Computer Science (CSE)

Major and Minor in Computer Science

Department of Computer Science, College of Engineering and Applied Sciences

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Minors of particular interest to students majoring in Computer Science: Business Management (BUS)

Department Information - Computer Science (CSE)

Computer science is the study of computer systems, including the architecture of computers, development of computer software, information processing, computer applications, algorithmic problem-solving, and the mathematical foundations of the discipline.

The Computer Science major provides professional education in computer science to prepare the student for graduate study or for a career in the computing field. Students learn concepts and skills needed for designing, programming, and applying computer systems while also learning the theoretical and mathematical foundations of computer science. They have sufficient freedom in the program to pursue other academic interests in the liberal arts, sciences, and engineering to complement their study of computer science. The Computer Science program is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

Many students prepare for their professional careers through internships at local companies. Computer science graduates are recruited heavily, and career opportunities include developing software systems for a diverse range of applications such as: user interfaces; networks; databases; forecasting; web technologies; and medical, communications, satellite, and embedded systems. Many are employed in the telecommunication and financial industries, and some are self-employed as heads of software consulting companies.

The Department of Computer Science offers two undergraduate majors: Computer Science and Information Systems. Requirements and courses for the latter appear under the program title in the alphabetical listings of Approved Majors, Minors, and Programs. The two programs of study share a number of courses, particularly in the first two years, so that it is possible to follow a program that permits a student to select either major by the start of the junior year. The Department also offers a minor in computer science, a joint B.S./M.S. program, and an honors program.

Program Educational Objectives

The graduates of the computer science program will, within 3-5 years after graduation:

- Establish themselves as practicing professionals or engage in advanced study and
- Advance professionally through organized training or self-learning.

Student Outcomes

The students will demonstrate the following:

a. An ability to apply knowledge of computing and mathematics appropriate to the program’s student outcomes and to the discipline;
b. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution;
c. An ability to design, implement, and evaluate, a computer-based system, process, component or program to meet desired needs;
d. An ability to function effectively on teams to accomplish a common goal;
e. An understanding of professional, ethical, legal, security and social issues and responsibilities.
f. An ability to communicate effectively with a range of audiences;
g. An ability to analyze the local and global impact of computing on individuals, organizations, and society;
h. Recognition of the need for and an ability to engage in continuing professional development;
i. An ability to use current techniques, skills, and tools necessary for computing practice;
j. An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices;
k. An ability to apply design and development principles in the construction of software systems of varying complexity.
Computing Facilities

Computing facilities for undergraduates are maintained by both the University Computing Center and the Department of Computer Science. For a description of the computing services provided by the University Computing Center, see the Student Services section of this Bulletin.

The Department of Computer Science provides additional laboratories to support undergraduate instruction and research. The laboratory facilities are regularly upgraded to keep pace with advances in technology. Current computing facilities include the Computer Science Undergraduate Computing Laboratory; the Programming Techniques Teaching Laboratory with facilities for classroom instruction; the Computer Associates Transactions Laboratory, used primarily for upper-level courses on databases, transaction processes, and Web applications; the Computer Science Advanced Programming Laboratory, also donated by Computer Associates, Inc., which provides computing support for upper-level courses on such topics as operating systems and user interfaces; and the Computer Science Multimedia Laboratory, used for courses on multimedia design. Most of the laboratories are connected to the Internet via the campus network and are easily accessible by students from campus residences or from off-campus via modem.

The Departmental research laboratories are available to undergraduate students working on supervised projects with computer science faculty.

Transfer Credits

Students who wish to transfer credits for courses equivalent to CSE 114, 214, or CSE 215 in order to use them as prerequisites for other CSE courses or toward the requirements for acceptance into the major must demonstrate proficiency in the course material by passing a proficiency examination, given during the first week of each semester.

Requirements for the Major and Minor in Computer Science (CSE)

Enrolling in CSE Courses

To enroll in CSE courses, students must:

Have completed all prerequisites with a grade of C or higher. (Pass/No Credit grades are not acceptable to meet prerequisites.) For transfer students, official transfer credit evaluations must have been completed.

Failure to satisfy the prerequisites or to attend the first class may result in deregistration. The Pass/No Credit option is not available for CSE courses.

Acceptance into the Computer Science Major

Qualified freshman may be accepted directly into the Computer Science major upon admission to the University. Currently enrolled students and transfer students may apply for acceptance to the major after completing at least ten credits of required CSE courses, including CSE 114 and CSE 215, with grades of B- or higher and a grade point average of 3.20 or higher in these courses. Only one of these courses may be repeated. Transfer students who have completed equivalent courses at another school with grades of B- or higher need not retake these courses, but should keep in mind that grades do not transfer and grade point averages are calculated on the basis of courses completed at Stony Brook. Students must have completed course evaluations for all transferred courses that are to be used to meet requirements of the major. Priority is given to students with a cumulative grade point average of 3.00 or higher.

Requirements for the Major

The major in Computer Science leads to the Bachelor of Science degree. Completion of the major requires approximately 80 credits. At least 24 credits from items 1 to 3 below, and at least 18 credits from items 2 and 3, must be completed at Stony Brook.

1. Required Introductory Courses

• CSE 114 Computer Science I
• CSE 214 Computer Science II
• CSE 215 Foundations of Computer Science or CSE 150 Foundations of Computer Science: Honors
• CSE 219 Computer Science III
• CSE 220 Systems Fundamentals I

Note: Students in the CSE Honors Program may substitute CSE 160, CSE 161 and CSE 260, CSE 261 Computer Science A, B: Honors with labs for CSE 114, 214 and 219.

2. Required Advanced Courses

• CSE 303 Introduction to the Theory of Computation or CSE 350 Theory of Computation: Honors
• CSE 373 Analysis of Algorithms or CSE 385 Analysis of Algorithms: Honors
• CSE 308 Software Engineering
• CSE 320 Systems Fundamentals II
• Three courses chosen from: CSE 304, CSE 305, CSE 306, CSE 307, CSE 310/346, CSE 328. The three courses must include CSE 305 or CSE 306.

3. Computer Science Electives
Three upper-division CSE electives. Technical electives do not include teaching practica (CSE 475), the senior honors project (CSE 495, 496), and courses designated as non-technical in the course description (such as CSE 301).

4. AMS 151, AMS 161 Applied Calculus I, II
Note: The following alternate calculus course sequences may be substituted for AMS 151, AMS 161 in major requirements or prerequisites: MAT 125, MAT 126, MAT 127, or MAT 131, MAT 132, or MAT 141, MAT 142 or MAT 171. Equivalency for MAT courses achieved through the Mathematics Placement Examination is accepted to meet MAT course requirements.

5. One of the following:
   • MAT 211 Introduction to Linear Algebra
   • AMS 210 Applied Linear Algebra
   • AMS 326 Numerical Analysis

6. Both of the following:
   • AMS 301 Finite Mathematical Structures
   • AMS 310 Survey of Probability and Statistics or AMS 311 Probability Theory or AMS 312 Mathematical Statistics

7. At least one of the following natural science lecture/laboratory combinations:
   BIO 201/204 or BIO 202/204 or BIO 203/204 or CHE 131/133 or CHE 152/154 or PHY 126/133 or PHY 127/133 or PHY 131/133 or PHY 141/133

8. Additional natural science courses selected from above and the following list:
   AST 203, AST 205, CHE 132, CHE 321, CHE 322, CHE 331, CHE 332, GEO 102, GEO 103, GEO 112, GEO 113, PHY 125, PHY 132, PHY 134, PHY 142, PHY 251, PHY 252
   Note: The courses selected in 7 and 8 must carry at least 12 credits.

9. Professional Ethics
   • CSE 312 Legal, Social, and Ethical Issues in Information Systems

10. Upper-Division Writing Requirement: CSE 300 Technical Communications
    All degree candidates must demonstrate technical writing skills at a level that would be acceptable in an industrial setting. To satisfy the requirement, students must pass CSE 300, a course that requires the completion of various writing assignments, including at least one significant technical paper.
    Note: All students are encouraged to discuss their program with an undergraduate advisor. In Requirement 2 above, CSE/ESE double majors may substitute ESE 440, ESE 441 Electrical Engineering Design I, II for CSE 308 Software Engineering provided that the design project contains a significant software component. Approval of the Department of Computer Science is required.

Grading
All courses taken to satisfy Requirements 1 through 10 must be taken for a letter grade. The courses in Requirements 1-6, 9, and 10 must be passed with a letter grade of C or higher. The grade point average for the courses in Requirements 7 and 8 must be at least 2.00. A grade of C or higher is also required in prerequisite courses listed for all CSE courses.

Specialization in Human-Computer Interaction
The specialization in human-computer interaction emphasizes both the psychology aspects of effective human-computer interactions and the technical design and implementation of systems for those interactions. It requires four core course, two electives, and a project. Students may declare their participation in the specialization after completing the courses in 1a and 1b. All courses must be completed with a grade of C or higher.

1. Core Courses
   a. CSE 323 Human-Computer Interaction
   b. PSY 260 Survey of Cognition and Perception
   c. CSE 328 Fundamentals of computer Graphics or CSE 332 Introduction to Visualization
   d. CSE 333 User Interface Development or PSY 384 Research Lab: Human Factors

2. Two electives from the following, including at least one CSE course:
   • CSE 327 Fundamentals of Computer Vision
   • CSE 328 Fundamentals of Computer Graphics
   • CSE 332 Introduction to Visualization
   • CSE 333 User Interface Development
   • CSE 334 Introduction to Multimedia Systems
   • CSE 336 Internet Programming
   • CSE 352 Artificial Intelligence
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- CSE 364 Advanced Multimedia Techniques
- CSE 366 Introduction to Virtual Reality
- CSE 378 Introduction to Robotics
- CSE 390-394 Special Topics in Computer Science*
- PSY 366 Human Problem Solving
- PSY 368 Sensation and Perception
- PSY 369 Special Topics in Cognition and Perception
- PSY 384 Research Lab: Human Factor

*Special topic must be in human-computer interaction.

3. Project

Completion of CSE 487 Research in Computer Science or CSE 488 Internship in Computer Science or CSE 495/CSE 496 Senior Honors Research Project I, II, on a topic in human-computer interaction. The project may not be applied towards the requirements of another specialization.

Specialization in Game Programming

The specialization in game programming prepares students for a career as either a professional game developer or researcher. Game graphics and multiplayer network programming techniques are stressed. The specialization also emphasizes original game development, game design methodology, and team projects and presentations. It requires five core courses, two electives, and a project. Students may declare their participation in the specialization after completing the courses in 1a and 1b. All courses must be completed with a grade of C or higher.

1. Core Courses
   a. CSE 306 Operating Systems
   b. CSE 310 Data Communication and Networks or CSE 346 Computer Communications
   c. CSE 328 Fundamentals of Computer Graphics
   d. CSE 380 Computer Game Programming
   e. CSE 381 Advanced Game Programming

2. Two electives from the following:

   CSE 304 Compiler Design
   CSE 331 Computer Security Fundamentals
   CSE 334 Introduction to Multimedia Systems
   CSE 337 Scripting Languages
   CSE 352 Artificial Intelligence
   CSE 355 Computational Geometry
   CSE 364 Advanced Multimedia Techniques
   CSE 375 Concurrency
   CSE 376 Advanced Programming in UNIX/C

3. Project

Completion of CSE 487 Research in Computer Science or CSE 488 Internship in Computer Science or CSE 495/CSE 496 Senior Honors Research Project I, II, on a topic in game programming. The project may not be applied towards the requirements of another specialization.

Note: Students specializing in Game Programming are encouraged to complete the natural science sequence in physics, see part seven (7) of the Requirements for the Major in Computer Science.

Specialization in Computer Security

The specialization in Computer Security prepares students for a career as a security engineer, threat analyst, or security researcher. The courses under this specialization are taught by the computer science faculty affiliated with the National Security Institute. The specialization covers the fundamentals of security, while also exposing the student to some of the latest developments. It requires four core courses, two electives, and a project. Students may declare their participation in the specialization after completing the courses in 1a and 1b. All courses must be completed with a grade of C or higher.

1. Core Courses
   a. CSE 310 Data Communication and Networks or CSE 346 Computer Communications
   b. CSE 306 Operating Systems or CSE 376 Advanced Systems Programming in UNIX/C
   c. CSE 331 Computer Security Fundamentals
   d. CSE 360 Software Security, CSE 361 Web Security, CSE 362 Mobile Security, or CSE 363 Offensive Security

2. Two electives from the following:

   CSE 305 Principles of Database Systems
   CSE 306 Operating Systems
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CSE 315 Database Transaction Processing Systems
CSE 336 Internet Programming
CSE 375 Concurrency
CSE 376 Advanced Systems Programming in UNIX/C

3. Project

Completion of either CSE 487 Research in Computer Science or CSE 495, CSE 496 Senior Honors Research Projects I, II, on a topic in computer security. The project may not be applied towards the requirements of another specialization.

Specialization in Systems Software Development

The specialization in systems software development prepares students for a career in software applications development or systems software development. It requires four core courses, two electives, and a project. Students may declare their participation in the specialization after completing the courses in 1a and 1b. All courses must be completed with a grade of C or higher.

1. Core Courses
   a. CSE 310 Computer Networks or CSE 346 Computer Communications
   b. CSE 306 Operating Systems or CSE 376 Advanced Systems Programming in Unix/C
   c. CSE 331 Computer Security Fundamentals
   d. CSE 311 Systems Administration or CSE 337 Scripting Languages

2. Two electives from the following:
   - CSE 304 Compiler Design
   - CSE 305 Principles of Database Systems
   - CSE 306 Operating Systems
   - CSE 311 Systems Administration
   - CSE 336 Internet Programming
   - CSE 337 Scripting Languages
   - CSE 370 Wireless and Mobile Networking
   - CSE 376 Advanced Systems Programming in UNIX/C
   - Special topics courses in systems software development

3. Project

Completion of CSE 487 Research in Computer Science or CSE 488 Internship in Computer Science or CSE 495/CSE 496 Senior Honors Research Project I, II, on a topic in systems software development. The project may not be applied towards the requirements of another specialization.

The Honors Program

The Honors Program in Computer Science, a highly selective academic program within the major in Computer Science, offers a specially designed curriculum to a limited number of exceptional students. The program is open to freshmen and to continuing students. To be admitted as a freshman, students must demonstrate overall academic excellence by achieving a combined SAT score of 1350 on the critical reading and math components of the SAT (with a score of 700 or higher in math), an unweighted high school average of 93 or higher (on a 100 point scale), and high grade averages in mathematics and the natural sciences. Continuing Computer Science majors who have completed at least three CSE courses and have maintained a cumulative grade point average of 3.50 and an average of 3.50 in CSE courses may apply for admission to the honors program in the sophomore or junior year. Continued participation in the program requires that students maintain a grade point average of 3.50, both cumulative and for all CSE courses.

Honors course offerings include introductory course sequences in programming and in the foundations of computing, advanced courses on selected topics that reflect active research areas within the Department, and a two-semester senior honors project. Students will be able to take at least one honors course each semester throughout a four-year program of study. Honors program students must complete the regular requirements of the Computer Science major. Final conferral of honors is contingent upon successful completion of all required courses in the Computer Science major including a minimum of three honors courses, plus the two-semester honors project, with a cumulative grade point average of 3.50 and an average of 3.50 for all CSE courses. (For this purpose, suitable advanced undergraduate courses and graduate courses may be counted as honors courses with prior approval of the department.)

Honors students in good standing at the end of the junior year will, on application, be recommended for admission to the five-year joint B.S./M.S. program in Computer Science. B.S./M.S. applicants who successfully complete the honors program may be considered for a tuition waiver in the fifth year as well as for a graduate student assistantship. (It is recommended that these students complete an undergraduate teaching practicum in the junior or senior year.)

Requirements for the Minor

The minor in Computer Science is open to all students not majoring in either Computer Science or Information Systems or minoring in Information Systems. To declare the minor in Computer Science, students must complete CSE 114 and either CSE 214 or CSE 215 with grades of C or higher. The minor requires seven CSE courses totaling 22 to 24 credits as outlined below.

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1. CSE 114  Computer Science I  
2. CSE 214  Computer Science II  
3. CSE 219  Computer Science III or CSE 220 Systems Fundamentals I  
4. Four additional courses that are part of the CSE major, including three upper division CSE courses totaling at least nine credits (but excluding CSE 300, CSE 312, CSE 475, CSE 487, CSE 488). Note: CSE 301 can not be used as a technical elective for the minor.  
Note: Each of these courses must be passed with a letter grade of C or higher.  

Joint B.S./M.S. Program  
Computer Science majors may apply for admission to a special program that leads to a Bachelor of Science degree at the end of the fourth year and a Master of Science degree at the end of the fifth year. Students usually apply to the program in their junior year.  

Students must satisfy the respective requirements of both the B.S. degree and the M.S. degree, but the main advantage of the program is that six credits may be simultaneously applied to both the undergraduate and graduate requirements. The M.S. degree can therefore be earned in less time than that required by the traditional course of study.  

For more details about the B.S./M.S. program, see the undergraduate or graduate program director in the Department of Computer Science.  

Sample Course Sequence for the Major in Computer Science  
A course planning guide for this major may be found here. The major course planning guides are not part of the official Undergraduate Bulletin, and are only updated periodically for use as an advising tool. The Undergraduate Bulletin supersedes any errors or omissions in the major course planning guides.  

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### JUNIOR

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### SENIOR

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Notes:

- SBC refers to the following (five) categories: HUM, SBS, ARTS, USA, GLO
- Students may satisfy the Pursue Deeper Understanding and Prepare for Life-Long Learning categories of the SBC by completing CSE 300 and one of the following course clusters:
  - CSE 305, 308
  - CSE 306, 308
CSE

Computer Science

CSE 101: Introduction to Computers
Introduces central ideas of computing and computer science, instills practices of computational thinking, and engages students in the creative aspects of the field. Also introduces appropriate computing technology as a means for solving computational problems and exploring creative endeavors. Requires some programming.
Prerequisite: Level 3 or higher on the mathematics placement examination
SBC: TECH
3 credits

CSE 102: Introduction to Web Design and Programming
An introduction to the design of Web pages, specifically the development of browser and device independent HTML, with an emphasis on the XHTML standards. Includes the use of style sheets (CSS) and techniques for page layout and verification. HTML is presented as a mark-up language, exploring the rules of HTML elements and attributes. Students learn the separation of page viewing information from the HTML through CSS style sheets as well as the use of block layout without using HTML tables. Addresses HTML display properties including text, color, image, and graphic elements as well as approaches to HTML validation and techniques.
Advisory Prerequisite: CSE 101 or basic computer skills
SBC: TECH
3 credits

CSE 110: Introduction to Computer Science
An introduction to fundamentals of computer science. Topics covered include algorithmic design, problem-solving techniques for computer programming, fundamentals of digital logic and computer organization, the role of the operating system, introductory programming methodology including variables, assignment statements, control statements and subroutines (methods), programming paradigms, the compilation process, theoretical limits of computation, social and ethical issues. Intended for students who have not taken any college-level computer science course containing programming assignments in a high-level programming language.
Prerequisite: Level 3 or higher on the mathematics placement examination
SBC: TECH
3 credits

CSE 114: Computer Science I
An introduction to procedural and object-oriented programming methodology. Topics include program structure, conditional and iterative programming, procedures, arrays and records, object classes, encapsulation, information hiding, inheritance, polymorphism, file I/O, and exceptions. Includes required laboratory. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Prerequisite: Level 4 or higher on the math placement exam
Advisory Prerequisite: CSE 101 or ISE 108
SBC: TECH
4 credits

CSE 130: Introduction to Programming in C
Introduces programming concepts using the C language. Variables, data types, and expressions. Conditional and iterative statements, functions, and structures. Pointers, arrays, and strings. Scope of variables and program organization. Includes programming projects of an interdisciplinary nature. Suitable as an introductory programming course for non-CSE majors.
Prerequisite: Level 3 or higher on the mathematics placement examination
3 credits

CSE 150: Foundations of Computer Science: Honors
Introduction to the logical and mathematical foundations of computer science for computer science honors students. Topics include functions, relations, and sets; recursion and functional programming; basic logic; and mathematical induction and other proof techniques.
Prerequisite: one MAT course that satisfies D.E.C. C or QPS or score of level 4 on the math placement exam; admission to the Computer Science Honors Program or the Honors College or WISE or permission of the instructor
4 credits

CSE 160: Computer Science A: Honors
First part of a two-semester sequence, CSE 160 and CSE 260. Emphasizes a higher-level, object-oriented approach to the construction of software. Focus on software engineering issues such as programming style, modularity, and code reusability. Includes the way in which software tools can be used to aid the program development process. First considers the construction of small programs, continues by treating the design and implementation of program modules, and culminates in an introduction to object-oriented design techniques suitable for larger programs.
Prerequisite: Computer Science Honors Program or Honors College or WISE program or University Scholar or permission of instructor
Corequisite: CSE 161
SBC: TECH
3 credits

CSE 161: Laboratory for Computer Science A: Honors
Must be taken concurrently with lecture component, CSE 160; a common grade for both courses will be assigned. Two and one-half hours of laboratory per week. Sessions will focus on development of pragmatic programming skills and use of programming environments and tools in a supervised setting.
Corequisite: CSE 160
1 credit

CSE 214: Computer Science II
An extension of programming methodology to data storage and manipulation on complex data sets. Topics include: programming and applications of data structures; stacks, queues, lists, binary trees, heaps, priority queues, balanced trees and graphs. Recursive programming is heavily utilized. Fundamental sorting and searching algorithms are examined along with informal efficiency comparisons.
Prerequisite: C or higher in CSE 114
3 credits

CSE 215: Foundations of Computer Science
Introduction to the logical and mathematical foundations of computer science. Topics include functions, relations, and sets; recursion and functional programming; elementary logic; and mathematical induction and other proof techniques. This course is offered as both CSE 215 and ISE 215.
Prerequisite: AMS 151 or MAT 125 or MAT 131
3 credits

CSE 219: Computer Science III
Development of the basic concepts and techniques learned in CSE 114 Computer Science I and CSE 214 Computer Science II into practical programming skills that include a systematic approach to program design.
coding, testing, and debugging. Application of these skills to the construction of robust programs of 1000 to 2000 lines of source code. Use of programming environments and tools to aid in the software development process.

Prerequisite: C or higher in CSE 214 and CSE major or ECE major

4 credits

CSE 220: Systems Fundamentals I

This course will introduce assembly language programming and essential concepts of computer organization and architecture. The focus of this course is on the computer organization of a computer system, including the processor architecture and the memory system. In particular, we will discuss the internal representation of information, performance evaluation methodology, instruction set architectures and implementation techniques for computer arithmetic, control path design, and pipelining.

Prerequisites: C or higher in CSE 214 or 260 and CSE major

3 credits

CSE 230: Intermediate Programming in C and C++

Intermediate programming concepts using the C language in a UNIX environment. Files, systems calls, stream I/O, the C preprocessor, bitwise operations, the use of makefiles, advanced formatting of input and output, conversions. Introduction to object-oriented programming using C++; classes, objects, inheritance, aggregation, and overloading. Suitable for all majors.

Prerequisite: CSE 130 or CSE 220 or ESE 124 or ESG 111 or BME 120 or MEC 102

3 credits

CSE 260: Computer Science B: Honors

Second part of a two-semester sequence. CSE 160 and CSE 260. Further development of the object-oriented design strategies presented in CSE 160. Continues with introductions to event-driven programming, graphical user interfaces, and design patterns. Includes an extended design and programming project.

Prerequisite: CSE 160

Corequisite: CSE 261

3 credits

CSE 261: Laboratory for Computer Science B: Honors

Must be taken concurrently with lecture component, CSE 260; a common grade for both courses will be assigned. Two and one-half hours of laboratory per week. Students will learn how to use integrated development environments and associated tools such as syntax-directed editors, debuggers, version management, refactoring, and profiling tools, and they will be exposed to advanced programming concepts such as threads, graphical user interface (GUI) construction, model/view/controller architecture, and application frameworks. Experiments with algorithmic running times will underscore the pragmatic implications of the theoretical concepts of algorithmic complexity covered in the lecture component. The laboratory sessions will also provide a forum in which students will present their initial designs and ultimately demonstrate their final implementations for the course programming project.

Corequisite: CSE 260

1 credit

CSE 300: Technical Communications

Principles of professional technical communications for Computer Science and Information Systems majors. Topics include writing business communications, user manuals, press releases, literature reviews, and research abstracts. Persuasive oral communications and effective presentation techniques, to address a range of audiences, will also be covered. This course satisfies the upper-division writing requirement for CSE and ISE majors.

Prerequisites: WRT 102, CSE or ISE major, U3 or U4 standing

SBC: SPK, WRTD

3 credits

CSE 301: History of Computing

A study of the history of computational devices from the early ages through the end of the 20th century. Topics include needs for computation in ancient times, development of computational models and devices through the 1800's and early 1900's, World War II and the development of the first modern computer, and early uses in business. Creation of programming languages and the microchip. Societal changes in computer usage due to the microcomputer, emergence of the Internet, the World Wide Web, and mobile computing. Legal and social impacts of modern computing. Cannot be used as a technical elective for the CSE major or minor. This course is offered as both CSE 301 and ISE 301.

Prerequisite: U2 standing or higher

Advisory Prerequisite: one course in computing

DEC: H

SBC: STAS

3 credits

CSE 303: Introduction to the Theory of Computation

An introduction to the abstract notions encountered in machine computation. Topics include finite automata, regular expressions, and formal languages, with emphasis on regular and context-free grammars. Questions relating to what can and cannot be done by machines are covered by considering various models of computation, including Turing machines, recursive functions, and universal machines.

Prerequisites: C or higher: CSE 214 and 215 and CSE major

3 credits

CSE 304: Compiler Design

Topics studied include formal description of programming languages, lexical analysis, syntax analysis, symbol tables and memory allocation, code generation, and interpreters. Students undertake a semester project that includes the design and implementation of a compiler for a language chosen by the instructor.

Prerequisites: C or higher: CSE 219 or CSE 260; CSE 220

Advisory Prerequisites: CSE 303 or CSE 350

3 credits

CSE 305: Principles of Database Systems

The design of database management systems to obtain consistency, integrity, and availability of data. Conceptual models and schemas of data: relational, hierarchical, and network. Students undertake a semester project that includes the design and implementation of a database system.

Prerequisites: C or higher: CSE 219 or CSE 260; CSE major

3 credits

CSE 306: Operating Systems

Students are introduced to the structure of modern operating systems. Topics include virtual memory, resource allocation strategies, concurrency, and protection. The design and implementation of a simple operating system are performed.

Prerequisites: C or higher: CSE 219 or CSE 260; CSE 320 or ESE 380; CSE Major or ECE major

3 credits

CSE 307: Principles of Programming Languages

Presents examples of important programming languages and paradigms such as LISP, ALGOL, ADA, ML, Prolog, and C++.
Students write sample programs in some of the languages studied. The languages are used to illustrate programming language constructs such as binding, binding times, data types and implementation, operations (assignment data-type creation, pattern matching), data control, storage management, parameter passing, and operating environment. The suitability of these various languages for particular programming tasks is also covered.

**Prerequisites:** C or higher: CSE 219 or CSE 260; CSE 220; CSE major.

### 3 credits

**CSE 308: Software Engineering**

Introduces the basic concepts and modern tools and techniques of software engineering. Emphasizes the development of reliable and maintainable software via system requirements and specifications, software design methodologies including object-oriented design, implementation, integration, and testing; software project management; life-cycle documentation; software maintenance; and consideration of human factor issues.

**Prerequisites:** C or higher: CSE 219 or CSE 260; CSE 305 or CSE 306; U4 standing; CSE major.

### 3 credits

**CSE 310: Computer Networks**


**Prerequisites:** C or higher: CSE 214 or CSE 260; CSE 220 or ISE 218; CSE major or ISE major. Advisory Pre- or Corequisite: AMS 310

### 3 credits

**CSE 311: Systems Administration**

This course covers practical techniques to manage information systems, also known as IT Systems Administration. Students will learn how to install computers for assorted hardware and software platforms (Windows, Unix/Linux, OS-X). Install networking equipment and configure it. Install server software on several systems (e.g. web, database, mail) and configure it. Secure the network, hosts, and services, and apply system patches. Set up redundant computing services, virtual machines/services, and hardware so that services can survive some hardware/software failures. Evaluate the performance, reliability, and security of the overall system.

**Prerequisites:** CSE 214 or CSE 230 or CSE 260 or ISE 208; ISE or CSE major

### 3 credits

**CSE 312: Legal, Social, and Ethical Issues in Information Systems**

This course deals with the impact of computers on us as individuals and on our society. Rapid changes in computing technology and in our use of that technology have changed the way we work, play, and interact with other people. These changes have created a flood of new social and legal issues that demand critical examination. For example, technologies such as Gmail, Facebook, MySpace, along with music sharing sites and wikis create new social, ethical, and legal issues. This course is offered as both CSE 312 and ISE 312.

**Prerequisites:** U3 or U4 standing, one D.E.C. E or SNW course

**SBC:** CER, ESI, STAS

### 3 credits

**CSE 320: Systems Fundamentals II**

This course will introduce C programming and essential concepts of operating systems, compilers, concurrency, and performance analysis, focused around several cross-cutting examples, such as memory management, error handling, and threaded programming.

**Prerequisites:** C or higher: CSE 220 and CSE major.

### 3 credits

**CSE 323: Human-Computer Interaction**

A survey course designed to introduce students to Human-Computer Interaction and prepare them for further study in the specialized topics of their choice. Students will have the opportunity to delve deeper in the course through a course project, and through a two-three week special topic selected at the instructor's discretion. Course is cross-listed as CSE 323, EST 323 and ISE 323.

**Prerequisites:** CSE 214 or CSE 230 or CSE 260 or ISE 208

### 3 credits

**CSE 325: Computers and Sculpture**

This multidisciplinary class surveys how computer science and computer technology are used in sculpture. Case studies with slides, videos, and software demonstrations illustrate a range of approaches of sculptors incorporating computers in their creative process. Various state-of-the art fabrication technologies are studied (with site visits if available on campus). Mathematical foundations are emphasized so students can recognize them when analyzing sculpture and choose the right tool when designing. In the weekly laboratory, these ideas are reinforced with projects using a range of available software and inexpensive construction materials, e.g., paper, cardboard, and foamcore.

**Prerequisite:** CSE 110 or CSE 101 or permission of instructor

### 3 credits

**CSE 327: Fundamentals of Computer Vision**

Introduces fundamental concepts, algorithms, and techniques in visual information processing. Covers image formation, binary image processing, image features, model fitting, optics, illumination, texture, motion, segmentation, and object recognition.

**Prerequisites:** CSE 214 or CSE 230 or CSE 260; AMS 210 or MAT 211

### 3 credits

**CSE 328: Fundamentals of Computer Graphics**

An introduction to computer graphics including graphics application programming; data structures for graphics; representing and specifying color; fundamental hardware and software concepts for calligraphic and raster displays; two-dimensional, geometric transformations; introduction to three-dimensional graphics; graphics standards; and input devices, interaction handling, and user-computer interface.

**Prerequisites:** C or higher: CSE 219 or CSE 260; CSE 220

### 3 credits

**CSE 331: Computer Security Fundamentals**

Introduces the basic concepts and terminology of computer security. Covers basic security topics such as cryptography, operating systems security, network security, and language-based security.

**Prerequisite:** CSE 220; CSE major

Advisory pre-or corequisite: CSE 320

### 3 credits

**CSE 332: Introduction to Visualization**

This course is an introduction to both the foundations and applications of visualization and visual analytics, for the purpose of understanding complex data in science, medicine, business, finance, and many
others. It will begin with the basics - visual perception, cognition, human-computer interaction, the sense-making process, data mining, computer graphics, and information visualization. It will then move to discuss how these elementary techniques are coupled into an effective visual analytics pipeline that allows humans to interactively think with data and gain insight. Students will get hands-on experience via several programming projects, using popular public-domain statistics and visualization libraries and APIs. This course is offered as both CSE 332 and ISE 332.

Prerequisites: CSE 214 or CSE 260; MAT 211 or AMS 210; AMS 310
3 credits

CSE 333: User Interface Development
Survey of user interface systems, with emphasis on responsive and adaptive strategies to accommodate cross-platform deployment across multiple devices such as desktops and mobile devices. Demonstration of the use of tool kits for designing user interfaces. Additional topics include human factors, design standards, and visual languages. Students participate in a project involving the design and implementation of user interface systems. This course is offered as both CSE 333 and ISE 333.

Prerequisite: CSE 214 or CSE 260
3 credits

CSE 334: Introduction to Multimedia Systems
Survey of technologies available for user interfaces. Discussion of hypertext; voice, music, and video together with tools and models for capturing, editing, presenting, and combining them. Capabilities and characteristics of a range of peripheral devices including devices based on posture, gesture, head movement, and touch. Case studies of academic and commercial multimedia systems including virtual reality systems. Students participate in laboratory exercises and build a multimedia project. This course is offered as both CSE 334 and ISE 334.

Prerequisite: U2, U3 or U4 standing
3 credits

CSE 336: Internet Programming
Introduces the design and development of software for Internet commerce. Topics include extended markup language, servlets, cookies, sessions, Internet media types, Web protocols, digital signatures, certificates, encryption, and the wireless Internet.

Prerequisite: CSE 219 or CSE 260
3 credits

CSE 337: Scripting Languages
Scripting languages are widely used in the IT industry. Programming with scripting languages, also known as scripting, has several advantages compared to programming with other types of languages in that scripts facilitate rapid program development; can automate high-level jobs or tasks very effectively; and can be used to compose various software components, even binaries, into more complex and powerful applications. This course introduces the principles of scripting, covers one or two selected scripting languages in depth, and illustrates the advanced use of scripting by extensive case studies in application areas such as system administration, web application development, graphical user interface development, and text processing.

Prerequisites: CSE 114 or CSE 160 or ISE 208; CSE or ISE major; U3 or U4 standing
3 credits

CSE 346: Computer Communications
Basic principles of computer communications. Introduction to performance evaluation of protocols. Protocols covered include those for local, metropolitan, and wide area networks. Introduction to routing, high speed packet switching, circuit switching, and optical data transport. Other topics include TCP/IP, Internet, web server design, network security, and grid computing. Not for credit in addition to CSE/ISE 316. This course is offered as both CSE 346 and ESE 346.

Pre- or corequisite for ESE and ECE majors: ESE 306
Pre- or corequisite for CSE majors: AMS 310 or 311
3 credits

CSE 350: Theory of Computation: Honors
Introduces the abstract notions of machine computation for honors students. Includes finite automata, regular expressions, and formal languages, with emphasis on regular and context-free grammars. Explores what can and cannot be computed by considering various models of computation including Turing machines, recursive functions, and universal machines.

Prerequisites: CSE 150; AMS 210 or MAT 211; CSE Honors Program or Honors College or WISE
4 credits

CSE 352: Artificial Intelligence
Topics covered include critique of artificial intelligence research; state-space problem representations and search algorithms; game-playing programs; theorem-proving programs; programs for the study and simulation of cognitive processes and pattern recognition. Further topics in current research as time permits.

Prerequisites: CSE 219 or CSE 260
3 credits

CSE 353: Machine Learning
Covers fundamental concepts for intelligent systems that autonomously learn to perform a task and improve with experience, including problem formulations (e.g., selecting input features and outputs) and learning frameworks (e.g., supervised vs. unsupervised), standard models, methods, computational tools, algorithms and modern techniques, as well as methodologies to evaluate learning ability and to automatically select optimal models. Applications to areas such as computer vision (e.g., character and digit recognition), natural-language processing (e.g., spam filtering) and robotics (e.g., navigating complex environments) will motivate the coursework and material.

Prerequisites: CSE 219 or CSE 260
Pre- or Co-requisite: AMS 310 or AMS 311 or AMS 312
3 credits

CSE 355: Computational Geometry
The design and analysis of efficient algorithms to solve geometric problems that arise in computer graphics, robotics, geographical information systems, manufacturing, and optimization. Topics include convex hulls, triangulation, Voronoi diagrams, visibility, intersection, robot motion planning, and arrangements. This course is offered as both AMS 345 and CSE 355.

Prerequisites: AMS 301; programming knowledge of C or C++ or Java
3 credits

CSE 356: Cloud Computing
Creating online services capable of handling millions of users requires a different mindset compared to traditional software development and deployment. Rather than building monolithic software packages from the ground up, bringing up modern online services calls for architecting systems by gluing together mature existing technologies deployed across many unreliable servers, working in concert to provide high-availability robust services. In this course, students will be exposed to the concepts and technologies behind deploying and scaling online services on the computing resources available in modern datacenters.

Prerequisites: C or higher: CSE 219; CSE 220; CSE major
Advisory prerequisite: CSE 336
3 credits

CSE 360: Software Security
This course will describe the principles and practice of securing software systems. Topics will include: software vulnerabilities; static and dynamic analysis techniques for vulnerability detection; exploit detection and prevention; secure software development techniques and defensive programming; malware detection and analysis; security policies and sandboxing; information flow. Prerequisites: CSE 331; CSE major 3 credits

CSE 361: Web Security
This course will cover all aspects of web security, including browser security, web server security, and web application security. Topics include: SOP and JavaScript; application and protocol vulnerabilities; probing, surveillance, and tracking; penetration testing; modern social engineering techniques; monetary incentives and monetization. Prerequisites: CSE 331; CSE major 3 credits

CSE 362: Mobile Security
The course covers the latest security technologies for mobile platforms (e.g., Android and iOS). It first introduces the security issues plaguing mobile apps and discusses defensive mechanisms, such as code signing, app permissions, and sandbox. It then peeks into mobile OS, explaining how jailbreaking/rooting works and the internals of iOS/Android security designs. Finally, it surveys modern hardware-level security features, such as secure booting, TrustZone, and biometrics. Prerequisites: CSE 331; CSE major 3 credits

CSE 363: Offensive Security
Hands-on course with the goal of understanding various security problems in depth, through a more adversarial way of thinking. By focusing on finding and exploiting vulnerabilities, the course will cover a broad range of topics, including the ethics of offensive security, reverse engineering, software vulnerability discovery and exploitation, malicious code analysis, network traffic interception and manipulation, reconnaissance and information gathering, physical security, and social engineering. All topics will be covered from a highly practical perspective, following a hands-on approach and tutorial-like sessions, along with programming assignments. Prerequisites: CSE 331; CSE major 3 credits

CSE 364: Advanced Multimedia Techniques
Digital media production techniques for high-bandwidth applications such as electronic magazine illustration, broadcast television, and motion picture special effects. Students explore techniques such as 3D modeling and character animation, video compositing, and high-resolution image processing in a state-of-the-art multimedia computing laboratory. High-capacity multimedia storage, high-speed networks, and new technologies such as DVD, HDTV, and broadband will be reviewed. This course is offered as both CSE 364 and ISE 364. Prerequisites: CSE/ISE 334 and permission of the instructor 3 credits

CSE 366: Introduction to Virtual Reality
An introduction to the practical issues in the design and implementation of virtual environments. Topics covered include the fundamentals of systems requirements, transformations, user-interaction models, human vision models, tracking systems, input/output devices and techniques, and augmented reality. The topics covered are explained through the use of real-life applications of virtual-reality systems in engineering, science, and medicine. Prerequisites: CSE 328, CSE/ISE 332, 333 3 credits

CSE 370: Wireless and Mobile Networking
The fundamentals of wireless communication. Link, network and transcript layer protocols for wireless and mobile networking. Cellular networks. Wireless LANs. Wireless multihop networks. Mobile applications. Prerequisite: CSE 310 or 346 3 credits

CSE 371: Logic
A survey of the logical foundations of mathematics: development of propositional calculus and quantification theory, the notions of a proof and of a model, the completeness theorem, Goedel's incompleteness theorem. This course is offered as both CSE 371 and MAT 371. Prerequisite: CSE 150 or CSE 215 or MAT 200 3 credits

CSE 373: Analysis of Algorithms
Mathematical analysis of a variety of computer algorithms including searching, sorting, matrix multiplication, fast Fourier transform, and graph algorithms. Time and space complexity. Upper-bound, lower-bound, and average-case analysis. Introduction to NP completeness. Some machine computation is required for the implementation and comparison of algorithms. This course is offered as CSE 373 and MAT 373. Prerequisites: C or higher in MAT 211 or AMS 210; CSE 214 or CSE 260 3 credits

CSE 376: Advanced Systems Programming in UNIX/C
Focuses on several aspects of producing commercial-grade system software: reliability, portability, security, and survivability. Uses Unix and C, heavily used in industry when developing systems and embedded systems code. Emphasizes techniques and tools to produce reliable, secure, and highly portable code. Requires substantial programming as well as a course project. Prerequisites: C or higher: CSE 219 or 260; CSE 320 or 230 or ESE 224 or ESG 111; CSE or ECE major 3 credits

CSE 377: Introduction to Medical Imaging
An introduction to the mathematical, physical, and computational principles underlying modern medical imaging systems. Covers fundamentals of X-ray computer tomography, ultrasonic imaging, nuclear imaging, and magnetic resonance imaging (MRI), as well as more general concepts required for these, such as linear systems theory and the Fourier transform. Popular techniques for the visualization, segmentation, and analysis of medical image data are discussed, as well as applications of medical imaging, such as image-guided intervention. The course is appropriate for computer science, biomedical engineering, and electrical engineering majors. Prerequisites: AMS 161 or MAT 127 or 132 or 142; AMS 210 or MAT 211 3 credits

CSE 378: Introduction to Robotics
Introduces basic concepts in robotics including coordinate transformation, kinematics, dynamics, Laplace transforms, equations of motion, feedback and feedforward control, and trajectory planning. Covers simple and complex sensors (such as cameras), hybrid and behavior based control and path planning. Concepts are illustrated through laboratories using the LEGO Robot Kit.
CSE 390: Special Topics in Computer Science
A lecture or seminar course on a current topic in computer science. Semester supplements to this Bulletin contain specific description when course is offered. May be repeated as the topic changes, but cannot be used more than twice to satisfy CSE major requirements.
Prerequisite: CSE Major
3 credits

CSE 392: Special Topics in Computer Science
A lecture or seminar course on a current topic in computer science. Semester supplements to this Bulletin contain specific description when course is offered. May be repeated as the topic changes, but cannot be used more than twice to satisfy CSE major requirements.
Prerequisite: CSE Major
3 credits

CSE 393: Special Topics in Computer Science
A lecture or seminar course on a current topic in computer science. Semester supplements to this Bulletin contain specific description when course is offered. May be repeated as the topic changes, but cannot be used more than twice to satisfy CSE major requirements.
Prerequisite: CSE Major
3 credits

CSE 394: Special Topics in Computer Science
A lecture or seminar course on a current topic in computer science. Semester supplements to this Bulletin contain specific description when course is offered. May be repeated as the topic changes, but cannot be used more than twice to satisfy CSE major requirements.
Prerequisite: CSE Major
3 credits

CSE 395: Senior Honors Research Project I
A two-semester research project carried out under the supervision of a computer science faculty member. Students who enroll in CSE 495 must complete CSE 496 in the subsequent semester and receive only one grade upon completion of the sequence.
Prerequisite: Admission to the Computer Science Honors Program
3 credits, S/U grading

CSE 396: Senior Honors Research Project II
A two-semester research project carried out under the supervision of a computer science faculty member. Students must submit a written project report and make a presentation to the department at the year-end Honors Project Colloquium.
Prerequisite: CSE 495
3 credits