COMPUTER SCIENCE

The Computer Science Department:

Department website: http://www.cs.columbia.edu

Office location: 450 Mudd

Office contact: ug-advising@cs.columbia.edu

Director of Undergraduate Studies: Dr. Jae Woo Lee, 715 CEPSR; 212-939-7066; jae@cs.columbia.edu

Undergraduate Administrator: CS Advising, ug-advising@cs.columbia.edu

The Computer Science Major

Students study a common core of fundamental topics, supplemented by a program of six electives that provides a high degree of flexibility. Three of the electives are chosen from a list of upper-level courses that represent area foundations within computer science. The remaining electives are selected from the complete list of upper-level computer science courses. Students are encouraged to work with their faculty advisor 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.

Our website is always the most current in terms of information and has many FAQs for students. Please view this here: cs.columbia.edu and contact ug-advising@cs.columbia.edu with any questions.

Student Advising

Consulting Advisers

Undergraduate students will be assigned a CS Faculty Advisor from the list on the CS website - https://www.cs.columbia.edu/education/undergraduate/advisors/. Students will typically have the same advisor throughout their time in the program. However, students are encouraged to check this list at the start of every term to ensure their advisor remains the same. To reach out to your CS Faculty Advisor, please email first or visit during office hours.

Enrolling in Classes

Computer Science Department courses are needed by many student populations and are in high demand. To facilitate all COMS students getting the courses they need and distribute seats fairly, please refer to our policy - https://www.cs.columbia.edu/cs-course-registration-policy/

Preparing for Graduate Study

The department offers a number of options at the graduate level, including the MS Express. Please refer to our FAQs - https://www.cs.columbia.edu/education/admissions8/ - or email ms-admissions@cs.colubia.edu with any questions.

Coursework Taken Outside of Columbia

Advanced Placement

The department grants 3 points for a score of 4 or 5 on the AP Computer Science A exam, along with an exemption from COMS W1004 Introduction to Computer Science and Programming in Java. However, we recommend that you take COMS W1004 before taking COMS W3134/W3137 Data Structures if you received a score of 4 or have not programmed in Java recently.

Barnard College Courses

Any course offered by the Computer Science @Barnard department can count towards degree requirements. Please refer to the major and minor program information pages for specific information.

Transfer Courses

Up to four transfer courses are accepted toward the major. Up to two transfer courses are accepted toward the minor. Calculus, linear algebra, and probability/statistics courses can be transferred in addition to the four/two-course limits. Each course must be approved as equivalent by the faculty who teaches it at Columbia. Please refer to the guide here - https://www.cs.columbia.edu/education/undergraduate/#sec8

Study Abroad Courses

If you are considering studying abroad, please consult with the CS Advisor as soon as possible. Each course for potential incorporation into your CS major or minor must be approved as equivalent by the faculty who teaches it at Columbia.

Summer Courses

Any Computer Science or approved cognate course offered during the summer session will count towards the degree, with the exception of online-only courses, which do not count towards degree requirements.

Undergraduate Research and Senior Thesis

Undergraduate Research in Courses

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 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.

Senior Thesis Coursework and Requirements

A thesis is not a requirement for the major or minor.

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

Undergraduate Research Outside of Courses

Laboratory Facilities

The department has well-equipped lab areas for research in computer graphics, computer-aided digital design, computer vision, databases and digital libraries, data mining and knowledge discovery, distributed systems, mobile and wearable computing, natural language processing, networking, operating systems, programming systems, robotics, user interfaces, and real-time multimedia.

Research labs contain several large Linux and Solaris clusters; Puma 500 and IBM robotic arms; a UTAH-MIT dexterous hand; an Adept-1 robot; three mobile research robots; a real-time defocus range sensor; interactive 3-D graphics workstations with 3-D position and orientation trackers; prototype wearable computers, wall-sized stereo projection systems; see-through head-mounted displays; a networking testbed with three Cisco 7500 backbone routers, traffic generators; an IDS testbed with secured LAN, Cisco routers, EMC storage, and Linux servers; and a simulation testbed with several Sun servers and Cisco Catalyst routers. The department uses a SIP IP phone system. The protocol was developed in the department.

The department's computers are connected via a switched 1Gb/s Ethernet network, which has direct connectivity to the campus OC-3 Internet and internet 2 gateways. The campus has 802.11b/g wireless LAN coverage.

The research facility is supported by a full-time staff of professional system administrators and programmers.

Participating in Research Projects

Students can reach out to professors whose research areas are of interest to them. Professors will typically require that students have completed the relevant coursework covering the background knowledge and skills.

Once a faculty member agrees to supervise the student's research work, the student will register for the professor's section of COMS W3998 or W4901.

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 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.

Department Honors and Prizes

Department Honors

The Computer Science Department does not award departmental honors.

Academic Prizes

Jonathan L. Gross Award for Academic Excellence: This award was established in 2017 in honor of the much loved Professor Emeritus Jonathan Gross. Each year a cash gift is awarded to one graduating masters student and to one graduating senior from each of the four undergraduate schools served by the Department of Computer Science.

Theodore R. Bashkow Award: Presented to a computer science senior who has excelled in independent projects. This is awarded in honor of Professor Theodore R. Bashkow, whose contributions as a researcher, teacher, and consultant have significantly advanced the state of the art of computer science.

Andrew P. Kosoresow Memorial Award for Excellence in Teaching and Service: Awarded for outstanding contributions to teaching in the Department of Computer Science and exemplary service to the Department and its mission.

Computer Science Scholarship Award: A cash prize awarded to two B.A. and two B.S. degree candidates for outstanding academic achievement in computer science.

Russell C. Mills Award: This annual award, established by the computer science department in 1992 in memory of Russell C. Mills, is a cash prize given to a computer science major who has exhibited excellence in the area of computer science.

Other Important Information

See the Requirements section for the policies on double counting and D grades.

Professors

Peter N. Belhumeur
Steven M. Bellovin
Luca Carloni
Xi Chen
Steven K. Feiner
Luis Gravano
Julia B. Hirschberg
Gail E. Kaiser
John R. Kender
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
Henning G. Schulzrinne
Rocco A. Servedio
Simha Sethumadhavan
Salvatore J. Stolfo
Bjarne Stroustrup
Vladimir Vapnik
Jeannette Wing
Junfeng Yang
Mihalis Yannakakis

Richard Zemei

Associate Professors

Alexandr Andoni
Elias Bareinboim
Augustin Chaintreau
Stephen A. Edwards
Roxana Geambasu
Daniel Hsu
Suman Jana
Martha Allen Kim
Baishakhi Ray
Carl Vondrick
Eugene Wu
Zhou Yu
Changxi Zheng
Xia Zhou

Assistant Professors

Josh Alman
Lydia Chilton
Ronghui Gu
Kostis Kaffes
David Knowles
Brian Smith
Henry Yuen

Senior Lecturer in Discipline

Paul Blaer
Adam Cannon
Jae Woo Lee

Lecturer in Discipline

Daniel Bauer
Brian Borowski
Tony Dear

Associated Faculty Joint

Andrew Blumberg
Shih-Fu Chang
Feniosky Peña-Mora
Clifford Stein

Affiliates

Shipra Agrawal
Mohammed AlQuraishi
Elham Azizi
Paolo Blikstein
Asaf Cidon
Matei Ciocarlie
Rachel Cummings
Noemie Elhadad
Javad Ghaderi
Gamze Gursoy
Xiaofan Jiang
Ethan Katz-Bassett
Hod Lipson
Smaranda Muresan
Liam Paninski
Brian Plancher
Mark Santolucito
Lisa Soros
Barbara Tversky
Venkat Venkatasubramanian
Rebecca Wright
Gil Zussman

Senior Research Scientists

Gaston Ormazabal
Moti Yung

Emeritus

Alfred V. Aho
Peter K. Allen
Edward G. Coffman Jr.
Zvi Galil
Jonathan L. Gross
Steven M. Nowick
Stephen H. Unger
Henryk Wozniakowski
Yechiam Yemini

Guidance for Undergraduate Students in the Department

Program Planning for all Students

The following requirements are new as of the academic year 2023-2024. Students who declared a CS major in the academic year 2022-2023 or earlier have the option to follow the old requirements. The old requirements are noted on the Undergraduate Programs pages of the Computer Science Department website (https://www.cs.columbia.edu/education/undergraduate/).

Please note that the information on the department website is more up-to-date than the information in the archived Bulletins. Students with questions about which requirements to follow are advised to talk with ug-advising@cs.columbia.edu.

Restrictions on overlapping courses

Students may receive credit for only one of the following two courses:

- COMS W1004 Introduction to Computer Science and Programming in Java
- COMS W1005 Introduction to Computer Science and Programming in MATLAB.

Students may receive credit for only one of the following three courses:

- COMS W3134 Data Structures in Java
- COMS W3136 ESSENTIAL DATA STRUCTURES
- COMS W3137 HONORS DATA STRUCTURES # ALGOL

COMS W1005 and COMS W3136 cannot be counted towards the Computer Science major, minor, and concentration.

No more than 6 points of project/thesis courses (COMS W3902, W3998, W4901) can count toward the 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, MATH UN2015
- MATH UN2015, MATH UN2010, APAM E3101, COMS W3251
- COMS W4771, COMS W4721

Double Counting

Double-counting policies are to be construed within the larger double-counting policy of the student's home school. Double-counting policies are detailed on each School's Bulletin and/or Catalog.

The CS department allows the following courses in the CS Core and Mathematics requirement to be double-counted with another major, minor, or concentration. No other courses can be double-counted with another program.

- COMS W1004
- Any calculus courses (including Honors Math A and B)
- One Linear Algebra course
- One Probability/Statistics course

Grading

A maximum of one course worth no more than 4 points passed with a grade of D may be counted toward the major or minor.

Course Numbering Structure

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

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

Guidance for First-Year Students

Pre-Introductory Courses

COMS W1004 is the first course in the Computer Science major curriculum, and it does not require any previous computing experience. Before taking COMS W1004, however, students have an option to start with one of the pre-introductory courses: ENGI E1006 or COMS W1002.

ENGI E1006 Introduction to Computing for Engineers and Applied Scientists is a general introduction to computing for STEM students. ENGI E1006 is in fact a required course for all engineering students. COMS W1002 Computing in Context is a course primarily intended for humanities majors, but it also serves as a pre-introductory course for CS majors. ENGI E1006 and COMS W1002 do not count towards Computer Science major.

Guidance for Transfer Students

Up to four transfer courses are accepted toward the major. Up to two transfer courses are accepted toward the minor or concentration. Calculus, linear algebra, and probability/statistics courses can be transferred in addition to the four/two-course limits.

Undergraduate Programs of Study

Major in Computer Science

All majors should confer with their program adviser each term to plan their programs of study. Students considering a major in computer science are encouraged to talk to a program adviser during their first or second year. The Computer Science major is composed of four basic components: The Mathematics Requirement, the Computer Science Core, the Area Foundation Courses, and the Computer Science Electives.

Mathematics Requirement (6-11 points)

Calculus Requirement: Select one of the following courses:

MATH UN1201	CALCULUS III
MATH UN1205	ACCELERATED MULTIVARIABLE CALC
APMA E2000	MULTV. CALC. FOR ENGI # APP SCI

Note that MATH UN1201 (Calculus III) requires Calculus I as a prerequisite but does NOT require Calculus II. MATH UN1205 and APMA E2000, however, require both Calculus I and Calculus II as prerequisites.

Linear Algebra Requirement: Select one of the following courses:

COMS W3251	COMPUTATIONAL LINEAR ALGEBRA (recommended)
MATH UN2010	LINEAR ALGEBRA
MATH UN2015	Linear Algebra and Probability
MATH UN2020	Honors Linear Algebra
APMA E2101	INTRO TO APPLIED MATHEMATICS
APMA E3101	APPLIED MATH I: LINEAR ALGEBRA

Probability / Statistics Requirement: Select one of the following courses:

MATH UN2015	Linear Algebra and Probability
IEOR E3658	PROBABILITY FOR ENGINEERS
STAT UN1201	CALC-BASED INTRO TO STATISTICS
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS

NOTE: Math 2015 Linear Algebra and Probability may simultaneously satisfy both linear algebra and probability requirements without the need to take additional classes thus reducing the total number of points required.

Pre-intro course (Optional, 3-4 points)

ENGI E1006	INTRO TO COMP FOR ENG/APP SCI (recommended but not required)
or COMS W1002	COMPUTING IN CONTEXT

Computer Science Core (20-21 points):

First Year

COMS W1004	Introduction to Computer Science and Programming in Java
or COMS W1007	

Sophomore Year

COMS W3134	Data Structures in Java

or COMS W3137	HONORS DATA STRUCTURES # ALGOL
COMS W3157	ADVANCED PROGRAMMING
COMS W3203	DISCRETE MATHEMATICS
Junior and Senior Year	
Complete the remaining required core courses:	
COMS W3261	COMPUTER SCIENCE THEORY
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS

Area Foundation Courses (9 to 12 points):

Select three from the following list:

COMS W4111	INTRODUCTION TO DATABASES
COMS W4113	FUND-LARGE-SCALE DIST SYSTEMS
COMS W4115	PROGRAMMING LANG # TRANSLATORS
COMS W4118	OPERATING SYSTEMS I
COMS 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 E4231	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 (9 to 12 points)

Any three COMS courses or jointly offered computer science courses such as CSXX or XXCS course that are worth at least 3 points and are at the 3000 level or above. This includes 3000-level courses offered by Barnard CS.

Restrictions

No more than 6 points of project/thesis courses (COMS W3902, W3998, W4901) can count toward the 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, MATH UN2015
- MATH UN2015, MATH UN2010, APAM E3101, COMS W3251
- COMS W4771, COMS W4721

Major in Computational Biology

For a description of the joint major in computer science—Biology, see the Biological Sciences section in this bulletin.

Major in Computer Science - Mathematics

For a description of the joint major in computer science—mathematics, see the *Mathematics* section in this bulletin.

Major in Information Science

The major in information science requires a minimum of 33 points, including a core requirement of five courses. Adjustments were made to the course lists below in March 2022.

The elective courses must be chosen with a faculty adviser to focus on the modeling and use of information within the context of a disciplinary theme. After discussing potential selections, students prepare a proposal of study that must be approved by the faculty adviser. In all cases, the six courses must be at the 3000 level or above, with at least three courses chosen from computer science. Following are some example programs. For more examples or templates for the program proposal, see a faculty adviser.

Note: In most cases, additional courses will be necessary as prerequisites in order to take some of the elective courses. This will depend on the student's proposed program of study.

Core Requirement

COMS W1001	Introduction to Information Science
or COMS W1002 Computing in Context	
COMS W1004	Introduction to Computer Science and Programming in Java
COMS W3107	Clean Object-Oriented Design
COMS W3134	Data Structures in Java
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS

Following are some suggested programs of instruction:

Information Science and Contemporary Society

Students may focus on how humans use technology and how technology has changed society.

The requirements include:

COMS W4111	INTRODUCTION TO DATABASES
COMS W4170	USER INTERFACE DESIGN
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W3410	COMPUTERS AND SOCIETY
SOCI UN3010	METHODS FOR SOCIAL RESEARCH
SOCI UN3960	SEMINAR - PROBLEMS OF LAW # SOCIETY

Information Science and the Economy

Students may focus on understanding information modeling together with existing and emerging needs in economics and finance as well as algorithms and systems to address those needs.

The requirements include:

COMS W4111	INTRODUCTION TO DATABASES
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4771	MACHINE LEARNING
ECON UN3412	INTRODUCTION TO ECONOMETRICS

ECON UN3025	FINANCIAL ECONOMICS
ECON UN3265	MONEY AND BANKING

Information Science and Health Sciences

Students may focus on understanding information modeling together with existing and emerging needs in health sciences, as well as algorithms and systems to address those needs.

The requirements include:

COMS W4111	INTRODUCTION TO DATABASES
COMS W4170	USER INTERFACE DESIGN
COMS W4701	ARTIFICIAL INTELLIGENCE
BINF G4001	
BIOL W4037	Bioinformatics of Gene Expression
ECBM E3060/E4060	

Major in Data Science

In response to the ever-growing importance of "big data" in scientific and policy endeavors, the last few years have seen explosive growth in theory, methods, and applications at the interface between computer science and statistics. The statistics and computer science departments have responded with a joint major that emphasizes the interface between the disciplines.

Prerequisites (15 points)	
MATH UN1101	CALCULUS I
MATH UN1102	CALCULUS II
MATH UN1201	CALCULUS III
MATH UN2010	LINEAR ALGEBRA
This introductory Statistics course:	
STAT UN1201	CALC-BASED INTRO TO STATISTICS
Statistics (12 points)	
STAT GU4203	PROBABILITY THEORY
STAT GU4204	STATISTICAL INFERENCE
STAT GU4205	LINEAR REGRESSION MODELS
STAT GU4241	STATISTICAL MACHINE LEARNING
or COMS W4771 Machine Learning	
Computer Science (12 points)	
Select one of the following courses:	
COMS W1004	Introduction to Computer Science and Programming in Java
COMS W1005	Introduction to Computer Science and Programming in MATLAB
COMS W1007	
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
Select one of the following courses:	
COMS W3134	Data Structures in Java
COMS W3136	ESSENTIAL DATA STRUCTURES
COMS W3137	HONORS DATA STRUCTURES # ALGOL
Two required courses:	
COMS W3203	DISCRETE MATHEMATICS
CSOR W4231	ANALYSIS OF ALGORITHMS I
Electives (15 points)	
Select two of the following courses:	
STAT UN3106	APPLIED MACHINE LEARNING
STAT GU4206	STAT COMP # INTRO DATA SCIENCE
STAT GU4224	BAYESIAN STATISTICS
STAT GU4243	APPLIED DATA SCIENCE
STAT Q4242	Advanced Machine Learning
Select three of the following courses:	
COMS W3261	COMPUTER SCIENCE THEORY
COMS W4111	INTRODUCTION TO DATABASES
COMS W4130	
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4252	INTRO-COMPUTATIONAL LEARN THRY
Any COMS W47xx course EXCEPT W4771	

Minor in Computer Science

Students who pass the Computer Science Advanced Placement Exam A with a 4 or 5 will receive 3 points and an exemption from COMS W1004.

The Computer Science Minor consists of 6 courses as follows:

1. COMS W1004: Intro to computer science and programming in Java (3) or COMS W1007: Honors intro to comp sci (3)

2. COMS W3134: Data structures in Java (3) or COMS W3137: Honors data structures and algorithms (4)

3. COMS W3203: Discrete mathematics (4)

4. One course of the following:

COMS W3157: Advanced programming (4)

COMS W3261: Comp science theory (3)

CSEE W3827: Fundamentals of computer systems (3)

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 linear algebra or probability/statistics course from the following: APMA E3101, APMA E2101, MATH UN2010, MATH UN2015, IEOR E3658, STAT UN1201, STAT GU4001 or STAT GU4203.

Restrictions

No more than 6 points of project/thesis courses (COMS W3902, W3998, W4901) can count toward the 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, MATH UN2015
- MATH UN2015, MATH UN2010, APAM E3101, COMS W3251
- COMS W4771, COMS W4721

For students who entered Columbia in or before the 2023-24 academic year

Concentration in Computer Science

The concentration in computer science requires a minimum of 22-24 points, as follows:

COMS W1004	Introduction to Computer Science and 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 (or any 3 point 4000-level computer science course)
Select one of the following courses:	
COMS W3251	COMPUTATIONAL LINEAR ALGEBRA
MATH UN2010	LINEAR ALGEBRA
MATH UN2015	Linear Algebra and Probability
MATH V2020	Honors Linear Algebra
APMA E2101	INTRO TO APPLIED MATHEMATICS
APMA E3101	APPLIED MATH I: LINEAR ALGEBRA
IEOR E3658	PROBABILITY FOR ENGINEERS
STAT UN1201	CALC-BASED INTRO TO STATISTICS
STAT GU4001	INTRODUCTION TO PROBABILITY AND STATISTICS

Computer Science

COMS W1001 Introduction to Information Science. *3 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

COMS W1003 INTRO-COMPUT SCI/PROGRAM IN C. *3.00 points*.

COMS W1004 Introduction to Computer Science and Programming in Java. *3 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 2025: COMS W1004

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1004	001/11948	T Th 11:40am - 12:55pm 417 International Affairs Bldg	Adam Cannon	3	111/398
COMS 1004	002/11949	T Th 1:10pm - 2:25pm 417 International Affairs Bldg	Adam Cannon	3	87/398

COMS W1005 Introduction to Computer Science and Programming in MATLAB. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

A general introduction to computer science concepts, algorithmic problem-solving capabilities, and programming skills in MATLAB. Assumes no prior programming background. Columbia University students may receive credit for only one of the following two courses: *W1004* or *W1005*.

COMS W1011 INTERMED COMPUTER PROGRAMMING. *3.00 points*.

COMS W1012 COMPUTING IN CONTEXT REC. *0.00 points*.

COMS W1103 HONORS INTRO COMPUTER SCIENCE. *3.00 points*.

COMS W1404 EMERGING SCHOLARS PROG SEMINAR. *1.00 point*.
Pass/Fail only.

Prerequisites: Instructor's permission
Corequisites: COMS W1004,COMS W1007,COMS W1002
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 2025: COMS W1404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 1404	001/11950	F 8:40am - 9:55am 502 Northwest Corner	Adam Cannon	1.00	0/16
COMS 1404	002/11951	F 10:10am - 11:25am 502 Northwest Corner	Adam Cannon	1.00	6/16
COMS 1404	003/11952	F 11:40am - 12:55pm 502 Northwest Corner	Adam Cannon	1.00	5/16
COMS 1404	004/11953	F 1:10pm - 2:25pm 502 Northwest Corner	Adam Cannon	1.00	4/16
COMS 1404	005/11954	F 2:40pm - 3:55pm 502 Northwest Corner	Adam Cannon	1.00	5/16
COMS 1404	006/11955	F 4:10pm - 5:25pm 502 Northwest Corner	Adam Cannon	1.00	6/16
COMS 1404	007/11956	F 9:30am - 10:45am 253 Engineering Terrace	Adam Cannon	1.00	4/16
COMS 1404	008/11957	F 11:00am - 12:15pm 253 Engineering Terrace	Adam Cannon	1.00	5/16
COMS 1404	009/11958	F 12:30pm - 1:45pm 253 Engineering Terrace	Adam Cannon	1.00	3/16
COMS 1404	010/11959	F 2:00pm - 3:15pm 253 Engineering Terrace	Adam Cannon	1.00	2/16

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.

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.

COMS W3011 INTERMED COMPUTER PROGRAMMING. *3.00 points*.

COMS W3101 PROGRAMMING LANGUAGES. *1.00 point*.
Lect: 1.

Prerequisites: Fluency in at least one programming language.
Introduction to a programming language. Each section is devoted to a specific language. Intended only for those who are already fluent in at least one programming language. Sections may meet for one hour per week for the whole term, for three hours per week for the first third of the term, or for two hours per week for the first six weeks. May be repeated for credit if different languages are involved

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 Clean Object-Oriented Design. *3.00 points*.
Prerequisites: Intro to Computer Science/Programming in Java (COMS W1004) or instructor's permission. May not take for credit if already received credit for COMS W1007.

Prerequisites: see notes re: points COMS W1004; COMS W1004 or permission of instructor. May not take for credit if already received credit for COMS W1007
A course in designing, documenting, coding, and testing robust computer software, according to object-oriented design patterns and clean coding practices. Taught in Java.Object-oriented design principles include: use cases; CRC; UML; javadoc; patterns (adapter, builder, command, composite, decorator, facade, factory, iterator, lazy evaluation, observer, singleton, strategy, template, visitor); design by contract; loop invariants; interfaces and inheritance hierarchies; anonymous classes and null objects; graphical widgets; events and listeners; Java's Object class; generic types; reflection; timers, threads, and locks

COMS W3123 ASSEMBLY LANG AND COMPUT LOGIC. *3.00 points*.

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 2025: COMS W3134

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3134	001/11962	M W 2:40pm - 3:55pm 309 Havemeyer Hall	Paul Blaer	3	225/320
COMS 3134	002/11963	M W 5:40pm - 6:55pm 501 Northwest Corner	Paul Blaer	3	167/164

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

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 2025: COMS W3157

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3157	001/11964	M W 4:10pm - 5:25pm 301 Uris Hall	Brian Borowski	4.00	155/175
COMS 3157	002/11965	M W 5:40pm - 6:55pm 301 Uris Hall	Brian Borowski	4.00	111/175

COMS W3202 FINITE MATHEMATICS. *3.00 points*.

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 2025: COMS W3203

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3203	001/13386	M W 2:40pm - 3:55pm 501 Northwest Corner	Tony Dear	4.00	145/164

COMS W3210 Scientific Computation. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: two terms of calculus.
Introduction to computation on digital computers. Design and analysis of numerical algorithms. Numerical solution of equations, integration, recurrences, chaos, differential equations. Introduction to Monte Carlo methods. Properties of floating point arithmetic. Applications to weather prediction, computational finance, computational science, and computational engineering.

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) COMS W3203; COMS W3134 AND COMS W3137 AND COMS W3136
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 2025: COMS W3261

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 3261	001/11966	T Th 1:10pm - 2:25pm 833 Seeley W. Mudd Building	Josh Alman	3.00	114/120
COMS 3261	002/11967	T Th 2:40pm - 3:55pm 833 Seeley W. Mudd Building	Josh Alman	3.00	115/120

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

COMS W3770 Mathematics for Machine Learning. *3.00 points*.
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 E3899 Research Training. *0.00 points*.
Research training course. Recommended in preparation for laboratory related research

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 Special Topics in Computer Science. *3 points*.
Lect: 3.

Prerequisites: the instructor's permission.
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. *1.00-2.00 points*.
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 E3999 Fieldwork. *1 point*.
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 required. May not be used as a technical or non-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, COMS W3136, or COMS W3137; or the instructor's permission.

Prerequisites: (COMS W3134) or (COMS W3136) or (COMS W3137) or 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 2025: COMS W4111

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4111	001/11968	M W 2:40pm - 3:55pm 301 Uris Hall	Kenneth Ross	3.00	181/266
COMS 4111	002/11969	F 10:10am - 12:40pm 207 Mathematics Building	Donald Ferguson	3.00	101/125
COMS 4111	V01/20241		Kenneth Ross	3.00	7/99

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

COMS E4115 PROGRAMMING LANG # TRANSL. *3.00 points*.

COMS W4115 PROGRAMMING LANG # TRANSLATORS. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (COMS W3261) and (CSEE W3827) or COMS W3134 OR COMS W3136 OR COMS W3137 OR CSEE W3827 AND COMS W3261; 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

Spring 2025: COMS W4115

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4115	001/11970	M W 4:10pm - 5:25pm 833 Seeley W. Mudd Building	Ronghui Gu	3.00	70/120
COMS 4115	V01/18062		Ronghui Gu	3.00	11/99

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 2025: COMS W4118

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4118	001/11971	T Th 4:10pm - 5:25pm 309 Havemeyer Hall	Kostis Kaffes	3.00	100/160
COMS 4118	V01/18065		Kostis Kaffes	3.00	2/99

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 W4121 COMPUTER SYSTEMS FOR DATA SCIENCE. *3.00 points*.
Prerequisites: CSOR W4246 OR STAT W4203; or equivalent as approved by faculty advisor. background in Computer System Organization and good working knowledge of C/C++
Corequisites: CSOR W4246,STAT GU4203
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

COMS W4137 From Algorithmic Thinking to Development. *3.00 points*.
Algorithmic problem-solving and coding skills needed to devise solutions to interview questions for software engineering positions. Solutions are implemented in Python, Java, C, and C . Approaches include brute-force, hashing, sorting, transform-and-conquer, greedy, and dynamic programming. Focus on experimentation and team work

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

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) or
Software lifecycle using frameworks, libraries and services. Major emphasis on software testing. Centers on a team project

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

Spring 2025: COMS W4160

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4160	001/11972	T Th 6:40pm - 7:55pm 313 Fayerweather	Hadi Fadaifard	3.00	65/75
COMS 4160	V01/20390		Hadi Fadaifard	3.00	3/99

COMS W4162 Advanced Computer Graphics. *3 points*.
Lect: 3.

Prerequisites: (COMS W4160) or COMS W4160
A second course in computer graphics covering more advanced topics including image and signal processing, geometric modeling with meshes, advanced image synthesis including ray tracing and global illumination, and other topics as time permits. Emphasis will be placed both on implementation of systems and important mathematical and geometric concepts such as Fourier analysis, mesh algorithms and subdivision, and Monte Carlo sampling for rendering. Note: Course will be taught every two years.

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.

Prerequisites: multivariable calculus, linear algebra, C++ programming proficiency. *COMS W4156* recommended.
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 2025: COMS W4167

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4167	001/11973	T Th 4:10pm - 5:25pm 451 Computer Science Bldg	Changxi Zheng	3.00	26/75

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 2025: COMS W4170

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4170	001/11975	M W 1:10pm - 2:25pm 417 International Affairs Bldg	Lydia Chilton	3.00	413/398
COMS 4170	002/18894	M 7:00pm - 9:30pm 428 Pupin Laboratories	Lydia Chilton	3.00	150/147
COMS 4170	V01/18066		Lydia Chilton	3.00	15/20

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 2025: COMS W4172

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4172	001/11976	T Th 1:10pm - 2:25pm 227 Seeley W. Mudd Building	Steven Feiner	3.00	37/45

COMS W4181 SECURITY I. *3.00 points*.
Not offered during 2023-2024 academic year.

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

COMS W4182 SECURITY II. *3.00 points*.
Not offered during 2023-2024 academic year.

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

Spring 2025: COMS W4182

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4182	001/11977	F 1:10pm - 3:40pm 1024 Seeley W. Mudd Building	John Koh	3.00	19/40
COMS 4182	V01/18068		John Koh	3.00	0/99

COMS W4186 MALWARE ANALYSIS#REVERSE ENGINEERING. *3.00 points*.
Not offered during 2023-2024 academic year.

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.

COMS W4203 Graph Theory. *3 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 W4205 Combinatorial Theory. *3 points*.
Lect: 3.**Not offered during 2023-2024 academic year.**

Prerequisites: (COMS W3203) and course in calculus.
Sequences and recursions, calculus of finite differences and sums, elementary number theory, permutation group structures, binomial coefficients, Stilling numbers, harmonic numbers, generating functions.

COMS W4223 Networks, Crowds, and the Web. *3.00 points*.
Prerequisites: Familiarity with elementary concepts of probability and data structures or experience programming with data
Introduces fundamental ideas and algorithms on networks of information collected by online services. It covers 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

Spring 2025: COMS W4223

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4223	001/14256	T Th 4:10pm - 5:25pm 313 Fayerweather	Augustin Chaintreau	3.00	68/78
COMS 4223	V01/18841		Augustin Chaintreau	3.00	32/99

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 2025: COMS W4232

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4232	001/11978	T Th 2:40pm - 4:00pm 702 Hamilton Hall	Alexandr Andoni	3.00	35/80
COMS 4232	V01/18070		Alexandr Andoni	3.00	1/99

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

COMS W4241 Numerical Algorithms and Complexity. *3 points*.
Lect: 3.

Prerequisites: knowledge of a programming language. Some knowledge of scientific computation is desirable.
Modern theory and practice of computation on digital computers. Introduction to concepts of computational complexity. Design and analysis of numerical algorithms. Applications to computational finance, computational science, and computational engineering.

COMS W4242 NUMRCL ALGORTHMS-COMPLEXITY II. *3.00 points*.

COMS W4252 INTRO-COMPUTATIONAL LEARN THRY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (CSOR W4231) or (COMS W4236) or 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

Spring 2025: COMS W4261

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4261	001/13820	M 7:00pm - 9:30pm 451 Computer Science Bldg	Allison Bishop	3.00	89/110

COMS W4281 INTRO TO QUANTUM COMPUTING. *3.00 points*.
Lect: 3.

Prerequisites: knowledge of linear algebra. Prior knowledge of quantum mechanics is not required, although it is helpful.
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.

COMS W4295 Topics in Theoretical Computer Science. *3.00 points*.
Selected topics in theoretical computer science. Content and prerequisites vary between sections and semesters. May be repeated for credit. Check "topics courses" webpage on the department website for more information on each section

COMS W4419 INTERNET TECHNOLOGY,ECONOMICS,AND POLICY. *3.00 points*.
Not offered during 2023-2024 academic year.

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. May not be used as a track elective for the computer science major.

Spring 2025: COMS W4419

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4419	001/11979	M W 4:10pm - 5:25pm 829 Seeley W. Mudd Building	Henning Schulzrinne	3.00	33/40

COMS W4444 PROGRAMMING # PROBLEM SOLVING. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) and (CSEE W3827) 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

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 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 2025: COMS W4460

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4460	001/11980	M W 8:40am - 9:55am 829 Seeley W. Mudd Building	William Reinisch	3.00	41/40

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 2025: COMS W4701

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4701	001/13152	M W 4:10pm - 5:25pm 301 Pupin Laboratories	Tony Dear	3.00	206/250
COMS 4701	V01/18072		Tony Dear	3.00	8/99

COMS W4705 NATURAL LANGUAGE PROCESSING. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or COMS W3134 OR COMS W3136 OR COMS W3137; Or instructor's permission
Computational approaches to natural language generation and understanding. Recommended preparation: some previous or concurrent exposure to AI or Machine Learning. Topics include information extraction, summarization, machine translation, dialogue systems, and emotional speech. Particular attention is given to robust techniques that can handle understanding and generation for the large amounts of text on the Web or in other large corpora. Programming exercises in several of these areas

Spring 2025: COMS W4705

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4705	001/11981	M W 10:10am - 11:25am 501 Schermerhorn Hall	Daniel Bauer	3.00	165/189
COMS 4705	V01/18074		Daniel Bauer	3.00	16/99

COMS W4706 Spoken Language Processing. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136 or COMS W3137) or *COMS W3134*, *W3136*, or *W3137*; or the instructor's permission.
Computational approaches to speech generation and understanding. Topics include speech recognition and understanding, speech analysis for computational linguistics research, and speech synthesis. Speech applications including dialogue systems, data mining, summarization, and translation. Exercises involve data analysis and building a small text-to-speech system.

COMS W4721 MACHINE LEARNING FOR DATA SCI. *3.00 points*.

Spring 2025: COMS W4721

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4721	001/15963	M W 2:40pm - 3:55pm 417 International Affairs Bldg	John Paisley	3.00	129/170

COMS W4725 Knowledge representation and reasoning. *3 points*.
Lect: 3.**Not offered during 2023-2024 academic year.**

Prerequisites: (COMS W4701)
General aspects of knowledge representation (KR). The two fundamental paradigms (semantic networks and frames) and illustrative systems. Topics include hybrid systems, time, action/plans, defaults, abduction, and case-based reasoning. Throughout the course particular attention is paid to design trade-offs between language expressiveness and reasoning complexity, and issues relating to the use of KR systems in larger applications.

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

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 2025: COMS W4732

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4732	001/13738	T Th 10:10am - 11:25am 451 Computer Science Bldg	Carl Vondrick	3.00	106/100
COMS 4732	V01/18075		Carl Vondrick	3.00	31/99

COMS W4733 COMPUTATIONAL ASPECTS OF ROBOTICS. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (COMS W3134 or COMS W3136COMS W3137) 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

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 W4737 Biometrics. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: a background at the sophomore level in computer science, engineering, or like discipline.
In this course. we will explore the latest advances in biometrics as well as the machine learning techniques behind them. Students will learn how these technologies work and how they are sometimes defeated. Grading will be based on homework assignments and a final project. There will be no midterm or final exam. This course shares lectures with *COMS E6737*. Students taking *COMS E6737* are required to complete additional homework problems and undertake a more rigorous final project. Students will only be allowed to earn credit for *COMS W4737* or *COMS E6737* and not both.

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 4771 Machine Learning) will be helpful but is not required.

Prerequisites: see notes re: points 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 E4762 Machine Learning for Functional Genomics. *3.00 points*.
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*.
Lect: 3.

Prerequisites: COMS W4701; Any introductory course in linear algebra and any introductory course in statistics are both required. Highly recommended: COMS W4701 or knowledge of Artificial Intelligence.
Topics from generative and discriminative machine learning including least squares methods, support vector machines, kernel methods, neural networks, Gaussian distributions, linear classification, linear regression, maximum likelihood, exponential family distributions, Bayesian networks, Bayesian inference, mixture models, the EM algorithm, graphical models and hidden Markov models. Algorithms implemented in MATLAB

Spring 2025: COMS W4771

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4771	001/11982	T Th 1:10pm - 2:25pm 451 Computer Science Bldg	Nakul Verma	3.00	67/110
COMS 4771	002/11983	T Th 2:40pm - 3:55pm 451 Computer Science Bldg	Nakul Verma	3.00	54/110
COMS 4771	V01/18077		Nakul Verma	3.00	2/99

COMS W4772 ADVANCED MACHINE LEARNING. *3.00 points*.
Lect: 3.

Prerequisites: (COMS W4771) or COMS W4771; Instructor's permission; knowledge of linear algebra & introductory probability or statistics is required.
An exploration of advanced machine learning tools for perception and behavior learning. How can machines perceive, learn from, and classify human activity computationally? Topics include appearance-based models, principal and independent components analysis, dimensionality reduction, kernel methods, manifold learning, latent models, regression, classification, Bayesian methods, maximum entropy methods, real-time tracking, extended Kalman filters, time series prediction, hidden Markov models, factorial HMMS, input-output HMMs, Markov random fields, variational methods, dynamic Bayesian networks, and Gaussian/Dirichlet processes. Links to cognitive science

COMS W4773 Machine Learning Theory. *3 points*.
Prerequisites: Machine Learning (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.

Prerequisites: see notes re: points 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 E4773 Machine Learning Theory. *3.00 points*.
Theoretical study of algorithms for machine learning and high-dimensional data analysis. Topics include high-dimensional probability, theory of generalization and statistical learning, online learning and optimization, spectral analysis

COMS W4774 Unsupervised Learning. *3.00 points*.
Prerequisites: Solid background in multivariate calculus, linear algebra, basic probability, and algorithms.

Prerequisites: see notes re: points 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: Discrete Math, Calculus, Statistics (basic probability, modeling, experimental design), some programming experience.

Prerequisites: see notes re: points 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 E4775 Causal Inference. *3 points*.
Prerequisites: (COMS4711W) and
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 W4776 Machine Learning for Data Science. *3 points*.
Lect.: 3

Prerequisites: (STAT GU4001 or IEOR E4150) and SIEO W3600 or W4150 or equivalent.
Introduction to machine learning, emphasis on data science.
Topics include least square methods, Gaussian distributions, linear classification, linear regression, maximum likelihood, exponential family distributions, Bayesian networks, Bayesian inference, mixture models, the EM algorithm, graphical models, hidden Markov models, support vector machines kernel methods. Emphasizes methods and problems relevant to big data. Students may not receive credit for both COMS W4771 and W4776.

COMS W4824 COMPUTER ARCHITECTURE. *3.00 points*.

COMS W4835 COMPUTER ORGANIZATION II. *3.00 points*.

COMS E4899 Research Training. *0.00 points*.
Research training course. Recommended in preparation for laboratory related research

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 W4910 CURRICULAR PRACTICAL TRAINING. *1.00 point*.

COMS E4995 COMPUTER ARTS/VIDEO GAMES. *3.00 points*.
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

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 2025: COMS W4995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4995	001/11984	M W 8:40am - 9:55am 451 Computer Science Bldg	Timothy Roughgarden	3.00	52/70
COMS 4995	002/11985	T 1:10pm - 3:40pm 829 Seeley W. Mudd Building	Gary Zamchick	3.00	41/40
COMS 4995	003/11986	Th 4:10pm - 6:40pm 829 Seeley W. Mudd Building	Christian Swinehart	3.00	36/40
COMS 4995	005/13153	F 12:10pm - 2:00pm 317 Hamilton Hall	Suman Jana	3.00	3/20
COMS 4995	006/13749	M 4:10pm - 6:40pm 825 Seeley W. Mudd Building	Elias Bareinboim	3.00	20/40
COMS 4995	008/13387	M W 2:40pm - 3:55pm 633 Seeley W. Mudd Building	Jae Lee	3.00	42/60
COMS 4995	009/13388	M W 5:40pm - 6:55pm 833 Seeley W. Mudd Building	Jae Lee	3.00	98/120
COMS 4995	010/13389	M W 2:40pm - 3:55pm 233 Seeley W. Mudd Building	Corey Toler-Franklin	3.00	7/45
COMS 4995	011/13753	T Th 2:40pm - 3:55pm 501 Schermerhorn Hall	Richard Zemel	3.00	117/140
COMS 4995	012/13758	F 1:10pm - 3:40pm 545 Seeley W. Mudd Building	Yongwhan Lim	3.00	47/54
COMS 4995	013/20415	F 1:10pm - 3:40pm 829 Seeley W. Mudd Building	Gary Zamchick	3.00	39/40
COMS 4995	030/15959	T 7:00pm - 9:30pm 413 Kent Hall	Adam Kelleher	3.00	44/71
COMS 4995	031/15960	W 7:00pm - 9:30pm 142 Uris Hall	Andrei Simion	3.00	76/95
COMS 4995	032/15961	W 7:10pm - 9:40pm 501 Northwest Corner	Vijay Pappu	3.00	81/85
COMS 4995	V08/18080		Jae Lee	3.00	3/99
COMS 4995	V09/18082		Jae Lee	3.00	2/99
COMS 4995	V11/18083		Richard Zemel	3.00	19/99
COMS 4995	V12/18078		Yongwhan Lim	3.00	3/99

Fall 2025: COMS W4995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
COMS 4995	030/11000	T 7:00pm - 9:30pm Room TBA	Andi Cupallari	3.00	0/85
COMS 4995	031/11001	T 7:00pm - 9:30pm Room TBA	Andrei Simion	3.00	0/120

COMS W4996 Special topics in computer science, II. *3 points*.
Lect: 3.**Not offered during 2023-2024 academic year.**

Prerequisites: Instructor's permission.
A continuation of COMS W4995 when the special topic extends over two terms.

Computer Science - Electrical Engineering

CSEE W3826 FUNDAMENTALS OF COMPUTER ORG. *3.00 points*.

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 2025: CSEE W3827

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 3827	001/12006	M W 11:40am - 12:55pm 501 Northwest Corner	Brian Plancher	3.00	168/164
CSEE 3827	002/12007	M W 1:10pm - 2:25pm 501 Northwest Corner	Brian Plancher	3.00	160/164

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 2025: CSEE W4119

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4119	001/12008	T Th 11:40am - 12:55pm 301 Uris Hall	Xia Zhou	3.00	131/150
CSEE 4119	V01/20475		Xia Zhou	3.00	10/99

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 2025: CSEE W4121

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4121	001/15957	Th 10:10am - 12:40pm 602 Hamilton Hall	Asaf Cidon	3.00	81/85
CSEE 4121	002/15958	Th 1:10pm - 3:40pm 717 Hamilton Hall	Asaf Cidon	3.00	84/85

CSEE W4140 NETWORKING LABORATORY. *3.00 points*.
Lect: 3.

Prerequisites: (CSEE W4119) or CSEE W4119; or equivalent.
In this course, students will learn how to put principles into practice, in a hands-on-networking lab course. The course will cover the technologies and protocols of the Internet using equipment currently available to large internet service providers such as CISCO routers and end systems. A set of laboratory experiments will provide hands-on experience with engineering wide-area networks and will familiarize students with the Internet Protocol (IP), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), User Datagram Protocol (UDP) and Transmission Control Protocol (TCP), the Domain Name System (DNS), routing protocols (RIP, OSPF, BGP), network management protocols (SNMP, and application-level protocols (FTP, TELNET, SMTP)

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 2025: CSEE W4823

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4823	001/11261	T Th 2:40pm - 3:55pm Room TBA	Mingoo Seok	3	0/120

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

Spring 2025: CSEE W4824

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4824	001/13627	M W 8:40am - 9:55am 142 Uris Hall	Tanvir Ahmed Khan	3.00	46/70

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 2025: CSEE W4840

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CSEE 4840	001/12009	M W 1:10pm - 2:25pm 451 Computer Science Bldg	Stephen Edwards	3.00	98/110

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

Computer Science - Biomedical Engineering

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 2025: CBMF W4761

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CBMF 4761	001/11947	T Th 5:40pm - 6:55pm 627 Seeley W. Mudd Building	Itsik Pe'er	3.00	36/52
CBMF 4761	V01/18003		Itsik Pe'er	3.00	2/99