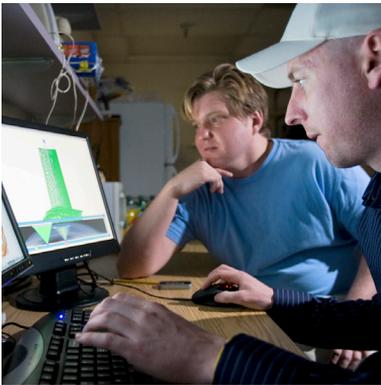


UNM SCHOOL OF ENGINEERING COMPUTER SCIENCE



UNDERGRADUATE INFORMATION PACKET

University of New Mexico Department of Computer Science MSC01 1130 Albuquerque, NM 87131

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INTRODUCTION

What is Computer Science?

Computer Science (CS) is the body of knowledge centered on the concepts of computation, information, and communication. This includes theories for understanding computing systems and methods. Computation occurs everywhere: your iPod, your car, your immune system, your brain, financial markets, ant colonies, chemical systems, DNA, quantum systems. Computer science is concerned with



everything about programs; how to solve problems with them, how to build them, how to classify and analyze them and prove they are correct, how to draw pictures with them, how to get them to learn and much, much more. CS studies these systems and others using three methodologies: engineering (high performance computing, game building), scientific (artificial intelligence, machine learning) and mathematical (cryptography, complexity theory).

Career Opportunities

Computer science is an exciting and rapidly growing field. Graduates with a Bachelor of Science degree in computer science can expect an entry-level annual salary of \$54,000, and starting salaries for M.S. and Ph.D. graduates can go up to \$100,000. Computer science will only expand as technology advances, and many wonderful opportunities exist for computer scientists, both during school and after graduation. Graduates might work within the computer industry as systems or application programmer, a systems analyst or designer, or in research. Outside the computer industry, opportunities exist in just about any job or field requiring an expert knowledge of computers and systems of hardware and software.

COMPUTER SCIENCE AT UNM

The CS undergraduate program at UNM is the only Computer Science program in the state accredited by the ABET Computing Sciences Accreditation Board. The Department prides itself on the diversity of its students and faculty, as well as its facilities and opportunities for students at all levels.

Student Opportunities

The Computer Science program at UNM has many opportunities for students to take advantage of. Some students pursue theoretical questions in great depth; others concentrate on diverse practical applications. Over the past several years, the UNM Computer Science Department has expanded opportunities for students, including a peer-tutoring program, aggressive nomination of students for awards and fellowships, and

departmental scholarships. Through funding from various sources, there are many scholarships available specifically for CS degree candidates, as well as opportunities to connect with research laboratories that open many doors for future careers. Students completing the program have successfully established their own businesses and research groups. The School of Engineering also offers scholarships, and many others are available through the UNM scholarship office. UNM also provides several special programs such as tutoring and counseling, as well as financial assistance for women and minority groups that traditionally have been poorly represented in engineering fields.

Facilities



The UNM Computer Science Department has over 200 general-purpose workstations, running Linux, Windows, and Mac OS X. The department network infrastructure consists of a switched 1GB backbone, which links the campus network and supports the principal departmental servers. There is a departmental lab available to students, with 20 workstations, primarily Linux, as well as several labs dedicated to specific research projects. Computer

science students also have access to the Arts, Research, Technology and Science Lab (ARTS Lab), an interdisciplinary center for developing creative relationships between. The Computer Science Department also maintains a wireless network in the Farris Engineering Center for faculty and students. There are two full-time staff and four part-time students providing systems support.

Faculty

In the UNM Computer Science Department, the faculty are committed to working with and assisting students in order to produce graduates who can be effective on the job. Research interests among the faculty include many cutting-edge topics, such as the modeling of avian influenza, computer security, artificial intelligence, high performance computing and arts and technology. In addition, the solid foundation in theory provided in the department ensures both long-term professional competence and the basis for graduate study. Members of the faculty are awarded grants from NSF, DARPA, SFI, DOE and other industry partners, and they work closely with the Santa Fe Institute, Los Alamos National Laboratory and Sandia National Laboratories in order to connect students to opportunities with New Mexico's world-class research.

More Information

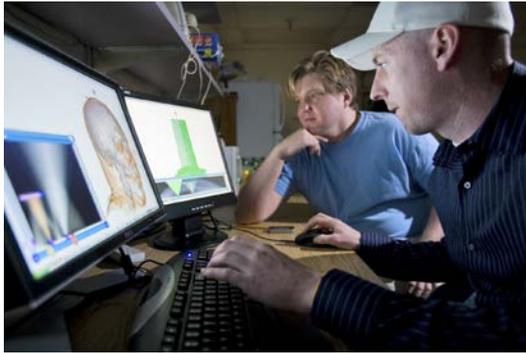
For more information about UNM Computer Science programs, please contact the Department of Computer Science, MSC01 1130, 1 University of New Mexico, Albuquerque, NM 87131-0001, Tel. (505) 277-3112, or send an email to csinfo@cs.unm.edu. You may also visit our website at www.cs.unm.edu. For general information about the University of New Mexico, such as admission requirements, application procedures and funding opportunities, please visit the Admissions and Recruitment Services website at <http://admissions.unm.edu/>.



THE UNDERGRADUATE DEGREE PROGRAM

Program Objectives for the Computer Science Degree

The primary goal of the degree program in Computer Science is to provide students the foundations for future work and careers in computation-based problem solving. These foundations support both a successful career path in computing as well as provide appropriate qualifications for further degree work in computation related disciplines. Our degree emphasizes development of analytical skills, acquisition of knowledge and



understanding of systems, languages and tools required for effective computation-based problem solving. Our core courses offer a broad base so that students who end their studies with the Bachelor of Science degree can continue to acquire new skills and advance in an always-evolving professional workplace. Our core courses also strive to cultivate the sophistication and insights needed for further study at the graduate level.

The following objectives are to be met by students obtaining a degree in Computer Science. Upon graduation, students will:

1. Have sufficient analytical skills and knowledge to make appropriate system and language choices for computer based problem solving.
2. Possess algorithm development skills for effective problem solving and programming.
3. Understand the software development process.
4. Besides the core computing skills, have significant background in application areas such as databases, graphics and artificial intelligence.
5. Communicate effectively in both oral and written modes.
6. Understand and respect the professional standards of ethics expected of a computer scientist as well as appreciate the social impact of computing.
7. Appreciate the intellectual environment offered by the University of New Mexico and adopt the goal of life-long learning in an ever-evolving world.

Analytical skills are at the heart of becoming an effective computer scientist. These skills are stressed even from the beginning courses in programming and discrete mathematics. The ability to develop a computational solution for a problem coming from a complex world of goals and processes also requires understanding of and experience with algorithm design, a wide variety of architecture and network designs and a select number of current computing languages. These analytic, design and programming skills are tested in senior-level applications courses, including work in databases, complex systems, computer vision and artificial intelligence. Supporting all of our education in computing is a philosophy that stresses analysis, communication, ethics and social responsibility.

Admission Requirements

Students wishing to enroll in the bachelor's program in computer science must apply for admission or transfer to the Computer Science Department, School of Engineering. The admission process is initiated through the Office of Admissions for students wishing to transfer to the University of New Mexico from other institutions. Grades earned in equivalent courses at other institutions will be used in determining eligibility for admission to the department. Students transferring to the Computer Science program from another college at the University of New Mexico should initiate the paperwork at the office of the Computer Science Department. Students transferring to the Computer Science program from another department within the School of Engineering should initiate their paperwork in their present department office. Students denied entrance to the department due to lack of sufficient credits or specific courses may enroll in computer science classes and reapply at a later time when they meet the entrance requirements. The criteria for admission are:

1. Completion of the following courses with a grade of B- or better: Math 162, and one of CS 151L or CS 152.
2. Fulfillment of requirements for admission to the School of Engineering (see the UNM Catalog for more information).



Advanced Placement and Transfer Credit

The department subscribes to the general policy of the School of Engineering with regard to advanced placement credit earned by examination.

Students with university level course work from other institutions will have their academic records evaluated by an undergraduate advisor from the department on an individual basis. The student should be aware that the department has the final say about which transfer credits can be applied toward the graduation requirements listed below. Because computer science programs vary greatly, students transferring from other institutions should not assume that computer science courses they have taken elsewhere can be applied toward the 51 hour computer science course work graduation requirement. Courses not accepted toward the 51 hours may be applied toward the 130 semester hour graduation requirement as general electives at the discretion of an undergraduate advisor.

Graduation Requirements

To receive the degree of Bachelor of Science in Computer Science, a student must satisfy all general University of New Mexico regulations concerning baccalaureate programs and the student must complete all work defined by the following groups. Only courses with a grade of C- or better may be used to satisfy any of the requirements defined herein. The following courses cannot be used to satisfy any of the requirements listed below: Reserve Officers Training Corp (ROTC), recreational physical education (PE-NP), Introductory Studies courses (e.g., IS-E 100) and mathematical courses prior to calculus.

If in doubt about the applicability of a course, contact the undergraduate advisor in the Computer Science Department.

1. Completion of 120 semester hours.
2. Completion of at least 42 hours in courses numbered 300 or above.
3. Completion of 51 hours in Computer Science with a grade of C or better. The 51 hours must consist of one of CS 151L or CS 152L completed with a B- or better and the following courses:

ECE 238L	Computer Logic Design
CS 241L	Data Organization
CS 251L	Intermediate Programming
CS 261	Mathematical Foundations of Computer Science
CS 293	Social and Ethical Issues in Computing
CS 341L	Introduction to Computing Systems
CS 351L	Design of Large Programs
CS 357	Declarative Programming
CS 361L	Data Structures and Algorithms I
CS 362	Data Structures and Algorithms II
CS 375	Introduction to Numerical Programming
CS 460	Software Engineering
CS 481	Operating Systems Principles

The remaining 9 hours are technical electives of the student's choosing to be taken from among the Computer Science Department offerings. Certain courses in the Department of Electrical and Computer Engineering are also acceptable as technical electives. All courses used as technical electives are subject to the approval of the undergraduate advisor and must be completed with a grade of B or better.

CS 259L may be substituted for CS 152L and CS 251L but only 5 hours of credit are awarded. The computer science hour requirement is reduced to 50, but the overall graduation requirement remains at 130. The following rules apply to completion of CS courses:

- a. Department offerings below the 300-level cannot be used as technical electives. The following courses also cannot be used as technical electives: CS 394 and 494.
- b. At most, 3 hours of CS 499 may be used toward satisfaction of this requirement.
- c. At least 15 credits at or above the 300-level used to satisfy requirement must be taken from full-time University of New Mexico faculty.
- d. At least 18 credits must be taken in the Computer Science Department at the University of New Mexico.

4. Completion of the mathematics sequence:
 MATH 162 and 163 (Calculus I and II), Calc I completed B- or better
 MATH 314 or 321 (Linear Algebra)
 STAT 345 (Elements of Mathematical Statistics and Probability Theory)
5. 9 credit hours of communications skills: ENGL 110 (or ENGL 112; or ENGL 113), ENGL 120 and one of ENGL 219 (Technical and Professional Writing), ENGL 220 (Expository Writing) or CJ 130 (Public Speaking).



Part of this requirement may be satisfied by passing an authorized proficiency examination. ENGL 110 and 120 are waived if the student obtains:

- an ACT score of 25 or higher (prior to October 1989)
- an ACT score of 29 or higher (after October 1989)
- an SAT score of 580 or higher (prior to April 1995) or
- an SAT score of 650 or higher (after April 1995)

When a student is exempted from ENGL 110 and 120, the student's total credit requirement is still the minimum required by the University for a bachelor's degree. Students may have to take additional credit hours to meet that minimum.

6. Satisfaction of University Core Curriculum requirements in humanities, social sciences, fine arts and second language plus additional non-technical courses to total a minimum of 30 credit hours. A description of the University Core Curriculum can be found in the UNM Catalog.
7. Four science courses (of 3 or more credit hours) taken by science and engineering majors, two of which must come from one of the following sequences, including the laboratories. The remaining hours can be more advanced courses in the discipline chosen for the sequence or they can be additional introductory laboratory science hours. Physics is recommended for students in the School of Engineering.

Astronomy 270 – 270L, 271 – 271L

Biology 201, 202, 203L, 204L

Chemistry 121L – 122L

Earth and Planetary Sciences 101 – 105L and 201L **or**

Env Sc 101 – 102L and Earth and Planetary Sciences 201L

Physics 160, 160L – 161, 161L

8. Course work sufficient to satisfy requirements of a minor. Minors approved by the College of Arts and Sciences are generally acceptable for Computer Science majors. The *University of New Mexico Catalog* should be consulted for the requirements for completing a minor in various fields of study. An interdisciplinary minor of not less than 24 hours can be developed to suit the goals of individual students; the Undergraduate Curriculum Committee of the

department must approve such a minor. The following courses taken from the Department of Electrical and Computer Engineering satisfy the requirement:

Minor in Computer Engineering: ECE 203L, ECE 206L, ECE 213, ECE 321, ECE 322, ECE 338 and ECE 438.

Minor in Electrical Engineering: ECE 203L, ECE 206L, ECE 213, ECE 314, ECE 321 and two of ECE 322, ECE 340, ECE 360, ECE 371, or ECE 445.

Mathematics minors may not use Department of Mathematics courses for Teachers and Education Students in constructing the minor. MATH 317 and MATH 327 cannot be used in constructing the minor.

Statistics minors must substitute 3 hours of advanced statistics for STAT 145 (not accepted by the department).

Students minoring in business cannot minor in Management Information Systems (MIS). In particular, the following courses cannot be used in constructing a minor: MGMT 290 (STAT 245), 301, 329, 331, 336, 337, and 371, 459, 460, 461, or any course related to CS or computer applications.

Courses taken to satisfy the requirements for a minor may also be used to satisfy the requirements of categories 1, 2, 5, 6 and 7.

All courses taken to satisfy the graduation requirements are subject to final approval by an undergraduate advisor. Courses taken for Credit/No Credit (CR/NC) may only be used to satisfy graduation requirement #1 (completion of 130 semester hours). At most, 24 semester hours taken for CR/NC may be applied towards the baccalaureate degree.

No one course may be used to satisfy more than one requirement of categories 3, 4 and 8. Due to the cross listing of various courses within the University and the different requirements for the minor from department to department, this has a number of implications. For example, mathematics minors cannot count the required sequence in mathematics toward the minor in mathematics, and computer engineering minors cannot use ECE 438 as a technical elective in fulfilling requirement 3.

Honors Program

Eligible undergraduates in the Computer Science Department are urged to enroll in the Honors Program. Students may graduate with University honors, Departmental Honors or both. Information is available from departmental advisors and the University Honors Center.

Minor in Computer Science

A minor in computer science is available for students in other departments. The requirements for a minor are completion of 15 credit hours of CS coursework those required for a computer science major. A minimum of 6 hours of these 15 credit hours must be at the 300 level or above. A grade of C or better is required for all CS course work counted toward the minor.

Interdisciplinary Film and Digital Media Program

The Interdisciplinary Film and Digital Media Program at the University of New Mexico is a model of interdisciplinary education for the twenty-first century that will give our students necessary critical, creative, and technical skills to apply digital technologies in innovative and productive ways. Students interested in how computer science applies to film and digital media may choose to pursue this program through the Department of Computer Science.

Advisement

Students are required to see an undergraduate advisor within the department each semester prior to registering for classes. The advisor will inform the student about the admissibility of classes used to satisfy graduation requirement 6 (18 hours in humanities, social and behavioral sciences, fine arts, and a second language), as some courses do not meet this requirement and therefore do not count towards graduation.

Curriculum in Computer Science

The following schedule is intended to be a guide for students when planning their course load for any particular semester. It should be noted that the schedule will normally be adjusted to compensate for any deficiencies or advanced preparation on the part of the student prior to beginning the freshman year. Students must take the ACT or SAT to aid in proper placement in Math and English. Students should not begin any Computer Science courses until they have knowledge of mathematics equivalent to MATH 150 (*Pre-Calculus Mathematics*), as indicated by the diagram provided. General electives include courses in humanities, social and behavioral sciences, the fine arts and foreign languages. It is recommended that a student not attempt more than 12 hours of technical material in one semester.



CURRICULUM FOR BACHELOR OF SCIENCE

FIRST YEAR			
Fall Semester		Spring Semester	
English 101	3	English 102	3
CS 152L	3	CS 251L	3
Math 162L	4	CS 261	3
Lab Science I	4	Math 163L	4
		Lab Science II	4
Total	14	Total	17
SECOND YEAR			
Fall Semester		Spring Semester	
CS 241L	3	CS 351L	4
ECE 238	4	Lab Science IV	3
Math 314	3	English Comm	3
CS 293	3	Elective/ Minor/ UNM Core	3
Lab Science III	3		
Elective/ Minor/ UNM Core	3		
Total	17	Total	13
THIRD YEAR			
Fall Semester		Spring Semester	
CS 361	3	CS 357	3
CS 375	3	CS 362	3
Stat 345	3	CS Elective	3
	6	Elective/ Minor/ UNM Core	9
Total	15	Total	18
FOURTH YEAR			
Fall Semester		Spring Semester	
CS 341	3	CS 460	3
CS Elective	3	CS 481	3
CS Elective	3	Elective/ Minor/ UNM Core	9
Elective/ Minor/ UNM Core	6		
Total	15	Total	15

COURSE OFFERINGS IN COMPUTER SCIENCE

A grade of C or better is required in all prerequisite courses. Students with equivalent knowledge may have the prerequisite waived by consent of instructor on an individual basis. Students are required to see an undergraduate advisor within the department each semester prior to registering for classes.

105. Introduction to Computer Programming. (3)

Introduction to Computer Programming is a gentle and fun introduction. Students will use a modern Integrated Development Environment to author small programs in a high level language that do interesting things.

108. Computer Science for All: An Introduction to Computational Science and Modeling. (3)

This course offers an introduction to computer science through modeling and simulation. Students will learn agent-based modeling of complex systems and see the applicability of computer science across fields. Course cannot apply to major in computer science or any other SOE major.

150L. Computing for Business Students. (3)

Students will use personal computers in campus laboratories to learn use of a word processor, a spreadsheet, and a database management program. The course will also cover access to the World Wide Web and other topics of current importance to business students. Course cannot apply to major or minor in computer science.

Prerequisite: MATH 120.

151L. Computer Programming Fundamentals for Non-Majors. (3)

An introduction to the art of computing. Not intended for Computer Science majors or minors. The objective of the course is an understanding of the relationship between computing and problem solving.

152L. Computer Programming Fundamentals. (3)

An introduction to the art of computing. The course objectives related to understanding relationships between computation, problem solving and programming using high-level languages.

Prerequisite: MATH 150 recommended.

241L. Data Organization. (3)

Data representation, storage and manipulation. Covers the memory organization of data storage and its relation to computation and efficiency. Topics include: linked vs. contiguous implementation, memory management, the use of indices and pointers, and an introduction to issues raised by the memory hierarchy. Programming assignments in C provide practice with programming styles that yield efficient code and computational experiments investigate the effect of storage design choices on the running time of programs.

Prerequisite: 151L, 152L or 259L.

251L. Intermediate Programming. (3)

An introduction to the methods underlying modern program development. Specific topics will include object-oriented design and the development of graphical user interfaces. Programming assignments will emphasize the use of objects implemented in standard libraries.

Prerequisite: 151L or 152L. Three lectures, 1 hr recitation.

259L. Data Structures with JAVA. [Data Structures with C++®.] (5)

An accelerated course covering the material of 151L and 251L in one semester. Topics include elementary data structures and their implementation, recursive procedures, data abstraction and encapsulation, and program organization and verification. Programs will be written in JAVA. Credit not allowed for both 259L and 151L/251L.

261. Mathematical Foundations of Computer Science. (3)

Introduction to the formal mathematical concepts of computer science for the beginning student. Topics include elementary logic, induction, algorithmic processes, graph theory and models of computation.

293. Social and Ethical Issues in Computing. (1)

Overview of philosophical ethics, privacy and databases, intellectual property, computer security, computer crime, safety and reliability, professional responsibility and codes, electronic communities and the Internet, and social impact of computers. Students make oral presentations and produce written reports.

341L. Introduction to Computer Architecture and Organization. (3)

Survey of various levels of computer architecture and design: microprogramming and processor architecture, advanced assembly language programming, operating system concepts and input/output via the operating system.

Prerequisites: 241L and ECE 238L.

351L. Design of Large Programs. (4)

A projects course with emphasis on object-oriented analysis, design and programming. Also discussed are programming language issues, programming tools and other computer science concepts as needed to do the projects (e.g., discrete-event simulation, parsing).

Prerequisites: 251L or 259L.

357. Declarative Programming. (3)

Course focuses on one of the declarative programming paradigms: functional, logic, or constraint programming. Specialized techniques are introduced with a view towards general principles. Selected advanced topics in programming language design and implementation are covered.

361L. Data Structures and Algorithms. (3)

An introduction to data structures and algorithms and the mathematics needed to analyze their time and space complexity. Topics include asymptotic notation, recurrence relations and their solution, sorting, hash tables, basic priority queues, search trees (including at least one balanced structure) and basic graph representation and search. Students complete a term project that includes an experimental assessment of competing data structures.

Prerequisites: (261 or MATH 327) and 241L.

362. Data Structures and Algorithms II. (3)

A continuation of 361L with an emphasis on design of algorithms. Topics include: amortized analysis and self-adjusting data structures for trees and priority queues; union-find; minimum spanning tree, shortest path and other graph algorithms; elementary computational geometry; greedy and divide-and-conquer paradigms.

365. Introduction to Scientific Modeling. (3)

Symbolic computation applied to scientific problem solving, modeling, simulation and analysis.

375. Introduction to Numerical Computing. (3)

(Also offered as MATH 375.) An introductory course covering such topics as solution of linear and nonlinear equations; interpolation and approximation of functions, including splines; techniques for approximate differentiation and integration; solution of differential equations; familiarization with existing software.

Prerequisites: MATH 163.

390. Topics in Computer Science for Non-Majors – Undergraduate. (1-3, no limit)

This course is intended to provide students in other disciplines with an opportunity to study aspects of modern computer science, tailored to their own field of study. May be repeated for credit.

Restriction: permission of instructor.

394. Computer Generated Imagery and Animation. (3)

(Also offered as ARTS 394 and MA 394.) Introduction to story boarding, modeling, rendering, animation and dynamics. Class uses high-level commercial animation software. Course emphasizes both the development of technical skills and the aesthetic aspects of computer imagery. Not allowed for graduate credit for computer science majors, or as a technical elective for undergraduate computer science majors.

Prerequisites: 131L and ARTS 121.

412. Introduction to Computer Graphics: Scanline Algorithms. (3)

This course is an introduction to the technical aspects of raster algorithms in computer graphics. Students will learn the foundational concepts of 2-D and 3-D graphics as they relate to real-time and offline techniques. Students will develop a video game as a final project to demonstrate the algorithms learned in class.

413. Introduction to Ray and Vector Graphics. (3)

Introductory Graphics. Topics include: Ray-Geometry intersections, viewing, lenses, local/global illumination, procedural textures/models, Spline curves and surfaces, statistical integration for Realistic Image Synthesis. Students will write a raytracing renderer from scratch, exploring high performance implementations and realistic rendering.

422./522. Digital Image Processing. (3)

Introduction to fundamentals of digital image processing. Specific topics include grey level histograms, geometric/grey level transformations, linear systems theory, Fourier transforms, frequency domain filtering, wavelet transforms, image compression, edge detection, color vision, and binary image morphology.

Prerequisites: 257L and (MATH 314 or MATH 321).

423. Introduction to Complex Adaptive Systems. (3)

Introduces topics in complex adaptive systems, including: definitions of complexity, fractals, dynamical systems and chaos, cellular automata, artificial life, game theory, neural networks, genetic algorithms and network models. Regular programming projects are required.

Prerequisites: 251 and MATH 163.

427./527. Principles of Artificially Intelligent Machines. (3)

Survey of artificial intelligence exclusive of pattern recognition. Heuristic search techniques, game playing, mechanical theorem proving, additional topics selected by the instructor.

Prerequisite: 351L.

429. Introduction to Machine Learning. (3)

Introduction to principles and practice of systems that improve performance through experience. Topics include statistical learning framework, supervised and unsupervised learning, Bayesian analysis, time series analysis, reinforcement learning, performance evaluation and empirical methodology; design tradeoffs.

Prerequisite: 362 or 530 or 561.

442. Introduction to Parallel Processing. (3)

(Also offered as ECE 432.) Machine taxonomy and introduction to parallel programming. Performance issues, speed-up and efficiency. Interconnection networks and embeddings. Parallel programming issues and models: control parallel, data parallel and data flow. Programming assignments on massively parallel machines.

Prerequisites: 341L or ECE 344L; 351L or ECE 331. 481 or ECE 437 recommended.

444./544. Introduction to Cybersecurity. (3)

This class will focus on proactive security, i.e. designing networks, algorithms and data structures which are provably robust to attack. Grades will be based on class participation, presentations, and class projects.

454./554. Compiler Construction. (3)

Syntax analysis and semantic processing for a block-structured language. Lexical analysis, symbol tables, run-time management. Students will write a compiler.

460. Software Engineering. (3)

Software engineering principles will be discussed and applied to a large team developed project. Other topics relevant to the production of software will also be covered, including ethics, legalities, risks, copyrights and management issues.

464./564. Introduction to Database Management. (3)

Introduction to database management systems. Emphasis is on the relational data model. Topics covered include query languages, relational design theory, file structures and query optimization. Students will implement a database application using a nonprocedural query language interfaced with a host programming language.

471. Introduction to Scientific Computing. (3)

(Also offered as MATH 471.) Introduction to scientific computing fundamentals, exposure to high performance programming language and scientific computing tools, case studies of scientific problem solving techniques.

473./573. Physics and Computation. (3) Moore

(Also offered as NSMS 573) A survey of complex systems at the interface between physics and computer science, including phase transition, power laws, social networks, NP-completeness, and Monte Carlo methods.

481. Computer Operating Systems.

[Digital Computer Operating Systems.] (3)

(Also offered as ECE *437.) Fundamental principles of modern operating systems design, with emphasis on concurrency and resource management. Topics include processes, inter-process communication, semaphores, monitors, message passing, input/output device, deadlocks memory management, files system design.

485. Introduction to Computer Networks. (3)

(Also offered as ECE 440.) Theoretical and practical study of computer networks, including network structures and architectures. Principles of digital communications systems. Network topologies, protocols and services. TCP/IP protocol suite. Point-to-point networks; broadcast networks; local area networks; routing, error and flow control techniques.

491. Special Topics–Undergraduates. (1-6 to a maximum of 12)

Undergraduate seminars in special topics in computer science. May be repeated for credit because subject matter varies.

494. Advanced Topics in Computer Generated Imaging. (3 to a maximum of 6)

(Also offered as MA 494 and ARTS 494./594.) A continuation of 394. Students are expected to research and make presentations on advanced topics in CGI. Significant term project required. Not allowed for graduate credit for computer science majors, or as a technical elective for undergraduate computer science majors. May be repeated for credit.

499. Individual Study–Undergraduate. (1-3 to a maximum of 6)

Guided study, under the supervision of a faculty member, of selected topics not covered in regular courses. At most 3 hours may be applied toward the CS hour requirement. May be repeated for credit.