

# Computer Science (CSE)

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**Degrees awarded:** M.S. in Computer Science; M.S. in Information Systems Engineering; Ph.D. in Computer Science

The Department of Computer Science offers an M.S. and a Ph.D. in Computer Science, and an M.S. in Information Systems Engineering.

The M.S. program in Computer Science is designed primarily to train students with professional goals in business, industry, or government, requiring a detailed knowledge of computer science concepts and applications. The program concentrates primarily on applied computer science, emphasizing software development, programming, computer systems, and applications. Each student is given the experience of working on a large-scale software or hardware development project involving analysis, design, evaluation, and implementation.

The Ph.D. program in Computer Science is for students interested in obtaining academic or research positions in colleges and universities or in government or commercial research laboratories. The program gives students a rigorous and thorough knowledge of a broad range of theoretical and practical research subject areas and develops the ability to recognize and pursue significant research in computer science. The first two years of graduate study are devoted to coursework. By the end of the second year the research phase of the student's graduate career should be underway, with participation in advanced study and preliminary research work. The final years of graduate study are devoted to dissertation research.

The primary areas of Departmental research interests include, among others, algorithms, architecture, artificial intelligence, computation theory, concurrency, databases, image processing, graphics, languages, logic, networking, and operating systems.

Information in this *Bulletin* concerning the M.S. and Ph.D. programs in Computer Science is an abbreviated version of the Graduate Program Handbook found at [www.cs.sunysb.edu/graduate/GraduateHandbook.html](http://www.cs.sunysb.edu/graduate/GraduateHandbook.html). Students must refer to the *Handbook* for further details and up-to-date information.

Additional information about the graduate program in Computer Science can be found on the Department's Web site at [www.cs.sunysb.edu](http://www.cs.sunysb.edu)

The program for Master's of Science in Information Systems Engineering (M.S.I.S.) emphasizes the engineering and application aspects of Information Technology (IT). The program differs from a traditional Information Systems program in that it focuses on an engineering approach to IT. The curriculum of the program also emphasizes individual communications skills and team participation.

The M.S.I.S. degree program has distinct specialization tracks geared to different classes of IT employment. The curriculum, consisting of 30 credits of coursework, is designed to accommodate students from a wide variety of backgrounds. An Executive track, specially designed for full-time employees with working experience, facilitates the 30 credits to be completed with an evening/weekend schedule. Specialization tracks for the program include Software Engineering, Systems Engineering, and Telecommunications. The core component of the program consists of courses in analysis, modeling, and design; data communications and networking; data management; hardware; programming; and technology integration. Following the completion of the core requirements, students can specialize in one of the tracks by choosing appropriate electives. Students are expected to solve real-world problems by applying and integrating newly acquired skills. The integration requirement can be satisfied at any time after the completion of the core courses.

## Computing Environment

The Department of Computer Science is composed of a number of special-interest labs (Experimental Systems, File Systems, Human Interface with Computers, Logic Modeling, Security Systems, Visualization, and Wireless Networking and Multimedia) connected by a multi-gigabyte backbone. Typical

systems are PCs running FreeBSD, Linux, MS Windows, and Sun Sparc systems. There are numerous multi-processor/large memory systems including a graphics cluster of Linux and MS Windows PCs. General-access labs provide UNIX and MS Windows systems, and each office desktop is equipped with a workstation. The Department maintains its own dial-up service and wireless network. The Stony Brook campus is connected to the Internet via multiple OC3 connections.

## Admission to the M.S. and Ph.D. in Computer Science

Admission to the M.S. and Ph.D. programs are handled separately by the Departmental admissions committee. The requirements for admission to graduate study in computer science include:

A. Bachelor's Degree: A bachelor's degree, usually in a science or engineering discipline or in mathematics, with a grade point average of at least B (3.0/4.0) in all undergraduate coursework, and in the science, mathematics, and engineering courses;

B. Basic Mathematics: Two semesters of college-level calculus, plus a course in linear algebra; also desirable is a course in either probability theory or probability and statistics;

C. Minimal Background in Computer Science: As a measure of that background, the student must satisfy five of the following proficiency requirements:

1. Theory of Computation: CSE 303 or CSE 540
2. Algorithms: CSE 373 or CSE 548
3. Language/Compilers: CSE 304, CSE 307, CSE 504, or CSE 526
4. Architecture: CSE 320 or CSE 502
5. Databases: CSE 305 or CSE 532
6. Operating Systems: CSE 306 or CSE 506
7. Networks or Graphics: CSE 310, CSE 533, CSE 328, or CSE 528

D. Acceptance by the Department of Computer Science and Graduate School;

E. All applicants to the M.S. or Ph.D. program must submit Graduate Record Examination (GRE) scores for the general aptitude tests. Applicants are encouraged to submit GRE test scores for the advanced examination in Computer Science as well. More information on the application process can be found at [www.cs.sunysb.edu/graduate](http://www.cs.sunysb.edu/graduate)

## Admission to the M.S. in Information Systems Engineering

Admission to the regular program is based on the following criteria:

A. A baccalaureate degree from an accredited applied science or engineering program with a minimum GPA of 2.75. (Provisional admissions may be granted in exceptional cases if the GPA is less than 2.75 but above 2.25 provided it is approved by the Graduate School at the recommendation of the IS Graduate Committee. Provisionally admitted students are required to take at least two courses in the first semester and receive a B average to continue in the program.);

B. GRE scores (provisionally admitted students without GRE scores must take the examination within the first semester of their registration);

C. A minimum score of 550 in TOEFL for applicants whose first or native language is not English;

D. Letters of recommendation;

E. Other documents as described in the Graduate Bulletin.

Admission to the Executive track is based on the following criteria:

A. A baccalaureate degree from an accredited applied science or engineering program, with a minimum GPA of 2.75;

B. IT-related work experience;

C. Details of work experience, responsibilities/duties, and career goals;

D. A minimum score of 550 in TOEFL if the baccalaureate degree is from a foreign institution;

E. Letters of recommendation from current and previous employers and teachers.

For admission to the M.S. in Information Systems Engineering program, all applicants are required to submit completed applications to the Graduate School through the College of Engineering and Applied Sciences, with the following documents: (a) an official graduate application form specially designed for appli-

cants to the proposed program with non-refundable application fee as prescribed by the University, (b) three letters of recommendation, (c) two official copies of all previous transcripts (if in a foreign language, English translation is required together with the originals), (d) details of the employment history and duties/responsibilities, (e) scores of GRE, (f) scores of TOEFL in case of applicants for whom English is not the first language, and (g) a personal statement describing previous accomplishments, career objectives, and future goals. Students in the Executive track may waive GRE requirements with the approval of the Graduate School.

All applications submitted in time are reviewed by the Graduate Committee and applicants who meet the requirements are selected on a competitive basis. Applications are scored on a scale reflecting academic achievements, GRE scores, work experience, and career goals. Preference is given to the applicants with relevant experience. Special considerations are made for women, minorities, and physically challenged applicants provided they meet the minimum admission criteria. Preference also is given first to New York residents and second to U.S. citizens and permanent residents.

Applicants for the Executive Track are considered in a separate pool. Their applications must contain a support letter from the employer describing the length of service in the company, the responsibilities and authority, evaluation of the job performance, and how the participation in the Executive track by the applicant benefits the company.

Students of high caliber seeking to enter the program with an incomplete set of undergraduate courses or not having enough prerequisites are required to complete a predetermined number of foundation courses (normally consisting of nine credits), including Fundamentals of Information Systems; Information Systems and Business; Information Technology Hardware and Software; and Programming, Data, and Object Structures.

## Faculty

### Professors

Bachmair, Leo, Ph.D., 1987, University of Illinois, Urbana-Champaign: Computational logic; automated deduction; symbolic computation.

Chiueh, Tzi-cker, Ph.D., 1992, University of California, Berkeley: Processor architecture; parallel I/O; high-speed networks; compression.

Kaufman, Arie, *Chair*, Ph.D., 1977, Ben-Gurion University: Computer graphics; visualization; user interfaces; computer architecture; virtual reality; multimedia.

Kifer, Michael, Ph.D., 1984, Hebrew University of Jerusalem: Database systems; logic programming; knowledge representation; Web information systems; workflow management systems.

Ko, Ker-I, Ph.D., 1979, Ohio State University: Computational complexity; theory of computation; computational learning theory.

Liang, Jerome, Ph.D., 1987, City University of New York: Medical imaging; image processing.

Mitchell, Joseph, Ph.D., 1986, Stanford University: Operations research; computational geometry; combinatorial optimization.

Qin, Hong, Ph.D., 1995, University of Toronto, Canada: Computer graphics; geometric and physics-based modeling; computer-aided design; computer animation and simulation; scientific computing and visualization; virtual environments; computational vision; medical imaging; human-computer interaction; robotics.

Ramakrishnan, I.V., *Graduate Program Director*, Ph.D., 1983, University of Texas, Austin: Automated reasoning; technologies for Web-based computing.

Sekar, R.C., Ph.D., 1991, Stony Brook University: Computer security; distributed systems; programming languages/software engineering.

Skiena, Steven, Ph.D., 1988, University of Illinois, Urbana-Champaign: Computational biology; combinatorial algorithms; combinatorial computing environments; data structures.

Smolka, Scott A., Ph.D., 1984, Brown University: Computer-aided verification of safety-critical systems; computer system security.

Stark, Eugene, Ph.D., 1984, Massachusetts Institute of Technology: Programming language semantics; theory of concurrency; formal methods; operating systems.

Warren, David S., Ph.D., 1979, University of Michigan: Logic programming; database systems; knowledge representation; natural language and logic.

Wittie, Larry D., Ph.D., 1973, University of Wisconsin: Computer architecture; massively parallel computation; simulation of memory and attention to mammal brains.

Yang, Yuanyuan, Ph.D., 1992, Johns Hopkins University: Parallel and distributed computing systems; high-speed networks; multicast communication; optical networks; high-performance computer architecture; computer algorithms; fault tolerant computing.

### Associate Professors

Arkin, Esther, Ph.D., 1986, Stanford University: Combinatorial optimization; network flows; computational geometry.

Badr, Hussein G., Ph.D., 1981, Pennsylvania State University: Computer communication networks and protocols; performance evaluation; modeling and analysis.

Bender, Michael, Ph.D., 1998, Harvard University: Algorithms; scheduling; data structures; cache and I/O-efficient computing; parallel computing.

Brennan, Susan, Ph.D., 1990, Stanford University: Cognitive psychology; linguistics; human-computer interaction.

Das, Samir, Ph.D., 1994, Georgia Institute of Technology: Mobile/wireless networking; ad hoc and sensor networks; parallel discrete-event simulation; performance evaluation.

Grosu, Radu, Ph.D., 1994, Technical University of Munich, Germany: Model-based design and verification of embedded software systems; model checking; abstract interpretation; logic and automata theory; type theory; computational models in systems biology; applied formal methods; software and systems engineering.

Liu, Yanhong Annie, Ph.D., 1996, Cornell University: Programming languages; compilers; software systems.

Mueller, Klaus, Ph.D., 1998, Ohio State University: Computer graphics; visualization; projector-based graphics; augmented reality; virtual reality; medical imaging face recognition; GPU-acceleration of general purpose computing; visual data mining; functional brain analysis.

Ramakrishnan, C.R., Ph.D., 1995, Stony Brook University: Formal verification of concurrent systems; logic programming; computer security.

Samaras, Dimitris, Ph.D., 2000, University of Pennsylvania: Computer vision; computer graphics; medical imaging; animation and simulation; image-based rendering; physics-based modeling.

Stoller, Scott, Ph.D., 1997, Cornell University: Distributed systems; software testing and verification; program analysis and optimization.

Wasilewska, Anita, Ph.D., 1975, Warsaw University: Logic; knowledge representation; artificial intelligence.

Zadok, Erez, Ph.D., 2000, Columbia University: Operating systems; file systems; storage; networking; software engineering; security.

Zelinsky, Gregory J., Ph.D., 1994, Brown University: Visual search; visual working memory; object detection and recognition; visual attention and eye movements; scene perception and representation.

### Assistant Professors

Gao, Jie, Ph.D., 2004, Stanford University: Algorithms; ad hoc communication and sensor networks; computational geometry.

Gu, Xianfeng, Ph.D., 2004, Harvard University: Computer graphics; computer vision; medical imaging; computational conformal geometry; global differential geometry; harmonic analysis; computational algebraic topology; computational optics; biometrics.

Gupta, Himanshu, Ph.D., 1999, Stanford University: Databases; data mining; data warehousing.

Johnson, Robert, Ph.D., 2007, University of California, Berkeley: Software security; system and network security; cryptography; digital rights management; operating systems; networks; algorithm design and analysis.

Lv, Qin, Ph.D., 2006, Princeton University: Development of efficient systems for managing and exploring massive amounts of digital data; focus on search systems, data management, distributed systems, storage systems and networking, but also spans the areas of algorithm design, machine learning, data mining, and specific application domains such as multimedia, bioinformatics, sensor networks, healthcare, and scientific computing.

Rizzo, Robert, Ph.D., 2001, Yale University: Computational biology.

Sion, Radu, Ph.D., 2004, Purdue University: Data security and privacy in distributed networked environments.

Stent, Amanda, Ph.D., 2001, University of Rochester: Natural language processing.

Vasilescu, M. Alex O., 2005, University of Toronto: Computer vision; computer graphics; tensor algebra; physics-based modeling; machine learning.

Wong, Jennifer, Ph.D., 2006, University of California, Los Angeles: Interaction of statistical models and optimization for CAD and embedded systems; low power wireless communication; sensor networks.

### Affiliated Faculty for Program in Information Systems Engineering

Chiueh, Tzi-cker, Computer Science

Doboli, Alex, Electrical and Computer Engineering

Djuric, Petar, Electrical and Computer Engineering

Donetski, Dmitri, Electrical and Computer Engineering

Feinberg, Eugene, Applied Mathematics

Huang, Peisen, Mechanical Engineering

Kao, Imin, Mechanical Engineering

Kaufman, Arie E., Computer Science

Kelly, Robert F., Computer Science

Lindquist, W. Brent, Applied Mathematics

Mujica-Parodi, Lillianne, Biomedical Engineering

Murray, John, Electrical and Computer Engineering

Robertazzi, Thomas G., Electrical and Computer Engineering

Teng, Tian-Lih, Technology and Society

Zhou, Rong, Computer Science

### Executive Committee of Program in Information Systems Engineering

Djuric, Petar, Electrical and Computer Engineering

Kaufman, Arie E., Computer Science

Kelly, Robert F., Computer Science

Lindquist, W. Brent, Applied Mathematics

Robertazzi, Thomas G., Electrical and Computer Engineering

Teng, Tian-Lih, Technology and Society

Zhou, Rong, Computer Science

*Number of teaching, graduate, and research assistants, Fall 2006: 120*

## Degree Requirements Requirements for the M.S. Degree in Computer Science

Students in the M.S. degree program choose between two options, the M.S. with thesis and the M.S. with project. The course requirements depend on the option chosen.

### A. Registration

Students must register for at least one graduate credit in the semester in which the diploma is awarded.

### B. Language Requirement

There is no foreign language requirement.

### C. Course Requirements

Students are required to complete 31 graduate credits in the Department of Computer Science. There are no specific courses required other than a thesis or project, with the stipulation that the proficiency requirements must be satisfied. Students can take up to four credits of CSE 587 (at most two courses) to fill in missing proficiency requirements. All seven proficiency requirements must be satisfied by the time of M.S. certification. A list of graduate courses is provided in the course compendium at the end of this section.

### D. Grade Point Average

To be certified for graduation a cumulative graduate grade point average of 3.0/4.0 or better is required.

### E. No-Thesis Option

Students choosing the no-thesis option are required to take the courses CSE 523/524, Laboratory in Computer Science. The two courses may not be taken in the same semester. These courses provide students with the experience of dealing with large-scale, computer-oriented problems such as those encountered in commercial, industrial, or research environments. Students taking CSE 523/524 may not use any CSE 599 (M.S. Thesis Research) credits toward their M.S. degree.

### F. Thesis Option

A student choosing the thesis option must select a project (or thesis) advisor by the end of the second semester in

the program. The role of the advisor is to guide the student through the M.S. studies, formulate a project or thesis topic, and supervise the student toward completion of the assigned task. The thesis must be approved by a Departmental faculty committee of no less than three members appointed by the graduate program director. At the discretion of the committee, the student may be required to present a seminar on the topic of his or her thesis. A student registers for CSE 599 when writing a thesis. No more than nine credits of this course can be applied toward the 31 credits required for the M.S. degree.

### G. Switching Between the M.S. and Ph.D. Programs

An M.S. student who wishes to advance to the Ph.D. program must take the qualifying examination. Regular applicants to the Ph.D. program will not be considered from current M.S. students. Please refer to the *Graduate Program Handbook* for more details.

### Requirements for the M.S. Degree in Information Systems Engineering

To receive the M.S. in Information Systems Engineering degree the student must obtain a minimum of 3.0 overall GPA in the courses taken to satisfy the requirements of this program. In addition, the student must satisfy all other requirements of the Graduate School not mentioned here. Following are the specific requirements that must be met to obtain the degree:

Each student must complete a minimum of 30 credits of graduate course work, consistent with program guidelines.

Each student must complete 15 credits of core courses (Analysis; Data Management; Design, Data Communications, and Networking; Modeling; Quantitative Computer Architecture; and Systems Engineering Principles).

A three-credit course covering an integration topic is required for all students (e.g., ISE 511, CSE 580, or CSE 523).

The required courses total 18 credits, including the 15 credits of core courses and three credits of integration. A minimum of 12 credits of electives is required of all students, out of which nine credits must be taken in the area of specialization. In case of core courses waived for equivalent courses taken previously, the student must earn those

credits through electives at Stony Brook University, bringing the total credits to a minimum of 30.

A maximum of six credits of graduate coursework can be transferred for the courses taken elsewhere provided these credits were not used by the previous institution to award a degree.

Each student is assigned an academic advisor who must approve the coursework, area of specialization, and sequence of courses.

*Curriculum for the Executive Track:* The Executive track is designed primarily for the employees of one company (or a group of companies). This requirement is identical to the requirement of the standard program. The curriculum is common to all the students in the program and targeted to the interests of the sponsoring company (or companies).

### Courses for the M.S. Degree in Information Systems Engineering

*Information Systems Engineering (ISE)*

ISE 503 Data Management  
ISE 504 Analysis, Modeling, and Design  
ISE 506 Quantitative Computer Architecture

ISE 516 Systems Engineering Principles  
ISE 517 Human Factors in Systems Engineering

*Applied Mathematics and Statistics (AMS)*

(A complete description of AMS courses below can be found at [www.grad.sunysb.edu/academics/bulletin/Ams.pdf](http://www.grad.sunysb.edu/academics/bulletin/Ams.pdf))

AMS 507 Introduction to Probability  
AMS 550 Operations Research: Stochastic Models

AMS 553 Simulation and Modeling

*Biomedical Engineering (BME)*  
(A complete description of BME courses below can be found at [www.bme.sunysb.edu/bme/grad/courses.html](http://www.bme.sunysb.edu/bme/grad/courses.html))

BME 526 Biological Systems Engineering

*Technology and Society (EMP/EST)*

(A complete description of EMP courses below can be found at [www.sunysb.edu/est/courses/graduate.html](http://www.sunysb.edu/est/courses/graduate.html))

EMP 518 Project Management  
EST 530 Internet Electronic Commerce  
EST 582 Systems Approach to Human-Machine Systems

*Electrical and Computer Engineering (ESE)*

(A complete description of ESE courses below can be found at [www.ee.sunysb.edu/~www/grad/coursedescriptions\\_b.html](http://www.ee.sunysb.edu/~www/grad/coursedescriptions_b.html))

ESE 504 Performance and Evaluation of Communication and Computer Systems

ESE 505 Traffic Performance Analysis of Mobile, Wireless, and Personal Communication Systems

ESE 528 Communication Systems

ESE 546 Computer Communication Networks I

ESE 547 Digital Signal Processing

ESE 548 Computer Communication Networks II

*Business Technology Management*

(A complete description of BTM courses below can be found at [www.grad.sunysb.edu/academics/bulletin/Bus.pdf](http://www.grad.sunysb.edu/academics/bulletin/Bus.pdf))

BTM 514 Quality Management and Quality Assurance

*Computer Science (CSE)*

(A complete description of CSE courses below can be found at [www.cs.sunysb.edu/graduate/courses/](http://www.cs.sunysb.edu/graduate/courses/))

CSE 500 Patterns in Programming

CSE 506 Operating Systems

CSE 515 Introduction to Transaction Processing Systems

CSE 523 Introduction to Software Engineering and Project Planning I

CSE 524 Introduction to Software Engineering and Project Planning II

CSE 533 Computer Network Communications Protocols

CSE 536 Introduction to User-Interface Development

### Requirements for the Ph.D. Degree in Computer Science

#### A. Residence

The student must complete two consecutive semesters of full-time graduate study. Full-time study is 12 credits per semester until 24 graduate credits have been earned. Students who have earned 24 graduate credits at another school may be assigned advanced status and are required to take only nine credits per semester for full-time status.

#### B. Qualifying Examination

Students must pass the written qualifying examination to demonstrate their ability to undertake the course of study leading to the Ph.D. degree. Qualifying examinations are given twice a year: in May (usually the week after the finals period) and in early January. Students must refer to [www.cs.sunysb.edu/graduate/QualsHandbook.html](http://www.cs.sunysb.edu/graduate/QualsHandbook.html) for further details and up-to-date information on the qualifying examination. The following is a short summary of the contents of this examination.

The exam consists of three parts, three hours each, based on undergraduate

material as described below. Undergraduate Stony Brook courses covering that material are listed in parentheses. An appropriate way for students who have already taken an undergraduate course in a particular area to prepare for the exam is to take a graduate course in that area. Questions test not just routine knowledge but also the student's ability to use that material in a creative way.

#### **Theory and Mathematics:**

Theory of Computation, Languages, and Automata Analysis of Algorithms and Logic. The examination is based on the following courses: CSE 303, CSE 371, CSE 213, and CSE 373.

#### **Software:**

Programming Languages, Compilers, Databases, and Graphics. The examination is based on CSE 304, CSE 305, CSE 307, and CSE 328.

#### **Systems:**

Networks and Communications, Operating Systems, Computer Architecture, and Computer Organization. The examination is based on CSE 310, CSE 306, CSE 320, and CSE 220.

The results of the written examination will be communicated to each student individually following a meeting of the faculty, which evaluates the results of the examination along with the student's ability to do research and the likelihood of completing the program.

#### **C. Course Requirements**

In the first year, a student seeking the Ph.D. degree will normally register for a full-time load of courses selected in conjunction with an advisor to prepare for the qualifying examination. By the time of graduation, each student is required to accumulate at least 20 credits of full (regular lecture) courses, internship, special topics courses, or seminars. At most five credits of seminars and internship can be included in the 20 credits required for graduation; generic courses such as CSE 587, CSE 593, CSE 600, CSE 698, and CSE 699 cannot be included. In addition, the following requirements should be noted:

*M.S.-specific courses.* Students in the Ph.D. program may not enroll in CSE 523/524 or CSE 599. These courses are specific to the M.S. program.

*Ongoing research seminar.* The student must register and complete two semesters of CSE 600. Credits earned in this course cannot be used

toward the 20 credits required for the Ph.D. program.

*Internship, CSE 696.* At most two credits of Internship in Research can be counted toward the 20 credits required for the Ph.D. program.

*Dissertation Research, CSE 699.* The Dissertation Research course can be taken only by Ph.D. students who have been advanced to candidacy (have G5 status). Prior to the advancement, students conduct research and participate in projects by taking CSE 593: Independent Study. G4 students can register for up to nine credits of CSE 593 in any semester. G3 students can register for only up to three credits of CSE 593.

*Teaching requirement.* University policy requires that all doctoral students participate in an appropriately structured teaching practicum. This can be CSE 698 in conjunction with a T.A. in the first year.

#### **D. Research Proficiency Examination (RPE)**

The purpose of the Research Proficiency Examination is to ascertain the breadth and depth of the student's preparation to undertake a significant original research investigation.

By the end of the third semester since admission into the Ph.D. program, an RPE committee will have been formed for each student and an agreement reached on a research project. (M.S. students who were admitted to the Ph.D. program after passing the qualifying examination must form the RPE committee by the end of their first semester in the Ph.D. program.)

By the end of the fourth semester (at the latest), the student will take the RPE. (M.S. students who switched to Ph.D. must take the RPE by the end of their second semester in the Ph.D. program.)

Having passed both the qualifying examination and the RPE, the student is advanced to candidacy. This status, called G5, is conferred by the Dean of the Graduate School upon recommendation of the Department. Note that unlike the change from G3 to G4, the change from G4 to G5 is not automatic—the student must request to be advanced to candidacy by notifying the Computer Science Graduate Coordinator. Students must advance to candidacy at least one year before defending their dissertations. The Graduate School requires G5 students to register for nine credits,

which can be research or other graduate courses relevant to their dissertation. Courses outside of the major require the approval of the dissertation advisor and Graduate Director. Failure to complete the RPE within the specified timeframe and obtain the G5 status is considered evidence of unsatisfactory progress.

#### **E. Thesis Proposal Requirement**

After the student has completed the requirements in subsections C and D, and with the approval of the student's research advisor, the student will present a thesis proposal. The purpose of the thesis proposal is to assess the student's progress toward the the Ph.D. thesis. The proposal must be submitted to the student's thesis committee within 18 months of the time the student has passed the research proficiency examination. Failure to fulfill this requirement by that time without a formal extension may be considered evidence of unsatisfactory progress toward the Ph.D. degree.

The major requirements of the thesis proposal are as follows: (1) the student must be thoroughly familiar with the background and current status of the intended research area; (2) the student must have clear and well-defined plans for pursuing the research objectives; and (3) the student must offer evidence of progress in achieving these objectives.

The student will present the thesis proposal to the thesis committee in a seminar presentation. It is limited to members of the committee, invited computer science faculty, and invited graduate students. Faculty members are free to question the student on any topics they feel are in any way relevant to the student's objectives and career preparation. Most questions, however, will be directed toward verifying the student's grasp of the intended specialty in depth. The student will be expected to show complete familiarity with the current and past literature of this area.

The findings of the committee will be communicated to the student as soon as possible and to the Graduate School within one week of the presentation of the proposal. If the committee finds the thesis proposal unsatisfactory, the student will submit an improved proposal, if such resubmission is approved by the Dean of the Graduate School.

## F. Dissertation

An important requirement of the Ph.D. program is the completion of a dissertation, which must be an original scholarly investigation. The dissertation shall represent a significant contribution to the scientific literature, and its quality shall be compatible with the publication standards of appropriate reputable scholarly journals.

## G. Approval and Defense of Dissertation

The dissertation must be orally defended before a dissertation examination committee, and the candidate must obtain approval of the dissertation from this committee. The oral defense of the dissertation is open to all interested faculty members and graduate students. The final draft of the dissertation must be submitted to the committee no later than three weeks prior to the date of the defense.

## H. Satisfactory Progress and Time Limit

A student who does not meet the target dates for the Qualifying Examination, the Research Proficiency Examination, and the Thesis Proposal, or who does not make satisfactory progress toward completing thesis research may lose financial support. The candidate must satisfy all requirements for the Ph.D. degree within seven years after completing 24 credit hours of graduate courses in the Department of Computer Science at Stony Brook. In rare instances, the Dean of the Graduate School will entertain a petition to extend this time limit, provided it bears the endorsement of the Department's graduate program director. A petition for extension must be submitted before the time limit has been exceeded. The Dean or the Department may require evidence that the student is still properly prepared for the completion of work.

## I. Part-Time Students

Students admitted into the Ph.D. program for part-time study are bound by all the rules set out henceforth. In particular, part-time students should adhere to the schedule for the Qualifying Examination, Research Proficiency Examination, and Thesis Proposal unless a different schedule has been approved in writing by the Graduate Director.

## J. Satisfactory Progress and Time Limit

A Ph.D. student who has passed the Research Proficiency Examination

can complete the requirements for an M.S. degree by satisfying the proficiency requirements and completing 31 credits of coursework. Passing the Qualifying Examination is considered to have satisfied the proficiency requirements. (Another way to satisfy these requirements is, of course, to take the required courses.)

At most nine credits of seminars (excluding CSE 600), special topics courses, or CSE 593 (Independent study) can be included in the required 31 credits. A student who has switched from the M.S. program to the Ph.D. program can in addition use the previously earned credits of CSE 523/524 toward the aforesaid nine credits. These nine credits together with the RPE are considered to be equivalent to the Thesis Option in the M.S. program. The remaining 22 credits required for the M.S. degree must be satisfied by taking technical graduate courses in computer science (i.e., excluding courses such as CSE 523/524, CSE 587, CSE 593, CSE 596, CSE 599, CSE 696, CSE 698, CSE 699, seminars, and special topics).

## Courses

A current list of courses can be found at [www.cs.stonybrook.edu/graduate/courses/index.html](http://www.cs.stonybrook.edu/graduate/courses/index.html)

## Required Courses for the M.S. Non-Thesis Option

### CSE 500 Patterns in Programing

This course provides an introduction to programming patterns often encountered in software systems. It presents the role of patterns and introduces patterns used by computer scientists and software engineers. The course covers a wide breadth of program types including user interfaces, numerical computing, event handling, and use of varied data structures. Patterns developed during the course are predominantly object-oriented patterns, including factory, facade, and many others. Not accepted for credit toward M.S. degree.

*Prerequisite: permission of instructor*  
*3 credits, ABCF grading*

## Graduate Courses

### CSE 502 Computer Architecture

Topics covered include instruction pipelines and memory caches to improve computer performance; instruction-level parallelism; machines: superscalar versus VLIW; cache and main memory hierarchy design tradeoffs; compiler optimizations to speed pipelines; low-power computer system design: processor, OS, and compiler support; graphics, DSP, and media processor design; disk I/O system design; inter-

connections and networking; and introduction to parallel architecture. Advanced topics include asynchronous microprocessors; FPGA-based reconfigurable computing; system on a chip; embedded processors; intelligent RAM and superconducting computers.

*Prerequisite: CSE 345*

*Spring, 3 credits, ABCF grading*

### CSE 504 Compiler Design

This course covers advanced topics in compilation, including memory management, dataflow analysis, code optimization, just-in-time compilation, and selected topics from compilation of object-oriented and declarative languages.

*Prerequisites: CSE 304 and CSE 307*

*Spring, 3 credits, ABCF grading*

### CSE 505 Computing with Logic

The course explores logic-based computing and logic programming. It includes an introduction to programming in logic, covering basic techniques for solving problems in a logic programming system. Particular attention will be paid to user interface issues and how a logic system can provide a useful computing environment. The course covers implementation issues, emphasizing how a logic programming system generalizes both traditional programming language systems and traditional database systems.

*Prerequisite: CSE 214*

*3 credits, ABCF grading*

### CSE 506 Operating Systems

This course is an in-depth study of important concepts and techniques found in modern computer operating systems. An undergraduate course in operating systems is a prerequisite. The course focuses on in-depth study of such important issues as virtual memory, file systems, networking, and multiprocessor support, with an eye to recent directions in these areas. Textbook readings are supplemented where appropriate by papers from the research literature. An important part of the course is the case study of an actual operating system. Students study the source code for this operating system and do programming exercises and projects that involve modifying the operating system and measuring its performance.

*Prerequisite: CSE 306*

*Spring, 3 credits, ABCF grading*

### CSE 507 Introduction to Computational Linguistics

Overview of computational approaches to language use. Core topics include mathematical and logical foundations, syntax, semantics, and pragmatics. Special topics may include speech processing, dialog system machine translation information extraction, and information retrieval. Statistical and traditional approaches are included. Students will develop familiarity with the literature and tools of the field.

*Prerequisites: CSE 537; CSE 541*

*recommended*

*Spring, 3 credits, ABCF grading*

### CSE 508 Network Security

Principles and practice of computer network security. Cryptography, authentication protocols, public key infrastructures, IP/www/E-commerce security, firewalls, VPN, and

intrusion detection.

*Prerequisite: CSE/ISE 310, or CSE 346 or equivalent; limited to CSE graduate students; others, permission of instructor*  
3 credits, ABCF grading

### CSE 509 Computer System Security

Principles and practice of building and administering secure systems. Authentication and access control. Operating system security. Program security, database security. Key management. Information flow. Assurance. Vulnerability analysis and intrusion detection.  
*Prerequisite: CSE 306 or CSE 376, or equivalent; limited to CSE graduate students; others, permission of instructor*  
3 credits, ABCF grading  
May be repeated for credit

### CSE 510 Hybrid Systems

Hybrid systems combine discrete state-machines and continuous differential equations and have been used as models of a large number of applications in areas such as real-time software, embedded systems, robotics, mechatronics, aeronautics, process control and biological systems. The course will cover the state-of-the-art of modeling, design and analysis of hybrid systems.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
Spring, 3 credits, ABCF grading  
May be repeated for credit

### CSE 515 Introduction to Transaction Processing Systems

Discusses transaction processing systems. Topics covered include models of transactions, including nested transactions and workflow; architectures of transaction processing systems, including client-server, two-tiered and three-tiered architectures; concurrency controls for conventional and relational databases including two-phase locking and the SQL isolation levels; logging and recovery; distributed transactions including the two-phase commit protocol; replication; Internet commerce, including encryption, the SSL and SET protocols, goods atomicity, and electronic cash.

*Prerequisite: CSE 305*  
Fall, 3 credits, ABCF grading

### CSE 523 Introduction to Software Engineering and Project Plan

A project in programming or digital system design that will extend over two consecutive semesters. The student starts the project in one semester by registering for CSE 523 and completes the project in the following semester by registering for CSE 524. Before the deadline date designated by the course instructor the student will prepare a one-to-two-page description of the work that is expected to be completed during the two semester sequence. This description, reviewed and approved by the student's advisor, will reside in the student's file. Performance in completing the course requirements will be evaluated with reference to the implied promise contained. Amendments to the project description must be approved by the advisor. This course is graded separately from CSE 524.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor.*

*Fall, spring, and summer, 3 credits, ABCF grading*  
May be repeated once for credit

### CSE 524 Lab in Computer Science II

This course involves implementation and completion of the project undertaken in CSE 523. Results are to reflect all aspects of large-scale problem-solving, including cost analysis, design, testing, and documentation. A final report documenting requirements, design, implementation, and testing is required. When appropriate, a user's manual may be written.

*Prerequisite: CSE 523*  
Spring, 3 credits, ABCF grading

### CSE 525 Introduction to Robotics

This course introduces fundamental concepts in robotics. In the first half of the course, basic concepts will be discussed, including coordinate transformation, kinematics, dynamics, Laplace transforms, equations of motion, feedback and feedforward control, and trajectory planning. These topics will be exemplified with Matlab/Simulink simulation studies. The second half of the course will focus on applying the knowledge from the initial lectures to various motor systems, including manipulators, artificial eye systems, locomotory systems, and mobile robotics. There will be homeworks for Matlab/Simulink and a final project, a midterm, and a final.

3 credits, ABCF grading

### CSE 526 Principles of Programming Languages

Discusses programming language concepts and design, with emphasis on abstraction mechanisms. Topics include language paradigms (procedural, object-oriented, functional, and logic), language concepts (values, bindings, types, modules), and foundations (lambda calculus, denotational semantics). Examples will be drawn from several representative languages, such as C, Java, Standard ML, and Prolog.

*Prerequisite: CSE 307*  
Spring, 3 credits, ABCF grading

### CSE 527 Introduction to Computer Vision

Introduction to basic concepts in computer vision. Low-level image analysis, image formation, edge detection, segmentation. Image transformations for image synthesis methods for 3-D scene reconstruction, motion analysis, object recognition.

*Prerequisites: CSE 214, linear algebra, calculus, C/C++ proficiencies*  
3 credits, ABCF grading

### CSE 528 Computer Graphics

This course emphasizes a hands-on approach to the use of computer graphics. The topics covered include models, picture description, and interaction; c windowing, clipping, panning, and zooming; geometrical transformations in 2-D and 3-D; algorithms for raster displays (scan-line conversion, polygon fill, polygon clipping, etc.); hidden line and hidden surface removal, shading models; user interaction. The students will implement a substantial graphics application program.

*Prerequisite: CSE 328*  
Fall, 3 credits, ABCF grading

### CSE 529 Simulation and Modeling

A comprehensive course in formulation, implementation, and application of simulation models. Topics include data structures, simulation languages, statistical analysis, pseudo-random number generation, and design of simulation experiments. Students apply simulation modeling methods to problems of their own design. This course is offered as CSE 529, AMS 553, and MBA 553.

*Prerequisite: CSE 214 or equivalent; AMS 310 or 507 or equivalent; or permission of instructor*  
3 credits, ABCF grading

### CSE 530 Geometric Foundations

This course will focus on mathematical tools, geometric modeling techniques, and fundamental algorithms that are relevant to graphics, visualization, and other visual computing areas. The goal is to provide graduate students with a comprehensive knowledge of geometric concepts and demonstrate the significance of these mathematical tools and geometric algorithms in graphics and relevant areas. Course topics include geometric algorithms for both polygonal and curved objects, theory of parametric and implicit representations, modeling methods of curves, surfaces, and solids, in-depth spline theory, rudiments of wavelet theory and multi-resolution shape representations, differential geometry fundamentals, and other sophisticated topics and latest advances in the field.

*Prerequisites: CSE 328 and CSE 332*  
Spring, 3 credits, ABCF grading

### CSE 532 Theory of Database Systems

The course will cover advanced topics in modern database systems, including object-oriented databases, rule-based databases, temporal and active databases, parallel and distributed databases, distributed object model, data mining, online analytical processing, data warehousing, multimedia databases.

*Fall and spring, 3 credits, ABCF grading*

### CSE 533 Network Programming

Topics include socket and client-server programming, remote procedure calls, data compression standards and techniques, real-time protocols (audio chat, etc.) security and cryptography (specifically, application layer security issues, authentication), Web-related programming (CGI, Java/JavaScript, HTTP, etc.), network management (SNMP-based management, dynamic/CORBA-based management).

*Prerequisites: CSE 306 and CSE 310*  
Fall and spring, 3 credits, ABCF grading

### CSE 534 Fundamentals of Computer Networks

Data Transmission: Introduction to Fourier analysis; data coding and signals, noise, Nyquist's Theorem, Shannon's theorem, bandwidth/baud rate/bit rate; data multiplexing techniques, ASK, FSK, PSK; Modems, and modern standards and techniques (e.g. Trellis Coding, etc.), Data Link Layer: Protocols; Error detection and correction; flow control; etc., Network Layer: protocols; routing algorithms; flow and detection and correction; congestion control; etc., quality-of-service issues at the network and transport layer; local area networks (including MAC, high-speed LANs; wireless LANs; bridges; etc), high-speed

networks (BISDN; ATM standard, etc.).

*3 credits, ABCF grading*

### **CSE 535 Asynchronous Systems**

Discusses asynchronous systems, their description using concurrent and distributed programming languages, and their verification. Topics include concurrent programming using shared memory and message passing, formal semantics of communication, reliability, and concurrent algorithms.

*Prerequisite: Limited to CSE graduate students; others, permission of Department*  
*3 credits, ABCF grading*

### **CSE 536 Introduction to User-Interface Development**

Survey of user-interface systems, includes command language, windowing, multiple input/output devices, architecture of user interface management systems, toolkits for designing user-interface, human factors, standards, visual languages. The course also includes discussion of emerging technologies, such as systems for cooperative work, physically distributed user-interfaces, parallelism and user-interfaces, virtual reality. A substantial project requiring the design, implementation, and evaluation of a user-interface will be required.

*3 credits, ABCF grading*

### **CSE 537 Artificial Intelligence**

A comprehensive introduction to the problems of artificial intelligence and techniques for attacking them. Topics include problem representation, problem-solving methods, search, pattern recognition, natural language processing, learning, expert systems, AI programming languages and techniques. Covers both theoretical methods and practical implementations.

*Prerequisites: MAT 371 or CSE 541*  
*Fall, 3 credits, ABCF grading*

### **CSE 540 Theory of Computation**

Topics include models of computation: finite-state machines, stack machines, Turing machines, Church's thesis; computability theory: halting problem and unsolvability, introductory recursion theory; complexity theory: complexity measures, time and space hierarchy, NP-complete problems.

*Prerequisite: CSE 303*  
*Fall, 3 credits, ABCF grading*

### **CSE 541 Logic in Computer Science**

A survey of the logical foundations of mathematics and the relationships to computer science; development of propositional calculus and quantification theory; the notions of a proof and of a model; completeness theorem.

*Pre- or co-requisite: MAT 313 and CSE 213*  
*Spring, 3 credits, ABCF grading*

### **CSE 542 Speech Processing**

Introductory speech processing course, surveying speech analysis, speech recognition and speech synthesis. Students will develop familiarity with speech processing tools (PRAAT, HTK, Festival).

*Prerequisite: CSE 526 or permission of instructor*  
*Spring, 3 credits, ABCF grading*

### **CSE 547 Discrete Mathematics**

This course introduces such mathematical tools as summations, number theory, binomial coefficients, generating functions, recurrence relations, discrete probability, asymptotics, combinatorics, and graph theory for use in algorithmic and combinatorial analysis. This course is offered as both CSE 547 and AMS 547.

*Prerequisite: AMS 301*  
*Spring, 3 credits, ABCF grading*

### **CSE 548 Analysis of Algorithms**

Techniques for designing efficient algorithms, including choice of data structures, recursion, branch and bound, divide and conquer, and dynamic programming. Complexity analysis of searching, sorting, matrix multiplication, and graph algorithms. Standard NP-complete problems and polynomial transformation techniques. This course is offered as both AMS 542 and CSE 548.

*Prerequisite: CSE 373 recommended*  
*Spring, 3 credits, ABCF grading*

### **CSE 549 Computational Biology**

This course focuses on current problems in computational biology and bioinformatics. Our emphasis will be algorithmic, on discovering appropriate combinatorial algorithm problems and the techniques to solve them. Primary topics will include DNA sequence assembly, DNA/protein sequence assembly, DNA/protein sequence comparison, hybridization array analysis, RNA and protein folding, and phylogenetic trees.

*Prerequisite: CSE 373 or CSE 548; or consent of instructor*  
*Fall, 3 credits, ABCF grading*

### **CSE 555 Computational Geometry**

Study of the fundamental algorithmic problems associated with geometric computations, including convex hulls, Voronoi diagrams, triangulation, intersection, range queries, visibility, arrangements, and motion planning for robotics. Algorithmic methods include plane sweep, incremental insertion, randomization, divide-and-conquer, etc. This course is offered as both AMS 545 and CSE 555.

*Prerequisite: CSE 373 or CSE 548*  
*Spring, 3 credits, ABCF grading*

### **CSE 564 Visualization**

The course emphasizes a hands-on approach to scientific visualization. Topics include traditional visualization, the visualization process, visual perception, basic graphics and imaging concepts, volume and surface visualization, volume graphics, visualization of sampled and computed data case studies, and visualization systems.

*Spring, 3 credits, ABCF grading*

### **CSE 580 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. The course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*3 credits, ABCF grading*  
*May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.*

### **CSE 581 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. The course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*3 credits, ABCF grading*  
*May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.*

### **CSE 582 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. The course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*3 credits, ABCF grading*  
*May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.*

### **CSE 587 Proficiency Requirement in Computer Science**

Students can get credit for a 300-level undergraduate course by registering for CSE 587. The syllabus of the undergraduate course must specify additional work that graduate students must do in order to pass the course. Graduate students taking an undergraduate course under CSE 587 number must be graded separately from the undergraduate students. See *Graduate Student Handbook* for restrictions on the use of this course.

*Fall and spring, 2 credits, ABCF grading*  
*May be repeated for credit*

### **CSE 590 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. The course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
*Spring, 3 credits, ABCF grading*  
*May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.*

### **CSE 591 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. The course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
*Spring, 3 credits, ABCF grading*  
*May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.*

### **CSE 592 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. The course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.



*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
 Spring, 3 credits, ABCF grading  
 May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.

### **CSE 593 Independent Study in Computer Science**

Students can register for this course to conduct or participate in a project under the supervision of a Computer Science faculty member. The student must prepare a description of the project or the course to be taken and submit it before the add/drop deadline to the project sponsor. The description will reside in the student's file. Both M.S. and Ph.D. students can take this course. This course cannot be taken as part of M.S. Thesis research—use CSE 599 in this case. Ph.D. students take CSE 593 for any kind of research or project work prior to advancement to candidacy (G5 status). After the advancement, CSE 699 should be used to conduct Dissertation Research.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
 Fall, spring, and summer, 1-9 credits,  
 ABCF grading  
 May be repeated for credit

### **CSE 594 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. This course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered. May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy the CSE major requirements for the M.S.

*Prerequisite: Admission to CSE Graduate Program; instructor's permission*  
 Fall, spring, every year, 3 credits,  
 ABCF grading  
 May be repeated for credit

### **CSE 595 Topics in Computer Science**

An advanced lecture course on a new topic in computer science. This course is primarily designed for M.S. students, but can be taken by Ph.D. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*Fall, spring, every year, 3 credits,  
 ABCF grading*  
 May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy the CSE major requirements for the M.S.

### **CSE 596 M.S. Internship in Research**

Participation in private corporations, public agencies, or non-profit institutions. Students will be required to have a faculty coordinator as well as a contact in the outside organization to participate with them in regular consultations on the project, and to submit a final report to both. At most one credit can be accepted toward the M.S. degree.

*Prerequisite: Permission of graduate program director*  
 Fall and spring, 1-3 credits, S/U grading  
 May be repeated for credit

### **CSE 599 M.S. Thesis Research**

This course can be used only for M.S. Thesis research; non-thesis research should be done under the designation of CSE 593: Independent Study. M.S. students who wish to enroll in CSE 599 for any number of credits must prepare a one-to-two-page description of the work to be completed. The description must be approved by the research advisor, signed by both student and advisor, and will reside in the student's file. Amendments to the proposal must be approved by the advisor. Up to nine credits of CSE 599 can be counted toward the 31 credits that are required for graduation.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
 Fall, spring, and summer, 1-12 credits,  
 S/U grading  
 May be repeated for credit

## **Advanced Courses**

The following are courses normally considered appropriate for the Ph.D. program, although they can be elected by M.S. students with permission of the advisor.

### **CSE 600 Topics in Modern Computer Science**

A survey of current computer science research areas and issues. This course comprises lectures by faculty members and visitors, selected readings, and introductory-level research problems.

*Prerequisite: Permission of instructor*  
 1 credit, S/U grading  
 May be repeated for credit

### **CSE 601 Advanced Image Processing**

Modern approaches to image processing, statistical image formation and image models, image restoration, reconstruction and segmentation, and applications to medical imaging. Crosslisted with ESE 559.

*Prerequisites: Linear analysis, engineering math, Fourier analysis, calculus, programming*  
 3 credits, ABCF grading

### **CSE 602 Advanced Computer Architecture**

The focus will be on the architectural rather than micro-architectural issues, and a systems approach to computer architecture taking into account the interaction between the architecture and the compiler, operating system, database, and networking. The course starts with superscalar/VLIW processor architecture and proceeds to memory hierarchy, storage systems, network hardware, graphics processor, and database machines. The emphasis will be on hands-on evaluation of architectural ideas, the exploration of software/hardware design trade-offs, and the articulation of experimental procedures and performance analysis. A publication-quality class project will be required.

*Prerequisite: CSE 502 or permission of instructor*  
 3 credits, ABCF grading

### **CSE 605 Performance Evaluation of Computer Systems**

The purpose of this course is to provide background and training in understanding and

evaluating performance of computer systems, including centralized, distributed, parallel, client/server based systems, and computer communication networks. The goal is to develop a perspective on how the performance of computer systems or networks should be evaluated to decide on various design alternatives. The course will include various analytical techniques, mainly based on Markov models and queuing theory, and simulation modeling.

*Prerequisites: Limited to CSE graduate students; others, permission of instructor*  
 Fall, 3 credits, ABCF grading  
 May be repeated twice for credit

### **CSE 606 Performance Evaluation of Computer Systems**

The purpose of this course is to provide background and training in understanding and evaluating performance of computer systems, including centralized, distributed, parallel, client/server-based systems, and computer communication networks. The goal is to develop a perspective on how the performance of computer systems or networks should be evaluated in order to decide on various design alternatives. The course will include various analytical techniques, mainly based on Markov models and queuing theory, and simulation modeling.

*Prerequisites: Limited to CSE graduate students; others, permission of instructor*  
 Fall, 3 credits, ABCF grading  
 May be repeated twice for credit

### **CSE 608 Advanced Computer Security**

Advanced course on principles and practice of engineering secure information systems. Topics covered include threats and vulnerabilities, counter measures, legal policy issues, risk management and assurance. In-depth coverage of various research problems, which will vary from one offering of the course to another.

*Prerequisite: CSE 508 or permission of instructor*  
 Spring, 3 credits, ABCF grading  
 May be repeated twice for credit

### **CSE 610 Parallel Computer Architectures**

Topics include parallel computer systems; important parallel applications; parallel computation models; interconnection networks; SIMD and MIMD architectures; hybrid architectures; memory management; cache coherence; distributed shared memory; synchronization methods; operating systems; compilers; and programming tools.

*Prerequisite: CSE 502 or permission of instructor*  
 3 credits, ABCF grading

### **CSE 611 Transaction Processing**

An advanced course in transaction processing systems covering the latest developments in the area. Topics include stable storage, distributed database systems, commitment protocols, failures, replication and advanced models of transactions.

*Prerequisite: CSE 515*  
 3 credits, ABCF grading

**CSE 612 Advanced Visualization and Volume Graphics**

This course discusses advanced concepts in the area of volumetric data modeling and visualization. Topics included are: visual exploration of multi-variate and multi-dimensional datasets on regular and irregular grids, modeling of natural phenomena and simulation of realistic illumination, volumes as magic clay for sculpting and deformation effects, non-photorealistic rendering for illustration and artistic works, information-centric exploration of large datasets and exploitation of hardware for acceleration. The course strives to provide a snapshot on the current state of the art and will be supported mostly by recent research papers. Students will expand on a topic of their choice by completing an individual project.

*Prerequisites: CSE 564; limited to CSE graduate students; others, permission of instructor*

*Fall, 3 credits, ABCF grading*

**CSE 613 Parallel Programming**

Algorithms and technique for programming highly parallel computers. Trends in parallel and distributed computing; shared address space and message passing architectures; design issues for parallel algorithms; converting sequential algorithms into equivalent parallel algorithms; synchronization and data sharing; improving performance of parallel algorithms; interconnection network topologies, routing, and flow control; latency limits on speedup of algorithms by parallel implementations.

*Prerequisite: CSE 502 or permission of instructor*

*3 credits, ABCF grading*

**CSE 614 Advanced Programming Languages**

Selected topics on advanced programming languages technology. Program analysis and transformation, program optimization and program manipulation systems. Very high-level and declarative languages such as sets and relations-based languages and deductive and object-oriented languages.

*Prerequisite: CSE 526 or CSE 504*

*Spring, 3 credits, ABCF grading*

*May be repeated for credit*

**CSE 615 Advanced Computer Vision**

Survey of methods used for the analysis of images by computer, including computer vision and pattern recognition. Topics to be covered are image formation, image segmentation and edge detection, binary images and shape analysis, shape from shading, motion field and optical flow, surface inference, classification techniques.

*Prerequisite: B.S. degree in Computer Science, Engineering, Mathematical or Physical Sciences*

*3 credits, ABCF grading*

**CSE 616 Digital Multimedia Systems**

In-depth survey of multimedia computing, including media conversion, data compression, multimedia data representation and modeling, authoring techniques, audio and video editing, 2-D and 3-D animation, media synchronization, distributed multimedia, and advanced application development.

*Prerequisite: CSE 333 or CSE 536*

*3 credits, ABCF grading*

**CSE 618 Advanced Computer Graphics**

Advanced topics in rendering and modeling realistic 3-D imagery including texture mapping and synthesis, radiosity, amorphous phenomena, artificial life, and animation. Further contents include introductions to free-form curves and surfaces, volume rendering, and image-based rendering.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*

*3 credits, ABCF grading*

*May be repeated up to nine times for credit*

**CSE 620 Virtual Reality**

Practical issues in the design and implementation of virtual environments. Topics include system requirements, transformations, user-interaction models, human vision models, input/output devices and techniques, tracking systems, augmented reality, and virtual-reality applications. The course will involve a substantial programming project to implement an immersive virtual reality system.

*Prerequisite: CSE 328, 528, 332, or 564*

*3 credits, ABCF grading*

**CSE 621 Physics-based Modeling for Visual Computing**

A unified approach to various fields such as graphics, visualization, computer-aided geometric design, biomedical imaging, vision, and virtual environment. The course will explore select research topics centered on physics-based modeling methodology and associated computational methods for theoretical and practical problems in widespread areas of visual computing. The emphasis will be on geometric and solid modeling, geometric design techniques, wavelets and multi-resolution analysis, deformable models based on mathematical physics, variational analysis, optimization methods, numerical simulation with finite-difference and finite-element algorithms, differential equations for initial-value and boundary-value problems, force-driven interaction with constraints, dynamic sculpting system, and a large variety of applications for visual computing.

*Prerequisite: CSE 528 or permission of instructor*

*3 credits, ABCF grading*

**CSE 622 Advanced Database Systems**

The course covers selected topics on the cutting edge of database technology, such as deductive database query languages and systems, object-oriented data models, persistent programming languages, heterogeneous databases, and advanced transaction models.

*Prerequisite: CSE 532 or permission of instructor*

*3 credits, ABCF grading*

**CSE 624 Advanced Operating Systems**

This is a survey of modern operating system techniques, especially those needed for distributed operating systems. Topics include network topologies, interprocess communication, failure detection and system recovery, local kernel functions, global network services, location transparency, large network

constraints, distributed control algorithms (synchronization, configuration, deadlock detection, and searches), and existing distributed operating systems.

*Prerequisite: CSE 506 or permission of instructor*

*3 credits, ABCF grading*

**CSE 625 Asynchronous Systems**

Formal specification and verification of asynchronous systems. Topics include concurrent programming, process algebras, logics for describing the properties of concurrent systems, and formal semantics of communication.

*Prerequisite: CSE 535 or permission of instructor*

*3 credits, ABCF grading*

*May be repeated for credit*

**CSE 626 Switching and Routing in Parallel and Distributed Systems**

This course covers various switching and routing issues in parallel and distributed systems. Topics include message switching techniques, design of interconnection networks, permutation, multicast and all-to-all routing in various networking nonblocking, and rearrangeable capability analysis and performance modeling.

*Prerequisites: ESE 503 and 545 or CSE 502 and 547, or permission of instructor*

*3 credits, ABCF grading*

**CSE 628 Natural Language Processing**

A survey of computational approaches to natural language processing issues in phonology, morphology, syntax, semantics, and pragmatics. Topics to be discussed include natural language parsing algorithms, generation algorithms, and knowledge representations. Models for speech recognition systems, story understanding systems, and natural language front ends to databases and other application programs will be investigated.

*Prerequisite: CSE 537*

*3 credits, ABCF grading*

**CSE 630 Theory of Computational Complexity**

Machine-based polynomial-time complexity theory, including nondeterministic computation, probabilistic computation, time and space trade-off, and complexity hierarchy; applications to related areas such as combinatorial algorithms and cryptography.

*Prerequisites: CSE 540 or CSE 548 or permission of instructor*

*3 credits, ABCF grading*

**CSE 631 Advanced Logic in Computer Science**

The course may include the following: deductive theorem proving (resolution, sequent-style calculi, natural deduction), inductive theorem proving, equational reasoning (rewrite systems), non-classical logics (modal logics, intuitionistic logic).

*Prerequisite: CSE 541 or permission of instructor*

*3 credits, S/U grading*

**CSE 633 Computability and Undecidability**

Computability theory based on Turing machines and recursive functions; proof by diagonalization and reducibility; unsolvable problems in set, group, number and language

theory; reducibility orderings and degrees of unsolvability; priority methods and Post's problem.

*Prerequisite: CSE 540 or permission of instructor*  
*Spring, 3 credits, ABCF grading*

### **CSE 634 Data Mining Concepts and Techniques**

Data mining is a new, promising and flourishing interdisciplinary field drawing work from areas including database technology, artificial intelligence, machine learning, pattern recognition, high-performance computing, and data visualization. It focuses on issues relating to the feasibility, usefulness, efficiency and scalability of techniques for automated extraction of patterns representing knowledge implicitly stored in large databases, warehouses, and other massive information repositories. The course gives a broad, yet in-depth overview of the field of data mining and presents one or two techniques in rigorous detail.

*Prerequisite: Database course*  
*3 credits, ABCF grading*

### **CSE 636 Analysis and Synthesis of Computer Communication Networks**

Topics include analysis of message queuing and buffering in computer networks; survey of OSI layered architecture; network topology; local, metropolitan, and wide area networks; circuit and packet switching techniques; high-speed and lightweight network concepts: Synchronous Optical Network (SONET), Fiber Distributed Data Interface (FDDI), Distributed Queue Dual Bus (DQDB-QPSX), Integrated Services Digital Networks (ISDN), Broadband-ISDN, and Asynchronous Transfer Mode (ATM).

*Prerequisite: CSE 533*  
*3 credits, ABCF grading*

### **CSE 637 Program Semantics and Verification**

Topics include formal approaches to defining semantics of programming languages: denotational, operational, axiomatic, and transformational semantics; formal systems for program verification; logics of program, type theory, lambda calculus; further topics selected from term rewriting approach to proving properties of data types, and semantics and verification of languages with concurrent and parallel constructs.

*Prerequisite: CSE 541*  
*3 credits, ABCF grading*

### **CSE 638 Advanced Algorithms**

This is an advanced course in the design and analysis of combinatorial algorithms, focusing on recent material and special topics, including randomized algorithms, approximation algorithms for NP-complete problems, string algorithms, amortized analysis of data structures, and heuristic methods such as simulated annealing. Material will be selected to have little or no overlap with traditional introductory algorithms courses.

*Prerequisite: CSE 548 or permission of instructor*  
*3 credits, ABCF grading*

## **Seminars and Special Topics Courses**

**CSE 640 Seminar in Theory of Computing**  
*1 credit, S/U grading*

**CSE 641 Seminar in Logic in Computer Science**  
*1 credit, S/U grading*

**CSE 642 Seminar in Algorithms**  
*1 credit, S/U grading*

**CSE 643 Seminar in Concurrency**  
*1 credit, S/U grading*

**CSE 644 Seminar in Databases**  
*1 credit, S/U grading*

**CSE 645 Seminar in Languages**  
*1 credit, S/U grading*

**CSE 646 Seminar in Artificial Intelligence**  
*1 credit, S/U grading*

**CSE 647 Seminar in Image Processing**  
*1 credit, S/U grading*

**CSE 648 Seminar in Graphics**  
*1 credit, S/U grading*

**CSE 649 Seminar in Operating Systems**  
*1 credit, S/U grading*

**CSE 650 Seminar in Architecture**  
*1 credit, S/U grading*

**CSE 651 Seminar in Applications**  
*1 credit, S/U grading*

**CSE 652 Seminar in User Interfaces**  
*1 credit, S/U grading*

**CSE 653 Seminar in Virtual Reality**  
*1 credit, S/U grading*

**CSE 654 Seminar in Visualization**  
*1 credit, S/U grading*

**CSE 655 Seminar in Modeling and Simulation**  
*1 credit, S/U grading*

**CSE 656 Seminar in Computer Vision**  
 Current readings in computer vision and image understanding.

*Prerequisite: Limited to CSE graduate students; others need instructor consent*  
*Fall, 1 credit, S/U grading*  
*May be repeated for credit*

**CSE 657 Seminar in Design Analysis**  
 Methods for constructing reliable and efficient computer systems. Topics include: modeling and specification, analysis and verification, design and optimization, code generation, simulation and testing. Tool support. Applications and case studies.

*Prerequisite: Limited to CSE graduate*

*students; others need instructor consent*  
*Fall, 1 credit, S/U grading*  
*May be repeated for credit*

### **CSE 658 Seminar on Mobile and Wireless Networking**

This seminar course will draw topics from mobile and wireless networks of current interest. The main focus will be multi-hop wireless networks. It will cover topics on mobile routing, multiple access and transport protocols for such networks. It will also cover topics from micromobility architectures and pervasive computing.

*Prerequisites: Limited to CSE graduate students; others, permission of instructor*  
*Fall, 1 credit, S/U grading*  
*May be repeated twice for credit*

### **CSE 659 Seminar in Computer Security**

Seminar course, covering various research problems in computer security.

*Spring, 1 credit, S/U grading*  
*May be repeated for credit*

### **CSE 660 Seminar in Media Networks**

Graduate seminar that covers recent work on multimedia and networks.

*Fall and spring, 1 credit, S/U grading*  
*May be repeated for credit*

### **CSE 661 Seminar in Data Privacy**

Current research in data privacy.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
*Spring, 1 credit, S/U grading*  
*May be repeated for credit*

### **CSE 662 Seminar in Applied Cryptography**

*1 credit, S/U grading*  
*May be repeated for credit*

**CSE 665 Special Topics in Theory of Computing**  
*2 credits, ABCF grading*

**CSE 666 Special Topics in Logic in Computer Science**  
*2 credits, ABCF grading*

**CSE 667 Special Topics in Algorithms**  
*2 credits, ABCF grading*

**CSE 668 Special Topics in Concurrency**  
*2 credits, ABCF grading*

**CSE 669 Special Topics in Databases**  
*2 credits, ABCF grading*

**CSE 670 Special Topics in Languages**  
*2 credits, ABCF grading*

**CSE 671 Special Topics in Artificial Intelligence**  
*2 credits, ABCF grading*

**CSE 672 Special Topics in Image Processing**  
*2 credits, ABCF grading*

**CSE 673 Special Topics in Graphics**  
*2 credits, ABCF grading*

**CSE 674 Special Topics in Operating Systems**  
2 credits, ABCF grading**CSE 675 Special Topics in Architecture**  
2 credits, ABCF grading**CSE 676 Special Topics in Applications**  
2 credits, ABCF grading**CSE 677 Special Topics in User Interfaces**  
2 credits, ABCF grading**CSE 678 Special Topics in Virtual Reality**  
2 credits, ABCF grading**CSE 679 Special Topics in Visualization**  
2 credits, ABCF grading**CSE 680 Special Topics on Modeling and Simulation**

This is an advanced modeling and simulation course on selected research topics. This application-oriented course tries to address issues of modeling and simulation from graphics, animation, CAD/CAM, medicine, artificial life, and virtual environments. Primary areas covered by this course include visual modeling, mathematical methods for geometry, shape design technology, computational physics for simulation, and scientific computing techniques. New topics will be added each year to reflect the latest state of the art.

*Prerequisite: Graphics/visualization background or permission of the instructor*  
Fall and spring, 2 credits, ABCF grading

**CSE 681 Special Topics in Computer Vision**

Advanced research topics course.  
*Prerequisite: Limited to CSE graduate students; others need instructor consent*  
Fall, 2 credits, ABCF grading  
May be repeated for credit

**CSE 682 Special Topics in Design Analysis**

Methods for constructing reliable and efficient computer systems. Topics include: modeling and specification, analysis and verification, design and optimization, code generation, simulation and testing. Tool support. Applications and case studies.  
*Prerequisite: Limited to CSE graduate students; others, instructor consent*  
Fall, 2 credits, ABCF grading  
May be repeated for credit

**CSE 683 Special Topics in Mobile and Wireless Networking**

This course will draw topics from mobile and wireless networks of current interest. The main focus will be multi-hop wireless networks. It will cover topics on mobile routing, multiple access and transport protocols for such networks. It will also cover topics from micromobility architectures and pervasive computing.

*Prerequisites: Limited to CSE graduate students; others, permission of instructor*  
Fall and spring, 2 credits, ABCF grading  
May be repeated twice for credit

**CSE 684 Special Topics in Computer Security**

Special topics course covering selected research areas in computer security.  
Spring, 2 credits, ABCF grading  
May be repeated once for credit

**CSE 685 Special Topics in Media Networks**

Current topics in media networks.  
*Prerequisite: Limited to CSE graduate students*  
Fall and spring, 2 credits, ABCF grading  
May be repeated for credit

**CSE 686 Special Topics in Data Privacy**

Advanced research topics course.  
*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
Spring, 2 credits, S/U grading  
May be repeated for credit

**CSE 687 Special Topics in Applied Cryptography**

2 credits, ABCF grading  
May be repeated for credit

**CSE 690, 691, 692 Advanced Topics in Computer Science**

An advanced lecture course on new topics in computer science. This course is primarily designed for Ph.D. students, but can be taken by M.S. students as well. Semester supplements to this *Bulletin* contain specific description when course is offered.

*Prerequisite: Limited to CSE graduate students; others, permission of instructor*  
Spring, 3 credits, ABCF grading  
May be repeated for credit as the topic changes, but cannot be used more than twice to satisfy CSE major requirements for M.S.

**Ph.D. Teaching and Research Experience****CSE 696 Internship in Research**

See CSE 596 for similar description.  
Fall and spring, 1 credit, S/U grading  
May be repeated for credit

**CSE 698 Practicum in Teaching**

Normally taken by Ph.D. students in their first year in conjunction with a TA.  
Fall, spring, and summer, 1-3 credits, ABCF grading  
May be repeated for credit

**CSE 699 Dissertation Research On Campus**

This course is normally taken by advanced Ph.D. students when they conduct research toward their thesis. Only Ph.D. students who have been advanced to candidacy (G5 status) can take this course. Students who have the G3 and G4 status and participate in a research project with their advisor can register for CSE 593 Independent Study.

*Prerequisite: Must be advanced to candidacy (G5); major portion of research must take place on SB campus, at Cold Spring Harbor, or at Brookhaven National Lab; limited to CSE graduate students; others, permission of instructor*  
Fall, spring, and summer, 1-9 credits, S/U grading  
May be repeated for credit

**CSE 700 Dissertation Research Off Campus—Domestic**

*Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place off campus, but in the U.S. and/or U.S. provinces (Brookhaven National Lab and Cold Spring Harbor Lab are considered on campus); all international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor*  
Fall, spring, and summer, 1-9 credits, S/U grading  
May be repeated for credit

**CSE 701 Dissertation Research Off Campus—International**

*Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place outside the U.S. and/or U.S. provinces; domestic students have the option of the health plan and may also enroll in MEDEX; international students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed; international students who are not in their home country are charged for the mandatory health insurance (if they are to be covered by another insurance plan they must file a waiver by the second week of classes; the charge will be removed only if other plan is deemed comparable); all international students must receive clearance from an International Advisor*  
Fall, spring, and summer, 1-9 credits, S/U grading  
May be repeated for credit

**CSE 800 Summer Research**

0 credit, S/U grading  
May be repeated for credit

**ISE 503 Data Management**

This course provides an understanding of the issues in managing database systems as an essential organizational resource. Students learn the enterprise data architecture components, data storage configurations, and information retrieval methods. It expands from the relational model to the multidimensional model, object-relational techniques, and web accessed data. The course includes concepts, principles, issues, and techniques for managing corporate data resources. Techniques for managing the design and development of large database systems including logical data models, concurrent processing, data distribution, database administration, data warehousing, data cleansing, and data mining. Students will use current methods and tools for database design and development.  
*Prerequisite: Limited to CSE/ISE graduate students; others, permission of instructor*  
3 credits, ABCF grading  
May be repeated up to nine times for credit

**ISE 504 Analysis, Modeling, and Design**

This course provides an understanding and application of system analysis and design processes. Students evaluate and choose appropriate system development methodologies and

design a system. Students learn the importance of effective communication and integration with users and user systems. The course emphasizes interpersonal skill development with clients, users, team members, and others associated with the development, operation, and maintenance of systems. The course includes the system development life cycle; analysis and design techniques; information systems planning and project identification and selection, requirements collection and structuring, process modeling, data modeling, design of interface and data management, system implementation and operation, system maintenance, change management implications of systems, and globalization issues in systems. Students will use current methods and tools such as rapid application development, prototyping, and visual development.

*3 credits, ABCF grading*

*May be repeated once for credit*

### **ISE 506 Quantitative Computer Architecture**

Explores the physical structure of a computer; machine representation of information; architecture and organization of various main-frame, mini-, and microcomputers; primary and secondary storage; and input and output communication. Architectural choices are compared and used to determine resulting function and performance. Architectural trade-offs are also identified.

*3 credits, ABCF grading*

*May be repeated up to nine times for credit*

### **ISE 507 Project Management**

The course focuses on both the technical aspects of project management and the human aspects. Technical components include project definition, work breakdown structure development, and the use of optimization techniques for planning a project and optimizing schedules. Graphical approaches to project definition are addressed, as are needs analysis, preliminary design, and detailed design and implementation. Human aspects of project management include forming a project team, managing performance, and resolving conflicts.

*Prerequisite: ISE graduate students or permission of instructor*

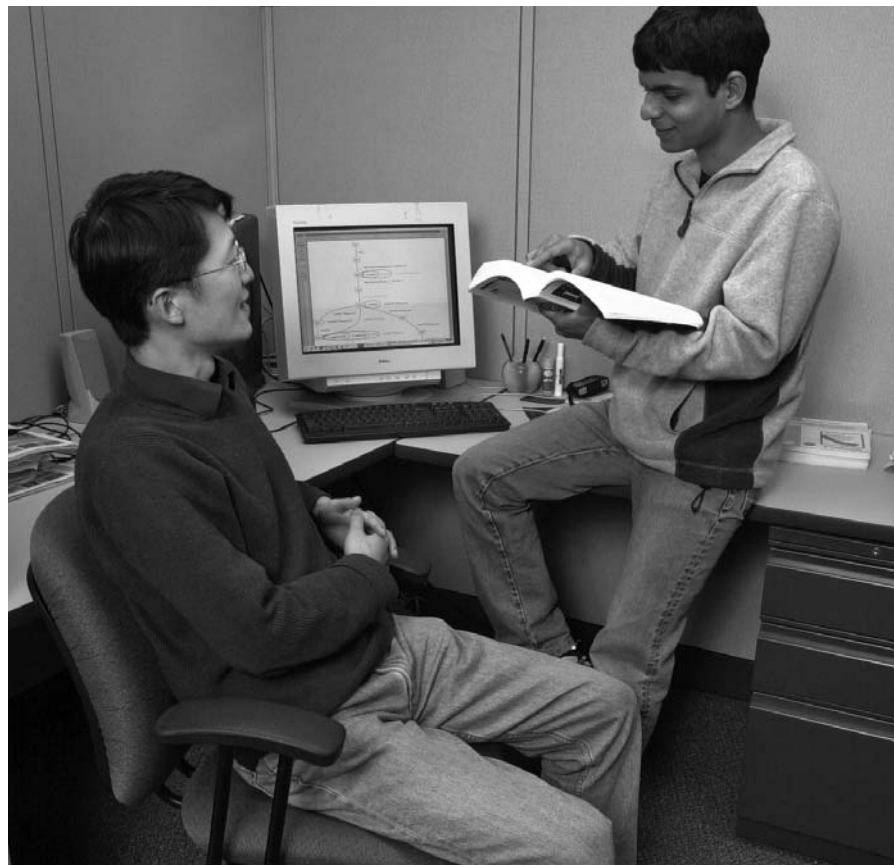
*3 credits, ABCF grading*

### **ISE 516 Systems Engineering Principles**

An introduction to the full range of systems engineering concepts, tools and techniques. These elements are applied to both large- and small-scale projects. The course provides a review of the stages of an integrated, top-down, life-cycle approach to design engineering—from analysis of customer requirements to maintenance and support, from definition of systems operational concepts through material disposal and ability and maintainability engineering, human factors, safety, logistics engineering, quality engineering and value-cost engineering. The course also includes a treatment of crucial management issues, such as the planning and development of Systems Engineering Management Plans (SEMPs), work breakdown structures (WBSs), cost projections, and supplier selection and management.

*3 credits, ABCF grading*

*May be repeated once for credit*



### **ISE 517 Human Factors in Systems Engineering**

The course focuses on techniques to integrate human factors into the design of systems so that the systems match human abilities and limitations. The course addresses techniques to translate system requirements into project-specific design requirements. The course addresses physiological and mental characteristics of humans and emphasizes methods used to generate human factors inputs for engineering work products. The course describes the effect of human factors on each stage of development. Cannot be used towards M.S. or Ph.D. degree in Computer Science.

*Prerequisite: Limited to CSE and ISE graduate students; others, permission of instructor*

*Spring, 3 credits, ABCF grading*

*May be repeated once for credit*