical engineering must register for 12 points of doctoral research instruction. Registration in MECE E9800 may not be used to satisfy the minimum residence requirement for the degree

Spring 2026: MECE E9800

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECE 9800	001/17953		Nicolas Chbat	3.00-12.00	0/1

MECH E4320 INTRO TO COMBUSTION. *3.00 points*.
Prerequisites: Introductory thermodynamics, fluid dynamics, and heat transfer at the undergraduate level or instructor's permission.
Thermodynamics and kinetics of reacting flows; chemical kinetic mechanisms for fuel oxidation and pollutant formation; transport phenomena; conservation equations for reacting flows; laminar nonpremixed flames (including droplet vaporization and burning); laminar premixed flames; flame stabilization, quenching, ignition, extinction, and other limit phenomena; detonations; flame aerodynamics and turbulent flames

MECS E4510 EVOLUTIONARY COMPUTATION#DESIGN AUTOMATI. *3.00 points*.
Prerequisites: Basic programming experience in any language.
Fundamental and advanced topics in evolutionary algorithms and their application to open-ended optimization and computational design. Covers genetic algorithms, genetic programming, and evolutionary strategies, as well as governing dynamic of coevolution and symbiosis. Includes discussions of problem representations and applications to design problems in a variety of domains including software, electronics, and mechanics

MECS E4603 APPLIED ROBOTICS: ALGORITHMS#SOFTWARE. *3.00 points*.

MECS E6616 ROBOT LEARNING. *3.00 points*.
Prerequisites: (MECE E4602) and (MECS E4603) or (COMS W4733) MECE E4602 OR MECS E4603 OR COMS W4733
Robots using machine learning to achieve high performance in unscripted situations. Dimensionality reduction, classification, and regression problems in robotics. Deep Learning: Convolutional Neural Networks for robot vision, Recurrent Neural Networks, and sensorimotor robot control using neural networks. Model Predictive Control using learned dynamics models for legged robots and manipulators. Reinforcement Learning in robotics: model-based and model-free methods, deep reinforcement learning, sensorimotor control using reinforcement learning

Spring 2026: MECS E6616

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MECS 6616	001/12169	M W 10:10am - 11:25am 203 Mathematics Building	Matei Ciocarlie	3.00	68/90

MEEE E6620 Applied Acoustics and Signal Recognition. *3.00 points*.
Prerequisites: (APMA E3101 and MATH UN2030) knowledge of a programming language, or permission of instructor.
Applied recognition and classification of acoustic and other time-dependent signals using a selection of tools borrowed from different disciplines. Feature extraction and analysis techniques such as spectral and cepstral features. Applications include machine and structural health monitoring, human biometrics, speech and acoustic events, imaging, geophysics, electronics, networking, languages, communications, and finance. Practical algorithms are covered in signal generation, modeling, feature extraction, metrics for comparison and classification, parameter estimation, supervised, un-supervised, and hierarchical clustering and learning, optimization, scaling and alignment, signals as codes emitted from natural sources, information theoretic concepts such as hidden markov modeling, latest deep learning techniques and architectures for time series analysis, and realtime large-scale systems.

MEEM E6432 SMALL-SCALE MECH BEHAVIOR. *3.00 points*.
Prerequisites: APMA E4200 AND ENME E3113; ENME E3113 or equivalent; APMA E4200 or equivalent
Mechanics of small-scale materials and structures require nonlinear kinematics and/or nonlinear stress vs. strain constitutive relations to predict mechanical behavior. Topics include variational calculus, deformation and vibration of beam, strings, plates, and membranes; fracture, delamination, bulging, buckling of thin films, among others. Thermodynamics of solids will be reviewed to provide the basis for a detailed discussion of nonlinear elastic behavior as well as the study of the equilibrium and stability of surfaces

Undergraduate Programs

- Mechanical Engineering (BS) (p. 318)
- Mechanical Engineering Minor (p. 332)

Mechanical Engineering (BS)

Mechanical Engineering

The Mechanical Engineering Undergraduate Program at Columbia University has the following Program Educational Objectives (PEOs) for its graduates:

1. Practice mechanical engineering in a broad range of industries.
2. Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.
3. Conduct themselves in a responsible, professional, and ethical manner.
4. Participate in activities that support humanity and economic development nationally and globally, developing as leaders in their fields of expertise.

As stated on the Mechanical Engineering department website, graduates of the Mechanical Engineering program at Columbia University will attain the following Student Outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on teams whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Highly qualified students are permitted to pursue an honors course consisting of independent study under the guidance of a member of the faculty.

Upon graduation, the student may wish to enter employment in industry or government, or continue with graduate study. Alternatively, training in mechanical engineering may be viewed as a basis for a career in business, patent law, medicine, or management. Thus, the department's undergraduate program provides a sound foundation for a variety of professional endeavors.

The BS Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and Program Criteria for Mechanical and Similarly Named Engineering Programs.

Undergraduates who wish to declare mechanical engineering as their major should do so prior to the start of their junior year. Students who declare in their first year should follow the Early Decision Track. Students who declare in their second year should follow the Standard Track. Students who wish to declare during or after the fall semester of their junior year must first obtain approval from the Mechanical Engineering Department.

Of the 18 points of elective content in the third and fourth years, at least 9 points of technical elective courses, including at least 6 points from the Department of Mechanical Engineering, must be taken. A technical elective can be any engineering course offered in the SEAS bulletin that is 3000 level or above. Any course with a description in the Mechanical Engineering section of this bulletin counts as a Mechanical Engineering course. Those prior remaining points of electives are intended primarily as an opportunity to complete the four-year, 27-point nontechnical requirement. Consistent with professional accreditation standards, courses in engineering science and courses in design must have a combined credit of 45 points. Students should see their advisers for details.

Undergraduate students who intend to pursue graduate studies in engineering are strongly encouraged to take the combination of a stand-alone course in linear algebra (either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA) and a stand-alone course in ordinary differential equations (either MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS or MATH UN3027 Ordinary Differential Equations), instead of the combined topics course APMA E2101 INTRO TO APPLIED MATHEMATICS. In addition, such students are encouraged to take a course in partial differential equations (APMA E3102 APPLIED MATHEMATICS II: PDE'S or APMA E4200 PARTIAL DIFFERENTIAL EQUATIONS) as well as a course in numerical methods (APMA E4301 NUMERICAL METHODS/PDE'S, APMA E4302 METHODS IN COMPUTATIONAL SCI, or APMA E4300 COMPUT MATH:INTRO-NUMERCL METH) as technical electives. Ideally, planning for these courses should start at the beginning of the sophomore year.

Fundamentals of Engineering (FE) Exam

The FE exam is a state licensing exam and the first step toward becoming a Professional Engineer (P.E.). P.E. licensure is important for engineers to obtain—it shows a demonstrated commitment to professionalism and an established record of abilities that will help a job candidate stand out in the field. Ideally, the FE exam should be taken in the senior year while the technical material learned while pursuing the undergraduate degree is still fresh in the student's mind. In addition to the FE exam, achieving P.E. licensure requires some years of experience and a second

examination, which tests knowledge gained in engineering practice. For more information, please see http://ncees.org/exams/fe-exam.

The Mechanical Engineering Department strongly encourages all seniors to take this exam and offers a review course covering material relevant to the exam, including a practice exam to simulate the testing experience. The FE exam is given in the fall and spring of each year. The review course is offered in the spring semester, concluding before the spring exam.

Integrated B.S./M.S. Program

The Integrated B.S./M.S. degree program is open to a qualified group of Columbia juniors and makes possible the earning of both the B.S. and M.S. degree in an integrated fashion. Benefits of this program include optimal matching of graduate courses with corresponding undergraduate prerequisites, greater ability to plan ahead for most advantageous course planning, opportunities to do research for credit during the summer after senior year, and up to 6 points of 4000-level technical electives from the B.S. requirement may count toward the fulfillment of the point requirement of the M.S. degree. Additional benefits include simplified application process, no GRE is required, and no reference letters are required. To qualify for this program, students must have a cumulative GPA of at least 3.4 and strong recommendations from within the Department. Students should apply for the program by April 30 in their junior year. For more information on requirements and access to an application form, please visit me.columbia.edu/integrated-bsms-program.

Express M.S. Application

The Express M.S. Application is offered to current seniors, including 3-2 students, who are enrolled in the BS program. In the Express M.S. Application, a master's degree can be earned seamlessly. Graduate classes are available for seniors to apply toward their M.S. degree and the advanced courses that will be taken have been designed to have the exact prerequisites completed as an undergraduate. Other advantages include the opportunity for better course planning and creating a streamlined set of courses more possible. Additional benefits include simplified application process, no GRE is required and no reference letters are required. To qualify for this program, your cumulative GPA should be at least 3.3. For more information on requirements and access to an application, please visit me.columbia.edu/ms-express-application-1.

Barnard 4+1 Mechanical Engineering Pathways - Physics

The Barnard 4+1 Pathway in Physics is offered to current Barnard College juniors with a GPA of 3.5 or higher to apply to Master's programs in Civil Engineering, Electrical Engineering, and Mechanical Engineering. Students should inquire with Beyond Barnard and plan on attending an introductory information sessions for the unique 4+1 Pathway they may be interested in pursuing.

Faculty contact at Barnard: Professor Reshmi Mukherjee, rmukherj@barnard.edu; at SEAS: Professor Gerard Ateshian, gaa3@columbia.edu

Degree Track

An overview of the degree track in PDF format can be found here.

Mechanical Engineering Program Standard Track

First Year

Semester I

MATH UN1101	CALCULUS I
Choose one of the following Physics courses depending on sequence:	
PHYS UN1401 (Sequence 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Sequence 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Sequence 3)	ACCELERATED PHYSICS I
Choose a one-semester Chemistry lecture:	
CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
Choose one of the following Computer Science courses (taken Semester I or III):	
COMS W1004	PROGRAMMING IN JAVA
COMS W1005	INTRO-COMPUT SCI/PROG-MATLAB
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II
Choose one of the following Physics courses depending on sequence:	
PHYS UN1402 (Sequence 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Sequence 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Sequence 3)	ACCELERATED PHYSICS II
CHEM UN1500[1]	GENERAL CHEMISTRY LABORATORY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI
Choose one of the following Physics courses depending on sequence:	
PHYS UN1403 (Sequence 1) [3]	INTRO-CLASSCL # QUANTUM WAVES

PHYS UN2601 (Sequence 2) [3]	PHYSICS III:CLASS/QUANTUM WAVE

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
HUMA UN1121 or UN1123	Art Humanities

Choose one of the following Computer Science courses (taken Semester I or III):

COMS W1004	PROGRAMMING IN JAVA
COMS W1005	INTRO-COMPUT SCI/PROG-MATLAB
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Mathematics:

APMA E2101[4]	INTRO TO APPLIED MATHEMATICS
Linear Alebra and ODE[5, 6]	

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS
ENME E3105	MECHANICS

Third Year

Semester V

MECE E3018	MECHANICAL ENGINEERING LAB I
MECE E3100	INTRO TO MECHANCIS OF FLUIDS
MECE E3301	THERMODYNAMICS
MECE E3408	COMPUTER GRAPHICS # DESIGN
MECE E3414	Mechanics of Solids for Mechanical Engineers
MECE E1008 (taken Semester V or VI)	INTRO TO MACHINING

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[7,8]

Semester VI

MECE E3028	MECHANICAL ENGINEERING LAB II
ENME E3106	DYNAMICS AND VIBRATIONS
MECE E3311	HEAT TRANSFER
MECE E3610	MATERIALS/PROCESSES IN MANUFAC
ELEN E1201[9]	INTRO-ELECTRICAL ENGINEERING
MECE E1008 (taken Semester V or VI)	INTRO TO MACHINING

Technical Electives (taken Semester VI, VII, or VIII)[10, 11]

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[7, 8]

Fourth Year

Semester VII

MECE E3409	MACHINE DESIGN
MECE E3420	ENG DES-CONCPT/DESIGN GENERATN
EEME E3601	Introduction to Continuous Control Systems

Technical Electives (taken Semester VI, VII, or VIII)[10, 11]

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[7, 8]

Semester VIII

MECE E3430	ENGINEERING DESIGN

Technical Electives (taken Semester VI, VII, or VIII)[9, 10]

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[8, 9]

1 May substitute Physics Lab PHYS UN1494 INTRO TO EXPERIMENTAL PHYS-LAB (3) or PHYS UN3081 INTERMEDIATE LABORATORY WORK (2).

2 Offered in spring semester.

3 May substitute EEEB UN2001 ENVIRONMENTAL BIOLOGY I, BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC, or higher.

4 Students who take APMA E2101 INTRO TO APPLIED MATHEMATICS must complete an additional 3 point course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective in math of basic science (SEAS course at 3000-level or higher), with the approval of your ME faculty adviser, may be substituted for this purpose.

5 Linear algebra may be fulfilled by either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA orMATH UN2010 LINEAR ALGEBRA.

6 Ordinary differential equations may be fulfilled by either MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS or MATH UN3027 Ordinary Differential Equations.

7 Required for class of 2025 and beyond.

8 Not required for Combined Plan students.

9 Not required for Combined Plan students.

10 Strongly recommended to be taken in Semester III or IV.

11 Students who take APMA E2101 INTRO TO APPLIED MATHEMATICS must complete an additional course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective in APMA may be substituted for this purpose.

12 12 points required; 6 must be MECE courses. Any course with a description in the Mechanical Engineering section of this bulletin counts as a Mechanical Engineering course.

Mechanical Engineering Program Early Decision Track

First Year

Semester I

MATH UN1101	CALCULUS I

Choose one of the following Physics courses depending on track:

PHYS UN1401 (Track 1)	INTRO TO MECHANICS # THERMO
PHYS UN1601 (Track 2)	PHYSICS I:MECHANICS/RELATIVITY
PHYS UN2801 (Track 3)	ACCELERATED PHYSICS I

Choose a one-semester Chemistry lecture:

CHEM UN1403	GENERAL CHEMISTRY I-LECTURES
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING

Choose one of the following Computer Science courses (taken Semester I or III):

COMS W1004	PROGRAMMING IN JAVA
COMS W1005	INTRO-COMPUT SCI/PROG-MATLAB
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
PHED UN1001	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Semester II

MATH UN1102	CALCULUS II

Choose one of the following Physics courses depending on track:

PHYS UN1402 (Track 1)	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1602 (Track 2)	PHYSICS II: THERMO, ELEC # MAG
PHYS UN2802 (Track 3)	ACCELERATED PHYSICS II
CHEM UN1500[1]	GENERAL CHEMISTRY LABORATORY
ENGL CC1010 (taken Semester I or II)	UNIVERSITY WRITING
ENME E3105	MECHANICS
PHED UN1002	PHYSICAL EDUCATION ACTIVITIES
ENGI E1102 (taken Semester I or II)	THE ART OF ENGINEERING

Second Year

Semester III

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Physics courses depending on track:[3]

PHYS UN1403 (Track 1)	INTRO-CLASSCL # QUANTUM WAVES
PHYS UN2601 (Track 2)	PHYSICS III:CLASS/QUANTUM WAVE

Choose one of the following Required Nontechnical Electives:

HUMA CC1001	Literature Humanities I
COCI CC1101	CONTEMP WESTERN CIVILIZATION I
Global Core (3–4)	
MECE E3301	THERMODYNAMICS
MECE E3408	COMPUTER GRAPHICS # DESIGN

Choose one of the following Computer Science courses (taken Semester I or III):

COMS W1004	PROGRAMMING IN JAVA
COMS W1005	INTRO-COMPUT SCI/PROG-MATLAB
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI

Semester IV

APMA E2000 & APMA E2001 (taken Semester III or IV)	MULTV. CALC. FOR ENGI # APP SCI

Choose one of the following Mathematics:

APMA E2101[5]	INTRO TO APPLIED MATHEMATICS
Linear Algebra and ODE[6, 7]	

Choose one of the following Required Nontechnical Electives:

HUMA CC1002	Literature Humanities II
COCI CC1102	CONTEMP WESTRN CIVILIZATION II
Global Core (3–4)	
ELEN E1201	INTRO-ELECTRICAL ENGINEERING
MECE E3414	Mechanics of Solids for Mechanical Engineers

Third Year

Semester V

MECE E3018	MECHANICAL ENGINEERING LAB I
MECE E3100	INTRO TO MECHANCIS OF FLUIDS
MECE E3414	Mechanics of Solids for Mechanical Engineers
MECE E1008 (taken Semester V or VI)	INTRO TO MACHINING
HUMA UN1121 or UN1123	Art Humanities

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[8]

Semester VI

MECE E3028	MECHANICAL ENGINEERING LAB II
ENME E3106	DYNAMICS AND VIBRATIONS
MECE E3311	HEAT TRANSFER
MECE E3610	MATERIALS/PROCESSES IN MANUFAC
MECE E1008 (taken Semester V or VI)	INTRO TO MACHINING
ECON UN1105 & ECON UN1155	PRINCIPLES OF ECONOMICS

Technical Electives (taken Semester VI, VII, or VIII)[9,10]

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[8]

Fourth Year

Semester VII

MECE E3409	MACHINE DESIGN
MECE E3420	ENG DES-CONCPT/DESIGN GENERATN
EEME E3601	Introduction to Continuous Control Systems

Technical Electives (taken Semester VI, VII, or VIII)[9, 10]

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[8]

Semester VIII

MECE E3430	ENGINEERING DESIGN

Technical Electives (taken Semester VI, VII, or VIII)[9, 10]

Nontech Electives (Students must complete the 27-point requirement.) (taken Semester V, VI, VII, or VIII)[8]

[1] May substitute Physics Lab PHYS UN1494 INTRO TO EXPERIMENTAL PHYS-LAB (3) or PHYS UN3081 INTERMEDIATE LABORATORY WORK (2).
[2] Offered in spring semester.
[3] May substitute EEEB UN2001 ENVIRONMENTAL BIOLOGY I, BIOL UN2005 INTRO BIO I: BIOCHEM,GEN,MOLEC, or higher.
[4] Required for class of 2025 and beyond.
[5] Students who take APMA E2101 INTRO TO APPLIED MATHEMATICS must complete an additional course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective in APMA may be substituted for this purpose.
[6] Linear algebra may be fulfilled by either APMA E3101 APPLIED MATH I: LINEAR ALGEBRA or MATH UN2010 LINEAR ALGEBRA.
[7] Ordinary differential equations may be fulfilled by either MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS or MATH UN3027 Ordinary Differential Equations.
[8] Not required for Combined Plan students.
[9] Students who take APMA E2101 INTRO TO APPLIED MATHEMATICS must complete an additional course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective in APMA may be substituted for this purpose.
[10] 12 points required; 6 must be MECE courses. Any course with a description in the Mechanical Engineering section of this bulletin counts as a Mechanical Engineering course.

Graduate Programs

The Department of Mechanical Engineering offers two doctoral degrees: Doctor of Philosophy (Ph.D.) and Doctor of Engineering Science (Eng.Sc.D.), and the Master of Science degree. The Ph.D. degree is conferred by the Graduate School of Arts and Science, and the Eng.Sc.D. degree is conferred by The Fu Foundation School of Engineering and Applied Science.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students–ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements.

- Mechanical Engineering (MS) (p. 323)
- Mechanical Engineering (PhD) (p. 325)

Mechanical Engineering (MS)

Master of Science Degree Program

The program leading to the Master of Science degree in mechanical engineering requires completion of a minimum of 30 points of approved coursework consisting of no fewer than ten courses. In general, attainment of the degree requires one academic year of full-time study, although it may also be undertaken on a part-time basis, for domestic students, over a correspondingly longer period. A minimum grade-point average of 2.5 is required for graduation. A thesis based on either experimental, computational, or analytical research is optional and may be counted in lieu of up to 6 points of coursework.

The M.S. degree in mechanical engineering allows a student to take a sequence of courses tailored to their interests and objectives; this is referred to as the standard track. Alternatively, M.S. students can pick from a set of predefined tracks.

1. All courses must be at the graduate level, i.e., numbered 4000 or higher, with at least two 6000-level lecture courses in SEAS. At least one of the 6000-level courses must be in Mechanical Engineering.
2. Every program must contain at least one course in mathematics (APMA, MATH, STAT course designations) covering material beyond what the student has taken previously. It is recommended to be taken early in the sequence, in order to serve as a basis for the technical coursework. Alternatively, any one of the following courses may be taken to satisfy the math requirement:

BMEN E4110	BIOSTATISTICS FOR ENGINEERS
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4771	MACHINE LEARNING
IEOR E4150	INTRO-PROBABILITY # STATISTICS [1]
MECE E4520	DATA SCIENCE FOR MECHANICAL SYSTEMS
ORCA E4500	FOUNDATIONS OF DATA SCIENCE

[1] Same as STAT GU4001 INTRODUCTION TO PROBABILITY AND STATISTICS.

3. Out-of-department study is encouraged, but must be taken in consultation with a faculty adviser.
4. At least five courses must be in Mechanical Engineering. Any course with a description in the Mechanical Engineering section of this bulletin counts as a Mechanical Engineering course.

Students who are not on the standard track can select a concentration in either biomechanics, energy systems, micro/nanoscale engineering, or robotics and control. The requirements for a concentration are identical to those of the standard track, with one exception: students must take at least 15 points from a list determined by an adviser in consultation with an advisory committee. The currently available concentrations are listed below.

M.S. in Mechanical Engineering with Concentration in Biomechanics

Advisers: Professors Gerard Ateshian, Karen Kasza, Kristin Myers, and Vijay Vedula

The concentration in biomechanics is developed in coordination with the Department of Biomedical Engineering. It provides the M.S. candidate with knowledge of the mechanics of biological tissues. The 4000-level courses offered in this concentration provide foundations of fluid and solid mechanics applicable to biomechanics, as well as applications of mechanics to specific cell, tissue, and organ systems. The higher-level courses provide deeper foundations on theoretical and computational approaches relevant to biomechanics. This concentration is a suitable preparation for careers in the biomedical devices industry or engineering and scientific consulting.

To choose this concentration, select "Mechanical Engineering Biomechanics Master of Science" in the Program field when filling in the online application for the M.S. program. The name of this program will be listed on graduates' transcripts.

Requirements: While satisfying the requirements for a Master of Science in Mechanical Engineering, take at least five courses from:

MEBM E4703	MOLECULAR MECHANICS IN BIOLOGY
MEBM E4710	MORPHOGENESIS:BIOL MAT SHP/STR
MECE E4100	MECHANICS OF FLUIDS
MECE E6100	ADVANCED MECHANICS OF FLUIDS
MECE E6106	Finite Element Method for Fluid Flow and Fluid-Structure Interactions
MEBM E6310 & MEBM E6311	MIXT THEORIES FOR BIOL TISSUES and MIXT THEORIES FOR BIOL TISSUES
MECE E6422 & MECE E6423	INTRO-THEORY OF ELASTICITY I and INTRO-THEORY OF ELASTICITY II
MECE E8501	ADVNCD CONTINUUM BIOMECHANICS

When offered by the Biomedical Engineering Department, the following courses may also count toward the Biomechanics track:

BMEN E4301	
BMEN E4302	BIOMECHANICS OF MUSCULOSKELETAL SOFT TIS
BMEN E4305	CARDIAC MECHANICS
BMEN E4310	SOLID BIOMECHANICS
BMEN E4320	FLUID BIOMECHANICS
BMEN E4340	BIOMECHANICS OF CELLS
BMEN E4350	Biomechanics of Developmental Biology
BMEN E4570	
BMEN E4750	SOUND AND HEARING

BMEN E6301	MODELING OF BIOL TISS WITH FEM
BMME E4702	

One 3-credit research course can be counted toward the concentration if the research is approved by the student's adviser and is biomechanics related.

M.S. in Mechanical Engineering with Concentration in Energy Systems

Advisers: Professors Michael Burke, Bianca Howard, Vijay Modi, and Arvind Narayanaswamy

The concentration in energy systems provides the M.S. candidate with a global understanding of current energy challenges. Advanced thermofluidic knowledge is provided to design and optimize energy systems, with a strong emphasis on renewable energies. Courses related to energy and environmental policy, two strong areas of Columbia as a global university, can be integrated into the course sequence. This specialization is a suitable preparation for careers in energy production and energy consultation.

Requirements: While satisfying the requirements for a Master of Science in Mechanical Engineering, take at least five courses from:

MECE E4210	ENERGY INFRASTRUCTURE PLANNING
MECE E4211	ENERGY SOURCES AND CONVERSION
MECE E4302	ADVANCED THERMODYNAMICS
MECE E4304	TURBOMACHINERY
MECE E4305	MECH # THERMODYNAMICS OF PROPULSION
MECE E4312	SOLAR THERMAL ENGINEERING
MECE E4313	Decarbonizing Buildings Studio: Energy system retrofits at speed and scale
MECE E4314	ENERGY DYNAMICS OF GREEN BLDGS
MECH E4320	INTRO TO COMBUSTION
MECE E4330	THERMOFLUID SYSTEMS DESIGN
MECE E4350	Building Energy Modeling and Simulation
MECE E6100	ADVANCED MECHANICS OF FLUIDS
MECE E6102	COMPUTATNL HEAT TRANSF-FL FLOW
MECE E6104	CASE STUDIES-COMPUT FLUID DYN
MECE E6313	ADVANCED HEAT TRANSFER
When offered by other departments, any of the following courses may also count toward the concentration:	
APPH E4130	SOLAR ENERGY & STORAGE
CHEN E4201	ENGIN APPL OF ELECTROCHEMISTRY
ENME E6370	TURBULENCE THEORY # MODELING
When offered by other departments, one of the following courses may also count toward the concentration:	
ELEN E4510	Grid Modernization # Clean Tech
ELEN E4511	POWER SYSTEMS ANALYSIS ((instructor permission))
When offered by other departments, one of the following courses may also count toward the concentration:	
EAEE E4220	Energy System Economics and Optimization
ELEN E6906	TPCS-ELEC # COMPUT ENGINEERING
When offered by other departments, one of the following courses may also count toward the concentration:	
EAEE E4300	INTRO TO CARBON MANAGEMENT
EAEE E4301	CARBON STORAGE
EAEE E4302	CARBON CAPTURE
EAEE E4305	CO2 UTILIZATION AND CONVERSION
EAEE E6126	

Furthermore, one 3-credit research course can be counted toward the concentration if the research is approved by the student's adviser and is energy related.

M.S. in Mechanical Engineering with Concentration in Micro/Nanoscale Engineering

Advisers: Professors James Hone, Jeffrey Kysar, and P. James Schuck

The concentration in micro/nanoscale engineering provides the M.S. candidate with an understanding of engineering challenges and opportunities in micro- and nanoscale systems. The curriculum addresses fundamental issues of mechanics, fluid mechanics, optics, heat transfer, and manufacturing at small-size scales. Application areas include MEMS, bio-MEMS, microfluidics, thermal systems, and carbon nanostructures.

Requirements: The requirements for the micro/nanoscale engineering track ensures that students obtain an education in micro/nanoscale engineering that is both broad and deep. Students will be required to take at least five classes from a selected pool that covers many aspects of micro/nanoengineering. Currently, eight classes are compatible with the general requirements for the Master of Science degree in Mechanical Engineering. These include:

MECE E4058	MECHATRONICS # EMBEDDED MICRO
MECE E4212	MICROELECTROMECHANICAL SYSTEMS
MECE E4213	Lab-on-a-Chip and Microrobotic Devices
MECE E4214	MEMS Sensors and Systems
MECE E6137	NANOSCALE ACTUATION # SENSING
MECE E6432	SMALL-SCALE MECH BEHAVIOR
MECE E4461	Materials Selection for Mechanical Design

When offered by other departments, the following courses may also count toward the micro/nanoscale concentration:

APPH E6081	SOLID STATE PHYSICS I
ELEN E4106	Advanced Solid State Devices and Materials
ELEN E4411	FUNDAMENTALS OF PHOTONICS
ELEN E4944	PRNCPLS OF DEVICE MICROFABRCTN
ELEN E6331	PRINCPLS SEMICONDUCTR PHYSCS I
ELEN E6414	PHOTONIC INTEGRATED CIRCUITS
ELEN E6945	DEVICE NANOFABRICATION
MSAE E4090	NANOTECHNOLOGY
MSAE E4100	CRYSTALLOGRAPHY
PHYS GU4018	SOLID STATE PHYSICS

One 3-credit research course can be counted toward the concentration if the research is approved by the student's adviser and is micro/nanoscale related.

M.S. in Mechanical Engineering with Concentration in Robotics and Control

Advisers: Professors Sunil Agrawal, Matei Ciocarlie, and Hod Lipson

The field of robotics is seeing unprecedented growth, in areas as diverse as manufacturing, logistics, transportation, health care, space

exploration, and more. This program prepares students for a career in robotics and its many applications in society. Students perform in-depth study of topics such as robotic manipulation, navigation, perception, human interaction, medical robotics, assistance and rehabilitation. This specialization is a suitable preparation for joining established companies, information-age dominant players investing heavily in this field, or the new wave of robotics start-ups aiming to provide disruptive innovations. Many of the acquired skills can be applied in other fields as diverse as automation, manufacturing, computer graphics or machine vision. This program can also be a foundation for a research career in robotics and related areas, in both academia and industry.

Requirements: While satisfying the requirements for a Master of Science in Mechanical Engineering, take at least five courses from:

MECE E4058	MECHATRONICS # EMBEDDED MICRO
MECE E4213	Lab-on-a-Chip and Microrobotic Devices
MECE E4602	INTRODUCTION TO ROBOTICS
MECE E4603	ANALYSIS-CONTROL MANUFCT SYSTM
MECE E4606	DIGITAL MANUFACTURING
MECE E4611	ROBOTICS STUDIO
MECE E4613	Industrial Automation
MECE E6400	ADVANCED MACHINE DYNAMICS
MECE E6614	ADV TPC:ROBOTICS/MECH SYNTHES
MECE E6620	APPLIED ACOUSTICS AND SIGNAL RECOGNITION
MECS E4510	EVOLUTIONARY COMPUTATION# DESIGN AUTOMATI
MECS E6615	ROBOTIC MANIPULATION
EEME E6910	Topics in Control
EEME E6911	Topics in Control
EEME E6912	Topics in Control
EEME E6913	Topics in Control
EEME E6914	Topics in Control
EEME E6915	Topics in Control
EEME E6916	Topics in Control
EEME E6917	Topics in Courses
EEME E6918	Topics in Control
EEME E6919	Topics in Control
MECS E6616	ROBOT LEARNING
MEEE E4600	Continuous Control Systems
EEME E4601	DISCRETE CONTROL SYSTEMS
MEEC E6600	Mathematics of Machine Learning, Signals, and Control
EEME E6602	MODERN CONTROL THEORY
MEEE E6610	Nonlinear and Adaptive Control
BMME E4702	
MEBM E4439	MODELING # ID OF DYNAMIC SYST
BMEN E4440	PHYSIOLOGICAL CONTROL SYSTEM

When offered by other departments, a maximum of one of the following courses may be used to satisfy the robotics requirements:

COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4731	Computer Vision I: First Principles
COMS W4733	COMPUTATIONAL ASPECTS OF ROBOTICS
ELEN E4810	DIGITAL SIGNAL PROCESSING

One 3-credit research course can be counted toward the concentration if the research is approved by the student's adviser and is robotics related.

Mechanical Engineering (PhD)

Doctoral Degree Program

All applications to the doctoral program in mechanical engineering are administered by The Fu Foundation School of Engineering and Applied Science. Students who matriculate into the doctoral program without a master's degree earn a Master of Science degree while pursuing their doctoral degree.

Doctoral candidates are expected to attain a level of mastery in an area of mechanical engineering and must therefore choose a field and take the most advanced courses offered in that field. Candidates are assigned a faculty adviser whose task is to help choose a program of courses, provide general advice on academic matters, and monitor academic performance. Candidates also choose a faculty member in the pertinent area of specialization to serve as their research adviser. This adviser helps select a research problem and supervises the research, writing, and defense of the dissertation.

Program Requirements

- 30 credits beyond master's degree
- GPA of 3.2 or better in graduate courses
- 4 semesters of graduate seminar MECE E9500 GRADUATE SEMINAR
- Completion of all milestones
- Completion of two semesters teaching experience, each equivalent to 20hrs/week effort

See me.columbia.edu/academics/doctoral-program for more information.

Undergraduate Minors

Undergraduate minors are designed to allow engineering and applied science students to study, to a limited extent, a discipline other than their major. Besides engineering minors offered by Columbia Engineering departments, liberal arts minors are also available.

A minor requires at least 15 points of credit, and no more than one course can be taken outside of Columbia or met through AP or IB credit. This includes courses taken through study abroad. In Engineering departments with more than one major program, a minor in the second program may be permitted, if approved by the department.

No substitutions or changes of any kind from the approved minors are permitted (see lists below). No appeal for changes will be granted. Please note that the same courses may not be used to satisfy the requirements of more than one minor. No courses taken for pass/fail may be counted for a minor. Minimum GPA for the minor is 2.0. Departments outside the Engineering School have no responsibility for nonengineering minors offered by Engineering.

For a student to receive credit for a course taken while studying abroad, the department offering the minor must approve the course in writing, ahead of the student's study abroad.

Students must expect a course load that is heavier than usual. In addition, unforeseen course scheduling changes, problems, and conflicts may occur. The School cannot guarantee a satisfactory completion of the minor.

A

- Aerospace Engineering Minor
- American Studies Minor
- Anthropology Minor (p. 326)
- Applied Mathematics Minor (p. 326)
- Applied Physics Minor (p. 327)
- Architecture Minor (p. 327)
- Art History Minor (p. 327)
- Artificial Intelligence Minor

B

- Biomedical Engineering Minor (p. 327)

C

- Catalan Minor
- Chemical Engineering Minor (p. 327)
- Civil Engineering Minor (p. 327)
- Computer Science Minor (p. 328)

D

- Dance Minor (p. 328)

E

- Earth and Environmental Engineering Minor (p. 328)
- East Asian Studies Minor (p. 328)
- Economics Minor (p. 328)
- Electrical Engineering Minor (p. 329)
- Engineering Mechanics Minor (p. 329)
- English and Comparative Literature Minor (p. 329)
- Entrepreneurship and Innovation Minor (p. 330)
- Ethnicity and Race Minor (p. 330)

F

- Film and Media Studies Minor (p. 330)
- French and Francophone Studies Minor (p. 330)
- Fusion Energy Minor

G

- German Minor (p. 330)
- Greek or Latin Minor (p. 331)

H

- Hispanic Studies Minor (p. 331)
- History Minor (p. 331)

I

- Industrial Engineering Minor (p. 331)
- Italian Minor

J

- Jewish Studies Minor

L

- Linguistics Minor (p. 331)

M

- Materials Science Minor (p. 332)
- Mechanical Engineering Minor (p. 332)
- Middle Eastern, South Asian, and African Studies Minor (p. 332)
- Mining Engineering Minor
- Music Minor (p. 332)

O

- Operations Research Minor (p. 332)

P

- Philosophy Minor (p. 332)
- Political Science Minor (p. 332)
- Portuguese Minor
- Psychology Minor (p. 333)

R

- Religion Minor (p. 333)

S

- Sociology Minor (p. 333)
- Statistics Minor (p. 333)
- Statistics Minor Applied Track
- Statistics Minor Theory Track
- Sustainable Engineering Minor (p. 333)

W

- Women's, Gender and Sexuality Studies Minor

Anthropology Minor

- ANTH UN1002 THE INTERPRETATION OF CULTURE or ANTH UN1008 THE RISE OF CIVILIZATION
  Note: ANTH UN1002 *serves as a preview to sociocultural anthropology, while* ANTH UN1008 *serves as a preview to archaeology*
- Any four courses in the Anthropology department, in ethnomusicology, or taught by an Anthropology instructor, regardless of department. No distribution requirement.

Applied Mathematics Minor

The Applied Mathematics Minor consists of 5 courses as follows:

1) Linear Algebra (Take One)

APMA E3101	APPLIED MATH I: LINEAR ALGEBRA
or MATH UN2010	LINEAR ALGEBRA
or COMS W3251	COMPUTATIONAL LINEAR ALGEBRA
or APMA E4007	APPLIED LINEAR ALGEBRA

2) PDE or Dynamical Systems (Take One)

APMA E3102	APPLIED MATHEMATICS II: PDE'S
or MATH UN3028	PARTIAL DIFFERENTIAL EQUATIONS
or APMA E4101	APPL MATH III:DYNAMICAL SYSTMS

3) Scientific Computing (Take One)	
APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
or APMA E4301	NUMERICAL METHODS/PDE'S
4) An Additional APMA Course (Take One)	
Any non-seminar APMA 3000+ course not counted above	
5) An Additional Applied Math Major Course (Take One)	
MATH UN2500	ANALYSIS AND OPTIMIZATION [1]
or IEOR E3658	PROBABILITY FOR ENGINEERS

[1] This course may be replaced with any non-seminar APMA 3000+, MATH 3000+, or STAT 4000+ course not counted above

Applied Physics Minor

Prospective students should consult the first- and second-year requirements for applied physics majors to ensure that prerequisites for the applied physics minor are satisfied in the first two years.

Coursework counting toward the applied physics minor may not include advanced placement credits.

APPH E4901	SEM-PROBLMS IN APPLIED PHYSICS
APPH E3200	MECHANICS:FUND # APPLICATIONS
APPH E3100	INTRO TO QUANTUM MECHANICS
APPH E3300	APPLIED ELECTROMAGNETISM
MSAE E3111	THERMO/KINETIC THRY/STAT MECH
Choose two of the following:	
APPH E4010	INTRODUCTN TO NUCLEAR SCIENCE
APPH E4100	QUANTUM PHYSICS OF MATTER
APPH E4110	MODERN OPTICS
APPH E4112	LASER PHYSICS
APPH E4300	APPLIED ELECTRODYNAMICS
APPH E4301	INTRO TO PLASMA PHYSICS

Architecture Minor

Studio: Choose one to three of the following:	
ARCH UN1020	INTRO ARCH DESIGN#VIS CULTURE
ARCH UN2101	ARCHITECTURAL DESIGN: SYSTEMS AND MATERIALS
ARCH UN2103	ARCHITECTURAL DESIGN: ENVIRONMENTS AND MEDIATIONS
ARCH UN3117	MOD ARCHITECTURE IN THE WORLD
One to three courses: any lecture, seminar, or workshop offered or approved by the Architecture Department	

Art History Minor

- 1–3. At least one course in three of four of the historical periods: (a) Ancient (up to 400 CE/AD); (b) 400–1400; (c) 1400–1700; (d) 1700–present
- 4–5. Two additional courses covering two of five world regions: (a) Africa; (b) Asia; (c) Europe; (d) North America; (e) Australia; (f) Latin America; (g) Middle East; (h) medieval Europe
- 6–7. Two courses from the Department of Art History and Archaeology

Biomedical Engineering Minor

The Biomedical Engineering program offers a minor that consists of the following six courses. Participation in the minor is subject to the approval of the major program adviser.

BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC
BIOL UN2006	INTRO BIO II:CELL BIO,DEV/PHYS
BMEN E3010	BIOMEDICAL ENGINEERING I
BMEN E3020	BIOMEDICAL ENGINEERING II
BMEN E4001	QUANTITATIVE PHYSIOLOGY I
BMEN E4002	QUANT PHYSIOLOGY II:ORGAN SYST

Chemical Engineering Minor

Of the six courses required, at least three must have the *CHEN*, *CHEE*, or *CHAP* designator.

CHEN E2100	Material and Energy Balances
CHEN E3230	REACTOR KINETICS/REACTOR DESIGN
Choose one of the following:	
CHEE E3010	PRIN-CHEM ENGIN-THERMODYNAMICS
MSAE E3111	THERMO/KINETIC THRY/STAT MECH
MECE E3301	THERMODYNAMICS
BMEN E4210	DRIVING FORCES OF BIOLOGICAL SYSTEMS
Choose one of the following:	
CHEN E3110	PRINCIPLES OF TRANSPORT PHENOMENA
EAEE E3200	TRANSPORT/CHEM RATE PHENOMENA
MECE E3100	INTRO TO MECHANCIS OF FLUIDS
ENME E3161	FLUID MECHANICS
BMEN E3320	FLUID BIOMECHANICS
Choose two of the following courses:	
Any 3000-level or higher CHEN or cross-listed (CHAP, BMCH, CHEE, CHBM, CHOR, MECH) course	

Civil Engineering Minor

The Civil Engineering and Engineering Mechanics Department offers a Civil Engineering minor which consists of six courses:

ENME E3105	MECHANICS
ENME E3113	MECHANICS OF SOLIDS
Choose one of the following:	
CIEN E3121	STRUCTURAL ANALYSIS
ENME E3161	FLUID MECHANICS
MECE E3100	INTRO TO MECHANCIS OF FLUIDS
Choose three of the following:	
CIEN E3000	THE ART OF STRUCTURAL DESIGN
ENME E3161	FLUID MECHANICS
ENME E3114	EXPERIMENTAL MECH OF MATERIALS
ENME E3332	A FIRST CRSE/FINITE ELEMENTS
MECE E3414	Mechanics of Solids for Mechanical Engineers
CIEN E3125	STRUCTURAL DESIGN
CIEN E4241	GEOTECHNCL ENGNEERNG FUNDMNTLS
EACE E3250	Hydrosystems Engineering
EACE E4163	Sustainable Water Treatment and Reuse

CIEN E3129	PROJECT MGMT FOR CONSTRUCTION
CIEN E4131	PRIN OF CONSTRUCTN TECHNIQUES

Computer Science Minor

Students who pass the Computer Science Advanced Placement Exam A with a 4 or 5 will receive 3 points and exemption from COMS W1004. Participation in the minor is subject to the approval of the major program adviser. For further information, please see the Quick Guide at cs.columbia.edu/education/undergraduate.

The Computer Science Minor consists of 6 courses as follows:

1. Choose one of the following:	
COMS W1004	PROGRAMMING IN JAVA
or COMS W1007	
COMS W1007	
2. Choose one of the following:	
COMS W3134	Data Structures in Java
COMS W3137	HONORS DATA STRUCTURES # ALGOL
3. Discrete Math:	
COMS W3203	DISCRETE MATHEMATICS
4. Choose one of the following:	
COMS W3157	ADVANCED PROGRAMMING
COMS W3261	COMPUTER SCIENCE THEORY
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
5. Any 3000-level or 4000-level COMS/CSXX/ XXCS course of at least 3 points	
6. Any 3000-level or 4000-level COMS/CSXX/ XXCS course of at least 3 points OR one course from the following (linear algebra or probability/ statistics): APMA E3101, APMA E2101, MATH UN2010, MATH UN2015, IEOR E3658, STAT UN1201, or STAT GU4001.	

Dance Minor

The dance minor consists of five 3-point courses. Please note that no performance/choreography courses below count toward the nontech requirement for Engineering students.

History/Criticism	
Choose two of the following:	
DNCE BC2565	WORLD DANCE HISTORY
DNCE BC2570	DANCE IN NEW YORK CITY
DNCE BC3000	FROM PAGE TO STAGE: DANCE # LITERATURE
DNCE BC3001	HISTORY OF THEATRICAL DANCING
DNCE BC3002	Choreographing Race in America
DNCE BC3200	DANCE IN FILM
DNCE BC3240	SEEING THE BODY
DNCE BC3550	Dance in Africa
DNCE BC3567	DANCES OF INDIA
DNCE BC3576	DANCE CRITICISM
DNCE BC3577	Performing the Political: Embodying Change in American Performance
Performance/Choreography	
Choose two of the following:	
DNCE BC2563	DANCE COMPOSITION: FORM
DNCE BC2564	DANCE COMPOSITION: CONTENT
DNCE BC2567	MUSIC FOR DANCE
DNCE BC3601	REHEARSAL # PERFRMNCE IN DANCE
DNCE BC3602	Rehearsal and Performance in Dance
DNCE BC3603	Rehearsal and Performance in Dance
DNCE BC3604	REHEARSAL#PERFRMNCE IN DANCE
DNCE BC3605	REHEARSAL#PERFRMNCE IN DANCE
DNCE BC3606	
DNCE BC3607	REHEARSAL#PERFRMNCE IN DANCE
Elective	

Earth and Environmental Engineering Minor

EAEE E2100	A BETTER PLANET BY DESIGN
EACE E4252	Foundations of Environmental Engineering
Choose two of the following:	
EAEE E3103	ENERGY,MINERALS,MATERIALS SYST
EAEE E3200	TRANSPORT/CHEM RATE PHENOMENA
CHEE E3010	PRIN-CHEM ENGIN-THERMODYNAMICS
EAEE E4003	AQUATIC CHEMISTRY
EACE E3250	Hydrosystems Engineering
EAEE E3901	ENVIRONMENTAL MICROBIOLOGY
EAEE E4160	SOLID # HAZARDOUS WASTE MGMT
EACE E3255	ENVIRONMENTAL CONTROL AND POLLUTION REDUCTION
Choose two of the following:	
Any 3000-level or higher EAEE or cross-listed (CHEE, CIEE, EACE, EACH, EAIA, EEEL) course	

East Asian Studies Minor

Choose two of the following survey courses in Chinese, Japanese, Korean, Tibetan, or Vietnamese civilization:	
ASCE UN1359	INTRO TO EAST ASIAN CIV: CHINA
ASCE UN1361	INTRO EAST ASIAN CIV: JPN
ASCE UN1363	INTRO TO EAST ASIAN CIV: KOREA
ASCE UN1365	INTRO EAST ASIAN CIV: TIBET
ASCE UN1367	INTRO EA CIV: VIETNAM
Choose three elective courses dealing with East Asia	

Note: The elective courses may be taken in departments outside of East Asian Languages and Cultures. The minor does not include a language requirement. However, one semester of an East Asian language class may be used to fulfill one of the three electives, as long as at least two semesters of that language have been taken. Placement exams may not be used in place of these courses.

Economics Minor

ECON UN1105	PRINCIPLES OF ECONOMICS
ECON UN3211	INTERMEDIATE MICROECONOMICS
ECON UN3213	INTERMEDIATE MACROECONOMICS
ECON UN3412	INTRODUCTION TO ECONOMETRICS

Note: ECON UN1105 is a prerequisite for ECON UN3211, ECON UN3213, and ECON UN3412. Students must have completed Calculus I before taking ECON UN3213, Calculus III before taking ECON UN3211, and one of the introductory statistics courses (see list) before taking ECON UN3412.

Electives

Choose two of the following Elective courses:

ECON UN2105	THE AMERICAN ECONOMY
ECON UN2257	THE GLOBAL ECONOMY
ECON UN3025	FINANCIAL ECONOMICS
ECON UN3265	MONEY AND BANKING
ECON UN3901	ECONOMICS OF EDUCATION
ECON UN3952	MACROECONOMICS#FORMATION OF EXPECTATIONS
ECON GU4020	ECON OF UNCERTAINTY # INFORMTN
ECON GU4211	ADVANCED MICROECONOMICS
ECON GU4213	ADVANCED MACROECONOMICS
ECON GU4230	ECONOMICS OF NEW YORK CITY
ECON GU4251	INDUSTRIAL ORGANIZATION
ECON GU4260	MARKET DESIGN
ECON GU4280	CORPORATE FINANCE
ECON GU4301	ECONOMIC GROWTH # DEVELOPMNT I
ECON GU4321	ECONOMIC DEVELOPMENT
ECON GU4370	POLITICAL ECONOMY
ECON GU4400	LABOR ECONOMICS
ECON GU4412	ADVANCED ECONOMETRICS
ECON GU4413	Econometrics of Time Series and Forecasting
ECON GU4415	GAME THEORY
ECON GU4438	ECONOMICS OF RACE IN THE U.S.
ECON GU4465	PUBLIC ECONOMICS
ECON GU4480	GENDER # APPLIED ECONOMICS
ECON GU4500	INTERNATIONAL TRADE
ECON GU4505	INTERNATIONAL MACROECONOMICS
ECON GU4700	FINANCIAL CRISES
ECON GU4710	FINANCE AND THE REAL ECONOMY
ECON GU4750	GLOBALIZATION # ITS RISKS
ECON GU4840	BEHAVIORAL ECONOMICS
ECON GU4850	COGNITIVE MECH # ECON BEHAVIOR
ECON GU4860	BEHAVIORAL FINANCE

Note: Electives may be taken only after the completion of both ECON UN3211 and ECON UN3213, with the exception of ECON UN2257 and ECON UN2105, which may be taken after completion of ECON UN1105. Some of the elective courses listed above have additional prerequisites. Courses may be taken only after the completion of all prerequisites. Please see the Columbia College bulletin for course descriptions and complete lists of prerequisites.

Statistics

Choose one of the following Probability and Statistics options (course or sequence):

SIEO W3600	INTRO PROBABILITY/STATISTICS
or STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
IEOR E3658 & IEOR E4307	PROBABILITY FOR ENGINEERS and STATISTICS AND DATA ANALYSIS
STAT GU4203 & STAT GU4204	PROBABILITY THEORY and STATISTICAL INFERENCE
STAT GR5203 & STAT GR5204	PROBABILITY and STATISTICAL INFERENCE

Notes:

- The statistics course must be finished before taking ECON UN3412, and it is recommended that students take ECON UN3412 in the semester following the statistics course.
- Some courses done as part of the economics minor may count toward fulfilling the School's nontechnical requirements. However, other courses, such as ECON UN3412, may not be applied toward satisfaction of the nontechnical course requirements. To determine which economics class can count toward the nontech elective requirement, please consult the nontech elective section of this bulletin for further details.
- Students with AP credit for economics and an exemption for ECON UN1105 may use the credit toward the minor.
- Transfer or study abroad credits may not be applied to fulfill the requirements of the economics minor.

Electrical Engineering Minor

ELEN E1201	INTRO-ELECTRICAL ENGINEERING (May be replaced by a similar course or roughly equivalent experience)
ELEN E3201	CIRCUIT ANALYSIS
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
ELEN E3081 & ELEN E3082	CIRCUIT ANALYSIS LABORATORY and DIGITAL SYSTEMS LABORATORY
ELEN E3801	SIGNALS AND SYSTEMS
ELEN E3106	SOLID STATE DEVICES-MATERIALS
or ELEN E3401	ELECTROMAGNETICS

Note: Not available to computer engineering majors

Engineering Mechanics Minor

The Civil Engineering and Engineering Mechanics Department offers an Engineering Mechanics minor which consists of six courses:

ENME E3105	MECHANICS
ENME E3113	MECHANICS OF SOLIDS
ENME E3161	FLUID MECHANICS
or MECE E3100	INTRO TO MECHANCIS OF FLUIDS
Choose three of the following:	
ENME E3106	DYNAMICS AND VIBRATIONS
ENME E3114	EXPERIMENTAL MECH OF MATERIALS
or MECE E3414	Mechanics of Solids for Mechanical Engineers
CIEN E3121	STRUCTURAL ANALYSIS
ENME E4202	ADVANCED MECHANICS
ENME E4113	ADVANCED MECHANICS OF SOLIDS
ENME E4114	MECHANCS OF FRACTURE # FATIGUE
ENME E4214	THEORY OF PLATES AND SHELLS
ENME E4215	THEORY OF VIBRATIONS
MECE E3301	THERMODYNAMICS

English and Comparative Literature Minor

- Any five courses in the English Department with no distribution requirement. No speech courses, only one writing course and excluding ENGL CC1010 UNIVERSITY WRITING, may be taken; total 15 points.

Entrepreneurship and Innovation Minor

Minimum: 15 points

Required Courses	
IEOR E2261	ACCOUNTING AND FINANCE
IEOR E4998	MANAG TECH INNOV # ENTREPRENEURSHIP
Opportunity Discovery & Product Innovation	
Choose one of the following:	
COMS W4460	PRIN-INNOVATN/ENTREPRENEURSHIP
IEME E4200	HUMAN-CENTERED DESIGN AND INNOVATION
IEME E4505	Frontiers of Tough Tech
Startup Management	
Choose one of the following:	
CHEN E4020	PROTECTN OF INDUST/INTELL PROP
ECON GU4280	CORPORATE FINANCE
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS
IEOR E4510	PROJECT MANAGEMENT
Industry Focus and Case Studies	
Choose one of the following:	
CIEN E4136	Entrepreneurship in Engineering and Construction
COMS W4444	PROGRAMMING # PROBLEM SOLVING
ENGI E4502	Design of UI/UX for Connected Systems
COMS W4170	USER INTERFACE DESIGN
IEOR E4207	HUMAN FACTORS: PERFORMANCE

Ethnicity and Race Minor

CSER UN1010	INTRO TO COMP ETHNIC STUDIES
One of the following courses:	
CSER UN3928	COLONIZATION/DECOLONIZATION
CSER UN3942	RACE AND RACISMS

Three additional CSER courses with approval from the Department

Film and Media Studies Minor

Students who take the minor should begin with Intro to Film and Media Studies. Lab classes and seminars will only be available to students who have declared minors in Film and Media Studies. All minors are entitled to one lab class, although they may take a second for their other elective if space permits. Students can apply only one study abroad or transfer class (3-credit equivalent) to completion of the minor. This restriction also applies to film-related classes offered in other Columbia programs.

The minor consists of five courses (fifteen credits) as follows:

FILM UN1000	INTRO TO FILM # MEDIA STUDIES
Two of the following four courses, one of which must be FILM UN2010 or UN2020:	
FILM UN2010	CINEMA HIST I: BEGIN-1930
FILM UN2020	CINEMA HIST II: 1930-1960
FILM UN2030	CINEMA HIST III:1960-1990
FILM UN2040	CINEMA HISTORY IV: AFTER 1990

Any two courses offered by the Department of Film and Media Studies [1]

[1] Only one elective can be from the following labs:

- FILM UN2410 LAB IN WRITING FILM CRITICISM
- FILM UN2420 LABORATORY IN SCREENWRITING
- FILM UN2510 LAB IN FICTION FILMMAKING
- FILM UN2520 LAB IN NONFICTION FILMMAKING

French and Francophone Studies Minor

The minor is composed of five courses, or a minimum of 15 points beyond the language requirement / prerequisite (FREN UN2102 INTERMEDIATE FRENCH II), which are distributed as follows.

Core (6 points) [1]	
FREN UN3405	Read, Think, Write in French
FREN UN3409	INTRO TO FRENCH # FRANCOPHONE HISTORY
or FREN UN3410	Intro French # Francophone Literature
Interdisciplinary Electives (9 points)	
The remaining three electives can be fulfilled by various French or Francophone literature courses at the 3000 or 4000 level. These elective courses can include advanced literature, culture, and history courses offered by the Department of French, as well as our popular "French Thru/Through X" (FREN UN32XX) courses, which reinforce advanced French language proficiency through various cultural themes (including Current Events, Paris, Pop Culture, the Visual Arts, and so on). Although students should prioritize classes taught in the Department of French at Columbia, some French courses at Barnard College may be taken with the approval of the Director of Undergraduate Studies.	

[1] Students prior to the class of 2028 may elect to take a core comprised of both FREN UN3409 INTRO TO FRENCH # FRANCOPHONE HISTORY and FREN UN3410 Intro French # Francophone Literature.

German Minor

The total number of courses required for the minor is 5 courses (minimum of 15 points).

Pre-requisites: The minor requires at least 4 semesters of German language (through Intermediate II), or equivalent proficiency determined by placement test. However, students can count the second semester of intermediate German (GERM UN2102 INTERMEDIATE GERMAN II) towards their five courses and begin other coursework (in translation) before completing the four semesters of language.

Language/Literature and Culture distribution: A maximum of 6 points can be fulfilled with upper-level language courses (Intermediate II and/or Advanced). The remaining credits (at least three courses) need to be 3000/4000-level literature/culture courses.

GERM UN3333	INTRO TO GERMAN LIT (GERMAN)
Recommended Electives:	
1. One of the period survey courses in German literature and culture	
GERM UN3442	Literature in the 18th and 19th Centuries
GERM UN3443	SURVEY OF GERMAN LIT:19C (GER)
GERM UN3444	Readings in 20th and 21st century Literature

2. Advanced Topics	
GERM UN3991	Advanced Topics in German Literature
Other electives:	
The remaining courses can be chosen, in consultation with the Director of Undergraduate Studies, from the department's other 3000- or 4000-level offerings in German and Comparative Literature-German (taught in German or English).	

Greek or Latin Minor

- A minimum of 13 points in the chosen language at the 1200 level or higher
- 3 points in ancient history of the appropriate civilization

Hispanic Studies Minor

SPAN UN3300	ADV LANGUAGE THROUGH CONTENT
SPAN UN3349 & SPAN UN3350	HISPANIC CULTURES I (SP) and HISPANIC CULTURES II (SP)
Three additional 3000-level elective courses in the Department of Latin American and Iberian Cultures	

Note: Please see the director of undergraduate studies in the Department of Latin American and Iberian Cultures for more information and to declare the minor.

History Minor

- Minimum 5 courses in the History Department with no distribution or seminar requirements. Transfer or study-abroad credits may not be applied.

Industrial Engineering Minor

The IE minor includes four (4) required courses and two (2) elective courses, adding up to a total of 18 credits.

IEOR E3658	PROBABILITY FOR ENGINEERS [1]
or STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
or STAT GU4203	PROBABILITY THEORY
IEOR E3402	PRODUCTN-INVENTORY PLAN-CONTRL
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E4003	CORPORATE FINANCE FOR ENGINEERS
Any two (2) 3000-level or above IEOR courses (with the prefixes IEOR, ORCS, or CSOR): 6 points	

[1] IEOR E3658 PROBABILITY FOR ENGINEERS is preferred.

Note: In addition to fulfilling the requirements above, students majoring in Operations Research, Financial Engineering, or Engineering Management Systems must complete three additional IEOR elective courses that are not used to satisfy the requirements of their major.

Linguistics Minor

Choose three of the following:	
AMST UN3931	Topics in American Studies (languages of America/language contact)
ENGL GU4901	HISTORY OF THE ENGLISH LANGUAGE
LING UN3101	INTRODUCTION TO LINGUISTICS
LING C3102	
LING UN3103	Language, Brain and Mind
LING GU4108	LANGUAGE HISTORY
LING GU4120	LANG DOCUMENTATION/FIELD MTHDS
LING GU4171	LANGUAGES OF AFRICA
LING GU4190	DISCOURSE ANALYSIS
LING GU4376	PHONETICS # PHONOLOGY
LING GU4800	LANGUAGE # SOCIETY
LING GU4903	SYNTAX
Three additional courses from either a) the core linguistics courses, or b) a linguistics-related course from another department subject to approval from the program. Courses previously approved include the following:	
Anthropology	
ANTH UN1009	INTRO TO LANGUAGE # CULTURE
ANTH W4042	Agent, Person, Subject, Self
ANTH GR6067	LANGUAGE AND ITS LIMITS
ANTH GR6125	
Chinese	
CHNS GU4019	HISTORY OF CHINESE LANGUAGE
Computer Science	
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4995	TOPICS IN COMPUTER SCIENCE (with approval)
COMS E6998	TOPICS IN COMPUTER SCIENCE (with approval)
Comparative Language and Society	
CPLS GU4111	World Philology
French	
FREN BC3011	
Hungarian	
HNGR UN3343	DESCRIPTIVE GRAMMAR-HUNGARIAN
Philosophy	
PHIL UN2685	INTRO TO PHIL OF LANGUAGE
PHIL UN3411	SYMBOLIC LOGIC
PHIL UN3685	PHILOSOPHY OF LANGUAGE
PHIL GU4490	LANGUAGE AND MIND
Psychology	
PSYC UN2215	Cognition and the Brain
PSYC UN2440	Language and the Brain
PSYC UN2450	BEHAVIORAL NEUROSCIENCE
PSYC BC3164	PERCEPTION AND LANGUAGE
PSYC W3265	Auditory Perception (Seminar)
PSYC BC3369	LANGUAGE DEVELOPMENT
PSYC GU4232	Production and Perception of Language
PSYC G4272	Advanced Seminar in Language Development
Sociology	
SOCI G4030	Sociology of Language
Spanish	
SPAN BC3382	SOCIOLING ASPECTS U.S.SPANISH
SPAN GU4010	LANGUAGE CROSSING IN LATINX CARIBBEAN CULTURAL PRODUCTION
SPAN G4030	Spanish Pragmatics
SPAN GR5450	A COGNITIVE LINGUISTICS ACCOUNT OF LANGUAGE

Materials Science Minor

- Any five MSAE E3000 or MSAE E4000-level courses, excluding:

MSAE E3900	UNDERGRAD RES IN MATERIALS SCI
MSAE E3156	DESIGN PROJECT
MSAE E3157	DESIGN PROJECT
MSAE E4301	MATERIALS SCIENCE LABORATORY

Mechanical Engineering Minor

Choose four of the following:	
MECE E3100	INTRO TO MECHANCIS OF FLUIDS
or ENME E3161	FLUID MECHANICS
or CHEN E3110	PRINCIPLES OF TRANSPORT PHENOMENA
or EAEE E3200	TRANSPORT/CHEM RATE PHENOMENA
ENME E3105	MECHANICS
ENME E3106	DYNAMICS AND VIBRATIONS
MECE E3301	THERMODYNAMICS
or CHEE E3010	PRIN-CHEM ENGIN-THERMODYNAMICS
or MSAE E3111	THERMO/KINETIC THRY/STAT MECH
MECE E3414	Mechanics of Solids for Mechanical Engineers
MECE E3408	COMPUTER GRAPHICS # DESIGN
MECE E3311	HEAT TRANSFER
MECE E3610	MATERIALS/PROCESSES IN MANUFAC
EEME E3601	Introduction to Continuous Control Systems
Electives: Two additional mechanical engineering courses from either the above list or the following (not all courses in this list are given every year):	
MECE E3401	MECHANICS OF MACHINES
MECE E3450	COMPUTER AIDED DESIGN
Any 3-credit 4000-level courses listed in the Mechanical Engineering Bulletin can also be used to fulfill these additional course requirements	

Middle Eastern, South Asian, and African Studies Minor

- Five courses, to be chosen with the approval of the MESAAS Director of Undergraduate Studies; no elementary or intermediate language courses may be counted.

Music Minor

The SEAS Music Minor is organized around pathways of personal interest, designed with the guidance of an advisor in the Department of Music. Any combination of 15 credits from the Music course list will fulfill the minor. Of those 15 credits, up to 6 maximum performance credits, consisting of lessons and/or ensembles, are allowed for any pathway. Excludes Music Hum courses. Note: Music Performance Program credits do not count towards the 128 credits SEAS students must earn to graduate; in addition, students must audition and be accepted into the Music Performance Program in order to register for lessons and/or ensembles).

Below is the SEAS pathway that students can use as a guide. The courses listed in this pathway are not required and serve only as suggestions to SEAS students, to be presented as they are advised in the minor.

Choose one of the following:	
MUSI UN2318	MUSIC THEORY I
MUSI UN2319	MUSIC THEORY II
or Variable/Elective at Computer Music Center	
Choose one of the following:	
MUSI UN3128	History of Western Music: Middle Ages to Baroque
MUSI UN3129	History of Western Music: Classical Era to 20th Century
MUSI UN3400	TOPICS IN MUSIC # SOCIETY
Electives [1]	
Three nontechnical electives, chosen in consultation with the Music DUS	

[1] With up to 6 possible in lessons or ensembles, enrollment by audition, with the understanding that such courses will NOT count toward the total 128 credits SEAS students must earn to graduate

Operations Research Minor

The OR minor includes four (4) required courses and two (2) elective courses, adding up to a total of 18 credits.

IEOR E3658	PROBABILITY FOR ENGINEERS
or STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS
or STAT GU4203	PROBABILITY THEORY
IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
IEOR E3608	FOUNDATIONS OF OPTIMIZATION
IEOR E3404	SIMULATION MODELING AND ANALYSIS
Any two (2) 3000-level or above IEOR courses (with the prefixes IEOR, ORCS, or CSOR): 6 points. (IEOR E3402: Production Inventory Planning and Control (3 points) is strongly recommended.)	

[1] IEOR E3658 PROBABILITY FOR ENGINEERS is preferred.

Note: In addition to fulfilling the requirements above, students majoring in Industrial Engineering must complete three additional IEOR elective courses that are not used to satisfy the requirements of the major.

Philosophy Minor

- Any five courses in the Philosophy Department with no distribution requirement; total 15 points. See also the list of exceptions under Elective Nontechnical Courses (p. 8).

Note: Please be aware that some philosophy courses may not count as nontechnical electives.

Political Science Minor

Choose two of the following:	
POLS UN1101	POLITICAL THEORY I
POLS UN1201	INTRO TO AMERICAN POLITICS
POLS UN1501	INTRO TO COMPARATIVE POLITICS
POLS UN1601	INTERNATIONAL POLITICS
Any three courses in the Political Science Department with no distribution requirement; total 9 points	

Psychology Minor

PSYC UN1001	THE SCIENCE OF PSYCHOLOGY
Any four courses from, at a minimum, two of the three groups below.	
Perception and Cognition	
Courses numbered in the 2200s, 3200s, or 4200s	
Psychobiology and Neuroscience	
PSYC UN2430	COGNITIVE NEUROSCIENCE
Course numbered in 2400s, 3400s, or 4400s	
Social, Personality, and Abnormal	
Course numbered in the 2600s, 3600s, or 4600s	

Religion Minor

- Five courses (total 15 points), one of which must be at the 2000 level

Sociology Minor

SOCI UN1000	THE SOCIAL WORLD
SOCI UN3000	SOCIAL THEORY
Any three 2000-, 3000-, or 4000-level courses offered by the Department of Sociology; total 6 points	

Statistics Minor

Students who declared the Statistics minor prior to the 2026–2027 academic year should follow the requirements outlined on this page. Students declaring in 2026–2027 or later, or those in the Class of 2029 and beyond, should refer to the updated Statistics minor requirements.

STAT UN1101	INTRODUCTION TO STATISTICS
STAT UN2102	Applied Statistical Computing
STAT UN2103	APPLIED LINEAR REG ANALYSIS
STAT UN2104	APPL CATEGORICAL DATA ANALYSIS
STAT UN3105	APPLIED STATISTICAL METHODS
STAT UN3106	APPLIED MACHINE LEARNING

Notes:

- The curriculum is designed for students seeking practical training in applied statistics; students seeking a foundation for advanced work in probability and statistics should consider substituting

STAT GU4203	PROBABILITY THEORY
STAT GU4204	STATISTICAL INFERENCE
STAT GU4205	LINEAR REGRESSION MODELS
STAT GU4206	PROGRAMMING FOR DATA SCIENCE
STAT GU4207	ELEMENTARY STOCHASTIC PROCESS

- Students may, with permission of the Director of Undergraduate Studies in Statistics, substitute for courses. Students may count up to two courses toward both the Statistics minor and another Engineering major.

Sustainable Engineering Minor

Total of six courses required from the following lists (no substitutions allowed):

Choose four of the following:	
EAEE E2002	
EAEE E2100	A BETTER PLANET BY DESIGN
EACE E3250	Hydrosystems Engineering
CIEE E3260	ENGINEERING FOR COMMUNITY DEVELOPMENT
EAEE E3901	ENVIRONMENTAL MICROBIOLOGY
EAEE E4001	INDUST ECOLOGY-EARTH RESOURCES
ECIA W4100	MGMT # DEVPT OF WATER SYSTEMS
APPH E4130	SOLAR ENERGY & STORAGE
EAEE E4190	PHOTOVOLTAIC SYSTEMS ENGIN
MECE E4211	ENERGY SOURCES AND CONVERSION
EAEE E4257	ENVIR DATA ANALYSIS # MODELING
EESC GU4404	
MECE E4350	Building Energy Modeling and Simulation
MECE E4313	Decarbonizing Buildings Studio: Energy system retrofits at speed and scale
MECE E4612	SUSTAINABLE MANUFACTURING
Choose one of the following: [1]	
ECON UN2257	THE GLOBAL ECONOMY
PLAN A4151	ECONOMICS FOR PLANNERS
PLAN A4304	INTRODUCTION TO HOUSING
ECON GU4321	ECONOMIC DEVELOPMENT
ECON GU4527	ECON ORG # DEVELOPMNT OF CHINA
PLAN A4579	Introduction to Environmental Planning
ECON GU4625	ECONOMICS OF THE ENVIRONMENT
Choose one of the following: [1]	
POLS UN3212	
POLS UN3213	AMERICAN URBAN POLITICS
SOCI UN3235	Social Movements
SOCI UN3324	Global Urbanism

[1] If courses are not available, requesting approval for a similar course from the groups "Economics" or "Law, Policy and Human Rights," respectively from the Columbia College Sustainable Development course list is possible. For more information visit bulletin.columbia.edu/columbia-college/departments-instruction/sustainable-development/#coursestext.

Interdisciplinary Engineering Courses

Of the following courses, some may be requirements for degree programs, and others may be taken as electives. See your departmental program of study or consult with an adviser for more information.

ENGI E1102 THE ART OF ENGINEERING. *4.00 points*.
Bridge between the science-oriented, high school way of thinking and the engineering point of view. Fundamental concepts of math and science reviewed and re-framed in an engineering context; numerous examples of each concept drawn from all disciplines of engineering represented at Columbia. Non-technical issues of importance in professional engineering practice such as ethics, engineering project management, and societal impact. Only open to Columbia Engineering first-year undergraduate students or second-year transfer students. Lab fee: $150

Spring 2026: ENGI E1102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 1102	001/10889	F 11:00am - 1:00pm 301 Pupin Laboratories	David Vallancourt	4.00	251/258

Fall 2026: ENGI E1102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 1102	001/11498	F 11:00am - 1:00pm 417 International Affairs Bldg	David Vallancourt	4.00	212/259

ENGI W4100 RESEARCH TO REVENUE. *3.00 points*.
An interschool course with Columbia Business School that trains engineering and business students to identify and pursue innovation opportunities that rely on intellectual property coming out of academic research. Idea generation, market research, product development, and financing. Teams develop and present business model for a technological invention. This course has limited enrollment by application, and is open to advanced undergraduate students and graduate students. Consult with department for questions on fulfillment of technical elective requirement.

ENGI E4200 Global Engineering Concepts. *3.00 points*.
Prerequisites: Students must be enrolled in the Global Engineering track.
Introduces students to contemporary cases in engineering that impact the world globally and locally. Taught by Columbia Engineering faculty members, approaching the cases in an interdisciplinary manner, bringing students together across the MS programs. Focuses on the School's vision of Engineering for Humanity in five areas: Sustainability, Health, Security, Connectedness, and Creativity

ENGI E4201 Global Engineering Fieldwork. *1.00 point*.
Prerequisites: Students must be enrolled in the Global Engineering Track GET specialization. Instructor's written approval.
Final reports required. May not be audited. International students must consult with the International Students and Scholars Office

Summer 2026: ENGI E4201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 4201	001/11762		Jenny Mak, Elizabeth Strauss	1.00	0/150
ENGI 4201	002/11763		Elizabeth Strauss, Jenny Mak	1.00	2/150

ENGI E4300 Design Justice: Human-Centered Design and Social Justice. *3.00 points*.
Prerequisites: IEME E4200 or COMS W4170 Or instructor's permission.
Introduction to Human-Centered Design and Innovation. Unpack the role of design in the market economy for an individual consumer, for a designer/developer and for an enterprise or other organization. Consider how designing in good faith for most can lead to injustice for some. Examine how - to use the PROP framework of the Columbia School of Social Work[1] - power, race, oppression, and privilege can be executed through the design process. Equip students with tools to engage in the design process and to facilitate the engagement of others. Explore strategies for guiding design and innovation towards more just solutions. [1] https://socialwork.columbia.edu/about/dei/dei-mission-statement/

ENGI E4990 ADVANCED MASTER'S RESEARCH. *0.00-6.00 points*.
Prerequisites: Previous research at Columbia.
Research Course for Master's Students. Students must be nominated by a faculty member. The research credits may not be counted towards the credits required for the Master's degree

Spring 2026: ENGI E4990

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 4990	001/16940		Alexis Moore	0.00-6.00	60/49

ENGI E4999 Engineering Fieldwork. *1.00-2.00 points*.
Only for Engineering graduate students in the relevant programs who need relevant work experience as part of their program of study. May not be taken for pass/fail credit or audited

Summer 2026: ENGI E4999

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 4999	001/11645		Ryan Day, Alexis Moore, Elizabeth Strauss	1.00-2.00	17/100

ENGI E6100 Effective Communication for Engineers and Applied Scientists. *1.50 point*.
Strategic and tactical aspects of communication for effective planning, creation, and execution of communication with impact. Prepares students for doctoral program milestones (poster sessions, conference presentations, dissertation proposals, and defense, job talks, and professional lectures). Focus on (1) describing technical research to various audiences (2) crafting compelling narratives and storytelling; (3) understanding the power of effective communication in advancing academic or industry careers

ENGI E8000 DOCTORAL FIELD WORK. *1.00 point*.
Fieldwork is integral to the academic preparation and professional development of doctoral students. This course provides the academic framework for fieldwork experience required for the student's program of study. Fieldwork documentation and faculty adviser approval is required prior to registration. A final written report must be submitted. This course will count toward the degree program and cannot be taken for pass/fail credit or audited. With approval from the department chair or the doctoral program director, doctoral students can register for this course at most twice. In rare situations, exceptions may be granted by the Dean's Office to register for the course more than twice (e.g., doctoral students funded by industrial grants who wish to perform doctoral fieldwork for their corporate sponsor). The doctoral student must be registered for this course during the same term as the fieldwork experience.

For information on courses in other divisions of the University, please consult the bulletins of Columbia College and the Graduate School of Arts and Sciences.

Professional Development and Leadership

The Professional Development and Leadership (PDL) course aims to enhance and expand our graduate students' professional, interpersonal, intrapersonal, and leadership abilities. Core sessions focus on the development of skills and perspectives needed to compete and succeed in a fast-changing technical climate. Topics include professional portfolio (resume, professional writing, social media presence), communication skills, leadership, ethics, life management (stress, sleep, and time management), and more. Elective sessions cover topics such as emotional intelligence, data visualization, and interview preparation, aiming to provide Columbia Engineers and Applied Scientists with essential tools to advance their professional and personal success.

M.S. students must complete the professional development and leadership course, ENGI E4000 PROF DEVELOPMENT#LEADERSHIP, as a graduation requirement. Doctoral students will be enrolled in ENGI E6001 Professional development and leadership for first year doctoral students –ENGI E6004 Professional development and leadership for fourth year doctoral students and should consult their program for specific PDL requirements. Undergraduate students are encouraged but not required to participate in the Professional Development and Leadership program.

Professional Development and Leadership Team

Ryan Atwell
Ryan Day
Christian Hernandez
Jenny Mak
Conner Moore
Haley Planicka
Elizabeth Strauss
seas-pdl@columbia.edu
pdl.engineering.columbia.edu

Professional Development and Leadership Core Faculty

Julian Berman: Technical Sessions
Austin Cartagena and Ryan Day: Engineer Your Job Search
Chuck Garcia: Communication
Helio Fred Garcia: Ethics and Integrity
Sophia Hyoseon Lee: English Communication
Jenny Mak: Engineer Your Resume
Elizabeth Strauss: Professional Writing

Professional Development and Leadership Courses

M.S. Courses

ENGI E4000 PROF DEVELOPMENT#LEADERSHIP. *0.00 points*.
The PDL course aims to enhance and expand Columbia Engineering graduate students' interpersonal, professional, and leadership skills, through five core sessions, covering (1) in-person communication skills; (2) resume; (3) business writing; (4) social media and the job search; and (5) academic and professional ethics and integrity. ENGI E4000 also requires 5 elective sessions to further students' development based on their personal interests. Students must select at least one life management elective and one interview elective. This course is offered at the Pass/D/Fail grading option

Spring 2026: ENGI E4000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 4000	015/12677		Jenny Mak, Elizabeth Strauss, Ryan Day	0.00	62/150

Fall 2026: ENGI E4000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 4000	001/14516		Jenny Mak, Elizabeth Strauss	0.00	0/100
ENGI 4000	002/14517		Jenny Mak, Elizabeth Strauss	0.00	0/125
ENGI 4000	003/14518		Jenny Mak, Elizabeth Strauss	0.00	0/150
ENGI 4000	004/14519		Jenny Mak, Elizabeth Strauss	0.00	0/100
ENGI 4000	005/14520		Jenny Mak, Elizabeth Strauss	0.00	0/550
ENGI 4000	006/14521		Jenny Mak, Elizabeth Strauss	0.00	0/275
ENGI 4000	007/14522		Jenny Mak, Elizabeth Strauss	0.00	0/60
ENGI 4000	008/14523		Jenny Mak, Elizabeth Strauss	0.00	0/100
ENGI 4000	009/14524		Jenny Mak, Elizabeth Strauss	0.00	0/400
ENGI 4000	010/14528	F 12:45pm - 2:45pm 301 Uris Hall	Elizabeth Strauss, Jenny Mak	0.00	0/250
ENGI 4000	010/14528	F 3:00pm - 5:00pm 301 Uris Hall	Elizabeth Strauss, Jenny Mak	0.00	0/250
ENGI 4000	011/14529	F 12:45pm - 2:45pm 309 Havemeyer Hall	Jenny Mak, Elizabeth Strauss	0.00	0/200
ENGI 4000	011/14529	F 3:00pm - 5:00pm 309 Havemeyer Hall	Jenny Mak, Elizabeth Strauss	0.00	0/200
ENGI 4000	012/14530	W 2:10pm - 4:00pm 326 Uris Hall	Jenny Mak, Elizabeth Strauss	0.00	0/150
ENGI 4000	013/14531	M 2:10pm - 4:00pm 332 Uris Hall	Jenny Mak, Elizabeth Strauss	0.00	0/300
ENGI 4000	014/14525		Jenny Mak, Elizabeth Strauss	0.00	0/200
ENGI 4000	016/14532	T 2:10pm - 4:00pm 303 Uris Hall	Jenny Mak, Elizabeth Strauss	0.00	0/30

Doctoral Courses

ENGI E6001 Professional development and leadership for first year doctoral students. *0.00 points*.
For first year doctoral students, emphasizing the skills needed for success in orienting them to Columbia and doctoral studies, including teaching and presentation skills (i.e., Microteaching, how to grade, hold office hours, conduct recitations, etc.); cultivating relationships with mentors, faculty, and colleagues; inclusivity; managing your budget; wellness; research and academic integrity and ethics

Fall 2026: ENGI E6001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 6001	001/14533		Elizabeth Strauss, Jenny Mak	0.00	0/175

ENGI E6002 Professional development and leadership for second year doctoral students. *0.00 points*.
ENGI E6002 is designed for second year doctoral students, emphasizing the skills needed for continued success in the doctoral program, including presentation and communication skills; academic writing skills; academic conference preparation; resiliency and project management skills

Fall 2026: ENGI E6002

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 6002	001/14534		Jenny Mak, Elizabeth Strauss	0.00	0/175

ENGI E6003 Professional development and leadership for third year doctoral students. *0.00 points*.
For third year doctoral students to facilitate career exploration including teaching, presentation and communication skills; public speaking and facilitation; CV and resume writing; and Getting Things Done

Fall 2026: ENGI E6003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 6003	001/14535		Jenny Mak, Elizabeth Strauss	0.00	0/175

ENGI E6004 Professional development and leadership for fourth year doctoral students. *0.00 points*.
For fourth year doctoral students supporting job search and degree completion, including searching for job opportunities (Academia, Industry); interview preparation; creating an academic portfolio; conducting a job talk; negotiation and mediation skills

Fall 2026: ENGI E6004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
ENGI 6004	001/14536		Jenny Mak, Elizabeth Strauss	0.00	0/150

Graduate Career Placement

Austin Cartagena
Ryan Day
Joy Dong
Conner Moore
Kim Nguyen
seas-gcp@columbia.edu
career.engineering.columbia.edu

Many resources are available to Columbia Engineers and Scientists in their job search and career exploration. While enrolled in a graduate program at Columbia Engineering, you will also be coached by your dedicated Career Placement Officer. We look forward to working with you on your professional development and job search throughout your time at Columbia.

Applied Mathematics – *Kim Nguyen*
Applied Physics – *Kim Nguyen*
Artificial Intelligence – *seas-gcp@columbia.edu (interim)*
Biomedical Engineering – *Blair Dayton*
Business Analytics – *Sara Yllescas*
Carbon Management – *Raina Ranaghan*
Chemical Engineering – *Raina Ranaghan*
Civil Engineering and Engineering Mechanics – *Jenna Kumabe*
Computer Engineering – *Jennifer Lee*
Computer Science – *Stephon Moulterie*
Data Science – *Jacqueline Kishel*
Earth and Environmental Engineering – *Raina Ranaghan*
Electrical Engineering – *Jennifer Lee*
Executive Master's in Engineering and Applied Science – *Austin Cartagena*
Financial Engineering – *Lucy Mahbub (interim)*
Industrial Engineering – *Lucy Mahbub (interim)*
Management Science and Engineering – *Karina Ko*
Materials Science – *Kim Nguyen*
Medical Physics – *Kim Nguyen*
Mechanical Engineering – *Emily McCormack*
Operations Research – *Lucy Mahbub (interim)*
Quantum Science and Technology - *Jennifer Lee*

English Communication Courses

M.S. Courses

ENGI E5000	WORKPLACE COMMUNICATION IN ENGLISH (x, y, and s)
ENGI E5001	PROFESSIONAL PRESENTATION (x, y, and s)
ENGI E5002	PROFESSIONAL COMMUNICATION IN ENGLISH (x, y, and s)
ENGI E5003	ACADEMIC WRITING (x, y, and s)
ENGI E5004	English Conversation and Culture
ENGI E5005	PROFESSIONAL#WORKPLACE COMM IN ENGLISH
ENGI E5006	PROFESSIONAL#WORKPLACE COMM IN ENGLISH
ENGI E5007	PROFESSIONAL#WORKPLACE COMM IN ENGLISH
ENGI E5008	INDEPENDENT STUDY
ENGI E5009	INDEPENDENT STUDY (x, y, and s)

0 pts. Lect: 1.7. Professor Lee.

English communication proficiency is important for academic achievement and career success. In small group settings, interactions with instructor and fellow students to improve communication and writing skills. Individual tutoring sessions offered. Note: open only to Columbia Engineering master's students. Grading is Pass/D/Fail.

Doctoral Courses

ENGI E7000	ACADEMIC COMMUNICATION IN ENGLISH (x, y, and s)
ENGI E7001	PROFESSIONAL PRESENTATION (x, y, and s)
ENGI E7003	ENGLISH COMMUNICATION (x, y, and s)
ENGI E7009	INDEPENDENT STUDY (x, y, and s)

0 pts. Lect: 1.7. Professor Lee.

English communication proficiency is important for academic achievement and career success. In small group settings, interactions with instructor and fellow students to improve communication and writing skills. Individual tutoring sessions offered. Note: open only to Columbia Engineering Ph.D. and M.S. to Ph.D.-track students. Grading is Pass/D/Fail.

University and School Policies, Procedures, and Regulations

- Academic Integrity and Discipline (p. 342)
- Academic Procedures and Standards (p. 337)
- Academic Standing (p. 340)
- Distance Student Learning Complaints
- Enrollment Adjustments (p. 344)
- Essential Policies For The Columbia Community
- Official University Regulations
- Policy On Conduct And Discipline
- Student Grievances, Academic Concerns, and Complaints

Academic Procedures and Standards

Registration and Enrollment

Registration is the process that reserves seats in particular classes for eligible students. It is accomplished by following the procedures announced in advance of each term's registration period.

Enrollment is the completion of the registration process and affords the full rights and privileges of student status. Enrollment is accomplished by the payment or other satisfaction of tuition and fees and by the satisfaction of other obligations to the University.

Registration alone does not guarantee enrollment nor does registration alone guarantee the right to participate in class. In some cases, students will need to obtain the approval of the instructor, or of a representative of the department that offers a course, or permission of the School offering the class. Students should check this bulletin, their registration instructions, the Directory of Classes, and also with an adviser for all approvals that may be required.

To comply with current and anticipated Internal Revenue Service mandates, the University requires all students who will be receiving financial aid or payment through the University payroll system to report their Social Security number at the time of admission. Newly admitted students who do not have a Social Security number should obtain one well in advance of their first registration. International students should consult the International Students and Scholars Office, located at 545 W. 112th Street, 4th Floor (212-854-3587). Special billing authorization is required of all students whose bills are to be sent to a third party for payment. Students who are not citizens of the United States and who need authorization for special billing of tuition and/or fees to foreign institutions, agencies, or sponsors should go to the International Students and Scholars Office with two copies of the sponsorship letter.

University Regulations

Each person whose enrollment has been completed is considered a student of the University during the term for which they are enrolled unless their connection with the University is officially severed by being withdrawn or for other reasons. No student enrolled in any school or college of the University shall at the same time be enrolled in any other school or college, either of Columbia University or of any other institution, without the specific authorization of the dean or director of the school or college of the University in which they are first enrolled.

The privileges of the University are not available to any student until enrollment has been completed. Students are not permitted to attend any University course for which they are not officially enrolled unless they have been granted auditing privileges.

The University reserves the right to withhold the privileges of registration and enrollment or any other University privilege from any person who has outstanding financial, academic, or administrative obligations to the University.

Continuous registration until completion of all requirements is obligatory for each degree. Students are exempt from the requirement to register continuously only when granted a leave of absence by the Committee on Academic Standing (for undergraduate students) or the Office of Engineering Student Affairs (for graduate students).

Registration Instructions

Registration instructions are announced in advance of each registration period by the Registrar. Students should consult these instructions for the exact dates and times of registration activities. Students must be sure to obtain all necessary written course approvals and advisers' signatures before registering. Undergraduate students who have not registered for a full-time course load of at least 12 credits by the end of the change of program period will be withdrawn, as will graduate students who have not registered for any coursework by the end of the change of program period. International students enrolled in graduate degree programs must maintain full-time status until degree completion, with the exception of their final term of studies.

Degree Requirements and Satisfactory Progress

Attendance

Students are expected to attend their classes and laboratory periods. Instructors may consider attendance in assessing a student's performance and may require a certain level of attendance for passing a course.

Undergraduate

Undergraduate students are required to complete the School's degree requirements and graduate in eight academic terms. Full-time undergraduate registration is defined as at least 12 credits per term. However, in order to complete the degree in eight semesters, students must be averaging 16 credits per term. Students may not register for point loads greater than 21 points per term without approval from the Committee on Academic Standing.

To be eligible to receive the Bachelor of Science degree, a student must complete the courses prescribed in a faculty-approved major/program (or faculty-authorized substitutions) and achieve a minimum cumulative grade-point average (GPA) of 2.0. Although the minimum number of academic credits is 128 for the B.S. degree, some programs of the School require a greater number of credits in order to complete all the requirements. Undergraduate engineering degrees are awarded only to students who have completed at least 60 points of coursework that counts for the B.S. degree at Columbia. No credit is earned for duplicate courses or for courses that are taken pass/fail and the final grade is a P, with the exception of two nontechnical electives at the 3000-level or above and physical education courses, as noted below.

Undergraduates in the programs accredited by the Engineering Accreditation Commission of ABET (Biomedical Engineering, Chemical Engineering, Civil Engineering, Earth and Environmental Engineering, Electrical Engineering, and Mechanical Engineering) satisfy ABET requirements by taking the courses in prescribed programs, which have been designed by the departments so as to meet the ABET criteria.

Graduate

Graduate students are required to complete the School's degree requirements. Full-time graduate registration is defined as:

1. M.S., M.S./Ph.D. track, Eng.Sc.D. students: At least 12 credits per term. A typical course load is 12–15 credits per term, not including the last term.
2. Ph.D. students: Registration in the appropriate Residence Unit.

Degree requirements for master's degrees must be completed within five years; those for the doctoral degrees must be completed within seven years. Degree-seeking students must maintain continuous enrollment during academic terms (Fall and Spring) at Columbia Engineering until all degree requirements are met and their degree is scheduled for conferral. Students who fail to register by the end of the Change of Program Period will be withdrawn if they have not been authorized for a leave of absence.

Students who need more than the allowable time to complete their degree requirements or students who attempted to graduate but failed to meet degree requirements should submit a petition for a program extension to extend their studies.

A graduate student who has matriculated in a degree program is expected to:

1. maintain a cumulative GPA above the minimum requirement and
2. make normal progress toward completion of their degree requirements.

A minimum cumulative GPA of 2.5 or the minimum GPA required by the academic department, whichever is higher (in all courses taken as a degree candidate), is required for the M.S. degree. A minimum GPA of 3.0 or the minimum GPA required by the academic department, whichever is higher, is required for the Doctor of Engineering Science (Eng.Sc.D.) and the Doctor of Philosophy (Ph.D.) degrees.

Normal progress toward the degree, to ensure completion of the degree within the necessary timeframe, necessitates that students earn final grades sufficient to count toward the degree in their attempted credits for the semester.

Graduate students who do not meet the minimum cumulative GPA of the school and the department or are not making sufficient progress toward their degree requirements will be placed on Academic Action. Please review the Academic Monitoring section for more information.

Changes in Registration

Undergraduate

An undergraduate student who wishes to drop or add courses or to make other changes in their program of study after the change of program period must obtain the approval of their CSA Advising Dean. An undergraduate student who wishes to drop or add a course in their major must also obtain department approval. Note: The drop date for Columbia Core courses is the end of the Change of Program period for the current semester. After these dates, undergraduate students must petition the Committee on Academic Standing to drop a class after the deadlines.

In cases that have been referred for disciplinary action through the Dean's Discipline process, undergraduate students may not drop from the course in question without a successful petition to the Committee on Academic Standing.

Graduate

Graduate students who wish to drop or add a course or make other course-related changes after the change of program period must obtain approval from their department and their department must submit the relevant paperwork to the Office of Engineering Student Affairs for processing. The deadline for making program changes in each term is shown in the Academic Calendar. After these dates, graduate students must petition the Office of Engineering Student Affairs. For individual courses dropped after the end of the Change of Program period, there will be no tuition refund. Failure to attend a class will be indicated by a permanent unofficial withdrawal (UW) on the transcript.

In cases that have been referred for disciplinary action through the Dean's Discipline process, graduate students should contact the Office of Engineering Student Affairs.

Transfer Credits

Undergraduate

Undergraduate students may obtain academic credit toward the B.S. degree by completing coursework at other accredited four-year institutions. Normally, this credit is earned during the summer. To count as credit toward the degree, a course taken elsewhere must have an equivalent at Columbia University and the student must achieve a grade of at least C. An exception to this policy is made for students enrolled in an approved study abroad program. Students in an approved study abroad program will receive transfer credit if they earn a grade of C or higher. To transfer credit, a student must obtain prior approval from their CSA Advising Dean and the department before taking such courses. A course description and syllabus should be furnished as a part of the approval process. Courses taken before the receipt of the high school diploma may not be credited toward the B.S. degree. A maximum of 6 credits may be credited toward the degree for college courses taken following the receipt of a high school diploma and initial enrollment at Columbia University.

Graduate

For graduate students, Advanced Standing is granted in most cases instead of transfer credits. Advanced Standing refers to a student receiving credit towards their graduate degree program for previously completed graduate-level coursework within the following parameters:

1. M.S. students in on-campus programs can earn Advanced Standing toward the M.S. degree for graduate-level coursework (4000 level or above) completed at Columbia University only. No more than 15 points of Advanced Standing can be awarded, and the coursework can not have been counted towards a previous degree, minor, or certificate program. Advanced Standing points must be deemed appropriate and relevant to the degree program of study, as determined by the Department or Program. In most cases, regardless of Advanced Standing points, M.S. students are required to complete a minimum of 15 credits while enrolled as a Columbia Engineering graduate student.
2. M.S. students in CVN programs are not eligible for Advanced Standing. They may instead request up to 6 transfer credits for prior graduate-level coursework completed at either Columbia University or another institution. The coursework can not have been counted towards a previous degree, and the transfer credit section in the CVN admission application must be completed. Transfer credits are subject to approval by the faculty committee of the equivalent courses at Columbia Engineering.
3. Ph.D. students possessing a conferred master's degree upon entry into a Ph.D. program may be awarded 2 Residence Units toward their Ph.D., as well as 30 points of Advanced Standing toward their Ph.D., with approval from the academic department and the Office of Engineering Student Affairs.
4. Eng.Sc.D. students will earn Advanced Standing provided they earned their master's degree outside of Columbia Engineering to reflect their prior completion of an M.S. program. They can earn up to 30 points of Advanced Standing. These Advanced Standing points are separate from the points the students must complete as an Eng.Sc.D. student at Columbia Engineering.

Examinations

Midterm examinations: Instructors generally schedule these in late October and mid-March.

Final examinations: These are given at the end of each term. The Master University Examination Schedule is available online and is confirmed in November for the fall term and April for the spring term. This schedule is sent to all academic departments and is available for viewing on the Columbia website. Students should consult with their instructors for any changes to the exam schedule. Examinations will not be rescheduled to accommodate travel plans.

Note: If a student has three final examinations scheduled during one calendar day or two exams scheduled at the same time, as certified by the Registrar, an arrangement may be made with one of the student's instructors to take that examination at another, mutually convenient time during the final examination period. This rule refers to a calendar day, not a 24-hour time period. Undergraduate students unable to make suitable arrangements on their own should contact their CSA Advising Dean. Graduate students should contact the Office of Engineering Student Affairs.

Transcripts and Certifications

Information on obtaining University transcripts and certifications can be found on the Registrar's website. Please visit registrar.columbia.edu/content/transcripts-and-certifications.

Report of Grades

Grades can be viewed by using the Vergil feature located on the Student Services home page at vergil.columbia.edu. If students need an official printed report, they must request a transcript (please see Transcripts and Certifications above).

All graduate students must have a current mailing address on file with the Registrar's Office.

Transcript Notations

The grading system is as follows: A, excellent; B, good; C, satisfactory; D, poor but passing; F, failure (a final grade not subject to re-examination). Occasionally, P (Pass) is the only passing option available. The grade-point average is computed on the basis of the following index: A=4, B=3, C=2, D=1, F=0. Designations of + or – (used only with A, B, C) are equivalent to 0.33 (i.e., B+=3.33; B–=2.67). Grades of P, IN, YC, CP, UW, W, and MU will not be included in the computation of the grade-point average.

R (registration credit; no qualitative grade earned): not accepted for degree credit in any program. R credit is not available to undergraduate students for academic classes. In some divisions of the University, the instructor may stipulate conditions for the grade and report a failure if those conditions are not satisfied. The R notation will be given only to those students who indicate, upon registration and to the instructor, their intention to take the course for R, or who, with the approval of the instructor, file written notice of change of intention with the Registrar not later than the last day for change of program. Students wishing to change to R credit after this date are required to submit written approval from the course instructor to the Office of Engineering Student Affairs (ESA) who will submit it to the Registrar. The request to change to R credit must be made by the last day of the change of program period to change a course grading option. A course that has been taken for R credit may not be repeated later for examination credit and cannot be uncovered under any circumstances. The mark of R does not count toward degree requirements for graduate students. The mark of R is automatically given in Doctoral Research Instruction courses.

UW (unofficial withdrawal): given to students who discontinue attendance in a course but are still officially registered for it, or who fail to take a final examination without an authorized excuse.

IN (incomplete): granted only in the case of incapacitating illness as certified by the Health Services at Columbia, serious family emergency, or circumstances of comparable gravity. Undergraduate students request an IN by filling out a petition for an incomplete with their CSA Advising Dean prior to the final exam for the course in the semester of enrollment. Students requesting an IN must gain permission from both the Committee on Academic Standing (CAS) and the instructor. Graduate students should contact their instructor. If granted an IN, students must complete the required work within a period of time stipulated by the instructor but not to exceed one year. After a year, the IN will be automatically changed into an F or the contingency grade. The contingency grade is the grade that the student would earn if they completed no further work in the course, with any missing assignments counted as an F or zero.

YC (year course): a mark given at the end of the first term of a course in which the full year of work must be completed before a qualitative grade is assigned. The grade given at the end of the second term is the grade for the entire course.

CP (credit pending): given only in graduate research courses in which student research projects regularly extend beyond the end of the term. Upon completion, a final qualitative grade is then assigned and credit allowed. The mark of CP implies satisfactory progress.

MU (make-up examination): given to a student who has failed the final examination in a course but who has been granted the privilege of taking a second examination in an effort to improve their final grade. The privilege is granted only when there is a wide discrepancy between the quality of the student's work during the term and their performance on the final examination, and when, in the instructor's judgment, the reasons justify a make-up examination. A student may be granted the mark of MU in only two courses in one term, or, alternatively, in three or more courses in one term if their total point value is not more than 7 credits. The student must remove MU by taking a special examination administered as soon as the instructor can schedule it.

P/F (pass/fail): Undergraduates may select to take only one course that is offered for a letter grade pass/fail each semester. In general, courses taken pass/fail do not count toward degree requirements including the 128-point requirement. There are two exceptions to this rule. Physical Education classes do count toward the 128 point requirement, even though students do not receive letter grades for the class. Additionally, undergraduate students may take up to two courses of the 9-11 nontechnical elective credit on a P/F basis. These courses must be at the 3000 level or higher and must be courses that can be taken P/F by students attending Columbia College (e.g., instruction classes in foreign language and core curriculum classes are not eligible to be taken pass/fail). These 3000-level non-tech elective classes may not count toward a minor if the grade remains a P. Students do have the option of uncovering the letter grade of these two elective 3000-level non-tech classes by the end of the change of program period of the following semester after the course has been completed. Any other course that is taken P/F cannot be uncovered by an undergraduate student. For these classes, the undergraduate student will have to petition the Committee on Academic Standing to uncover the letter grade. Please note that Physical Education classes are the only courses taught solely on a P/F basis that may apply toward the 128 credits for the degree.

For graduate students, courses taken for the P/F option do not count toward the credits necessary for a student's degree requirements. Students have until the last day to change a course grading option to elect the P/F option. After that day, there is no uncovering for a letter grade. Additionally, the grading option cannot be changed after a final grade has been assigned.

W (official withdrawal): a mark given to students who, after the drop deadline for the semester, are granted a leave of absence or approved to drop an individual course.The grade of W, meaning "official withdrawal," will be recorded as the official grade for the course in lieu of a letter grade.

Name Changes

Columbia University recognizes that some students prefer to identify themselves by a First Name and/or Middle Name, other than their Legal Name. For this reason, beginning in the Spring 2016 semester, the University has enabled students to use a "Preferred Name" where possible in the course of University business and education.

Under Columbia's Preferred Name policy, any student may choose to identify a Preferred First and/or Middle Name in addition to the Legal Name. Students may request this service via a link on SSOL. The student's Preferred Name may be used in many University contexts, including SSOL, class rosters, CourseWorks, and Canvas, and on ID Cards. For some other records, the University is legally required to use a student's Legal Name. However, whenever reasonably possible, a student's "Preferred Name" will be used. Please see registrar.columbia.edu/content/name-and-address-changes for further details.

Students may change their name of record by submitting a name change affidavit to the Student Service Center. Affidavits are available from this office or online at registrar.columbia.edu.

Graduation

Columbia Engineering awards degrees three times during the year: in February, May, and October. There is one Commencement ceremony for the University in May.

Students must meet all program, department, and school requirements to graduate. This includes all required courses, minimum final grades for all courses, transcripts from previous institutions, meeting the minimum GPA requirements, etc. Failure to meet the requirements will disqualify students from a degree conferral.

Application or Renewal of Application for the Degree

In order to be considered for a degree or certificate, students must file an Application for Degree or Certificate. Students should complete the online Application for Degree available directly within SSOL, under the Degree Application Status tab. For additional support, please follow the instructions on the Registrar's website. Candidates for Master of Philosophy and doctoral degrees should inquire at their departments but must also follow the instructions of the Dissertation Office.

General application deadlines to submit the Application for the Degree are November 1 for February, January 1 for May, and August 1 for October. (When a deadline falls on a weekend or holiday, the deadline moves to the next business day.) Candidates for Master of Philosophy and doctoral degrees should refer to the Dissertation Office's dissertation dates and deadlines.

Students who fail to earn the degree by the conferral date for which they applied will be moved to a later conferral date.

Diplomas

There is no charge for the preparation and conferral of an original diploma. If your diploma is lost or damaged, there will be a charge of $100 for a replacement diploma. Note that replacement diplomas carry the signatures of current University officials. Applications for replacement diplomas are available on the Registrar's website: registrar.columbia.edu/registrar-forms/application-replacement-diploma. Any questions regarding graduation or diploma processing should be addressed to diplomas@columbia.edu.

Academic Standing

Academic Honors

Dean's List

To be eligible for Dean's List honors, an undergraduate student must achieve a grade-point average of 3.5 or better and complete at least 15 graded credits with no unauthorized incompletes, UWs, or grades lower than C.

Honors Awarded with the Degree

At the end of the academic year, a select portion of the candidates for the Bachelor of Science degree who have achieved the highest academic cumulative grade-point average are accorded Latin honors. Latin honors are awarded in three categories (cum laude, magna cum laude, and

summa cum laude) to no more than 25 percent of the graduating class, with no more than 5 percent summa cum laude, 10 percent magna cum laude, and 10 percent cum laude. Honors are awarded on the overall record of graduating seniors who will have completed a minimum of four semesters at Columbia upon graduation. Students who enter Columbia through the Combined Plan program are eligible for honors based on four semesters at Columbia. Students may not apply for honors.

Academic Monitoring

The SEAS Faculty Committee on Instruction determines academic policies and regulations for the School. Academic performance is reviewed by advisers at the end of each Fall and Spring semester. The Undergraduate Committee on Academic Standing and the Office of Engineering Student Affairs are expected to uphold the policies and regulations of the Committee on Instruction and determine when circumstances warrant exceptions to them.

Undergraduate

The Undergraduate Committee on Academic Standing, in consultation with the departments, meets to review undergraduate grades and progress toward the degree. Indicators of academic well-being are grades that average above 2.0 each term, and making adequate progress for the completion of the degree program, with no incomplete grades.

Possible academic sanctions include:

- *Warning:* C– in any core science course or in a required course for their major; low points toward degree completion
- *Academic Probation*: Students will be placed on academic probation if they meet any of the conditions below:
  - fall below a 2.0 GPA in a given semester
  - have not completed 12 points successfully in a given semester
  - have not completed chemistry, physics, University Writing, The Art of Engineering, and calculus during the first year
  - receive a D, F, UW, or unauthorized Incomplete in any first-year/sophomore required courses
  - receive a D, F, UW, or unauthorized Incomplete in any course required for the major
  - receive straight C's in the core science courses (chemistry, calculus, physics) or in required courses for their major
  - not making significant progress toward the degree
- *Continued Probation:* Students who are already on probation and fail to meet the minimum requirements as stated in their sanction letter.
- *Strict Probation:* Students who are already on probation, fail to meet the minimum requirements as stated in their sanction letter, and are far below minimum expectations. This sanction is typically applied when there are signs of severe academic difficulty.
- *Suspension and Dismissal:* Students who have been placed on academic probation and who fail to be restored to good academic standing in the following semester can be considered either for suspension or dismissal by the Undergraduate Committee on Academic Standing. The decision to suspend or dismiss a student will be made by the Committee on Academic Standing in the Berick Center for Student Advising and the Dean's Office in close consultation with the student's departmental adviser when the student has declared a major. In cases of suspension, the student will be required to make up the deficiencies in their academic record by taking appropriate courses at a four-year accredited institution. Students must be able to complete their degree requirements in their eighth semester at Columbia after readmission. If this is not achievable, then students should be considered for dismissal instead.

The courses that the student must take will be determined by the Undergraduate Committee of Academic Standing and by the student's departmental adviser when the student has declared a major. All proposed courses will be reviewed by the appropriate faculty who teach the equivalent classes at Columbia University. All courses that are being taken to fulfill a major requirement or as a technical elective must be approved by the student's departmental adviser. Courses being taken to count as a nontech elective or to count as general credit would only require the approval of the student's Advising Dean in the Berick Center for Student Advising. The existing procedures for the approval of outside credit will be followed in these cases. Students must receive a grade of B or better for the credit to be transferred.

Graduate

The Office of Engineering Student Affairs and academic departments monitor the academic progress of graduate students. If a student's academic performance (based on GPA and/or degree progress) indicates cause for concern, they may be placed on academic action and be guided toward resources and support. Examples of academic actions may include Academic Warning, Academic Probation, Strict Academic Probation, or Academic Dismissal.

Students will be placed on Academic Action if their cumulative GPA is below 2.5 **or the minimum GPA required by the academic department, whichever is higher.** Students may also be placed on academic action if they are not making satisfactory progress toward their degree. Doctoral students can also be placed on Academic Action if they are not making satisfactory progress toward their dissertation and doctoral milestones. Students who are on Academic Action and do not return to good standing after one semester may be dismissed from the program.

Columbia Engineering students are primarily governed by Columbia University and the School of Engineering and Applied Science policies. The Eng.Sc.D. and Ph.D. programs have nearly identical academic requirements regarding courses, qualifying examinations, and the dissertation, but differ in residence requirements and certain administrative details. Columbia Engineering Ph.D. students are expected to complete residence and dissertation requirements in accordance with the regulations of the Graduate School of Arts and Sciences. Students who have questions about which policy applies should contact Engineering Student Affairs for clarification.

Failure to Maintain Good Academic Standing

Failure to maintain good academic standing, including failure to make satisfactory academic progress toward the degree, may result in consequences such as a warning, probation, suspension, or dismissal. Academic departments and programs will advise graduate students who are not in good standing of the necessary corrective actions, deadlines, and consequences. Departments and programs may also have their own standards of satisfactory academic progress that students must meet.

Procedure for Dismissal

If a graduate student's performance remains unsatisfactory, the graduate program director and/or student affairs staff should confer with the Office of Engineering Student Affairs (ESA) regarding dismissal. The department/program and ESA will review the student's academic progress and reach a consensus on the appropriate action. If a dismissal is warranted, the department will draft a communication to the student outlining the reasons for the decision, which will be signed

by representatives of the department/program and ESA. The effective date of the dismissal will be included in the notification; it may take effect immediately or at the end of the then-current semester, depending on circumstances. In exceptional cases, a student may be dismissed from the degree program without a probationary period.

Appealing a Dismissal

A student may appeal a dismissal within ten business days of receiving notification. The appeal should be addressed to the department chair and the Deans of Students (esa-deans@columbia.edu). A student may appeal the decision on only two grounds:

- New information: An appeal based on new information must explain why this information was not available or not provided to the department at the time of the dismissal, and how this information would substantially alter the dismissal decision.

OR

- Procedural error: An appeal based on procedural error must identify with specificity each alleged error(s) with the process that led to the dismissal that could potentially change or affect the outcome to the detriment of the student.

A student will typically receive a determination on their appeal within ten business days. That decision is final, and there are no further appeals. Upon conclusion of the appeal process, a permanent transcript notation will be placed on the student's record for cases resulting in dismissal.

Academic Integrity and Discipline

Academic Integrity

Academic integrity defines a university and is essential to the mission of education. At Columbia, you are expected to participate in an academic community that honors intellectual work and respects its origins. The ability to synthesize information and produce original work is a key component in the learning process. As such, a violation of academic integrity is one of the most serious offenses that one can commit at Columbia. If found responsible, violations range from disciplinary warning to expulsion from the University. Compromising academic integrity not only jeopardizes a student's academic, professional, and social development but also violates the standards of our community. As a Columbia student, you are responsible for making informed choices with regard to academic integrity both inside and outside of the classroom.

Students rarely set out with the intent of engaging in violations of academic integrity. But classes are challenging at Columbia, and students may find themselves pressed for time, unprepared for an assignment or exam, or feeling that the risk of earning a poor grade outweighs the need to be thorough. Such circumstances lead some students to behave in a manner that compromises the integrity of the academic community, disrespects their instructors and classmates, and deprives them of an opportunity to learn. Students who find themselves in such circumstances should immediately contact their instructor and adviser for advice.

For undergraduate students, another resource is the Academic section of the Live Well | Learn Well site at wellbeing.columbia.edu/resources for Academic resources and support.

The easiest way to avoid academic integrity issues is to prepare yourself as best you can. Below are some basic suggestions to help:

- Discuss with each of your faculty their expectations for maintaining academic integrity.
- Understand that you have a student responsibility to uphold academic integrity based on the expectations outlined in each of your course syllabi.
- Understand instructors' criteria for academic integrity and their policies on citation and group collaboration.
- Clarify any questions or concerns about assignments with instructors as early as possible.
- Develop a timeline for drafts and final edits of assignments and begin preparation in advance.
- Avoid plagiarism: acknowledge people's opinions and theories by carefully citing their words and always indicating sources.
- Assume that collaboration in the completion of assignments is prohibited unless specified by the instructor.
- Utilize the campus resources, such as the Berick Center for Student Advising, Counseling and Psychological Services (CPS), and Engineering Student Affairs, if feeling overwhelmed, burdened or pressured.
- Attend Academic Integrity workshops offered throughout the academic year.
- If you suspect that an academic integrity violation may have occurred, know that you can talk to your instructor, Advising Dean, Director of Academic Integrity, Office of Engineering Student Affairs, or the Student Conduct and Community Standards Office to report any allegations of academic misconduct.

Students found responsible for an academic integrity violation may not be eligible to receive Latin Honors at Class Day or ineligible to take on leadership positions for a period of time and/or other distinctions.

Plagiarism and Acknowledgment of Sources

Columbia has always believed that writing effectively is one of the most important goals a college student can achieve. Students will be asked to do a great deal of written work while at Columbia, for instance: term papers, coding problem sets, seminar presentations, laboratory reports, and analytical essays of different lengths. These papers play a major role in course performance, but more importantly, they play a major role in intellectual development. Columbia's academic integrity policy in the Standards & Discipline defines plagiarism as "the use of words, phrases, or ideas belonging to the student, without properly citing or acknowledging the source, is prohibited. This may include, but is not limited to, copying computer programs for the purposes of completing assignments for submission."

One of the most prevalent forms of plagiarism involves students using information from the Internet or a large language model (LLM) without proper citation. While the Internet can provide a wealth of information, sources obtained from the web must be properly cited just like any other source. If you are uncertain how to properly cite a source of information that is not your own, whether from the Internet or LLM, it is critical that you do not hand in your work until you have learned the proper way to use in-text references, footnotes, and bibliographies. Faculty members or Teaching Assistants are available to help as questions arise about proper citations, references, and the appropriateness of group work on assignments. Students can also check with the Writing Center directly. Another option is to connect with Research Librarians who facilitate monthly citation management workshops online and in person. Information on these workshops is posted online on the Columbia Libraries website. Undergraduate students can also meet with the Director of Academic Integrity to review citation styles or options for

academic support by emailing ugrad-integrity@columbia.edu. Graduate students should consult with the Office of Engineering Student Affairs by emailing seas-conduct@columbia.edu. Ignorance of proper citation methods or academic integrity policies does not exonerate one from responsibility.

Personal Responsibility, Finding Support, and More Information

A student's education at Columbia University consists of two complementary components: a mastery over intellectual material within a discipline and the overall development of moral character and personal ethics. Participating in forms of academic dishonesty violates the standards of our community at Columbia and severely inhibits a student's chance to grow academically, professionally, and socially. As such, Columbia's approach to academic integrity is informed by its explicit belief that students must take full responsibility for their actions, meaning you will need to make informed choices inside and outside the classroom. Columbia offers a wealth of resources to help students make sound decisions regarding academics, extracurricular activities, and personal issues. Undergraduate students should consult their Advising Dean or meet with the Director of Academic Integrity in Suite 601 in Lerner Hall. Graduate students should consult the Office of Engineering Student Affairs.

Academic Integrity Policies and Expectations

Violations of policy may be intentional or unintentional and may include dishonesty in academic assignments or in dealing with University officials, including faculty and staff members. Moreover, dishonesty during the Dean's Discipline hearing process may result in more serious consequences.

Types of academic integrity violations:

- **Academic Dishonesty, Facilitation of:** Knowingly or negligently engaging in behavior that assists another student in a violation of academic integrity is prohibited.
- **Assistance, Unauthorized:** Giving unauthorized assistance to another student or receiving unauthorized assistance from another person on tests, quizzes, assignments or examinations, without the instructor's permission, is prohibited.
- **Bribery:** Offering or giving any favor or something of value for the purpose of improperly influencing a grade or other evaluation of a student in an academic program is prohibited.
- **Cheating:** Using or attempting to use unauthorized materials, information, study aids, or the ideas or work of another in order to gain an unfair advantage is prohibited. Cheating includes, but is not limited to, the possession, giving of, use, or consultation of unauthorized materials or using unauthorized equipment or devices on tests, quizzes, assignments or examinations, working on any examination, test, quiz or assignment outside of the time constraints imposed, the unauthorized use of prescription medication to enhance academic performance, or submitting an altered examination or assignment to an instructor for re-grading.
- **Collaboration, Unauthorized:** Collaborating on academic work without the instructor's permission is prohibited. This includes, but is not limited to, unauthorized collaboration on tests, quizzes, assignments, labs, and projects.
- **Dishonesty:** Falsification, forgery, or misrepresentation of information to any University official in order to gain an unfair academic advantage in coursework or lab work, on any application, petition, or documents submitted to the University, is prohibited. This includes, but is not limited to, falsifying information on a résumé, fabrication of credentials or academic records, misrepresenting one's own research, providing false or misleading information in order to be excused from classes or assignments, or intentionally underperforming on a placement exam. Furthermore, another party providing false information on another student's behalf is prohibited.
- **Ethics, Honor Codes, and Professional Standards, Violation of:** Violating established institutional policies related to the ethics, honor codes, or professional standards of a student's respective school is prohibited.
- **Failing to Safeguard Work:** Failure to take precautions to safeguard one's own work is prohibited. This includes, but is not limited to: leaving work on public computers; sharing work with other students for a completed course without authorization from the course instructor; and sharing course notes without instructor authorization.
- **Giving or Taking Academic Materials, Unauthorized:** Unauthorized taking, circulating, or sharing of past or present course material(s) without the instructor's permission is prohibited. This includes, but is not limited to, assignments, exams, lab reports, notebooks, and papers. Methods of obtainment and distribution include but are not limited to: taking photographs, videos, or screenshots; uploading to public websites (i.e. CourseHero, Github, etc.); emailing or other messaging platforms; sharing through Courseworks or Canvas; or taking and/or distributing unauthorized recordings of lectures/course instructions/office hours.
- **Obtaining Advanced Knowledge:** Unauthorized advance access to exams or other assignments without an instructor's permission is prohibited.
- **Plagiarism:** The use of words, phrases, or ideas that do not belong to the student, without properly citing or acknowledging the source, is prohibited. This may include, but is not limited to, copying computer code for the purposes of completing assignments for submission.
- **Sabotage:** Deliberately and/or intentionally harming or attempting to harm someone else's academic performance is prohibited. This includes, but is not limited to: altering another student's experiment data; disrupting the experiments or tests of others; taking actions which prevent others from completing work; or making modifications to parts of a group project without the knowledge of contributors.
- **Self-Plagiarism:** Using any material portion of an assignment to fulfill the requirements of more than one course, without the instructor's permission, is prohibited. This includes, but is not limited to, submitting original writing or any previous assignments (including assignments submitted for a prior course and/or degree).
- **Test Conditions, Violations of:** Compromising a testing environment, violating specific testing conditions, and/or violating test instructions to intentionally or unintentionally create access to an unfair advantage for oneself or others, is prohibited (for a prior course and/or degree).
- **Use of Artificial Intelligence Tools, Unauthorized:** Absent a clear statement from a course instructor granting permission, the use of generative Artificial Intelligence (AI) tools to complete an assignment or exam is prohibited. The unauthorized use of AI shall be treated similarly to unauthorized assistance and/or plagiarism.

For more information regarding Generative AI Policy, please visit the Office of the Provost Generative AI Policy webpage.

Disciplinary Procedures

Many policy violations that occur in the residence halls or within fraternity and sorority housing are handled by the Office of Residential

Life. More serious offenses are referred directly to the Center for Student Success and Intervention. Violations in University Apartment Housing are handled by building managers and housing officials. Some incidents regarding graduate students are referred directly to the School's housing liaison in the Office of Engineering Student Affairs.

In matters involving rallies, picketing, and other mass demonstrations, the Rules of University Conduct outlines procedures.

Dean's Discipline Process for Undergraduate and Graduate Students

It is expected that all students act in an honest way and respect the rights of others at all times. Dean's Discipline is the process utilized to investigate and respond to allegations of behavioral or academic misconduct. The Dean's Discipline process is not meant to be an adversarial or legal process, but instead aims to educate students about the impact their behavior may have on their own lives as well as on the greater community.

The process is initiated when an allegation is reported that a student may have violated University policies. Students may be subject to Dean's Discipline for any activity that occurs on or off campus that impinges on the rights of other students and community members. This also includes violations of local, state, or federal laws.

The Center for Student Success and Intervention is responsible for administering the Dean's Discipline disciplinary process for all disciplinary affairs concerning undergraduate students that are not reserved to some other body. The Office of Engineering Student Affairs is responsible for all disciplinary affairs concerning graduate students that are not reserved to some other body.

Students are expected to familiarize themselves with the Standards & Discipline handbook and the policies and expectations available on the Center for Student Success and Intervention website at cssi.columbia.edu, which is part of the required Academic Integrity Tutorial modules in CourseWorks. The Bulletin is also not to be considered the sole or comprehensive guide to policies at Columbia. Students should consult the policies and expectations of the various offices and departments for additional guidance.

Students found responsible for reportable violations of conduct, including academic integrity violations, will need to report such offenses on future recommendations for law, medical, or graduate school. Students found responsible for any violations of conduct may be disqualified from receiving Latin Honors or other awards. They may also be disqualified from participating in internships or other leadership roles. The parents or guardians of undergraduate students may also be notified in cases of receiving a sanctioned outcome of Disciplinary Probation or higher.

For more information about the discipline process for undergraduate students, please review the Academic Integrity website or Center for Student Success and Intervention. For more information about the discipline process for graduate students, please contact the Office of Engineering Student Affairs.

Confidentiality

Privacy and Reporting: Disciplinary proceedings conducted by the University are subject to the Family Education Rights and Privacy Act ("FERPA," also called "The Buckley Amendment"). There are several important exceptions to FERPA that will allow the University to release information to third parties without a student's consent. For example, the release of student disciplinary records is permitted without prior student consent to University officials with a legitimate educational interest such as a student's academic adviser, and to Columbia Athletics if the student is an athlete. The University will also release information when a student gives written permission for information to be shared. To obtain a FERPA waiver, please visit columbia.edu/cu/studentconduct/documents/FerpaRelease.pdf. To read more about the exceptions that apply to the disclosure of student records information, please visit the University Policies website at universitypolicies.columbia.edu.

Enrollment Adjustments

Leave of Absence

A Leave of Absence is an authorized, temporary break from academic participation. Leave requests (as well as requests to return from leave) require approval from the appropriate office as outlined in detail for each request type.

Medical Leave of Absence

Undergraduate Students

A medical leave of absence for an undergraduate student is granted by the James H. and Christine Turk Berick Center for Student Advising to an undergraduate student whose health prevents them from successfully pursuing full-time study. Undergraduates who take a medical leave of absence are guaranteed housing upon their return if they were already guaranteed housing. Students on medical leave may be eligible to continue participation in University-sponsored health insurance; please contact studentinsurance@columbia.edu for additional details.

Documentation from a physician or counselor must be provided before such a leave is granted. In order to apply for readmission following a medical leave, a student must submit proof of recovery from a physician or counselor. Please visit the CSA website for further details.

A medical leave for an undergraduate student is for a minimum of one year and cannot be longer than two years.

When a medical leave of absence is granted during the course of the semester, the fact that the student was enrolled for the semester and withdrew will be recorded on the student's transcript. The date of the withdrawal will also appear on the transcript. If the leave begins prior to the drop deadline, then the specific courses that the student is enrolled in will be deleted from the student's record. If after the drop deadline, the course grades will typically result in W (Official Withdrawal) in all courses. In certain circumstances, a student may qualify for an IN (Incomplete), which would have to be completed within two semesters after the student returns to Columbia. If the Incomplete is not completed by that time, an F or contingency grade such as W will be inserted as the final grade.

In exceptional cases, an undergraduate student may apply for readmission following a one-term medical leave of absence. In addition to providing a personal statement and supporting medical documentation for the Medical Leave Readmission Committee to review, the student will also need to provide a well-developed academic plan that has been approved by their departmental adviser and their Advising Dean as part of the readmission process. This plan must demonstrate that their return to Columbia Engineering following a one-semester leave of absence will allow the student to properly follow the sequence of courses as required for the major and to meet all other graduation requirements by their eighth semester. The final decision regarding whether or not a student

will be allowed to be readmitted after a one-semester leave will be made by the Medical Leave Readmission Committee.

During the course of the leave, students are not permitted to take any courses for the purpose of transferring credit and are not permitted to be on campus. For more information about the medical leave of absence policy, undergraduates should consult their CSA Advising Dean.

Graduate Students

A medical leave of absence for a graduate student is granted by the Office of Engineering Student Affairs; please consult with their office for more information.

Documentation from a physician or a counselor must be provided in order for such a leave to be granted.

When a medical leave of absence is granted during the course of the semester, a withdrawal will be recorded on the transcript. The withdrawal date will also appear on the transcript. If the leave begins prior to the drop deadline, then all courses the student is enrolled in will be deleted from their record. If the leave is after the drop deadline, the course grades will typically result in W (Official Withdrawal) in all courses. In certain circumstances, a student may qualify for an IN (Incomplete), which would have to be completed within two semesters after the student returns to Columbia. If the Incomplete is not completed by that time, an F or contingency grade, such as a W, will be inserted as the final grade.

A medical leave for a graduate student is for a minimum of one semester, up to two years (or four semesters) total. If a student does not return for their approved term, they will be withdrawn from the School. Students may return in the Fall or Spring terms.

In the case of a student under disciplinary sanction or with a pending disciplinary proceeding, the Deans of Engineering Student Affairs may attach conditions to the leave of absence to ensure that the student cannot avoid such sanction or submission to the proceeding due to their leave.

Students on medical leave may be eligible to remain in on-campus housing; please contact seas-housing@columbia.edu for additional details. Students on medical leave may be eligible to continue participation in University-sponsored health insurance; please contact studentinsurance@columbia.edu for additional details.

Graduate students requesting to return from medical leave must submit supporting medical documentation and a personal statement that includes a well-developed plan to complete their degree. Graduate students may also be required to meet with a medical provider at Columbia.

Doctoral students must be approved by their academic department, have a faculty advisor, and have funding from their faculty advisor and/or academic department prior to and when returning from an approved medical leave.

It is recommended that students submit the request to return form well in advance of the semester that they wish to return for. Please note that return requests are not processed until June 1 for fall returns and November 1 for spring returns.

During the course of the leave, students are not permitted to take any courses for the purpose of transferring credit and are not permitted to be on campus.

Further information about the Policy and procedures is on the Change of Status website.

Voluntary Leave of Absence

A voluntary leave of absence may be granted to eligible students who require a break from their studies due to personal reasons.

Undergraduate Students

A voluntary leave of absence (VLOA) may be granted by the Committee on Academic Standing to undergraduate students who request a temporary withdrawal from Columbia Engineering for a nonmedical reason. Students considering a voluntary leave must discuss this option in advance with their CSA Advising Dean. Voluntary leaves are granted for a period of one academic year only for undergraduate students; VLOAs will ordinarily not be granted for one semester, or for more than one year. Students must be in good academic standing at the time of the leave and must be able to complete their major and degree in eight semester. Please visit the CSA website for future details.

When a voluntary leave of absence is granted during the course of the semester, the fact that the student was enrolled for the semester and withdrew will be recorded on the student's transcript. The specific courses that the student is enrolled in for the semester will be deleted if the leave begins prior to the drop deadline. If after the drop deadline, the course grades will normally be a W (Official Withdrawal) in all courses. In certain circumstances, a student may qualify for an IN (Incomplete).

In exceptional cases, an undergraduate may apply for readmission following a one-term voluntary leave of absence. The student will need to provide to the Committee on Academic Standing a well-developed academic plan that has been approved by the departmental adviser and the Berick Center for Student Advising as part of the admission process. This plan must demonstrate that their return to Columbia Engineering following a one-semester voluntary leave of absence will allow the student to properly follow the sequence of courses as required for the major and to meet all other graduation requirements by their eighth semester. The Committee on Academic Standing will review the student's academic plan and request for readmission. The deadlines for petitioning for readmission are June 1 for the fall semester and November 1 for the spring semester. Undergraduates should consult the voluntary leave of absence policy statement available on the website of the Berick Center for Student Advising for more information regarding the readmission procedures from a voluntary leave of absence.

During the course of the leave, students are not permitted to take any courses for the purpose of transferring credit and are not permitted to be on campus. For more information about the voluntary leave of absence policy, undergraduates should consult their CSA Advising Dean.

Finally, students on a voluntary leave of absence must vacate University housing and are not eligible for University-sponsored health insurance. Students who choose to take voluntary leaves are not guaranteed housing upon return to the University. Undergraduate students who go on leave during their first year and had guaranteed housing prior to their leave are guaranteed housing upon readmission. International students should contact the International Students and Scholars Office to ensure that a leave will not jeopardize their ability to return to Columbia Engineering

Graduate Students

A voluntary leave of absence (VLOA) for a graduate student is granted by the Office of Engineering Student Affairs. Voluntary leaves are granted

for a minimum of one semester, up to one year (or two semesters) total. A graduate student must have been registered for at least one semester and have a minimum cumulative 2.5 GPA to request a voluntary leave. Additionally, doctoral students must have a faculty adviser and funding from their faculty adviser and/or academic department prior to and when returning from an approved voluntary leave of absence. The deadline to request a voluntary leave for a given term is the drop deadline for that term. VLOA requests made after the drop deadline may only be granted in exceptional circumstances.

When a voluntary leave of absence is granted during the course of the semester, the semester coursework will be deleted if the leave begins prior to the drop deadline. If after the drop deadline, the course grades will result in W (Official Withdrawal) in all courses. In certain circumstances, a student may qualify for an IN (Incomplete). For graduate students, an IN would have to be completed within two semesters after the student returns to Columbia. If the Incomplete is not completed by that time, an F or contingency grade such as W will be inserted as the final grade.

Students on a voluntary leave of absence must vacate University housing and are not eligible for University-sponsored health insurance.

A graduate student may request to return from a voluntary leave of absence for the fall or spring terms. A request to return must be made before the return semester begins. It is recommended that students submit the request to return form well in advance of the semester that they wish to return for. Please note that return requests are not processed until April 1 for fall returns/November 1 for spring returns. Please contact the Office of Engineering Student Affairs for more information.

Students may not take courses for transferable credit while on leave. Finally, students who choose to take voluntary leaves are not guaranteed housing upon return to the University. International students should contact the International Students and Scholars Office to ensure that a leave will not jeopardize their ability to return to the school.

Undergraduate Emergency Family Leave of Absence

Undergraduate students who must leave the University for urgent family reasons that necessitate a semester-long absence (e.g., family death or serious illness in the family) may request an emergency family leave of absence. Documentation of the serious nature of the emergency must be provided. Students must request an emergency family leave of absence from their Advising Dean in the James H. and Christine Turk Berick Center for Student Advising.

When an emergency family leave of absence is granted during the course of the semester, the fact that the student was enrolled for the semester and withdrew will be recorded on the student transcript. The specific courses that the student is enrolled in for the semester will be deleted if the leave begins prior to the drop deadline. If after the drop deadline, the course grades will normally be W (official withdrawal) in all courses. In certain circumstances, a student may qualify for an Incomplete, which would have to be completed by the first week of the semester in which the student returns to Columbia. If the Incomplete is not completed by that time, a W will be inserted.

To return, students must notify the Berick Center for Student Advising as soon as possible, ideally by November 1 for the spring semester and June 1 for the fall semester. Students must request readmission in writing and submit a statement describing their readiness to return. Students who were guaranteed housing prior to taking an emergency family leave are guaranteed housing upon readmission. Students may request permission to return after one semester as long as they can demonstrate that they can remain in sequence with their coursework and have the prior approval of the departmental adviser.

This plan must demonstrate that their return to Columbia Engineering following a one-semester leave of absence will allow the student to properly follow the sequence of courses as required for the major and to meet all other graduation requirements by their eighth semester.

Students who decide not to return must notify the James H. and Christine Turk Berick Center for Student Advising of their decision. The date of separation for the leave of absence will be the date of separation for withdrawal. Leaves may not extend beyond four semesters. Students who do not notify the Berick Center for Student Advising of their intentions by the end of the two-year period will be permanently withdrawn.

Leave for Military Duty

Please refer to the Military Leave of Absence Policy in *University Policies* at universitypolicies.columbia.edu for recent updates regarding leave for military duty.

Involuntary Leave of Absence Policy

Please refer to the Involuntary Leave of Absence Policy in *University Policies* at universitypolicies.columbia.edu.

Withdrawal

Students may withdraw if they wish to permanently discontinue their program of study. Students are strongly recommended to consult their advisor and/or Department prior to withdrawal.

Students who withdraw during a semester before the drop deadline have the semester coursework deleted. After the drop deadline, the course grades will result in W (Official Withdrawal) in all courses. Students who withdraw must vacate University housing and forfeit University-sponsored insurance.

Readmission

Students who withdrew or were withdrawn may be eligible to apply for readmission to the school. Specific readmission procedures are determined by the reasons for and timeframe of the withdrawal.

Undergraduate Students

Students who decide not to return must notify the James H. and Christine Turk Berick Center for Student Advising of their decision. The date of separation for the leave of absence will be the date of separation for withdrawal. Leaves may not extend beyond four semesters. Students who do not notify the Berick Center for Student Advising of their intentions by the end of the two-year period will be permanently withdrawn.

Further information for undergraduate students is available in the Berick Center for Student Advising. Undergraduate students applying for readmission should complete all parts of the appropriate readmission procedures by June 1 for the fall term or November 1 for the spring term.

Graduate Students

Graduate students applying for readmission must complete a change of status application and should consult the Office of Engineering Student

Affairs for additional information. Students are only eligible if their withdrawal date is within one year of their readmission request. Students who were withdrawn from the school due to a dismissal are not eligible to apply for readmission.

Readmission requests should be submitted for the next commencing Fall or Spring term. Requests are not processed until April 1 for fall returns/ November 1 for spring returns.

Readmission is not guaranteed - such requests are reviewed by the student's academic department and the Office of Engineering Student Affairs. Students who fail to apply for readmission within the outlined one-year timeframe can only return to the school by submitting an application to the Office of Graduate Admissions. Submitting an admission application does not guarantee reinstatement and is subject to review by the Department and the School's admissions committees.

Directory of University Resources

Undergraduate Admissions

Undergraduate Admissions
212 Hamilton, MC 2807
212-854-2522
ugrad-ask@columbia.edu
undergrad.admissions.columbia.edu

Undergraduate Advising

James H. and Christine Turk Berick Center for Student Advising
403 Lerner Hall, MC 1201
212-854-6378
csa@columbia.edu
cc-seas.columbia.edu/csa

Undergraduate Student Life

505–515 Lerner, MC 2601
212-854-3612
cc-seas.columbia.edu/studentlife

Multicultural Affairs
505 Lerner, MC 2607
212-854-0720
cc-seas.columbia.edu/OMA

Intercultural Resource Center (IRC)
552 West 114th Street, MC 5755
212-854-0720
cc-seas.columbia.edu/multicultural/aboutus/irc.php

Residential Life
515 Lerner, MC 4205
212-854-3612
cc-seas.columbia.edu/reslife

Student Engagement
515 Lerner, MC 2601
212-854-3612
cc-seas.columbia.edu/engagement

Columbia College

208 Hamilton, MC 2805
212-854-2441
college.columbia.edu

Core Curriculum Program

Center for the Core Curriculum
202 Hamilton, MC 2811
212-854-2453
college.columbia.edu/core

Art Humanities
826 Schermerhorn, MC 5517
212-854-4505
arthum.college.columbia.edu

Music Humanities
621 Dodge, MC 1813
212-854-3825
college.columbia.edu/core/classes/mh.php

Contemporary Civilization
514 Fayerweather, MC 2811
212-854-5682
college.columbia.edu/core/conciv

Literature Humanities
202 Hamilton, MC 2811
212-854-2453
college.columbia.edu/core/lithum

Undergraduate Writing Program
310 Philosophy, MC 4995
212-854-3886
uwp@columbia.edu
college.columbia.edu/core/uwp

Engineering Student Affairs

Graduate Student Affairs
530 S. W. Mudd, MC 4708
212-854-6438
seas-gsa@columbia.edu
gradengineering.columbia.edu

Graduate Admissions
1220 S. W. Mudd, MC 4708
212-854-4688
gradmit@columbia.edu
gradengineering.columbia.edu/admissions

Columbia Video Network

540 S. W. Mudd, MC 4719
212-854-6447
info@cvn.columbia.edu
cvn.columbia.edu

Career Support

Center for Career Education (Undergraduates)
East Campus, Lower Level, MC 5727
212-854-5609
careereducation@columbia.edu
careereducation.columbia.edu

Graduate Career Placement Center
212-854-5379
seas-gcp@columbia.edu
career.engineering.columbia.edu

Computing Support Center

Client Services Help Desk
202 Philosophy, MC 4926
212-854-1919
askcuit@columbia.edu
cuit.columbia.edu

The Earl Hall Center

University Chaplain
Office: W710 Lerner
Mailing: 202 Earl Hall, MC 2008
212-854-6242, 212-854-1493
ouc.columbia.edu

Equal Opportunity and Affirmative Action

103 Low Library, MC 4333
212-854-5511
eoaa.columbia.edu

Student Services for Gender-Based and Sexual Misconduct
800 Watson Hall
212-854-1717
genderbasedmisconduct.columbia.edu

Financial Aid (Undergraduate)

Undergraduate Financial Aid and Educational Financing
618 Lerner
Mailing: 100 Hamilton, MC 2802
212-854-3711
ugrad-finaid@columbia.edu
cc-seas.financialaid.columbia.edu

Financial Aid (Graduate)

Student Financial Planning
615 Lerner, MC 2802
212-854-7040
sfp@columbia.edu
sfs.columbia.edu/financial-aid/graduate

Institutional Financial Aid
(Grants, Fellowships, Assistantships)
Office of Engineering Student Affairs
530 S. W. Mudd, MC 4708
212-854-6438

Global Engagement

Center for Undergraduate Global Engagement (UGE)
606 Kent Hall, MC 3948
212-854-2559
uge@columbia.edu
global.undergrad.columbia.edu

Columbia Health

General Info: 212-854-2284
health@columbia.edu
health.columbia.edu

CU-EMS (Ambulance)
212-854-5555

Insurance and Immunization Compliance
John Jay, 3rd Floor, MC 3601
Insurance Office: 212-854-3286
studentinsurance@columbia.edu
Immunization Compliance Office:
212-854-7210
immunizationcompliance@columbia.edu

Student Health Insurance Plan Administrators
Aetna Student Health
1-800-859-8471
www.aetnastudenthealth.com/columbia

Alice! Health Promotion
John Jay, 3rd Floor, MC 3601
212-854-5453
alice@columbia.edu

Counseling and Psychological Services
Lerner, 8th floor, MC 2606
24/7 Support: 212-854-2878

Disability Services
108A Wien Hall, MC 3711
Voice/TTY: 212-854-2388
disability@columbia.edu

Medical Services
John Jay Hall, 4th Floor
212-854-6655 (Gay Health Advocacy Project)
24/7 Support: 212-854-7426

Sexual Violence Response
Lerner, 7th floor
24/7 Support: 212-854-HELP (4357)
SVResponse@cumc.columbia.edu

Housing and Dining

Columbia Housing
118 Hartley, MC 3003
212-854-2946
housing@columbia.edu
housing.columbia.edu

Columbia Dining
118 Hartley, MC 3003
212-854-4076
dining@columbia.edu
dining.columbia.edu

Intercollegiate Athletics and Physical Education

Dodge Physical Fitness Center
212-854-7149
perec.columbia.edu

International Students and Scholars (ISSO)

Office: 524 Riverside Drive,
Ground Floor
Mailing: 2960 Broadway, MC 5724
212-854-3587
isso@columbia.edu
isso.columbia.edu

Libraries

Butler Library Information
535 W. 114th Street
212-854-7309
library.columbia.edu

Science & Engineering Library
401 Northwest Corner
212-851-2950

Math/Science Departments

Biological Sciences
600 Fairchild, MC 2402
212-854-4581

Chemistry
344 Havemeyer, MC 3178
212-854-2202

Earth and Environmental Sciences
106 Geoscience, Lamont-Doherty
Earth Observatory, 845-365-8550

Mathematics
410 Mathematics, MC 4426
212-854-2432

Physics
704 Pupin, MC 5255
212-853-1320

Statistics
1255 Amsterdam Avenue
Room 1005 SSW, MC 4690
212-851-2132

Ombuds Office

660 Schermerhorn Ext., MC 5558
212-854-1234
ombuds@columbia.edu
ombuds.columbia.edu

On Wednesdays the Ombuds Officer is at the Columbia Medical Center office:
154 Haven Ave. Room 412
212-304-7026

Professional Development and Leadership

530 S. W. Mudd, MC 4708
646-761-1694
seas-pdl@columbia.edu
pdl.engineering.columbia.edu

Public Safety

101 Low Library, MC 4301
212-854-2797 (24 hours a day)
publicsafety@columbia.edu
publicsafety.columbia.edu

Campus Emergencies:
212-854-5555

Escort Service:
212-854-SAFE (7233)

Registrar

210 Kent, MC 9202
registrar@columbia.edu
registrar.columbia.edu

Student Conduct and Community Standards

800 Watson Hall
612 West 115 Street, MC 2611
212-854-6872
CSSI@columbia.edu
cssi.columbia.edu

Student Service Center

210 Kent, MC 9202
212-854-4400
ssc@columbia.edu
ssc.columbia.edu

University Life

212-853-1628
UniversityLife@columbia.edu
universitylife.columbia.edu

Wellness

Engineering Graduate Wellness:
530 Mudd
212-854-6438
seas-wellness@columbia.edu
wellness.engineering.columbia.edu

Undergraduate Wellness:
Stephanie King
605 Lerner
212-853-1369
sk3296@columbia.edu

Campus Maps

Visit the Columbia University Life website to view the campus maps.

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APPLIED MATHEMATICS PROGRAM: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS[1]	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	**and** ODE (3)[2]
PHYSICS (three sequences, choose one)	UN1401 (3) — UN1402 (3) — UN1403 (3)[3] → Lab UN1494 (3)[4] UN1601 (3.5) — UN1602 (3.5) — UN2601 (3.5) UN2801 (4.5) — UN2802 (4.5) → Lab UN3081 (2)[4]			
CHEMISTRY/ BIOLOGY (choose one course)	CHEM UN1403 (3), or higher **or** BIOL UN2001 (4) **or** BIOL UN2005 (4), or higher			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
REQUIRED TECH ELECTIVES	(3) Student's choice			
COMPUTER SCIENCE	ENGI E1006 (3) any semester			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	E1102 (4) either semester			

[1] Students with advanced standing may start the calculus sequence at a higher level (see page 12 for placement), in which case students are suggested to add linear algebra in the first two years.

[2] Applied mathematics majors should satisfy their ODE requirement with the Mathematics Department (ordinarily MATH UN2030). Students who take APMA E2101 prior to declaring their major in applied mathematics may use this course to satisfy their ODE requirement with the permission of the faculty adviser.

[3] Transfer students who have not fulfilled the physics requirement prior to enrolling at Columbia may substitute this course with PHYS BC3001.

[4] Or a lab course in Astronomy, Astrophysics, Biology, or Chemistry.

APPLIED MATHEMATICS: THIRD AND FOURTH YEARS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES		APMA E3101 (3)[1] Linear algebra (Applied math, I) APMA E4204 (3)[1] Complex variables APMA E4300 (3) Introduction to numerical methods (Computational math, I) APMA E4901 (0) Seminar	APMA E3102 (3)[1] Partial differential equations (Applied math, II) APMA E4101 (3) Introduction to dynamical systems (Applied math, III) Course from Group A[2]	MATH GU4061 (3)[1] Modern analysis APMA E4903 (3 or 4) Seminar Course from Group B[2]	APMA E3900 (3)[3] Research Courses designated MATH, APMA, or STAT (3)
ELECTIVES	**TECH**[4]	3 points	3 points	3 points	6 points
	NONTECH	3 points	3 points	3 points	3 points
TOTAL POINTS		15	15	16	15

[1] MATH UN2010 or COMS W3561 may be substituted for APMA E3101; MATH UN3028 or APMA E4200 may be substituted for APMA E3102; MATH UN3007 may be substituted for APMA E4204; MATH UN2500 may be substituted for MATH GU4061.

[2] One course from Group A (Probability) and one course from Group B (Applied Probability/Statistics) required for graduation. Group A: IEOR E3658: Probability for engineers or IEOR E4150: Introduction to probability and statistics; STAT GU4203: Probability theory; MATH W4155: Probability theory. Group B: IEOR E3106: Stochastic systems and applications; IEOR E4106: Stochastic models; STAT GU4204: Statistical inference; STAT GU4207: Elementary stochastic processes; COMS W4771: Machine learning.

[3] With an adviser's permission, an approved technical elective may be substituted.

[4] Any course in science, math, or engineering at the 3000-level or above qualifies as a technical elective, except for required or elective courses in the minor in entrepreneurship and innovation which do not count as technical electives unless authorized by an adviser. Elective courses may be chosen from other departments in SEAS and Arts and Sciences, e.g., the Departments of Mechanical Engineering, Electrical Engineering, Mathematics, and Statistics.

APPLIED PHYSICS PROGRAM: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS[1]	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	**and** ODE (3)[2]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → UN1403 (3) → Lab UN1494 (3) UN1601 (3.5) → UN1602 (3.5) → UN2601 (3.5) UN2801 (4.5) → UN2802 (4.5) → Lab UN3081 (2)			
CHEMISTRY/ BIOLOGY (choose one course)	CHEM UN1403 (3), **or** higher **or** BIOL UN2001 (4) **or** BIOL UN2005 (4), or higher			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
REQUIRED TECH ELECTIVES	(3) Student's choice			
COMPUTER SCIENCE	ENGI E1006 (3)[3] any semester			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] Students with advanced standing may start the calculus sequence at a higher level (see page 12 for placement), in which case students are suggested to add linear algebra in the first two years.

[2] Applied physics majors should satisfy their ODE requirement with the Mathematics Department (ordinarily MATH UN2030). Students who take APMA E2101 prior to declaring their major in applied physics may use this course to satisfy their ODE requirement with the permission of the faculty adviser.

[3] With permission of faculty adviser, students demonstrating familiarity with computational mathematics using Python may waive course requirement and use 3 credits for another technical course.

APPLIED PHYSICS: THIRD AND FOURTH YEARS					
		SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES		APPH E3200 (3) Mechanics MSAE E3111 (3) Thermodynamics APMA E3101 (3)[1] Linear algebra APPH E4901 (1) Seminar	APPH E3100 (3) Intro. to quantum mechanics APPH E3300 (3) Applied electromagnetism APMA E3102 (3)[2] Partial differential equations	APPH E4300 (3) Applied electrodynamics APPH E4100 (3) Quantum physics Course in first AP area (3) APPH E4903 (2) Seminar	Course in second AP area (3) APPH E4018 (2) Laboratory
ELECTIVES	**TECH**[3]	3 points	3 points	2 points	9 points
	NONTECH OR TECH	3 points	3 points	3 points	3 points
TOTAL POINTS		16	15	16	17

[1] MATH UN3028 Partial differential equations or APMA E4200 Partial differential equations may be substituted for APMA E3102 Applied mathematics II: PDE'S

[2] MATH UN2010 Linear algebra may be substituted for APAM E3101 Linear algebra;

[3] They must include at least 2 points of laboratory courses. If PHYS UN3081 is taken as part of the first two years of the program, these technical electives need not include laboratory courses. Technical electives must be at the 3000-level or above unless prior approval is obtained.

BIOMEDICAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester		
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → UN1403 (3) UN1601 (3.5) → UN1602 (3.5) → UN2601 (3.5) UN2801 (4.5) → UN2802 (4.5)			
CHEMISTRY (three sequences, choose one)	UN1403 (4) → UN1404 (4) UN1500 (3) (**or** semester 1) UN1604 (4) → UN1507 (3) UN2045 (4) → UN2046 (4), UN1507 (3)			
UNIVERSITY WRITING	CC1010 (3) either semester			
COMPUTER SCIENCE	ENGI E1006 (3) (**or** semester II)			
PHYSICAL EDUCATION[1]	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING[1]	ENGI E1102 (4) either semester			
NONTECHNICAL REQUIREMENTS[1]	HUMA UN1121 (3) **or** UN1123 (3)		HUMA CC1001, COCI CC1101, **or** Global Core (3–4)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
TECHNICAL REQUIREMENTS			ELEN E1201 Intro. to EE (3.5) BIOL UN2005 Intro. to biology, I (4)	APMA E2101 (3) Intro. to applied math BIOL UN2006 (4) Intro to biology, II BMEN E2910 (3)[3] Intro to Biomedical Eng Design
TOTAL POINTS[2]	20	19	14.5	18

[1] Students can mix these requirements according to what is available.

[2] Estimations

[3] Required for the Class of 2029 and beyond. For program information before Fall 2026, please view the 2025-2026 Bulletin.

BIOMEDICAL ENGINEERING: THIRD AND FOURTH YEARS				
	SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES	BMEN E3010 (3) Biomedical eng., I BMEN E3810 (3) BME laboratory, I BMEN E4001 (3) Quantitative physiol., I BMEN E4110 (4) Biostat. for engineers	BMEN E3020 (3) Biomedical eng., II BMEN E3820 (3) BME laboratory, II BMEN E4002 (3) Quantitative physiol., II Technical elective (3)[1]	BMEN E3910 (4) BME design, I Technical elective (3)[1] Technical elective (3)[1] Technical elective (3)[1]	BMEN E3920 (4) BME design, II Technical elective (3)[1] Technical elective (3)[11]
NONTECH ELECTIVES	3 points	3 points	3 points	
TOTAL POINTS	16	15	16	10

[1] Four of seven technical electives must have engineering content, and two of them must be from the Biomedical Engineering Department.

CHEMICAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS				
	SEMESTER I	**SEMESTER II**	**SEMESTER III**	**SEMESTER IV**
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0)	MATH UN2030 (3) ODE **or** APMA E2101 (3)
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → Lab UN1494 (3) UN1601 (3.5) → UN1602 (3.5) UN2801 (4.5) → UN2802 (4.5) → Lab UN3081 (2)			
CHEMISTRY (three sequences, choose one)	UN1403 (4) **and** Lab UN1500 (3) → UN1404 (4) → UN2443 (4) UN1604 (4) → UN1507 (3) UN2045 (4) → UN2046 (4) **and** Lab UN1507 (3)			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES			One core humanities elective (3–4 points)[1]	Three core humanities electives (11 points)[1]
CHEM. ENG. REQUIREMENT	CHEN E1000 (1) Chemical engineering for humanity		CHEN E2100 (3) Material and energy balances	CHEN E3020 (3) Analysis of chem. eng. problems
COMPUTER SCIENCE		ENGI E1006 (3)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			
TOTAL POINTS[2]	17	17	17	17

[1] Four core humanities electives should be taken as follows: In Semester III, HUMA CC1001 or COCI CC1101 (4) or any initial course in one of the Global Core sequences offered by the College (3–4); in Semester IV, HUMA CC1002 or COCI CC1102 (4) or ASCM UN2002 or the second course in the Global Core sequence elected in Semester III (3–4); also in Semester IV, ECON UN1105 (4) with UN1155 recitation (0) and either HUMA UN1121 or UN1123 (3).

[2] Taking the first track in each row and E1102 in Semester II.

CHEMICAL ENGINEERING: THIRD AND FOURTH YEARS					
		SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
MATHEMATICS			MATH elective (3)[1]		
PHYSICAL EDUCATION[4]			UN1001 (1)		UN1002 (1)
REQUIRED COURSES		CHEN E3110 (3) Transp. phenomena, I CHEE E3010 (3) Principles of chem. eng. thermodynamics I	CHEN E3230 (3) Reaction kinetics and reactor design CHEN E4140 (3) Eng. separations processes	CHEN E4500 (4) Process and product design, I	
REQUIRED LABS		Adv natural science lab (3)[2]		CHEN E4300 (3) Chem. eng. process control and safety	CHEN E3810 (3) Chem. eng. lab
REQUIRED ELECTIVES	**NONTECH**	3 points	3 points	3 points	
	TECH[3]	3 points	3 points	6 points	9 points
TOTAL POINTS (normal track)		15	16	16	13

[1] Math elective options include APMA E3101, MATH UN2010, APMA E3102, APMA E4150, APMA E4300, STAT GU4001, or another course approved by the major adviser.

[2] Total of 3 points required. Choose from CHEM UN2493 (1.5), CHEM UN2496 (1.5), CHEM UN2543 (3), CHEM UN2545 (3), CHEM UN3085(3), BIOL 2501 (3), EEEB 3015 (3), or another course approved by the major adviser.

[3] See the bulletin text for technical elective requirements.

[4] May be taken in any semester.

CIVIL ENGINEERING PROGRAM: FIRST AND SECOND YEARS				
	SEMESTER I	**SEMESTER II**	**SEMESTER III**	**SEMESTER IV**
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0)	APMA E2101 (3) Intro. to applied math.
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → Lab UN1494 (3) **or** chem. lab UN1601 (3.5) → UN1602 (3.5) UN2801 (4.5) → UN2802 (4.5) → Lab UN3081 (2)			
CHEMISTRY	one-semester lecture (3–4): UN1403 **or** UN1404 **or** UN2045 **or** UN1604 Chem lab UN1500 (3) either semester **or** physics lab			
GEOLOGY	EESC UN2100 (4.5), UN2200 (4.5), UN2300 (4.5), or equivalent			
MECHANICS	ENME E3105 (4) either semester			
CIVIL ENGINEERING	CIEN E3000 (3) (Spring semester; recommended but not required)			CIEN E3004 (3) Urban Infrastructure systems
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
COMPUTER SCIENCE	Computer Language: ENGI E1006 (3) or equivalent (any semester)			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

CIVIL ENGINEERING: THIRD AND FOURTH YEARS					
		SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
CORE REQUIRED COURSES		ENME E3113 (3) Mech. of solids ENME E3161 (4) Fluid mech. CIEN E3141 (4) Soil mech.	CIEN E3125 (3) Structural design CIEN E3126 (1) Computer-aided struct. design	CIEE E3111 (3.5) Uncertainty and risk in civil infrastructure systems CIEN E3129 (3) Proj. mgmt. for construction	CIEN E3128 (4) Design projects
CONCENTRATIONS	**GEOTECH ENG. (GE) OR STRUCT. ENG. (SE)**		ENME E3106 (3) Dynamics and vibrations ENME E3114 (4) Exper. mech. of materials CIEN E3121 (3) Struct. analysis	ENME E3332 (3) A first course in finite elements CIEN E3127 (3) Struct. design projects (SE) **or** CIEN E4241 (3) Geotech. eng. fund. (GE)	
	TECH ELECTIVES	3 points		3 points	9 points
	CIVIL ENG. AND CONSTR. MGMT.		ENME E3114 (4) Exper. mech. of materials CIEN E3121 (3) Struct. analysis **or** EACE E3250 (3) Hydrosystems eng.	CIEN E4133 (3) Capital facility planning and financing CIEN E3127 (3) Struct. design projects **or** CIEN E4241 (3) Geotech. eng. fund.	CIEN E4131 (3) Princ. of constr. tech.
	TECH ELECTIVES	6 points		3 points	6 points
	WATER RES./ ENVIRON. ENG.		EACE E3255 (3) Environ. control / pollution EACE E3250 (3) Hydrosystems eng. CIEN E3303 (1) Independent studies	EAEE E4350 (3) Plan./mgmt. of urban hydro systems.	EACE E4163 (3) Sust. water treat. / reuse EAEE E4006 (3) Field methods for environ. eng.
	TECH ELECTIVES	6 points		3 points	6 points
NONTECH ELECTIVES		3 points	3 points	3 points	
TOTAL POINTS		13	21	18.5	13

COMPUTER ENGINEERING PROGRAM: FIRST AND SECOND YEARS
EARLY-STARTING STUDENTS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	
				APMA E2101 (3)[1]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3)		→ Lab UN1494 (3) **or** chem. lab UN1500 (3)	
	UN1601 (3.5) → UN1602 (3.5)		→ Lab UN1494 (3) **or** chem. lab UN1500 (3)	
	UN2801 (4.5) → UN2802 (4.5)		→ Lab UN3081 (2) **or** chem. lab UN1500 (3)	
CHEMISTRY	one-semester lecture (3–4) UN1403 **or** UN1404 or UN2045 **or** UN1604 Lab UN1500 (3) either semester **or** physics lab UN1494 (3)			
CORE REQUIRED COURSES	ELEN E1201 (3.5) Intro. to elec. eng. (either semester)		ELEN E3801 (3.5) Signals and systems	COMS W3134 (3) **or** W3137 (4) Data structures CSEE W3827 (3) Fund. of computer sys.
REQUIRED LABS			ELEN E3084 (1) Signals and systems lab	ELEN E3082 (1) Digital systems lab
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES[2]			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
COMPUTER SCIENCE	ENGI E1006 (3)	COMS W1004 (3) **or** W1007 (3)	COMS W3203 (3) Discrete math.	
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] APMA E2101 may be replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101, or MATH UN2010, or COMS W3251.

[2] Some of these courses can be postponed to the junior or senior year to make room for taking the required core computer engineering courses.

COMPUTER ENGINEERING: THIRD AND FOURTH YEARS EARLY-STARTING STUDENTS					
		SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
CORE REQUIRED COURSES		IEOR E3658 (3)[1] Probability COMS W3157 (4) Advanced programming ELEN E3201 (3.5) Circuit analysis	ELEN E3331 (3) Electronic circuits COMS W3261 (3) Computer sci. theory	COMS W4118 (3) Operating systems **or** COMS W4115 (3) Programming lang.	
			(Choose 3 of 6) CSEE W4119 (3) Computer networks, EECS E4321 (3) Digital VLSI circuits, CSEE W4823 (3) Advanced logic design, CSEE W4824 (3) Computer architecture, CSEE W4840 (3) Embedded systems, CSEE W4868 (3) System-on-chip platforms		
REQUIRED LABS		ELEN E3081 (1) Circuit analysis lab	ELEN E3083 (1) Electronic circuits lab		
ELECTIVES	**TECH[2]**	15 points required; see details within the text			
	NONTECH	Complete 27-point requirement; see page 9 (27-Point Nontechnical Requirement)			
TOTAL POINTS[3]		17.5	17	15	15

For a discussion about programming languages used in the program, please see compeng.columbia.edu.

[1] SIEO W3600, STAT GU4203, and STAT GU4001 can be used instead of IEOR E3658, but W3600 and GU4001 may not provide enough probability background for elective courses such as ELEN E3701. Students completing an economics minor who want such a background can take IEOR E3658 and augment it with IEOR E4307.

[2] The total points of technical electives is reduced to 12 if APMA E2101 has been replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101 or MATH UN2010, or COMS W3251. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can apply for this waiver, but the courses must have been at an advanced level for this to be considered.

[3] "Total points" assumes that 20 points of nontechnical electives and other courses are included.

COMPUTER ENGINEERING PROGRAM: FIRST AND SECOND YEARS
LATE-STARTING STUDENTS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	APMA E2101 (3)[1]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → Lab UN1494 (3) **or** chem. lab UN1500 (3) UN1601 (3.5) → UN1602 (3.5) → Lab UN1494 (3) **or** chem. lab UN1500 (3) UN2801 (4.5) → UN2802 (4.5) → Lab UN3081 (2) **or** chem. lab UN1500 (3)			
CHEMISTRY	one-semester lecture (3–4) UN1403 **or** UN1404 **or** UN2045 **or** UN1604 Lab UN1500 (3) either semester **or** physics lab UN1494 (3)			
CORE REQUIRED COURSES	ELEN E1201 (3.5)[2] Intro. to elec. eng. (either semester)			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
COMPUTER SCIENCE	ENGI E1006 (3)	COMS W1004 (3) **or** W1007 (3)	W3203 (3) Discrete math.	
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] APMA E2101 may be replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101, or MATH UN2010, or COMS W3251.

[2] Transfer and combined-plan students are expected to have completed the equivalent of the first- and second-year program listed above before starting their junior year. Note that this includes some background in discrete math (see COMS W3203) and electronic circuits (see ELEN E1201). Transfer and combined-plan students are also expected to be familiar with Java before they start their junior year. If students must take the one-point Java course (COMS W3101-03) junior year, prerequisite constraints make it difficult to complete the remaining computer engineering program by the end of the senior year.

COMPUTER ENGINEERING: THIRD AND FOURTH YEARS LATE-STARTING STUDENTS					
		SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
CORE REQUIRED COURSES		IEOR E3658 (3)[1] Probability COMS W3134 (3) **or** W3137 (4) Data structures ELEN E3201 (3.5) Circuit analysis ELEN E3801 (3.5) Signals and systems	COMS W3157 (4) Advanced programming ELEN E3331 (3) Electronic circuits COMS W3261 (3)[2] Models of comp. CSEE W3827 (3) Fund. of computer systems	COMS W4118 (3) Operating systems **or** COMS W4115 (3) Programming lang. (Choose 3 of 6) CSEE W4119 (3) Computer networks, EECS E4321 (3) Digital VLSI circuits, CSEE W4823 (3) Advanced logic design, CSEE W4824 (3) Computer architecture, CSEE W4840 (3) Embedded systems, CSEE W4868 (3) System-on-chip platforms	
REQUIRED LABS		ELEN E3081 (1)[3] Circuit analysis lab ELEN E3084 (1)[3] Signals and systems lab	ELEN E3083 (1)[3] Electronic circuits lab ELEN E3082 (1)[3] Digital systems lab		
ELECTIVES	**TECH[4]**	15 points required; see details within the text			
	NONTECH	Complete 27-point requirement; see page 9 (27-Point Nontechnical Requirement)			
TOTAL POINTS[5]		15	18	15	18

For a discussion about programming languages used in the program, please see compeng.columbia.edu.

[1] SIEO W3600, STAT GU4203, and STAT GU4001 can be used instead of IEOR E3658, but W3600 and GU4001 may not provide enough probability background for elective courses such as ELEN E3701. Students completing an economics minor who want such a background can take IEOR E3658 and augment it with IEOR E4307.

[2] COMS W3261 can be taken one semester later than pictured.

[3] If possible, ELEN E3081 and ELEN E3084 should be taken along with ELEN E3201 and ELEN 3801, respectively, and ELEN E3083 and ELEN E3082 taken with ELEN E3331 and CSEE W3827 respectively.

[4] The total points of technical electives is reduced to 12 if APMA E2101 has been replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101 or MATH UN2010, or COMS W3251. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can apply for this waiver, but the courses must have been at an advanced level for this to be considered.

[5] Assuming technical electives taken Semesters VII and VIII, and 9 points of nontechnical electives taken Semesters VI, VII, and VIII.

COMPUTER SCIENCE PROGRAM: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0)	
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) UN1601 (3.5) → UN1602 (3.5) UN2801 (4.5) → UN2802 (4.5)		Chemistry or physics lab: PHYS UN1494 (3) **or** PHYS UN3081 (2) **or** CHEM UN1500 (3) **or** CHEM UN1507 (3) **or** CHEM UN3085 (4)	
CHEMISTRY/ BIOLOGY (choose one course)	CHEM UN1403 (3) **or** higher **or** EEEB UN2001 (4) **or** UN2005 (4) **or** higher either semester			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES	ECON UN1105 (4) **and** UN1105 recitation (0) any semester			
			HUMA CC1001 **or** COCI CC1101 **or** Major Cultures (3–4)	HUMA CC1002 **or** COCI CC1102 **or** Major Cultures (3–4)
				HUMA UN1121 **or** UN1123 (3)
REQUIRED TECH ELECTIVES	ENGI E1006 Computing for EAS (3) either semester			
COMPUTER SCIENCE	COMS W1004 (3) **or** COMS W1007 (3) Intro to computer science		COMS W3134 (3) **or** COMS W3137 (4) Data structures **and** COMS W3203 (4) Discrete math	COMS W3157 (4) Adv. programming **and** linear algebra or probability/statistics requirement (see list of accepted courses)1
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

COMPUTER SCIENCE: THIRD AND FOURTH YEARS					
		SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES		CSEE W3827 (3) Fund. of comp. systems **and** COMS W3261 (3) Computer sci. theory **and** Linear Algebra **or** Probability/Statistics requirement (see list of accepted courses)			
ELECTIVES	**NONTECH**		3 points	6 points	3 points
	TECH	6 points	12 points	9 points	9 points
TOTAL POINTS		15	15	15	12

EARTH AND ENVIRONMENTAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3) **or** MATH UN1207 (4)	MATH UN1102 (3) MATH UN1208 (4)	APMA E2000 (4) and E2001 (0)	APMA E2101 (3) MATH UN2030 (3) ODE
PHYSICS	UN1401 (3) **or** UN1601 (3.5) **or** UN2801 (4.5)	UN1402 (3) UN1602 (3.5) UN2802 (4.5)	CHEM UN2443 (3.5) **or** PHYS UN1403 (3) **or** PHYS UN2601 (3.5) **or** BIOL UN2005 (4)	EACE E4252 (3) Foundations of environmental engineering
CHEMISTRY	UN1403 (3.5) **and** Lab UN1500 (3) either semester **or** UN1604 (3.5) **or** UN2045 (3.5)	UN1404 (3.5) UN1507 (3) UN2046 (3.5) **and** Lab UN1507 (3)		
REQUIRED NONTECHNICAL ELECTIVES	ENGL CC1010 (3)		HUMA CC1001, COCI CC1101, **or** Global Core (3–4)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0) HUMA UN1121 **or** UN1123 (3)
REQUIRED PROFESSIONAL AND TECHNICAL ELECTIVES			EESC UN2100 (4.5) **or** EESC UN2200 (4.5) EAEE E2100 (3) A better planet by design	STAT GU4001 (3)
COMPUTER SCIENCE	ENGI E1006 (3) any semester			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

EARTH AND ENVIRONMENTAL ENGINEERING: THIRD AND FOURTH YEARS				
	SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES	EAEE E3103 (3) Energy, minerals, and material systems	EAEE E4003 (3) Aquatic chemistry	EAEE E3998 (2) Undergraduate design project	EACE E3255 (3) Environmental control and pollution reduction systems
	EAEE E3200 (3) Applied transport and chemical rate phenomena	EACE E3250 (3) Hydrosystems engineering	EAEE E4160 (3) Solid and hazardous waste management	EAEE E3999 (2) Undergraduate design project
	CHEE E3010 (3) Principles of chemical engineering thermodynamics	EAEE E3800 (4) Earth and environmental engineering lab, I EAEE E3901 (3) Environmental microbiology		
TECHNICAL ELECTIVES		3 points	6 points	9 points
NONTECHNICAL ELECTIVES	3 points		3 points	6 points
TOTAL POINTS	12	16	14	20

ELECTRICAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS
EARLY-STARTING STUDENTS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	**and** APMA E2101 (3)[1]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) UN1601 (3.5) → UN1602 (3.5) UN2801 (4.5) → UN2802 (4.5)			
CHEMISTRY	one-semester lecture (3–4) UN1403 **or** UN1404 **or** UN2045 **or** UN1604			
CORE REQUIRED COURSES	ELEN E1201 (3.5) Introduction to electrical engineering (either semester)		ELEN E3201 (3.5) Circuit analysis ELEN E3801 (3.5) Signals and systems	ELEN E3331 (3) Electronic circuits CSEE E3827 (3) Fund. of computer sys.
REQUIRED LABS			ELEN E3081 (1)[2] Circuit analysis lab ELEN E3084 (1)[2] Signals and systems lab	ELEN E3083 (1)[2] Electronic circuits lab ELEN E3082 (1)[2] Digital systems lab
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES	HUMA CC1001, COCI CC1101, **or** Global Core (3–4); HUMA UN1121 **or** UN1123 (3); HUMA CC1002, COCI CC1102, **or** Global Core (3–4); ECON UN1105 (4) **and** UN1155 recitation (0); some of these courses can be postponed to the junior or senior year, to make room for taking the above electrical engineering courses.			
COMPUTER SCIENCE	ENGI E1006 (3) either semester[3]			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] APMA E2101 may be replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101 or MATH UN2010.
[2] If possible, these labs should be taken along with their corresponding lecture courses.
[3] ENGI E1006 may not be offered every semester. See ee.columbia.edu for more discussion about the Computer Science sequences.

ELECTRICAL ENGINEERING: THIRD AND FOURTH YEARS
EARLY-STARTING STUDENTS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
PHYSICS (sequences continued)		UN1403 (3) UN2601 (3.5) Lab W3081 (2)	Lab UN1494 (3)[1]		
EE CORE REQUIRED COURSES		ELEN E3106 (3.5) Solid-state devices and materials	ELEN E3401 (4) Electromagnetics ELEN E3701 (3)[2] Intro. to communication systems **or** CSEE W4119 (3)[2] Computer networks		
EE REQUIRED LABS				ELEN E3043 (3) Solid state, microwave, and fiber optics lab ELEN E3399 (1) EE practice	ELEN E3390 (3)[3] Capstone design course
OTHER REQUIRED COURSES		IEOR E3658 **or** STAT GU4203[4]; **and** COMS W3136 (**or** W3134 or W3137)[5] (some of these courses *are not* offered both semesters. Students with an adequate background can take some of these courses in the sophomore year)			
ELECTIVES	**EE DEPTH TECH**	At least two technical electives in one depth area. The four depth areas are (a) photonics, solid-state devices, and electromagnetics; (b) circuits and electronics; (c) signals and systems; and (d) communications and networking (for details, see ee.columbia.edu)			
	BREADTH TECH	(at least 6 points total) At least two technical electives outside the chosen depth area; must be courses with significant engineering content (see ee.columbia.edu)			
	OTHER TECH	Additional technical electives (consisting of more depth or breadth courses, or further options listed at ee.columbia.edu/ee-undergraduate-program) as required to bring the total points of technical electives to 18[6]			
	NONTECH	Complete 27-point requirement; see page 9 (27-Point Nontechnical Requirement)			
TOTAL POINTS[7]		16.5	17	16	18

[1] Chemistry lab (CHEM UN1500) may be substituted for physics lab, although this is not generally recommended.

[2] These courses can be taken in the sophomore year if the prerequisites/corequisites are satisfied.

[3] The capstone design course provides ELEN majors with a "culminating design experience." As such, it should be taken near the end of the program and involve a project that draws on material from a range of courses. If special arrangements are made in ELEN E3399, it is possible to use courses such as ELEN E3998, E4350, E4998, EECS E4340, or CSEE W4840 in place of ELEN E3390.

[4] SIEO W3600 and STAT GU4001 cannot generally be used to replace IEOR E3658 or STAT GU4203.

[5] Students who plan to minor in Computer Science should choose COMS W3134 or W3137.

[6] The total points of technical electives is reduced to 15 if APMA E2101 has been replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101 or MATH UN2010. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can also apply for this waiver, but the courses must have been at an advanced level for this to be considered.

[7] "Total points" assumes that 20 points of nontechnical electives and other courses are included.

ELECTRICAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS
LATE-STARTING STUDENTS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101(3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	**and** APMA E2101 (3)[1]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → UN1403 (3) → Lab UN1494 (3)[2] UN1601 (3.5) → UN1602 (3.5) → UN2601 (3.5) UN2801 (4.5) → UN2802 (4.5) → Lab UN3081 (2)			
CHEMISTRY	one-semester lecture (3–4) UN1403 **or** UN1404 **or** UN2045 **or** UN1604			
ELECTRICAL ENGINEERING	ELEN E1201 (3.5) either semester[3]			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
COMPUTER SCIENCE	ENGI E1006 (3) any semester[4]			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] APMA E2101 may be replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101 or MATH UN2010.
[2] Chemistry lab (CHEM UN1500) may be substituted for physics lab, although this is not generally recommended.
[3] Transfer students and 3-2 Combined Plan students who have not taken ELEN E1201 prior to the junior year are expected to have taken a roughly equivalent course when they start ELEN E3201.
[4] ENGI E1006 may not be offered every semester. See ee.columbia.edu for more discussion about the Computer Science sequences.

ELECTRICAL ENGINEERING: THIRD AND FOURTH YEARS
LATE-STARTING STUDENTS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
EE CORE REQUIRED COURSES		ELEN E3106 (3.5) Solid-state devices and materials ELEN E3201 (3.5) Circuit analysis ELEN E3801 (3.5) Signals and systems	CSEE W3827(3) Fund. of computer sys. ELEN E3331 (3) Electronic circuits ELEN E3401 (4) Electromagnetics ELEN E3701 (3) Intro. to communication systems **or** CSEE W4119 (3) Computer networks		
EE REQUIRED LABS		ELEN E3081 (1)[1] Circuit analysis lab ELEN E3084 (1)[1] Signals and systems lab	ELEN E3083 (1)[1] Electronic circuits lab ELEN E3082 (1)[1] Digital systems lab	ELEN E3043 (3) Solid state, microwave, and fiber optics lab ELEN E3399 (1) EE practice	ELEN E3390 (3)[2] Capstone design course
OTHER REQUIRED COURSES		IEOR E3658 **or** STAT GU4203[3]; **and** COMS W3136 (**or** W3134 or W3137)[4] (Some of these courses are *not* offered both semesters)			
ELECTIVES	**EE DEPTH TECH**	At least two technical electives in one depth area. The four depth areas are (a) photonics, solid-state devices, and electromagnetics; (b) circuits and electronics; (c) signals and systems; and (d) communications and networking. (For details, see ee.columbia.edu.)			
	BREADTH TECH	(at least 6 points total) At least two technical electives outside the chosen depth area; must be courses with significant engineering content (see ee.columbia.edu)			
	OTHER TECH	Additional technical electives (consisting of more depth or breadth courses, or further options listed at ee.columbia.edu/ee-undergraduate-program) as required to bring the total points of technical electives to 18[5]			
	NONTECH	Complete 27-point requirement; see page 9 (27-Point Nontechnical Requirement)			
TOTAL POINTS[6]		15.5	18	16	18

Note: This chart shows one possible schedule for a student who takes most of their major program in the final two years. Please refer to the previous chart for a recommended earlier start.

[1] If possible, these labs should be taken along with their corresponding lecture courses.

[2] The capstone design course provides ELEN majors with a "culminating design experience." As such, it should be taken near the end of the program and involve a project that draws on material from a range of courses. If special arrangements are made in ELEN E3399, it is possible to use courses such as ELEN E3998, E4350, E4998, EECS E4340, or CSEE W4840 in place of ELEN E3390.

[3] SIEO W3600 and STAT GU4001 cannot generally be used to replace IEOR E3658 or STAT GU4203.

[4] Students who plan to minor in Computer Science should choose COMS W3134 or W3137.

[5] The total points of technical electives is reduced to 15 if APMA E2101 has been replaced by MATH UN2030 (formerly MATH E1210) and either APMA E3101 or MATH UN2010. Combined-plan students with good grades in separate, advanced courses in linear algebra and ODEs can also apply for this waiver, but the courses must have been at an advanced level for this to be considered.

[6] "Total points" assumes that 9 points of nontechnical electives are included.

INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH PROGRAM[1]: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0)	Linear algebra (3)[2]
PHYSICS (three sequences, choose one)	UN1401 (3) and UN1402 (3) UN1601 (3.5) and UN1602 (3.5) UN2801 (4.5) and UN2802 (4.5)		Chemistry or physics lab: PHYS UN1494 (3) **or** PHYS UN3081 (2) **or** CHEM UN1500 (3) **or** CHEM UN1507 (3) **or** CHEM UN3085 (4)	
CHEMISTRY (choose one course)	UN1403 (3) **or** UN1404 (3) **or** UN1604 (3.5) **or** UN2045 (3.5)			
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL ELECTIVES	ECON UN1105 (4) **and** UN1155 recitation (0) either semester		HUMA CC1001, COCI CC1101, **or** Global core (3–4)	HUMA CC1002, COCI CC1102, **or** Global core (3–4)
			HUMA UN1121 **or** UN1123 (3) either semester	
FIRST- AND SECOND-YEAR DEPT. REQUIREMENTS			IEOR E3658 (3) either semester	
COMPUTER SCIENCE	ENGI E1006 (3) in either semester[3]			IEOR E2000 (3)[4]
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] This includes all undergraduate programs within the Department of Industrial Engineering and Operations Research.
[2] The linear algebra requirement may be filled by either MATH UN2010 or APMA E3101 or COMS W3251.
[3] ENGI E1006 can be replaced by COMS W1004 or COMS W1007.
[4] IEOR E2000 can be replaced by COMS W3134 and COMS W4111. Students cannot get credit for IEOR E2000 if IEOR E2000 is taken after COMS W3134 and COMS W4111.

INDUSTRIAL ENGINEERING: THIRD AND FOURTH YEARS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES[1]		IEOR E3106 (3) Stochastic systems and applications IEOR E3608 (3) Foundations of optimization IEOR E4307 (3) Statistics and data analysis	IEOR E3402 (4) Production & inventory planning IEOR E3404 (4) Simulation IEOR E3609 (3) Advanced optimization	IEME E4200 (3) Human-centered design and innovation	IEOR E4405 (3) Scheduling
ELECTIVES	**NONTECH**	Students must complete the 27-point requirement. Please refer to page 9.			
	TECH[2]	15 points			
	MANAGEMENT[3]	3 points			
TOTAL ESTIMATED POINTS[4]		15	14	15	12

[1] Taking required courses later than the prescribed semester is not permitted.
[2] 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[3] 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[4] Students must complete a minimum of 128 points to graduate.

OPERATIONS RESEARCH: THIRD AND FOURTH YEARS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES[1]		IEOR E3106 (3) Stochastic systems and applications IEOR E3608 (3) Foundation of optimization IEOR E4307 (3) Statistics and data analysis	IEOR E3402 (4) Production & inventory planning IEOR E3404 (4) Simulation IEOR E3609 (3) Advanced optimization	IEOR E4407 (3) Game theoretic models of operations.	IEOR E4405 (3) Scheduling
ELECTIVES	**NONTECH**	Students must complete the 27-point requirement. Please refer to page 9.			
	TECH[2]	15 points			
	MANAGEMENT[3]	3 points			
TOTAL ESTIMATED POINTS[4]		15	14	15	12

[1] Taking required courses later than the prescribed semester is not permitted.
[2] 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[3] 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[4] Students must complete a minimum of 128 points to graduate.

OPERATIONS RESEARCH: ANALYTICS: THIRD AND FOURTH YEARS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES[1]		IEOR E3106 (3) Stochastic systems and applications IEOR E3608 (3) Foundation of optimization IEOR E4307 (3) Statistics and data analysis	IEOR E3404 (4) Simulation IEOR E3609 (3) Advanced optimization IEOR E4650 (3) Business analytics ORCS E4201 (4) Policy for privacy technologies		
ELECTIVES	NONTECH	Students must complete the 27-point requirement. Please refer to page 9.			
	TECH[2]	15 points			
	MANAGEMENT[3]	3 points			
TOTAL ESTIMATED POINTS[4]		15	13	15	12

[1] Taking required courses later than the prescribed semester is not permitted.
[2] 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[3] 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[4] Students must complete a minimum of 128 points to graduate.

OPERATIONS RESEARCH: ENGINEERING MANAGEMENT SYSTEMS: THIRD AND FOURTH YEARS

		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES[1]		IEOR E3106 (3) Stochastic systems and applications IEOR E3608 (3) Foundations of optimization IEOR E4307 (3) Statistics and data analysis	IEOR E3402 (4) Production & inventory planning IEOR E3404 (4) Simulation IEOR E3609 (3) Advanced optimization	IEOR E4003 (3) Corporate finance for eng.	IEOR E4998 (4) Managing technological innovations
ELECTIVES	NONTECH	Students must complete the 27-point requirement. Please refer to page 9.			
	TECH[2]	12 points			
	MANAGEMENT[3]	6 points			
TOTAL ESTIMATED POINTS[4]		15	14	15	12

[1] Taking required courses later than the prescribed semester is not permitted.
[2] 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[3] 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[4] Students must complete a minimum of 128 points to graduate.

OPERATIONS RESEARCH: FINANCIAL ENGINEERING: THIRD AND FOURTH YEARS					
		SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES[1]		IEOR E3106 (3) Stochastic systems and applications IEOR E3608 (3) Foundations of optimization IEOR E4003 (3) Corporate finance for eng IEOR E4307 (3) Statistics and data analysis	IEOR E3404 (4) Simulation IEOR E3609 (3) Advanced optimization IEOR E4700 (3) Intro. to FE	IEOR E4500 (3) Applications prog. for FE	
ELECTIVES	**NONTECH**	Students must complete the 27-point requirement. Please refer to page 9.			
	TECH[2]	15 points			
	MANAGEMENT[2]	3 points			
TOTAL ESTIMATED POINTS[4]		15	13	15	12

[1] Taking required courses later than the prescribed semester is not permitted.
[2] 15 points total. At least 6 points need to be at least 3000 level with the prefix IEOR, ORCS, or CSOR. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[3] 3 points total. Cannot double-count non-technical electives. The complete list is available at ieor.columbia.edu/undergraduate/electives.
[4] Students must complete a minimum of 128 points to graduate.

MATERIALS SCIENCE PROGRAM: FIRST AND SECOND YEARS				
	SEMESTER I	**SEMESTER II**	**SEMESTER III**	**SEMESTER IV**
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	**and** APMA E2101 (3)
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) UN1601 (3.5) → UN1602 (3.5) UN2801 (4.5) → UN2802 (4.5)		→ UN1403 (3) → UN2601 (3.5)	
CHEMISTRY	UN1403 (4) **or** UN1404 (4) **or** UN2045 (4) **or** UN1604 (4)			
REQUIRED LAB	PHYS UN1493 (3) **or** UN3081 (2) **or** CHEM UN1500 (3) **or** UN1507 (3) **or** UN3085 (4)			
UNIVERSITY WRITING	CC1010 (3) either semester			
NONTECHNICAL REQUIREMENTS[1]	HUMA CC1001, COCI CC1101, **or** Global Core (3–4); HUMA UN1121 (3) **or** UN1123 (3); HUMA CC1002, COCI CC1102, **or** Global Core (3–4); ECON UN1105 (4) **and** UN1155 recitation (0)			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			
COMPUTER SCIENCE	ENGI E1006 (3) any semester			
TECHNICAL REQUIREMENTS			MSAE E3010 (3) Foundations of materials science	

[1] Some nontech courses can be postponed to junior or senior year, so lab courses MSAE E3012 and MSAE E3013 can be taken along with MSAE E3010.

MATERIALS SCIENCE: THIRD AND FOURTH YEARS				
	SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES	MSAE E3012 (3)[1] Laboratory in mat. sci. I MSAE E3100 (3) Crystallography MSAE E4102 (3) Synthesis and processing of materials	MSAE E3013 (3)[1] Laboratory in mat. sci. II MSAE E3201 (3) Materials thermodynamics and phase diagrams MSAE E4250 (3) Ceramics and composites	MSAE E3156 (2) Design project MSAE E4206 (3) Electronic and magnetic properties of solids MSAE Elective (3)[2] 3000-, 4000-, 6000- level	MSAE E3157 (2) Design project MSAE E4202 (3) Kinetics of transformations in materials MSAE E4215 (3) Mechanical behavior of materials
TECHNICAL ELECTIVES	Students must complete 27 units of Technical Electives.			
NONTECHNICAL ELECTIVES	Students must complete the 27-point requirement.[3]			

[1] Motivated students are highly encouraged to take MSAE E3012 and MSAE E3103 in the sophomore year to obtain practical understanding of material covered in the junior and senior years.
[2] MSAE E4999 is excluded from the courses that may be applied to MSAE major core requirement.
[3] See page 9 or seas.columbia.edu for details (administered by the advising dean).

MATERIALS SCIENCE: THIRD AND FOURTH YEARS (TRANSFER STUDENTS)				
	SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES	MSAE E3010 (3) Foundations of materials science and engineering MSAE E3012 (3) Laboratory in materials science, I MSAE E4102 (3) Synthesis and processing of materials	MSAE E3013 (3) Laboratory in materials science, II MSAE E3201 (3) Materials thermodynamics and phase diagrams MSAE E4250 (3) Ceramics and composites	MSAE E3156 (2) Design project MSAE E3100 (3) Crystallography MSAE E4200 (3) Theory of crystalline materials MSAE E4206 (3) Electronic and magnetic properties of solids	MSAE E3157 (2) Design project MSAE E4202 (3) Kinetics of transformations in materials MSAE E4215 (3) Mechanical behavior of materials
TECHNICAL ELECTIVES	Students must complete 27 or 24 units of Technical Electives.[1]			
NONTECHNICAL ELECTIVES	Students must complete the 27-point requirement.[2]			

[1] Students transferring from another SEAS department into the Materials Science program in the junior year must complete the 27 units of technical elective requirement; Combined Plan 3/2 transfer students must complete 24 units of technical electives.
[3] Students transferring from another SEAS department into the Materials Science program in the junior year must complete the 27-point requirement; see page 9 or seas.columbia.edu for details (administered by the advising dean). Combined Plan 3/2 transfer students do not need nontechnical electives; see page 14 or seas.columbia.edu.

MECHANICAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS
STANDARD TRACK

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	
				APMA E2101 (3)[1] **or** Linear Algebra (3)[2] **and** ODE (3)[3]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → UN1403 (3)[4] UN1601 (3.5) → UN1602 (3.5) → UN2601 (3.5)[4] UN2801 (4.5) → UN2802 (4.5)			
CHEMISTRY	one semester lecture (3–4) UN1403 **or** UN1404 **or** UN2045 **or** UN1604	Lab UN1500 (3)[5]		
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL COURSES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4) HUMA UN1121 **or** UN1123 (3)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0)
REQUIRED TECHNICAL COURSES				ENME E3105 (4)
COMPUTER SCIENCE	Computer language: COMS W1004 or COMS W1005 (3) or ENGI E1006 (3) (in semester I or III)			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] Students who take APMA E2101 must complete an additional 3 point course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective 3000-level or higher), with the approval of your ME faculty adviser, may be substituted for this purpose.
[2] Linear algebra may be fulfilled by either APMA E3101 or MATH UN2010.
[3] Ordinary differential equations may be fulfilled by either MATH UN2030 or MATH UN3027.
[4] May substitute EEEB UN2001, BIOL UN2005, or higher.
[5] May substitute Physics Lab UN1494 (3) or UN3081 (2).

MECHANICAL ENGINEERING: THIRD AND FOURTH YEARS STANDARD TRACK				
	SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES	MECE E3018 (3) Lab I MECE E3100 (3) Fluids I MECE E3301 (3) Thermodynamics MECE E3408 (3) Graphics and design MECE E3414 (3)[1] Mechanics of solids for mechanical engineers	MECE E3028 (3) Lab II ENME E3106 (3) Dynamics and vibrations MECE E3311 (3) Heat transfer MECE E3610 (3) Materials and processes in manufacturing ELEN E1201 (3.5)[2] Intro. elec. eng.	MECE E3409 (3) Machine design MECE E3420 (3) Engineering design: concept EEME E3601 (3) Intro. to continuous control sys.	MECE E3430 (3) Engineering design: creation
	MECE E1008 (1) Intro to machining (either semester)			
TECHNICAL ELECTIVES[3]		12 points[5]		
NONTECH ELECTIVES[4]	Students must complete the 27-point requirement.[6]			
TOTAL ESTIMATED POINTS[7]	15–16	16.5–19.5	12–15	12

[1] Required for class of 2025 and beyond.
[2] Strongly recommended to be taken in Semester III or IV.
[3] If APMA E2101 is taken instead of Linear algebra and ODE, students must complete an additional 3-point course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective (3000-level or higher), with the approval of your ME faculty adviser, may be substituted for this purpose.
[4] Not required for Combined Plan students.
[5] 12 points required; 6 must be MECE courses. Any course with a description in the Mechanical Engineering section of the Bulletin counts as a MECE course.
[6] See page 9; not required for Combined Plan students.
[7] Students must complete a minimum of 128 points to graduate.

MECHANICAL ENGINEERING PROGRAM: FIRST AND SECOND YEARS
EARLY DECISION TRACK

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3)	MATH UN1102 (3)	APMA E2000 (4) and E2001 (0) either semester	APMA E2101 (3)[1] **or** Linear Algebra (3)[2] **and** ODE (3)[3]
PHYSICS (three sequences, choose one)	UN1401 (3) → UN1402 (3) → UN1403 (3)[4] UN1601 (3.5) → UN1602 (3.5) → UN2601 (3.5)[4] UN2801 (4.5) → UN2802 (4.5)			
CHEMISTRY	one semester lecture (3–4) UN1403 **or** UN1404 **or** UN2045 **or** UN1604	Lab UN1500 (3)[5]		
UNIVERSITY WRITING	CC1010 (3) either semester			
REQUIRED NONTECHNICAL COURSES			HUMA CC1001, COCI CC1101, **or** Global Core (3–4)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4)
REQUIRED TECHNICAL COURSES		ENME E3105 (4) Mechanics	MECE E3414 (3)[7] Mechanics of solids for mechanical engineers	ELEN E1201 (3.5) Intro. to elec. eng. MECE E3408 (3) Graphics and design
COMPUTER SCIENCE	Computer language: COMS W1004 or COMS W1005 (3) or ENGI E1006 (3) (in semester I and III)			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

[1] Students who take APMA E2101 must complete an additional 3 point course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective (3000-level or higher), with the approval of your ME faculty adviser, may be substituted for this purpose.

[2] Linear algebra may be fulfilled by either APMA E3101 or MATH UN2010.

[3] Ordinary differential equations may be fulfilled by either MATH UN2030 or MATH UN3027.

[4] May substitute EEEB UN2001, BIOL UN2005, or higher.

[5] May substitute Physics Lab UN1494 (3) or UN3081 (2).

MECHANICAL ENGINEERING: THIRD AND FOURTH YEARS
EARLY DECISION TRACK

	SEMESTER V	SEMESTER VI	SEMESTER VII	SEMESTER VIII
REQUIRED COURSES	MECE E3018 (3) Lab I MECE E3100 (3) Fluids I MECE E3301 (3) Thermodynamics	MECE E3028 (3) Lab II ENME E3106 (3) Dynamics and vibrations MECE E3311 (3) Heat transfer MECE E3610 (3) Materials and processes in manufacturing	MECE E3409 (3) Machine design MECE E3420 (3) Engineering design: concept EEME E3601 (3) Intro. to continuous control sys.	MECE E3430 (3) Engineering design: creation
	MECE E1008 (1) Intro to machining (either semester)			
REQUIRED NONTECHNICAL COURSES	HUMA UN1121 **or** UN1123 (3)	ECON UN1105 (4) **and** UN1155 recitation (0)		
TECHNICAL ELECTIVES[1]		12 points [3]		
NONTECH ELECTIVES	Students must complete the 27-point requirement.[4]			
TOTAL ESTIMATED POINTS[2]	12–16	16–19	12–15	12

[1] If APMA E2101 is taken instead of Linear Algebra and ODE, students must complete an additional 3-point course in math or basic science with one of the following course designators: MATH, PHYS, CHEM, BIOL, STAT, APMA, or EEEB. One technical elective (3000-level or higher), with the approval of your ME faculty adviser, may be substituted for this purpose.

[2] Students must complete a minimum of 128 points to graduate.

[3] 12 points required; 6 must be MECE courses. Any course with a description in the Mechanical Engineering section of the Bulletin counts as a MECE course.

[4] See page 9; not required for Combined Plan students.

MINING ENGINEERING PROGRAM: FIRST AND SECOND YEARS

	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV
MATHEMATICS	MATH UN1101 (3) **or** MATH UN1207 (4)	MATH UN1102 (3) MATH UN1208 (4)	APMA E2000 (4) and E2001 (0)	APMA E2101 (3) MATH UN2030 (3) ODE
PHYSICS	UN1401 (3) **or** UN1601 (3.5) **or** UN2801 (4.5)	UN1402 (3) UN1602 (3.5) UN2802 (4.5)	CHEM UN2443 (3.5) **or** PHYS UN1403 (3) **or** PHYS UN2601 (3.5) **or** BIOL UN2005 (4)	EACE E4252 (3) Foundations of environmental engineering
CHEMISTRY	UN1403 (3.5) **and** Lab UN1500 (3) either semester **or** UN1604 (3.5) **or** UN2045 (3.5)	UN1404 (3.5) UN1507 (3) UN2046 (3.5) **and** Lab UN1507 (3)		
REQUIRED NONTECHNICAL ELECTIVES	ENGL CC1010 (3)		HUMA CC1001, COCI CC1101, **or** Global Core (3–4)	HUMA CC1002, COCI CC1102, **or** Global Core (3–4) ECON UN1105 (4) **and** UN1155 recitation (0) HUMA UN1121 **or** UN1123 (3)
REQUIRED PROFESSIONAL AND TECHNICAL ELECTIVES			EESC UN2100 (4.5) **or** EESC UN2200 (4.5) EAEE E2100 (3) A better planet by design	STAT GU4001 (3)
COMPUTER SCIENCE	ENGI E1006 (3) any semester			
PHYSICAL EDUCATION	UN1001 (1)	UN1002 (1)		
THE ART OF ENGINEERING	ENGI E1102 (4) either semester			

MINING ENGINEERING: THIRD AND FOURTH YEARS				
	SEMESTER V	**SEMESTER VI**	**SEMESTER VII**	**SEMESTER VIII**
REQUIRED COURSES	EAEE E3103 (3) Energy, minerals, and material systems	EAEE E4003 (3) Aquatic chemistry	EAEE E3998 (2) Undergraduate design project	EAEE E3999 (2) Undergraduate design project
	EAEE E3200 (3) Applied transport and chemical rate phenomena	EACE E3250 (3) Hydrosystems engineering	EAEE E4200 (3) Intro to sustainable production of earth mineral & metal resources	EACE E3255 (3) Environmental control and pollution reduction systems
	CHEE E3010 (3) Principles of chemical engineering thermodynamics	EAEE E3800 (4) Earth and environmental engineering lab, I EAEE E3901 (3) Environmental microbiology		
TECHNICAL ELECTIVES		3 points	6 points	9 points
NONTECHNICAL ELECTIVES	3 points		3 points	6 points
TOTAL POINTS	12	16	14	20