BACHELOR OF SCIENCE IN
COMPUTER SCIENCE AND
CROP SCIENCES

Email: academic@cs.illinois.edu or cropsci@illinois.edu

Minimum required major and supporting coursework equates to 74-77 hours. All Campus General Education and College of ACES foreign language requirements must be met. The minimum hours required for graduate is 126. At least twenty-one hours of 300- and 400-level coursework must be taken on this campus.

A Major Plan of Study Form must be completed and submitted to the Department of Computer Science Office of Undergraduate Affairs and to the Undergraduate Teaching Office in Crop Sciences by the beginning of the fifth semester (60-75 hours). Please see the Computer Science advisor in 1210 Siebel Center, as well as the Crop Sciences Teaching Coordinator in Turner Hall AE-120.

To graduate from the Computer Science and Crop Sciences curriculum, a student must complete the following courses, all of which must be taken for a traditional letter grade.

Prescribed Courses including Campus General Education

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>RHET 105</td>
<td>Writing and Research and Public Speaking</td>
<td>6-7</td>
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<tr>
<td>&amp; CMN 101</td>
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<tr>
<td>Advanced Composition</td>
<td>Select from campus-approved list.</td>
<td>3-4</td>
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<tr>
<td>Cultural Studies</td>
<td>Select one course from Western culture, one from non-Western culture, and one from U.S. minority culture from campus approved lists.</td>
<td>9</td>
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<tr>
<td>Foreign Language</td>
<td>Coursework at or above the third level is required for graduation.</td>
<td>0-15</td>
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<tr>
<td>Quantitative Reasoning I</td>
<td>See Mathematical Foundations for specific requirement.</td>
<td>3</td>
</tr>
<tr>
<td>Quantitative Reasoning II</td>
<td>See Mathematical Foundations for specific requirement.</td>
<td>3</td>
</tr>
<tr>
<td>Natural Sciences and Technology</td>
<td>See Crop Sciences Core for specific requirement.</td>
<td>6</td>
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<tr>
<td>Humanities and the Arts</td>
<td>Select from campus-approved list.</td>
<td>6</td>
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<tr>
<td>Social and Behavioral Sciences</td>
<td>Select from campus-approved list.</td>
<td>6</td>
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<tr>
<td>ACES Required</td>
<td>ACES 101 Contemporary Issues in ACES</td>
<td>2</td>
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<td></td>
<td>Computer Science Core</td>
<td>22</td>
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<td></td>
<td>CS 100 Freshman Orientation</td>
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<td>CS 125 Intro to Computer Science</td>
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<td>CS 126 Software Design Studio</td>
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<td>CS 173 Discrete Structures</td>
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<td>CS 225 Data Structures</td>
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<td>CS 374 Introduction to Algorithms &amp; Models of Computation</td>
<td>4</td>
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<td>CS 421 Progmrng Languages &amp; Compilers</td>
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<td>Computer Science Technical Track</td>
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<td></td>
<td>To include either CS 240, or CS 233 and CS 241, plus up to two CS 400-level classes per approved list and constraints maintained on Computer Science department website.</td>
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<td>Mathematical Foundations (fulfills Quantitative Reasoning I and II)</td>
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<td>CS 361 Probability &amp; Statistics for Computer Science</td>
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<td></td>
<td>MATH 220 Calculus</td>
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<td>or MATH 226 Calculus I</td>
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<td></td>
<td>MATH 225 Introductory Matrix Theory</td>
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<td></td>
<td>MATH 231 Calculus II</td>
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<td>Crop Sciences Core</td>
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<td></td>
<td>CPSC 112 Introduction to Crop Sciences</td>
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<td>Select two of the following:</td>
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<td>CPSC 226 Introduction to Weed Science</td>
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<td></td>
<td>CPSC 270 Applied Entomology</td>
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<td></td>
<td>PLPA 204 Introductory Plant Pathology</td>
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<td>CPSC 261 Biotechnology in Agriculture</td>
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<td>CPSC 265 Genetic Engineering Lab</td>
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<td></td>
<td>CPSC 266 Data in Biology and Agriculture</td>
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<td>CPSC 352 Plant Genetics</td>
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<td>CPSC 440 Applied Statistical Methods I</td>
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<td>Select two of the following:</td>
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<td>CPSC 418 Crop Growth and Management</td>
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<td>CPSC 452 Advanced Plant Genetics</td>
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<td>CPSC 453 Principles of Plant Breeding</td>
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<td>CPSC 466 Genomics for Plant Improvement</td>
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<td>CPSC 498 Crop Sci Professional Develpmt</td>
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<td>Total Hours</td>
<td>126</td>
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Crop Sciences Courses

CPSC 112 Introduction to Crop Sciences  credit: 4 Hours.

Introductory course covering the principles and practices of crop production and sustainable agroecosystem management. Topics include plant growth and development, environmental factors influencing plant productivity, soil management, fertility, and nutrient cycling, pest control principles, and sustainability challenges facing modern crop production. Concepts are discussed in lecture and reinforced in hands-on laboratory sections.

This course satisfies the General Education Criteria for: Nat Sci Tech - Life Sciences
CPSC 113 Environment, Agric, & Society credit: 3 Hours.
Introduction to agriculture and the environment; examine the largest managed ecosystem and its influence on natural ecosystems; develop a working understanding of natural and agriculture ecosystems and their interaction; examine various agriculture management strategies that can be used to produce food for an increasing world population while maintaining or improving environmental quality.
This course satisfies the General Education Criteria for:
- Nat Sci Tech - Life Sciences
- Cultural Studies - Western

CPSC 116 The Global Food Production Web credit: 3 Hours.
Introduces students to the global web involved in the production of food we consume on a daily basis. Selected ecosystems of plants, people, and cultures in Asia, Africa, and Latin America will be studied based on involvement with various crops. Presents the origin and biology of plants; their evolution with humankind in various cultures; the spread and economic importance of crops around the world; and considers current hunger and environmental issues resulting from the global food web. Interactive communications with selected scientists, producers, and traders around the world through the World Wide Web and email system of the INTERNET permit students to get personal exposure to information and activities.
This course satisfies the General Education Criteria for:
- Cultural Studies - Non-West

CPSC 117 Agriculture and Science of Coffee credit: 3 Hours.
The growth and production of coffee and its impact on society and culture. The botanical aspects of coffee, coffee varieties/cultivars, and technologies for coffee growth, harvesting, post-harvest processing, and roasting will be discussed. The wide variety of coffee beverages, coffee flavor evaluation, coffee chemistry, coffee economics, and the physiological effects of coffee will also be examined.

CPSC 131 Agriculture in Mythology credit: 3 Hours.
Compare and contrast the role agriculture and plant sciences played in the development of ancient cultures. Study agricultural references in ancient global mythology. Develop an appreciation of how agricultural diversity of various ancient cultures influenced mythology in the cultures in different regions.
This course satisfies the General Education Criteria for:
- Cultural Studies - Non-West

CPSC 180 Medicinal Plants and Herbology credit: 3 Hours.
Same as HORT 180. See HORT 180.

CPSC 199 Undergraduate Open Seminar credit: 0 to 5 Hours.
Experimental course on a special topic in crop sciences. Topic may not be repeated except in accordance with the Code. Approved for Letter and S/U grading. May be repeated up to a maximum of 12 hours in separate terms if topics vary.

CPSC 213 Evolution in Action credit: 2 Hours.
Introduction to evolutionary theory. Examination of how domesticated species have evolved. Develops an appreciation of how agroecosystems have influences evolution of adjacent natural ecosystems. Elucidation of evolutionary mechanisms necessary for agricultural species to adapt to global climate change.

CPSC 215 The Prairie and Bioenergy credit: 3 Hours.
Designed for students who are interested in bioenergy and its production from prairie land. Instructors will provide information on the global trend of bioenergy production and consumption, importance of bioenergy, the role of Illinois prairie land in bioenergy production, potential U.S. bioenergy production, biofuels from plants, and socio-environmental benefits of bioenergy.

CPSC 226 Introduction to Weed Science credit: 3 Hours.
Fundamentals of weed biology, ecology, and management. Emphasis is placed on basic principles and specific management strategies that are relevant to both crop and non-crop ecosystems. Includes a laboratory/discussion. Same as HORT 226. Prerequisite: CPSC 112 or HORT 100 or IB 103.

CPSC 241 Intro to Applied Statistics credit: 3 Hours.
Introduces fundamental statistical procedures used to analyze and interpret data. General principles of descriptive and inferential statistics, measures of central tendency and dispersion, probability, correlation and regression, and tests of hypotheses are covered. An emphasis is placed on biological, environmental, and agricultural sciences, but numerous examples from other areas are discussed. Course content enhances students' ability to critically assess statistical information encountered in professional and every day activities. Credit is not given for both CPSC 241 and STAT 100 or ACE 261.
This course satisfies the General Education Criteria for:
- Quantitative Reasoning I

CPSC 261 Biotechnology in Agriculture credit: 3 Hours.
Basic introduction to the techniques and application of biotechnology to a wide range of agricultural areas, and specific examples are given. May serve as either a terminal course explaining the techniques or as an introductory base for future studies. Same as HORT 261. Prerequisite: Any 100-level course in a biosciences discipline.
This course satisfies the General Education Criteria for:
- Nat Sci Tech - Life Sciences

CPSC 265 Genetic Engineering Lab credit: 3 Hours.
Laboratory/discussion course that provides a hands-on introduction to the techniques and principles of genetic engineering, recombinant DNA and the impact of molecular genetics on society. Students will isolate DNA from plants and clone specific genes into bacterial plasmids, perform polymerase chain reactions, DNA restriction analysis and DNA blotting, and discuss the relevance of these techniques to both medicine and agriculture. Prerequisite: A general biology course.

CPSC 266 Data in Biology and Agriculture credit: 4 Hours.
This course focuses on the use of computing and data analysis to solve problems in biology and agriculture and includes an overview of computer methods and limitations of current computer, network and storage hardware for big data sets. The nature, use and future potential of different types of computer hardware and software in biology and agriculture (e.g. mobile applications, high performance computing, wireless networking) will be discussed. Examples of computing-related and computing-limited problems in biology and agriculture, such as image analysis, remote sensing and genetic analysis will be used as case studies. The potential of computing to improve the food system, medicine and other applications will be presented.

CPSC 270 Applied Entomology credit: 3 Hours.
Lectures, laboratory, and field trips cover the biology of insects and the recognition and management of insect pests of agricultural, forest, and urban ecosystems. Covers insect structure and physiology, classification, life histories, behavior, and pest management. Same as IB 220 and NRES 270.
This course satisfies the General Education Criteria for:
- Cultural Studies - Non-West
CPSC 293  Off-Campus Crop Sci Internship  credit: 1 to 5 Hours.
Supervised, off-campus experience in a field directly pertaining to a subject matter in crop sciences. Approved for S/U grading only. May be repeated to a maximum of 10 hours. For registration in this course, students should contact the Department Teaching Coordinator. Prerequisite: Sophomore standing, cumulative GPA of 2.0 or above at the time the internship is arranged, and consent of instructor.

CPSC 294  On-Campus Crop Sci Internship  credit: 1 to 5 Hours.
Supervised, on-campus learning experience with faculty engaged in research. Approved for S/U grading only. May be repeated to a maximum of 10 hours. For registration in this course, students should contact the Department Teaching Coordinator. Prerequisite: Sophomore standing, 2.0 GPA, consent of the advisor, and consent of the Department Teaching Coordinator.

CPSC 295  Undergrad Research or Thesis  credit: 1 to 4 Hours.
Individual research, special problems, thesis, development and/or design work under the supervision of an appropriate member of the faculty. May be repeated in the same or subsequent terms. No more than 12 hours of special problems, research, thesis and/or individual studies may be counted toward degree. Prerequisite: Junior standing, cumulative GPA of 2.5 or above at the time the activity is arranged, and consent of instructor.

CPSC 336  Tomorrow's Environment  credit: 3 Hours.
Introduction to interdisciplinary methods of analysis of environmental problems in a finite world; examination of the concept of the limits to growth; development of a working understanding of natural systems and environmental economics; and examination of various management strategies (technical, economic, and social) that can be used to improve environmental quality. Same as CHLH 336, and ENVS 336. Prerequisite: One course in the life sciences and one course in the social sciences, or consent of instructor.

CPSC 352  Plant Genetics  credit: 4 Hours.
The principles of heredity in relation to plant improvement. Same as NRES 352. Prerequisite: IB 103 or IB 104.

CPSC 382  Organic Chem of Biol Processes  credit: 4 Hours.
An overview of the structure, properties, and reactions of carbon-containing compounds relevant to biological processes and cellular structure. The chemistry of hydro carbon, aromatic, as well as oxygen-nitrogen-, phosphorus-, and sulfur-containing compounds will be examined. Macromolecular structures including biological membranes, carbohydrates, proteins and nucleic acids will also be discussed. Prerequisites: CHEM 102 and CHEM 104 or CHEM 202 and CHEM 204.

CPSC 396  Undergrad Honors Res or Thesis  credit: 1 to 4 Hours.
Individual research, special problems, thesis, development and/or design work under the direction of the Honors advisor. May be repeated in the same or subsequent terms. No more than 12 hours of special problems, research, thesis and/or individual studies may be counted toward degree. Prerequisite: Junior standing, admission to the ACES Honors Program, and consent of instructor.

CPSC 407  Diseases of Field Crops  credit: 3 Hours.
Same as PLPA 407. See PLPA 407.

CPSC 408  Integrated Pest Management  credit: 3 Hours.
Examination of fundamental concepts of pest management including a historical review of pests and pest management; an overview of major pests (insects, weeds, plant diseases and vertebrate) in a variety of settings (agronic, specialty crops, urban and structural); management options (area-wide, chemical, biological, cultural and physical); regulatory issues; and topics of current interest. 3 undergraduate hours. 3 graduate hours. Prerequisite: CPSC 226 or CPSC 270 or equivalent, both are preferred but only 1 is required.

CPSC 412  Principles of Crop Advising  credit: 3 Hours.
Fundamentals in crop development and management, soil structure, management, and fertility, and how crops and soils interact are examined. Students learn how to diagnose real-world problems in fields and field crops grown in the Midwestern US, and to develop practical solutions to such problems. Prepares students to be competitive in careers within commercial crop agriculture and to pass the Certified Crop Adviser examination. 3 undergraduate hours. 3 graduate hours. Prerequisite: CPSC 112 and NRES 201, or equivalent, or consent of instructor.

CPSC 413  Agriculture, Food, and the Environment  credit: 2 Hours.
Advanced course in the complex interactions of food production resulting from different agricultural systems and the environment. Develop an appreciation of the intricacies of producing food for a growing world population while minimizing the impact on the natural environment. Understand the implementation of new technology and strategies for future food production. 2 undergraduate hours. 2 graduate hours. Prerequisite: CPSC 112 or CPSC 113 or equivalent course or consent of instructor. For Online MS Program.

CPSC 414  Forage Crops and Pasture Eco  credit: 3 Hours.
Forages, their plant characteristics, ecology, and production; grasslands of farm and range as related to animal production and soil conservation. 3 undergraduate hours. 3 graduate hours. Offered in alternate years. Prerequisite: An introductory class in biology.

CPSC 415  Bioenergy Crops  credit: 3 Hours.
Provides an overview and understanding of biomass feedstock production systems for sustainable biofuels production. 3 undergraduate hours. 3 graduate hours. Prerequisite: CPSC 112 or consent of instructor.

CPSC 416  Native Plants and Agroecosystems  credit: 4 Hours.
Introduction to native plants and to their conservation use and agronomic benefit. Topics include learning to identify native plants using a regional flora, knowing the different ecological niches in the state of Illinois and which plants inhabit them, and choosing appropriate native plants to enhance the interaction between agronomic crops and natives. 4 undergraduate hours. 4 graduate hours. Credit is not given for CPSC 416 if credit for NRES 415 has been earned. Prerequisite: HORT 100 or IB 103.

CPSC 418  Crop Growth and Management  credit: 3 Hours.
Crop physiology and management as influenced by environment, plant species, and cropping system; relates plant growth processes to crop production practices based on current research. 3 undergraduate hours. 3 graduate hours. Prerequisite: IB 103 or CPSC 112 or equivalent, or consent of instructor.

CPSC 419  Midwest Agricultural Practices  credit: 1 Hour.
Introduces agronomic production practices in the Midwest and economics of the crop production value chain. Specifically designed for beginning graduate students in crop genetic improvement from non-agricultural backgrounds. 1 undergraduate hour. 1 graduate hour.
CPSC 426  Weeds Mgt in Agronomic Crops  credit: 3 Hours.
Principles of weed ecology and biology, and their application to weed management. Herbicides and their use in corn, soybeans and other agronomic crops. Specialized topics include weed management in reduced tillage, herbicide tolerant crops and management of problem weeds. 3 undergraduate hours. 3 graduate hours. Prerequisite: CPSC 226 or consent of instructor.

CPSC 428  Weed Science Practicum  credit: 2 Hours.
Intensive course on field diagnostic skills in weed science. Topics include weed and weed seed identification, sprayer calibration, herbicide application, herbicide injury symptomatology, and field diagnostics. Students who complete the course will be encouraged to enter the North Central Weed Science Society weeds contest, which occurs during the summer. 2 undergraduate hours. 2 graduate hours. Prerequisite: CPSC 226 or CPSC 426 or consent of instructor.

CPSC 431  Plants and Global Change  credit: 3 Hours.
The science of global atmospheric and climate change in the 21st Century. Understanding of how plants, including crops, will respond and may be adapted to these changes. Using plants to ameliorate predicted climate change. Same as IB 440 and NRES 431. 3 undergraduate hours. 3 graduate hours. Offered in alternate years. Prerequisite: CPSC 112 or IB 103.

CPSC 433  Basic Toxicology  credit: 3 Hours.
Same as CB 449, ENVS 480 and FSHN 480. Same as FSHN 480.

CPSC 436  Conservation Biology  credit: 4 Hours.
Same as ENVS 420 and IB 451. See IB 451.

CPSC 437  Principles of Agroecology  credit: 3 Hours.
Examines the dynamics and function of agricultural ecosystems and reviews fundamental concepts of ecology. Agricultural systems will be compared on the basis of energy flow, nutrient cycling, diversity, stability and required inputs. 3 undergraduate hours. 3 graduate hours. Offered in alternate years. Prerequisite: IB 100 or IB 103 or equivalent.

CPSC 438  Soil Nutrient Cycling  credit: 3 Hours.
Same as NRES 438. See NRES 438.

CPSC 439  Env and Sustainable Dev  credit: 3 Hours.
Same as NRES 439. See NRES 439.

CPSC 440  Applied Statistical Methods I  credit: 4 Hours.
Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; and techniques in testing hypotheses with an introduction to regression, correlation, and analysis of variance limited to the completely randomized design and the randomized complete-block design. Same as ABE 440, ANSC 440, FSHN 440, and NRES 440. 4 undergraduate hours. 4 graduate hours. Prerequisite: MATH 112 or equivalent.

CPSC 448  Biological Modeling  credit: 3 or 4 Hours.
Same as ANSC 449, GEOG 468, and IB 491. See GEOG 468.

CPSC 452  Advanced Plant Genetics  credit: 3 Hours.
Survey of selected contemporary topics in plant genetics and genomics. Topics include the nature of genes and genomes, crop domestication, selection, allelic diversity in populations, and genetics mapping. Serves as an introduction to functional genomics, population genetics, transmission genetics, quantitative genetics, and bioinformatics. Same as IB 478. 3 undergraduate hours. 3 graduate hours. Prerequisite: CPSC 352 or IB 204, or consent of instructor.

CPSC 453  Principles of Plant Breeding  credit: 4 Hours.
Principles, concepts and tools used in plant breeding. Includes methods and breeding schemes used with different plant species. Same as HORT 453. 4 undergraduate hours. 4 graduate hours. Prerequisite: IB 103; CPSC 352 or equivalent.

CPSC 454  Plant Breeding Methods  credit: 2 Hours.
Discussion of the application of current scientific tools and methods available to plant breeders for improving plants; emphasis on actual use of plant breeding methods and production of high quality seed. 2 undergraduate hours. 2 graduate hours. Offered summer only in alternate years. Prerequisite: CPSC 453.

CPSC 462  Plant Molecular Biology  credit: 1 Hour.
Same as IB 472. See IB 472.

CPSC 466  Genomics for Plant Improvement  credit: 2 Hours.
An overview of applying the methods of genomics to discover variation in genes and their expression, creating new genetic variation, and applying this information to the improvement of economically important plants. Emphasis on recent advances in genomic science and activities where functional genomics information is used to efficiently create and manipulate desirable phenotypes. Same as IB 477. 2 undergraduate hours. 2 graduate hours. Prerequisite: CPSC 352 or a similar course, or consent of instructor.

CPSC 467  Plant Genomics  credit: 1 Hour.
Same as IB 473. See IB 473.

CPSC 473  Mgmt of Field Crop Insects  credit: 3 Hours.
Ecological principles of insect populations in agroecosystems including: sampling insect populations, threshold development, bioeconomics and decision-making, population regulation, designing management strategies for field crop insect pests, and deployment of transgenic crops for management of insect pests. Case studies describing various pest management programs in field-crop settings will be provided. 3 undergraduate hours. 3 graduate hours. Prerequisite: CPSC 270 or an equivalent course, or consent of instructor.

CPSC 475  Insect Pathology  credit: 3 Hours.
Same as IB 483. See IB 483.

CPSC 479  Insect Pest Management  credit: 3 Hours.
Same as IB 482. See IB 482.

CPSC 484  Plant Physiology  credit: 3 Hours.
Same as IB 420. See IB 420.

CPSC 488  Soil Fertility and Fertilizers  credit: 3 Hours.
Same as NRES 488. See NRES 488.

CPSC 489  Photosynthesis  credit: 3 Hours.
Same as BIOP 432 and IB 421. See IB 421.

CPSC 491  Ugrad Bioinformatics Seminar  credit: 0 to 2 Hours.
Same as INFO 491 and IS 483. See INFO 491.

CPSC 498  Crop Sci Professional Devlpmt  credit: 1 Hour.
Topics related to professional development including resumes, interview skills, business etiquette, ethics, and presentations on opportunities in crop sciences and horticulture. 1 undergraduate hour. No graduate credit. Prerequisite: Junior standing in Crop Sciences or Horticulture.

CPSC 499  Seminar  credit: 1 to 4 Hours.
Group discussion or an experimental course on a special topic in crop sciences. Approved for both letter and S/U grading. May be repeated to a maximum of 12 hours.

CS Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/CS)
Computer Science Courses

CS 100  Freshman Orientation  credit: 1 Hour.
Introduction to Computer Science as a field and career for computer science majors. Overview of the field and specific examples of problem areas and methods of solution.

CS 101 Intro Computing: Engrg & Sci  credit: 3 Hours.
Fundamental principles, concepts, and methods of computing, with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; fundamental algorithms and data structures; use of computers in solving engineering and scientific problems. Intended for engineering and science majors. Prerequisite: MATH 220 or MATH 221.
This course satisfies the General Education Criteria for: Quantitative Reasoning II

CS 102 Little Bits to Big Ideas  credit: 4 Hours.
Same as INFO 102. See INFO 102.
This course satisfies the General Education Criteria for: Quantitative Reasoning I

CS 105 Intro Computing: Non-Tech  credit: 3 Hours.
Computing as an essential tool of academic and professional activities. Functions and interrelationships of computer system components: hardware, systems and applications software, and networks. Widely used application packages such as spreadsheets and databases. Concepts and practice of programming for the solution of simple problems in different application areas. Intended for non-science and non-engineering majors. Prerequisite: MATH 112.
This course satisfies the General Education Criteria for: Quantitative Reasoning I

CS 125 Intro to Computer Science  credit: 4 Hours.
Basic concepts in computing and fundamental techniques for solving computational problems. Intended as a first course for computer science majors and others with a deep interest in computing. Prerequisite: Three years of high school mathematics or MATH 112.
This course satisfies the General Education Criteria for: Quantitative Reasoning I

CS 126 Software Design Studio  credit: 3 Hours.
Fundamental principles and techniques of software development. Design, documentation, testing, and debugging software, with a significant emphasis on code review. Credit is not given for both CS 242 and CS 126. Prerequisite: CS 125. For majors only.

CS 173 Discrete Structures  credit: 3 Hours.
Discrete mathematical structures frequently encountered in the study of Computer Science. Sets, propositions, Boolean algebra, induction, recursion, relations, functions, and graphs. Credit is not given for both CS 173 and MATH 213. Prerequisite: One of CS 125, ECE 220; one of MATH 220, MATH 221.

CS 196 Freshman Honors  credit: 1 Hour.
Offered for honors credit in conjunction with other 100-level computer science courses taken concurrently. A special examination may be required for admission to this course. May be repeated. Prerequisite: Concurrent registration in another 100-level computer science course (see Schedule).

CS 199 Undergraduate Open Seminar in Computer Science  credit: 0 to 5 Hours.
Topics vary. Approved for Letter and S/U grading. May be repeated.

CS 210 Ethical & Professional Issues  credit: 2 Hours.
Ethics for the computing profession. Ethical decision-making; licensing; intellectual property, freedom of information, and privacy. Credit is not given for both CS 210 and ECE 316. Prerequisite: CS 225. Junior standing required.

CS 225 Data Structures  credit: 4 Hours.
Data abstractions: elementary data structures (lists, stacks, queues, and trees) and their implementation using an object-oriented programming language. Solutions to a variety of computational problems such as search on graphs and trees. Elementary analysis of algorithms. Prerequisite: CS 125 or ECE 220; CS 173 or MATH 213.
This course satisfies the General Education Criteria for: Quantitative Reasoning II

CS 233 Computer Architecture  credit: 4 Hours.
Fundamentals of computer architecture: digital logic design, working up from the logic gate level to understand the function of a simple computer; machine-level programming to understand implementation of high-level languages; performance models of modern computer architectures to enable performance optimization of software; hardware primitives for parallelism and security. Prerequisite: CS 125 and CS 173; credit or concurrent enrollment in CS 225.

CS 240 Introduction to Computer Systems  credit: 3 Hours.
Basics of computer systems. Number representations, assembly/machine language, abstract models of processors (fetch/execute, memory hierarchy), processes/process control, simple memory management, file I/O and directories, network programming, usage of cloud services. Prerequisite: CS 225 or both CS 205 and CS 110C++.

CS 241 System Programming  credit: 4 Hours.
Basics of system programming, including POSIX processes, process control, inter-process communication, synchronization, signals, simple memory management, file I/O and directories, shell programming, socket network programming, RPC programming in distributed systems, basic security mechanisms, and standard tools for systems programming such as debugging tools. Credit is not given for both CS 241 and ECE 391. Prerequisite: CS 225; credit or concurrent registration in CS 233.

CS 242 Programming Studio  credit: 3 Hours.
Intensive programming lab intended to strengthen skills in programming. Prerequisite: CS 241.

CS 296 Honors Course  credit: 1 Hour.
Group projects for honors credit in computer science. Sections of this course are offered in conjunction with other 200-level computer science courses taken concurrently. A special examination may be required for admission to this course. May be repeated. Prerequisite: Concurrent registration in another 200-level computer science course (see Schedule).

CS 357 Numerical Methods I  credit: 3 Hours.
Fundamentals of numerical methods for students in science and engineering; floating-point computation, systems of linear equations, approximation of functions and integrals, the single nonlinear equation, and the numerical solution of ordinary differential equations; various applications in science and engineering; programming exercises and use of high quality mathematical library routines. Same as MATH 357. Credit is not given for CS 357 if credit for CS 450 has been earned. (Counts for advanced hours in LAS). Prerequisite: A 100-level computer science course; MATH 225 or MATH 415; MATH 241.
CS 361 Probability & Statistics for Computer Science  credit: 3 Hours.
Introduction to probability theory and statistics with applications to computer science. Topics include: visualizing datasets, summarizing data, basic descriptive statistics, conditional probability, independence, Bayes theorem, random variables, joint and conditional distributions, expectation, variance and covariance, central limit theorem. Markov inequality, Chebyshev inequality, law of large numbers, Markov chains, simulation, the PageRank algorithm, populations and sampling, sample mean, standard error, maximum likelihood estimation, Bayes estimation, hypothesis testing, confidence intervals, linear regression, principal component analysis, classification, and decision trees. Same as STAT 361. Credit is not given for both CS 361 and ECE 313. Prerequisite: MATH 220 or 221; credit or concurrent registration in MATH 225. For majors only.

CS 374 Introduction to Algorithms & Models of Computation  credit: 4 Hours.
Analysis of algorithms, major paradigms of algorithm design including recursive algorithms, divide-and-conquer algorithms, dynamic programming, greedy algorithms, and graph algorithms. Formal models of computation including finite automata and Turing machines. Limitations of computation arising from fundamental notions of algorithm and from complexity-theoretic constraints. Reductions, undecidability and NP-completeness. Same as ECE 374. Prerequisite: CS 225; MATH 225 or MATH 415.

CS 397 Individual Study  credit: 1 to 3 Hours.
May be repeated. Prerequisite: Consent of instructor.

CS 398 Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in computer science intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. May be repeated in the same or separate terms if topics vary.

CS 410 Text Information Systems  credit: 3 or 4 Hours.
Theory, design, and implementation of text-based information systems. Text analysis, retrieval models (e.g., Boolean, vector space, probabilistic), text categorization, text filtering, clustering, retrieval system design and implementation, and applications to web information management. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 411 Database Systems  credit: 3 or 4 Hours.
Examination of the logical organization of databases: the entity-relationship model, the hierarchical, network, and relational data models and their languages. Functional dependencies and normal forms. Design, implementation, and optimization of query languages; security and integrity; concurrency control, and distributed database systems. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 412 Introduction to Data Mining  credit: 3 or 4 Hours.
Concepts, techniques, and systems of data warehousing and data mining. Design and implementation of data warehouse and on-line analytical processing (OLAP) systems; data mining concepts, methods, systems, implementations, and applications. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 413 Intro to Combinatorics  credit: 3 or 4 Hours.
Same as MATH 413. See MATH 413.

CS 414 Multimedia Systems  credit: 3 or 4 Hours.
Organization and structure of modern multimedia systems; audio and video encoding; quality of service concepts; scheduling algorithms for multimedia within OS and networks multimedia protocols over high-speed networks; synchronization schemes, user-interface design; multimedia teleservices. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or ECE 391.

CS 418 Interactive Computer Graphics  credit: 3 Hours.
Basic mathematical tools and computational techniques for modeling, rendering, and animating 3-D scenes. Same as CSE 427. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225; MATH 225 or MATH 415; MATH 241.

CS 419 Production Computer Graphics  credit: 3 or 4 Hours.
Advanced methods for representing, displaying, and rendering two-, three-, and four-dimensional scenes. General algebraic curves and surfaces, splines, Gaussian and bump-function representation, fractals, particle systems, constructive solid geometry methods, lighting models, radiosity, advanced ray-tracing methods, surface texturing animation techniques, data visualization methods. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 418.

CS 420 Parallel Programming  credit: 3 or 4 Hours.
Fundamental issues in design and development of parallel programs for various types of parallel computers. Various programming models according to both machine type and application area. Cost models, debugging, and performance evaluation of parallel programs with actual application examples. Same as CSE 402 and ECE 492. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 421 Programming Languages & Compilers  credit: 3 or 4 Hours.
Structure of programming languages and their implementation. Basic language design principles; abstract data types; functional languages; type systems; object-oriented languages. Basics of lexing, parsing, syntax-directed translation, semantic analysis, and code generation. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 233 and CS 373.

CS 422 Programming Language Design  credit: 3 or 4 Hours.
Exploration of major language design paradigms using imperative and functional programming as unifying themes. Tools include both practical language processor construction and theoretical models. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 421.

CS 423 Operating Systems Design  credit: 3 or 4 Hours.
Organization and structure of modern operating systems and concurrent programming concepts. Deadlock, virtual memory, processor scheduling, and disk systems. Performance, security, and protection. Same as CSE 423. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or ECE 391.

CS 424 Real-Time Systems  credit: 3 or 4 Hours.
Supervisory control aspects of Cyber Physical Systems (CPS): fundamentals of reliability analysis, real-time scheduling, simple feedback control, software fault tolerance architecture, wireless networking and energy saving, principles of safety critical system engineering. Student groups design and demonstrate supervisory control architecture for a robot. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241.

CS 425 Distributed Systems  credit: 3 or 4 Hours.
Protocols, specification techniques, global states and their determination, reliable broadcast, transactions and commitment, security, and real-time systems. Same as ECE 428. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or ECE 391.
CS 426 Compiler Construction credit: 3 or 4 Hours.
Compiler structure, syntax analysis, syntax-directed translation, automatically constructed recognizers, semantic analysis, code generation, intermediate language, optimization techniques. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 421.

CS 427 Software Engineering I credit: 3 or 4 Hours.
Software process, analysis and design. Software development paradigms, system engineering, function-based analysis and design, and object-oriented analysis and design. Course will use team-projects for hands-on exercises. Same as CSE 426. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 and CS 373.

CS 428 Software Engineering II credit: 3 or 4 Hours.
Continuation of CS 427. Software development, management, and maintenance. Project and configuration management, collaborative development models, software quality assurance, interoperability domain engineering and software reuse, and software re-engineering. Same as CSE 429. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 427.

CS 429 Software Engineering II, ACP credit: 3 Hours.
Continuation of CS 427. Identical to CS 428 except for the additional writing component. See CS 428. 3 undergraduate hours. 3 graduate hours. Prerequisite: CS 427.

This course satisfies the General Education Criteria for: Advanced Composition

CS 431 Embedded Systems credit: 3 Hours.
A survey of sampled data systems and embedded architecture; key concepts in common embedded system applications; signal processing and control; embedded microprocessor and device interface; time-critical I/O handling; data communications; real-time operating systems and techniques for the development and analysis of embedded real-time software; hands-on laboratory projects. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or ECE 391.

CS 433 Computer System Organization credit: 3 or 4 Hours.
Computer system analysis and design. Organizational dependence on computations to be performed; speed and cost of parts and overall machines; instruction set design; pipeline and vector machines; memory hierarchy design. Same as CSE 422. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 233.

CS 436 Computer Networking Laboratory credit: 3 or 4 Hours.
Same as ECE 435. See ECE 435.

CS 438 Communication Networks credit: 3 or 4 Hours.
Layered architectures and the OSI Reference Model; design issues and protocols in the transport, network, and data link layers; architectures and control algorithms of local-area, point-to-point, and satellite networks; standards in networks access protocols; models of network interconnection; overview of networking and communication software. Same as ECE 438. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or ECE 391; one of ECE 313, MATH 461, MATH 463.

CS 439 Wireless Networks credit: 3 or 4 Hours.
Same as ECE 439. See ECE 439.

CS 440 Artificial Intelligence credit: 3 or 4 Hours.
Major topics in and directions of research in artificial intelligence: AI languages (LISP and PROLOG), basic problem solving techniques, knowledge representation and computer inference, machine learning, natural language understanding, computer vision, robotics, and societal impacts. Same as ECE 448. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or ECE 391.

CS 445 Computational Photography credit: 3 or 4 Hours.
Computer vision techniques to enhance, manipulate, and create media from photo collections, such as panoramic stitching, face morphing, texture synthesis, blending, and 3D reconstruction. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225, MATH 225, and MATH 231.

CS 446 Machine Learning credit: 3 or 4 Hours.
Theory and basic techniques in machine learning. Major theoretical paradigms and key concepts developed in machine learning in the context of applications such as natural language and text processing, computer vision, data mining, adaptive computer systems and others. Review of several supervised and unsupervised learning approaches: methods for learning linear representations; on-line learning, Bayesian methods; decision-trees; features and kernels; clustering and dimensionality reduction. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 373 and CS 440.

CS 447 Natural Language Processing credit: 3 or 4 Hours.
Part-of-speech tagging, parsing, semantic analysis and machine translation. Relevant linguistics concepts from morphology (word formation) and lexical semantics (the meaning of words) to syntax (sentence structure) and compositional semantics (the meaning of sentences). 3 undergraduate hours. 3 or 4 graduate hours. Credit is not given for both CS 447 and LING 406. Prerequisite: CS 374.

CS 450 Numerical Analysis credit: 3 Hours.
Linear system solvers, optimization techniques, interpolation and approximation of functions, solving systems of nonlinear equations, eigenvalue problems, least squares, and quadrature; numerical handling of ordinary and partial differential equations. Same as CSE 401, ECE 491, and MATH 450. 3 undergraduate hours. 3 or 4 graduate hours. Credit is not given for both CS 450 and CS 457. Prerequisite: CS 101 or CS 125; CS 357 or MATH 415; MATH 285.

CS 457 Numerical Methods II credit: 3 Hours.
Continuation of CS 357. Orthogonalization methods for least squares, Krylov subspace methods, non-linear equations and optimization in multiple dimensions, initial and boundary value problems for ordinary and partial differential equations. 3 undergraduate hours. No graduate credit. Credit is not given for both CS 457 and CS 450. Prerequisite: CS 357.

CS 460 Security Laboratory credit: 3 Hours.
Operating systems security: access control, least privilege mechanism and malware techniques. Network security: firewalls, sniffing, tunnels, intrusion detection, AAA and worm structure. System security: forensics security architectures, and attack/defend exercises. Complements CS 461 via hands-on project. Same as ECE 419. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 461.

CS 461 Computer Security I credit: 4 Hours.
Fundamental principles of computer and communications security and information assurance: ethics, privacy, notions of threat, vulnerabilities, and risk in systems, information warfare, malicious software, data secrecy and integrity issues, network security, trusted computing, mandatory and discretionary access controls, certification and accreditation of systems against security standards. Security mechanisms: authentication, auditing, intrusion detection, access control, cryptography, security protocols, key distribution. Same as ECE 422. 4 undergraduate hours. 4 graduate hours. Prerequisite: CS 241 or ECE 391.
CS 463 Computer Security II  credit: 3 or 4 Hours.
Program security, trusted base, privacy, anonymity, non-interference, information flow, confinement, advanced auditing, forensics, intrusion detection, key management and distribution, policy composition and analysis, formal approaches to specification and verification of secure systems and protocols, and topics in applied cryptography. Same as ECE 424. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 461. Recommended: CS 475.

CS 465 User Interface Design  credit: 3 Hours.
A project-focused course covering fundamental principles of user interface design, implementation, and evaluation. Small teams work on a term-long project that involves: analysis of the problem domain, user skills, and tasks; iterative prototyping of interfaces to address user needs; conducting several forms of evaluation such as cognitive walkthroughs and usability tests; implementation of the final prototype. Non-technical majors may enroll as non-programmers who participate in all aspects of the projects with the possible exception of implementation. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 466 Introduction to Bioinformatics  credit: 3 or 4 Hours.
Algorithmic approaches in bioinformatics: (i) biological problems that can be solved computationally (e.g., discovering genes, and interactions among different genes and proteins); (ii) algorithmic techniques with wide applicability in solving these problems (e.g., dynamic programming and probabilistic methods); (iii) practical issues in translating the basic algorithmic ideas into accurate and efficient tools that biologists may use. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 467 Social Visualization  credit: 3 or 4 Hours.
Visualizing social interaction in networked spaces: investigation of patterns in networked communications systems such as messaging (email, instant messaging), social networking sites and collaborative sites; social network theory and visualizations; exploration of how to move beyond existing visualization techniques; visualizing the network identity over compilations of online data. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225.

CS 468 Tech and Advertising Campaigns  credit: 3 Hours.
Same as ADV 492. See ADV 492.

CS 473 Algorithms  credit: 4 Hours.
Design and analysis techniques, approximation algorithms, randomized algorithms and amortized analysis, and advanced topics such as network flow, linear programming, and dynamic data structures, among others. Same as CSE 414 and MATH 473. 4 undergraduate hours. 4 graduate hours. Prerequisite: CS 374, and one of CS 361, MATH 461, or STAT 400.

CS 475 Formal Models of Computation  credit: 3 or 4 Hours.
Finite automata and regular languages; pushdown automata and context-free languages; Turing machines and recursively enumerable sets; linear-bounded automata and context-sensitive languages; computability and the halting problem; undecidable problems; recursive functions; Chomsky hierarchy; computational complexity. Same as MATH 475. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 373.

CS 476 Program Verification  credit: 3 or 4 Hours.
Formal methods for demonstrating correctness and other properties of programs. Invariant assertions; Hoare axiomatics; well-founded orderings for proving termination; structural induction; computational induction; data structures; parallel programs; overview of predicate calculus. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225; CS 374 or MATH 414.

CS 477 Formal Software Devel Methods  credit: 3 or 4 Hours.
Mathematical models, languages, and methods for software specification, development, and verification. Same as ECE 478. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225; CS 373 or MATH 414.

CS 481 Stochastic Processes & Applic  credit: 3 or 4 Hours.
Same as IE 410. See IE 410.

CS 482 Simulation  credit: 3 Hours.

CS 483 Applied Parallel Programming  credit: 4 Hours.
Same as CSE 408 and ECE 408. See ECE 408.

CS 484 Parallel Programming  credit: 3 or 4 Hours.
Techniques for the programming of all classes of parallel computers and devices including shared memory and distributed memory multiprocessors, SIMD processors and co-processors, and special purpose devices. Key concepts in parallel programming such as reactive and transformational programming, speculation, speedup, isoefficiency, and load balancing. Synchronization primitives, libraries and languages for parallel programming such as OpenMP and MPI, performance monitoring, program tuning, analysis and programming of numerical and symbolic parallel algorithms. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241.

CS 491 Seminar  credit: 0 to 4 Hours.
Seminar on topics of current interest as announced in the Class Schedule. 0 to 4 undergraduate hours. 0 to 4 graduate hours. Approved for S/U grading only. May be repeated in the same or separate terms if topics vary to a maximum of 4 hours. Prerequisite: As specified for each topic offering, see Class Schedule or departmental course description.

CS 492 Senior Project I  credit: 3 Hours.
First part of a project course in computer science. Students work in teams to solve typical commercial or industrial problems. Work involves planning, design, and implementation. Extensive oral and written work is required both on-campus and possibly off-campus at sponsors' locations. CS 492 must be taken as a sequence with either CS 493 or CS 494. 3 undergraduate hours. No graduate credit. Credit is not given for both CS 492 and a project course in another engineering department for the same project. Prerequisite: For Computer Science majors with senior standing.

CS 493 Senior Project II, ACP  credit: 3 Hours.
Continuation of CS 492. Identical to CS 494 except for an additional writing component. See CS 494. 3 undergraduate hours. No graduate credit. Credit is not given for both CS 493 and a project course in another engineering department for the same project. Prerequisite: CS 492. This course satisfies the General Education Criteria for: Advanced Composition

CS 494 Senior Project II  credit: 3 Hours.
Continuation of CS 492. 3 undergraduate hours. No graduate credit. Credit is not given for both CS 493 and a project course in another engineering department for the same project. Prerequisite: CS 492.

CS 497 CS Team Project  credit: 1 to 3 Hours.
Student teams work with CS faculty to complete a significant project requiring advanced knowledge of CS principles. Project topics vary. 1 to 3 undergraduate hours. No graduate credit. May be repeated in the same term up to 6 hours, if topics vary; may be repeated in separate terms. Prerequisite: For majors only; junior or senior standing required.
CS 498  Special Topics  credit: 1 to 4 Hours.
Subject offerings of new and developing areas of knowledge in computer science intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 1 to 4 undergraduate hours. 1 to 4 graduate hours. May be repeated in the same or separate terms if topics vary.

CS 499  Senior Thesis  credit: 3 Hours.
Research and thesis development experience in computer science underguidance of a faculty member. Literature search, oral presentation, analysis and implementation, paper preparation, and completion of a written thesis. 3 undergraduate hours. No graduate credit. May be repeated to a maximum of 6 hours. Prerequisite: Consent of instructor. This course satisfies the General Education Criteria for: Advanced Composition