Computer Science

Chair

- Alberto Segre

Undergraduate majors: computer science (B.A., B.S.); informatics (B.A., B.S.)

Undergraduate minors: computer science; informatics

Graduate degrees: M.C.S.; M.S. in computer science; Ph.D. in computer science

Faculty: https://www.cs.uiowa.edu/people

Web site: http://www.cs.uiowa.edu/

The Department of Computer Science offers undergraduate programs in computer science and in informatics as well as graduate degree programs in computer science. It also offers courses that students in all majors may use to satisfy the General Education Program’s Quantitative or Formal Reasoning requirement and a First-Year Seminar designed for entering undergraduate students.

Undergraduate Programs of Study

- Major in computer science (Bachelor of Arts, Bachelor of Science)
- Major in informatics (Bachelor of Arts, Bachelor of Science)
- Minor in computer science
- Minor in informatics

The majors in computer science and informatics provide students with the necessary training for employment in careers such as software development and information management. Both majors provide good preparation for graduate study in a variety of disciplines. The minor in each discipline helps students acquire fundamental knowledge of the use and applications of computers.

The department encourages students majoring in computer science or informatics to consider earning a second major, certificate, or minor.

Students may declare a major in computer science or in informatics when they are admitted to the University or afterward. All students begin the majors as Bachelor of Arts students but may switch to the Bachelor of Science programs at any time.

Undergraduates majoring in computer science develop competence in programming principles and methodologies, problem-solving techniques, mathematics, and computer systems. Computer science training is critical for many careers in science, engineering, business, and health care.

The informatics major combines fundamental and practical computing knowledge with a choice of cognate areas from the liberal arts and sciences, providing students with the necessary background and specialized skills to work at the interface of computing and another discipline. Informatics students may begin the major without a chosen cognate area; they may declare a cognate at any time. Some cognates are available only with the Bachelor of Arts, others are available only with the Bachelor of Science. So a student’s choice of cognate determines whether he or she will earn a B.A. or a B.S.

Both computer science and informatics majors are advised at the Academic Advising Center until they have completed 24 s.h., at which point they are assigned a departmental advisor. Students being advised at the Academic Advising Center also can consult with a computer science or informatics faculty advisor.

Transfer students who have taken a course approved as equivalent to a required computer science or informatics course are exempt from that course. Transfer course grades are included in the computer science or informatics grade-point average.

Students should consult the Department of Computer Science web site or visit the department’s office for information about general policies, elective areas, and internships, scholarships, and student groups, such as the University’s chapter of the Association for Computing Machinery (ACM) and Women in Informatics and Computer Science (WICS).

ADVANCED PLACEMENT

The Computer Science Advanced Placement Program test may be used to satisfy requirements. See the Advanced Placement link under Undergraduate Programs on the Department of Computer Science web site.

JOINT BACHELOR’S/MASTER’S DEGREE PROGRAMS

Qualified computer science undergraduate students who plan to earn the Master of Computer Science degree may apply for the joint Bachelor of Arts/Master of Computer Science program or the joint Bachelor of Science/Master of Computer Science program. The joint programs allow students to earn both degrees in five years. See “Joint B.A./ M.C.S. and B.S./M.C.S.” later in this section.

EARLY ADMISSION TO THE GRADUATE COLLEGE

Undergraduate computer science or informatics students who have 6 s.h. or less to earn toward graduation may apply for early admission to the Graduate College. Early admission allows students in their final undergraduate semester to take courses for graduate credit in addition to the courses they need to complete their bachelor’s degrees.

B.A. and B.S.: Computer Science

The Bachelor of Arts with a major in computer science requires a minimum of 120 s.h., including at least 41 s.h. of work for the major. The Bachelor of Science with a major in computer science requires a minimum of 120 s.h., including at least 63 s.h. of work for the major. Students must maintain a g.p.a. of at least 2.00 in all courses for the major and in all UI courses for the major. They also must complete the College of Liberal Arts and Sciences General Education Program. A cumulative g.p.a. of at least 2.00 is required for graduation.

The computer science major for the Bachelor of Arts is designed for students who would like to gain considerable knowledge in computer science and have flexibility in choosing electives. Students preparing for careers in the computing field are encouraged to supplement the base requirements with additional computer science courses. The program’s flexibility makes it suitable for combination with other majors.
The computer science major for the Bachelor of Science is more rigorous than the B.A. major; it is designed to provide in-depth training for students who would like to acquire strength in math and science in order to enhance their skills and job prospects. It also is appropriate for those who plan to pursue graduate work in computer science, although it is not required for graduate study at most universities.

Course work for the major includes computer science courses as well as courses in mathematics, statistics, and other supporting disciplines. Work for the major may not be taken pass/nonpass.

Bachelor of Science students and Bachelor of Arts students considering a switch to the B.S. program should choose their General Education Program's Natural Sciences courses carefully, since they may be able to use the same courses to satisfy the Bachelor of Science major's natural science requirement; see "Natural Science Sequences (B.S.)" under "Additional Bachelor of Science Requirements" below.

The major in computer science (B.A. and B.S.) requires the following work.

**Common Requirements (B.A. and B.S.)**

**COMPUTER SCIENCE CORE**

All of these:
- CS:1210 Computer Science I: Fundamentals 4 s.h.
- CS:2210 Discrete Structures 3 s.h.
- CS:2230 Computer Science II: Data Structures 4 s.h.
- CS:2820 Object-Oriented Software Development 4 s.h.
- CS:3330 Algorithms 3 s.h.
- CS:3820 Programming Language Concepts 3 s.h.

One of these:
- CS:2630 Computer Organization 3 s.h.
- ECE:3350 Computer Architecture and Organization 3 s.h.

One of these:
- CS:3620 Operating Systems 3 s.h.
- CS:3640 Introduction to Networks and Their Applications 3 s.h.
- CS:4640 Computer Security 3 s.h.

**MATHEMATICS CORE**

Calculus I—one of these:
- MATH:1550 Engineering Mathematics I: Single Variable Calculus 4 s.h.
- MATH:1850 Calculus I 4 s.h.

Calculus II—one of these:
- MATH:1560 Engineering Mathematics II: Multivariable Calculus 4 s.h.
- MATH:1860 Calculus II 4 s.h.

**Additional Bachelor of Arts Requirements**

**MATHEMATICS CORE (B.A.)**

Linear algebra/probability and statistics—one of these:
- MATH:2700 Introduction to Linear Algebra 4 s.h.
- STAT:2020 Probability and Statistics for the Engineering and Physical Sciences 3 s.h.
- STAT:3120 Probability and Statistics 4 s.h.

Students who take MATH:2550 Engineering Mathematics III: Matrix Algebra and MATH:2560 Engineering Mathematics IV: Differential Equations can use the courses to satisfy the linear algebra requirement.

**ADVANCED COMPUTER SCIENCE ELECTIVES (B.A.)**

Bachelor of Arts students must earn at least 3 s.h. in advanced computer science electives chosen from these.

A computer science course (prefix CS) numbered 3620-5899, except CS:3910 and CS:3980

A computer science course (prefix CS) numbered 5900 or above, with department approval

Students may count a maximum of 3 s.h. earned in CS:3990 Honors in Computer Science or Informatics toward the advanced computer science elective requirement.

**Advanced Bachelor of Science Requirements**

**MATHEMATICS CORE (B.S.)**

Linear algebra:
- MATH:2700 Introduction to Linear Algebra 4 s.h.

Students who take MATH:2550 Engineering Mathematics III: Matrix Algebra and MATH:2560 Engineering Mathematics IV: Differential Equations can use the courses to satisfy the linear algebra requirement.

Probability and statistics—one of these:
- STAT:2020 Probability and Statistics for the Engineering and Physical Sciences 3 s.h.
- STAT:3120 Probability and Statistics 4 s.h.

Other probability and statistics courses (prefix STAT) with a calculus prerequisite may be approved by the department.

**COMPUTATION THEORY (B.S.)**

One of these:
- CS:4330 Theory of Computation 3 s.h.
- CS:4340 Limits of Computation 3 s.h.
- CS:4350 Logic in Computer Science 3 s.h.

**ADVANCED TECHNICAL ELECTIVES (B.S.)**

Bachelor of Science students must earn at least 12 s.h. (four courses) in advanced technical electives, as follows.

At least 6 s.h. from these:

A computer science course (prefix CS) numbered 3620-5899, except CS:3910 and CS:3980

A computer science course (prefix CS) numbered 5900 or above, with department approval

And:
Advanced technical electives in computer science (prefix CS), or in other disciplines with department approval, to complete the required 12 s.h.

An approved list of courses in other departments that satisfy this requirement can be found on the Computer Science web site under Major Requirements of the Undergraduate Programs.

Students may count a maximum of 3 s.h. earned in CS:3990 Honors in Computer Science or Informatics toward the advanced technical elective requirement.

**NATURAL SCIENCE SEQUENCES (B.S.)**

Bachelor of Science students take two or more courses in a sequence (totaling at least 6 s.h.) in a cognate area of natural science. The natural science sequence is intended to enhance the student's perspective by providing a deeper understanding of the scientific method. Typically, it consists of a sequence of courses taken in the same science department. Students often choose courses that also fulfill the General Education Program Natural Sciences requirement. Some possible choices are listed below; the department chair may approve others.

CLEP/APP credit may be used to satisfy part or all of the natural science requirement only if the appropriate science department at the University of Iowa accepts the credit as equivalent to one or more of the specific courses listed below.

**Astronomy:**
- ASTR:1771 General Astronomy I 4 s.h.
- ASTR:1772 General Astronomy II 4 s.h.

**Biology:**
- BIOL:1411-BIOL:1412 Foundations of Biology - Diversity of Form and Function 8 s.h.

**Chemistry:**
- CHEM:1110 Principles of Chemistry I 4 s.h.
- CHEM:1120 Principles of Chemistry II 4 s.h.

**Earth and environmental sciences—this course:**
- EES:1080 Introduction to Environmental Science 3-4 s.h.

And one of these:
- EES:1030 Introduction to Earth Science 3-4 s.h.
- EES:1050 Introduction to Geology 4 s.h.

Geographical and sustainability sciences:
- GEOG:1020 The Global Environment 3 s.h.
- GEOG:1050 Foundations of GIS 3 s.h.

Physics—one of these sequences:
- PHYS:1611-PHYS:1612 Introductory Physics I-II (recommended) 8 s.h.
- PHYS:1701-PHYS:1702 Physics I-II 8 s.h.

**B.A. and B.S.: Informatics**

The Bachelor of Arts with a major in informatics requires a minimum of 120 s.h., including at least 43-50 s.h. of work for the major. The Bachelor of Science with a major in informatics requires a minimum of 120 s.h., including at least 55-59 s.h. of work for the major. Students must maintain a g.p.a. of at least 2.00 in all courses for the major and in all UI courses for the major. They also must complete the College of Liberal Arts and Sciences General Education Program. A cumulative g.p.a. of at least 2.00 is required for graduation.

Required credit for the major depends on the choice of cognate area. Work for the major may not be taken pass/nonpass.

Both programs (B.A. and B.S.) combine foundational informatics course work with course work in a cognate discipline. The Bachelor of Arts major in informatics offers the cognate areas of art, economics, geoinformatics, health informatics, human-computer interaction, linguistics, music, social informatics, and individualized cognates. The Bachelor of Science major in informatics offers the cognate areas of bioinformatics, medical informatics, and individualized cognates.

Course work for the major includes the informatics core, one (B.A.) or two (B.S.) electives, a statistics course, and a set of courses in their chosen cognate area. Students are expected to have taken MATH:1005 College Algebra or the equivalent.

The informatics major (B.A. and B.S.) requires the following course work.

**INFORMATICS CORE**

The informatics core consists of six required computing courses (at least 19 s.h.) that emphasize data manipulation, databases, and networking. It provides more applications-oriented content than the traditional computer science curriculum yet is designed to offer students a sound basis in underlying computer science themes and techniques.

This course:
- CS:2110 Programming for Informatics 4 s.h.

One of these:
- CS:2420 Databases for Informatics 3 s.h.
- MSCI:3200 Database Management 3 s.h.

All of these:
- CS:1110 Introduction to Computer Science 3 s.h.
- CS:2520 Human-Computer Interaction 3 s.h.
- CS:2620 Networking and Security for Informatics 3 s.h.
- CS:3910 Informatics Project 3 s.h.

**INFORMATICS ELECTIVES**

B.A. students must complete at least one course (3 s.h.) and B.S. students must complete at least two (6 s.h.) from a list of approved computing informatics electives. Course selection must be approved by an informatics advisor. In addition to the courses listed below, students may have additional choices from the Department of Electrical and Computer Engineering and the Department of Management Sciences; consult an informatics faculty advisor for additional choices.

- MSCI:4220 Database Management and Web Services 3 s.h.

A computer science course (prefix CS) numbered 3000-4990, except CS:3910
**STATISTICS COURSE**

B.A. and B.S. students must complete one introductory statistics course. Some cognates require a specific statistics course. Students should consult with their advisors to choose a statistics course appropriate for their cognate area.

One of these:

- SOC:2160 Applied Statistics for Social Scientists 3 s.h.
- STAT:1020 Elementary Statistics and Inference 3 s.h.
- STAT:1030 Statistics for Business 4 s.h.
- STAT:2010 Statistical Methods and Computing 3 s.h.
- STAT:2020 Probability and Statistics for the Engineering and Physical Sciences 3 s.h.
- STAT:3120 Probability and Statistics 4 s.h.
- STAT:3510 Biostatistics 3 s.h.
- STAT:4143 Introduction to Statistical Methods 3 s.h.

**Bachelor of Arts Cognates**

Students must complete all requirements listed under one of the cognate areas below: art, economics, geoinformatics, health informatics, human-computer interaction, linguistics, music, social informatics, or an individualized cognate.

**ART**

The informatics major with the art cognate requires a minimum of 47 s.h. of work for the major, including 22 s.h. in cognate courses. Students learn about the design and maintenance of web services, applications of modern computerized artistic tools, and benefits and limitations of computers as a digital medium. They also gain insight into computerized tool design that is guided by knowledge of an artist’s requirements. The art cognate may lead to careers in web development, technology coordination for artistic productions, development of digital artistic tools, and artistic or technical development for entertainment companies. Cognate courses are primarily in art history, design, elements of art, and photography.

Some courses listed below are open only to students majoring in art, so they are appropriate choices only for students with a double major in art and informatics. Non-art majors should work with an informatics faculty advisor to develop an individual set of art cognate courses.

All of these:

- ARTS:1510 Basic Drawing 3 s.h.
- ARTS:1520 Design Fundamentals 3 s.h.
- DSGN:2110 Graphic Design I 3 s.h.
- DSGN:3120 Typography 4 s.h.

One of these:

- ARTH:1010 Art and Visual Culture 3 s.h.
- ARTH:1020 Masterpieces: Art in Historical and Cultural Perspectives 3 s.h.
- ARTH:1030 Themes in Global Art 3 s.h.
- ARTH:1040 Arts of Africa 3 s.h.
- ARTH:1050 From Cave Paintings to Cathedrals: Survey of Western Art I 3 s.h.
- ARTH:1060 From Mona Lisa to Modernism: Survey of Western Art II 3 s.h.
- ARTH:1070 Asian Art and Culture 3 s.h.
- ARTH:2020 Introduction to Western Architecture 3 s.h.
- ARTH:2220 Introduction to the Art of China 3 s.h.
- ARTH:2250 Introduction to the Art of Japan 3 s.h.
- ARTH:2320 Introduction to Ancient Art 3 s.h.
- ARTH:2420 Introduction to Medieval Art 3 s.h.
- ARTH:2520 Introduction to Italian Renaissance Art 3 s.h.
- ARTH:2620 Introduction to Baroque Visual Culture 3 s.h.
- ARTH:2730 Introduction to Nineteenth-Century Art 3 s.h.
- ARTH:2820 Introduction to Modern/Contemporary Art 3 s.h.
- ARTH:2920 Introduction to American Art 3 s.h.
- ARTH:2975 Undergraduate Seminar in the History of Art 3 s.h.

At least 6 s.h. from these, with at least one course (3 s.h.) numbered 3000 or above:

- DSGN:3110 Graphic Design II 4 s.h.
- DSGN:3130 Web Site Design I 3 s.h.
- DSGN:4130 Web Site Design II 4 s.h.
- PHTO:2513 Digital Photographic Imaging 3 s.h.
- PHTO:4555 Advanced Digital Imaging 4 s.h.
- TDSN:2240 Digital Drafting with AutoCAD 3 s.h.

**ECONOMICS**

The informatics major with the economics cognate requires a minimum of 49 s.h. of work for the major, including 24 s.h. in cognate courses, which are primarily from economics. The economics cognate is intended for students interested in working with economic, financial, or demographic data. It may lead to careers in administration, business, or government or to graduate study in management or policy areas.

All of these:

- ECON:1100 Principles of Microeconomics 4 s.h.
- ECON:1200 Principles of Macroeconomics 4 s.h.
- ECON:3100 Intermediate Microeconomics 3 s.h.
- ECON:3150 Intermediate Macroeconomics 3 s.h.
- MATH:1380 Calculus and Matrix Algebra for Business 4 s.h.

At least two of these, to complete 24 s.h. for the cognate:

- ECON:3250 American Economic History 3 s.h.
- ECON:3325 Personnel Economics 3 s.h.
- ECON:3335 Money, Banking, and Financial Markets 3 s.h.
- ECON:3345 Global Economics and Business 3 s.h.
- ECON:3350 Industry Analysis 3 s.h.
- ECON:3370 Household Finance 3 s.h.
- ECON:3620 Economic Growth and Development 3 s.h.
- ECON:3625 Environmental and Natural Resource Economics 3 s.h.
- ECON:3640 Regional and Urban Economics 3 s.h.
- ECON:3650 Policy Analysis 3 s.h.
- ECON:3690 Sports Economics 3 s.h.
ECON:3750 Transportation Economics 3 s.h.
ECON:3760 Health Economics 3 s.h.
ECON:3790 Antitrust Economics 3 s.h.
ECON:3800 Law and Economics 3 s.h.
ECON:3875 Topics in Policy Economics arr.
ECON:4090 Natural Resource Economics 3 s.h.
ECON:4110 International Economics 3 s.h.
ECON:4140 Labor Economics 3 s.h.
ECON:4160 Public Sector Economics 3 s.h.
ECON:4170 Monetary Economics 3 s.h.
ECON:4180 Industrial Organization 3 s.h.
ECON:4190 Mathematical Economics 3 s.h.
ECON:4700 Topics in Analytical Economics arr.
ECON:4800 Introduction to Econometrics 3 s.h.

GEOINFORMATICS

The informatics major with the geoinformatics cognate requires a minimum of 47 s.h. of work for the major, including 22 s.h. in cognate courses, which are primarily from geographical and sustainability sciences. The geoinformatics cognate is intended for students interested in geographic information systems (GIS) and spatial aspects of data. It may lead to careers in business, government, or public health or to graduate study in geography, public health, or policy areas.

All of these:
GEOG:1020 The Global Environment 3 s.h.
GEOG:1021 The Global Environment Lab 1 s.h.
GEOG:1050 Foundations of GIS 3 s.h.

Two of these:
GEOG:1010 Introduction to Human Geography 3 s.h.
GEOG:1070 Contemporary Environmental Issues 3 s.h.
GEOG:2110 Population Geography: Societies in Flux 3 s.h.
GEOG:2130 World Cities 3 s.h.
GEOG:2910 The Global Economy 3 s.h.

One of these:
GEOG:3520 GIS for Environmental Studies 3 s.h.
GEOG:3530 Mapping American Cities and Regions 3 s.h.
GEOG:4010 Field Methods in Physical Geography 3 s.h.
GEOG:4020 Field Methods: Mapping and Mobile Computing 3 s.h.

Two of these:
GEOG:3500 Introduction to Environmental Remote Sensing 3 s.h.
GEOG:3520 GIS for Environmental Studies 3 s.h.
GEOG:3530 Mapping American Cities and Regions 3 s.h.
GEOG:3920 Planning Livable Cities 3 s.h.
GEOG:4150 Health and Environment: GIS Applications 3 s.h.
GEOG:4500 Applications in Environmental Remote Sensing 4 s.h.

GEOG:4520 GIS for Environmental Studies: Applications 3 s.h.
GEOG:4570 Spatial Analysis and Location Models 3 s.h.
GEOG:4750 Environmental Impact Analysis 4 s.h.

HEALTH INFORMATICS

The informatics major with the health informatics cognate requires a minimum of 46 s.h. of work for the major, including 21 s.h. in cognate courses. The health informatics cognate is intended for students interested in applications of computing to health care, especially in public health. It may lead to careers in medical or health-related areas or to graduate and professional degree programs in public health, health informatics, and medical informatics. Cognate courses are selected primarily from public health, geography, and global health studies.

Once students complete the required courses in each of the four sets below, they must select additional courses from the sets to complete 21 s.h. of credit for the cognate.

One of these:
GHS:3720 Global Health Seminar 3 s.h.
MPH:2099 Fundamentals of Public Health 3 s.h.

At least two of these:
GEOG:1050 Foundations of GIS 3 s.h.
GEOG:3110 Geography of Health 3 s.h.
GEOG:3210 Health, Work, and the Environment 3 s.h.
GEOG:3520 GIS for Environmental Studies 3 s.h.
GEOG:4150 Health and Environment: GIS Applications 3 s.h.

At least two of these:
GHS:3850 Promoting Health Globally 3 s.h.
GHS:4160 History of Public Health 3 s.h.
GHS:4162 History of Global Health 3 s.h.
GHS:4340 Global Health and Global Food 3 s.h.
GHS:4600 Global Health and Human Rights 2-3 s.h.
INTD:3020 Equity Issues in the Health Sciences 3 s.h.
RHET:3610 Writing in the Presence of Death: Rhetoric, Narrative, and Hospice 3 s.h.

One of these:
EPID:4400 Epidemiology I: Principles 3 s.h.
HMP:4000 Introduction to the U.S. Health Care System 3 s.h.

HUMAN-COMPUTER INTERACTION

The informatics major with the human-computer interaction cognate requires a minimum of 43 s.h. of work for the major, including at least 18 s.h. in cognate courses. The human-computer interaction cognate is intended for students interested in designing useful and usable technologies. It can lead to careers in interaction design, web design, implementation of user interfaces, and evaluation of human-computer interactions as well as provide valuable skills for graduate study in human-computer interaction.

The cognate's courses are drawn largely from psychology, sociology, and industrial engineering. Four required
courses include foundational aspects of psychology or sociology, an examination of basic human abilities and performance relevant to information technology use, and an introduction to research topics in human-computer interaction.

This course:

CS:4500 Research Methods in Human-Computer Interaction 3 s.h.

Either these three psychology courses:

PSY:1001 Elementary Psychology 3 s.h.
PSY:2601 Introduction to Cognitive Psychology 3 s.h.
PSY:2810 Research Methods in Psychology 4 s.h.

Or these three sociology courses:

SOC:1010 Introduction to Sociology 3-4 s.h.
SOC:2130 Sociological Theory 3 s.h.
SOC:2170 Research Methods 3 s.h.

At least two of these for the cognate:

IE:3400 Human Factors 3 s.h.
IE:3450 Ergonomics 3 s.h.
PSY:2401 Introduction to Developmental Science 3 s.h.
PSY:2701 Biological Psychology 4 s.h.
PSY:3040 Psychology of Learning 3 s.h.
PSY:3060 Visual Perception and Cognition 3 s.h.
SOC:2220 Principles of Social Psychology 3-4 s.h.
SOC:4210 Small Group Analysis 3 s.h.

Most courses in this list have prerequisites, which students must complete before they may register for the course. The psychology courses (prefix PSY) require PSY:1001 Elementary Psychology and/or PSY:2701 Biological Psychology as prerequisite(s); the sociology course SOC:4210 requires SOC:1010 Introduction to Sociology or SOC:1020 Social Problems as a prerequisite. Students should choose courses from this list carefully.

LINGUISTICS

The informatics major with the linguistics cognate requires a minimum of 46 s.h. of work for the major, including at least 21 s.h. in cognate courses. Linguistics, the scientific study of human languages, is directly related to psychology, anthropology, and computer science as well as to more applied fields such as second language acquisition or speech and hearing science. The cognate focuses on computational representations of syntax and semantics for processing natural language. Cognate courses are drawn primarily from linguistics.

All of these:

LING:3001 Introduction to Linguistics 3 s.h.
LING:3005 Articulatory and Acoustic Phonetics 3 s.h.
LING:3010 Syntactic Analysis 3 s.h.
LING:3020 Phonological Analysis 3 s.h.
LING:3080 History of the English Language 3 s.h.

One of these:

CS:4440 Web Mining 3 s.h.
CS:4460 Introduction to Computational Linguistics 3 s.h.

One of these:

CLSA:2901/SOAS:2901 First-Year Sanskrit: First Semester 4 s.h.
CLSA:2902/SOAS:2902 First-Year Sanskrit: Second Semester 4 s.h.
CLSA:3901/SOAS:3901 Second-Year Sanskrit: First Semester 3 s.h.
CLSA:3902/SOAS:3902 Second-Year Sanskrit: Second Semester 3 s.h.
CLSL:1001 Classical and New Testament Greek I 5 s.h.
CLSL:1002 Classical and New Testament Greek II 5 s.h.
CLSLG:1001 Classical and New Testament Greek I 5 s.h.
CLSLG:1002 Classical and New Testament Greek II 5 s.h.
CLSLG:1001 Classical and New Testament Greek I 5 s.h.
CLSLG:1002 Classical and New Testament Greek II 5 s.h.

MUSIC

The informatics major with the music cognate requires a minimum of 48 s.h. of work for the major, including 23 s.h. in cognate courses. The music cognate is intended for students interested in audio recording, manipulation of sound, and digital media. It may help students prepare for careers in the entertainment industry. Cognate courses are primarily from music, with some from cinematic arts and theatre arts. Entering students must possess basic musicianship skills; an audition may be required for admission.

All of these:

MUS:1200 Fundamentals of Music for Majors 3 s.h.
MUS:1201 Musicianship and Theory I 4 s.h.
MUS:1202 Musicianship and Theory II 4 s.h.
MUS:1211 Group Instruction in Piano I 1 s.h.
MUS:1212 Group Instruction in Piano II 1 s.h.
MUS:3780 Audio Recording I 3 s.h.
MUS:3781 Audio Recording II 3 s.h.

Students who plan to take MUS:1201 Musicianship and Theory I or MUS:1202 Musicianship and Theory II must take the music theory diagnostic examination, which is administered online during summer, before fall semester begins. See Musicianship and Theory Placement on the School of Music web site for more information. Advanced placement in School of Music courses does not reduce the number of semester hours required for the cognate.

One of these:

MUS:1310 World Music 3 s.h.
MUS:1720 History of Jazz 3 s.h.
MUS:2301 History of Music I 3 s.h.
MUS:2302 History of Music II 3 s.h.
MUS:2311 Music of Latin America and the Caribbean 3 s.h.

At least one of these, to complete 23 s.h. for the cognate:
- CINE:1630 Introduction to Film Sound 3 s.h.
- CINE:4841 Film/Video Production: Sound Design 4 s.h.
- MUS:1007 Garage Band: The Basics 2 s.h.
- MUS:1010 Recital Attendance for Non-Majors 1 s.h.
- THTR:3260 Sound Design for the Theatre 3 s.h.

**SOCIAL INFORMATICS**

The informatics major with the social informatics cognate requires a minimum of 45 s.h. of work for the major, including 20 s.h. in cognate courses, all from sociology.

All of these:
- SOC:1010 Introduction to Sociology 3-4 s.h.
- SOC:2130 Sociological Theory 3 s.h.
- SOC:2170 Research Methods 3 s.h.

At least 11 s.h. from these:
- SOC:1020 Social Problems 3-4 s.h.
- SOC:1310 Gender and Society 3-4 s.h.
- SOC:1410 Introduction to Criminology 3 s.h.
- SOC:2220 Principles of Social Psychology 3-4 s.h.
- SOC:2222 Introduction to Social Work 4 s.h.
- SOC:2426 Deviance and Control 3 s.h.
- SOC:2810 Social Inequality 3 s.h.
- SOC:3220 Sociology of Mental Illness 3 s.h.
- SOC:3420 Juvenile Delinquency 3 s.h.
- SOC:3450 Criminal Legal System 3 s.h.
- SOC:3520 Political Sociology 3 s.h.
- SOC:3525 Public Opinion 3 s.h.
- SOC:3610 Organizations and Modern Society 3 s.h.
- SOC:3710 The American Family 3 s.h.
- SOC:3830 Race and Ethnicity 3 s.h.
- SOC:3840 Community and Urban Sociology 3 s.h.
- SOC:3850 Economy and Society 3 s.h.
- SOC:4210 Small Group Analysis 3 s.h.
- SOC:4400 Internship in Criminal Justice and Corrections 1-5 s.h.
- SOC:4420 Criminal Punishment 3 s.h.
- SOC:4460 Sociology of Law 3 s.h.
- SOC:4540 Political Sociology and Social Movements 3 s.h.
- SOC:4820 Sociology of Sexuality 3 s.h.
- SOC:4900 Selected Topics in Sociology 3 s.h.
- SOC:4910 Capstone Course in Sociology 3 s.h.
- SOC:4920 Social Services Organization Internship arr.
- SOC:4997 Honors Seminar 2 s.h.
- SOC:4998 Honors Research arr.

**INDIVIDUALIZED COGNATES**

Students interested in developing individualized cognates may work with an informatics faculty advisor. Individualized cognates may be drawn primarily from one department or an appropriate mix of departments. For the Bachelor of Arts, individualized cognates require an approved set of cognate courses totaling 18-25 s.h.

**Bachelor of Science Cognates**

Students must complete all requirements listed under one of the cognate areas below: bioinformatics, medical informatics, or an individualized cognate.

**BIOINFORMATICS**

The informatics major with the bioinformatics cognate requires a minimum of 58 s.h. of work for the major, including at least 30 s.h. in cognate courses. The bioinformatics cognate is intended for students interested in applications of computing to the biological sciences. It may lead to careers in laboratory research, biotechnology, data management, and other related areas. It also may prepare students for graduate programs in bioinformatics or genetics. The cognate offers a choice of two areas: genome bioinformatics, or phylogenetics and evolution. Cognate courses are drawn primarily from biology and chemistry.

All of these:
- BIOL:1411-BIOL:1412 Foundations of Biology - Diversity of Form and Function 8 s.h.
- CHEM:1110 & CHEM:1120 Principles of Chemistry I-II 8 s.h.
- CHEM:2210 Organic Chemistry I 3 s.h.

Students also must complete required courses in one of the following two areas—genome bioinformatics or phylogenetics and evolution.

**Genome Bioinformatics Area**

Both of these:
- BIOL:2512 Fundamental Genetics 4 s.h.
- BIOL:3172 Evolution 4 s.h.

One of these:
- BIOL:3314 Genomics 3 s.h.
- BIOL:4213 Bioinformatics 4 s.h.
- BIOL:5320 Computational Genomics 3 s.h.

**Phylogenetics and Evolution Area**

Both of these:
- BIOL:2512 Fundamental Genetics 4 s.h.
- BIOL:3172 Evolution 4 s.h.

One of these:
- BIOL:2673 Ecology 4 s.h.
- BIOL:4273 Population Genetics and Molecular Evolution 3 s.h.
- BIOL:4373 Molecular Phylogenetics 3 s.h.

**MEDICAL INFORMATICS**

The informatics major with the medical informatics cognate requires a minimum of 56 s.h. of work for the major, including at least 28 s.h. in cognate courses. The medical informatics cognate is intended for students interested in applications of computing to health care, especially in a clinical setting. It may lead to careers in medical or hospital settings, graduate programs in medical informatics, or professional degree programs in medicine, dentistry, nursing, or other allied health professions.
Cognate courses are drawn from biology, chemistry, health and human physiology, and public health.

Students who choose the medical informatics cognate must satisfy the major's statistics requirement with STAT:3510 Biostatistics.

All of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL:1411-BIOL:1412 Foundations of Biology - Diversity of Form and Function</td>
<td>8 s.h.</td>
</tr>
<tr>
<td>CHEM:1110 &amp; CHEM:1120 Principles of Chemistry I-II</td>
<td>8 s.h.</td>
</tr>
<tr>
<td>CHEM:2210 &amp; CHEM:2220 Organic Chemistry I-II</td>
<td>6 s.h.</td>
</tr>
</tbody>
</table>

At least two of these, to complete 28 s.h. in the cognate:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL:2512 Fundamental Genetics</td>
<td>4 s.h.</td>
</tr>
<tr>
<td>BIOL:3172 Evolution</td>
<td>4 s.h.</td>
</tr>
<tr>
<td>CHEM:2410 Organic Chemistry Laboratory</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>HHP:1100 Human Anatomy</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>HMP:4000 Introduction to the U.S. Health Care System</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

**INDIVIDUALIZED COGNATES**

Individualized cognates may be drawn primarily from one department or an appropriate mix of departments. For the Bachelor of Science, individualized cognates require an approved set of cognate courses totaling 27-31 s.h.

Students interested in developing individualized cognates should contact the Department of Computer Science for the name of an informatics faculty advisor.

**Four-Year Graduation Plan**

The Four-Year Graduation Plan is not available to students majoring in computer science or informatics. Students work with their advisors on individual graduation plans.

**Honors in the Major**

Students majoring in computer science or informatics have the opportunity to graduate with honors in the major. To graduate with honors in either major, students must complete 4-6 s.h. of CS:3990 Honors in Computer Science or Informatics and submit an acceptable honors thesis. Students are responsible for finding a faculty member willing to supervise their honors project. The faculty member must approve the proposed project and a timetable for the work. Students register for CS:3990 Honors in Computer Science or Informatics with the thesis supervisor's instructor number. See Honors on the department's web site for details.

Honors students majoring in computer science may count a maximum of 3 s.h. of CS:3990 Honors in Computer Science or Informatics toward the major's advanced computer science elective requirement (B.A.) or advanced technical elective requirement (B.S.). Students in the joint B.A./M.C.S. or B.S./M.C.S. program may register for 4-6 s.h. of CS:3990 Individualized Research or Programming Project instead of CS:3990; this will allow them to receive graduate credit for the course while satisfying the course requirements to graduate with honors.

Departmental honors students must be members of the University of Iowa Honors Program, which requires students to maintain a cumulative University of Iowa g.p.a. of at least 3.33 and to fulfill other requirements; visit Honors at Iowa to learn about the University's honors program.

**Minor: Computer Science**

The minor in computer science requires a minimum of 17 s.h. in computer science, including 12 s.h. in courses taken at the University of Iowa. Students must maintain a g.p.a. of at least 2.00 in all courses for the minor and in all UI courses for the minor. Course work in the minor may not be taken pass/nonpass. Students excused from courses required for the minor may substitute other computer science electives. The minor requires the following courses.

All of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS:1210 Computer Science I: Fundamentals</td>
<td>4 s.h.</td>
</tr>
<tr>
<td>CS:2210 Discrete Structures</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>CS:2230 Computer Science II: Data Structures</td>
<td>4 s.h.</td>
</tr>
</tbody>
</table>

At least one of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS:2630 Computer Organization</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>CS:2820 Object-Oriented Software Development</td>
<td>4 s.h.</td>
</tr>
<tr>
<td>CS:3330 Algorithms</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

Students choose one additional computer science course (prefix CS) numbered 3200-5890, except CS:3910 Informatics Project and CS:3980 Topics in Computer Science I, to complete the 17 s.h. required for the minor.

Students who have completed ENGR:1300 Engineering Problem Solving II and ENGR:2730 Computers in Engineering are considered to have satisfied the minor's requirement for CS:1210 Computer Science I: Fundamentals.

Students who have completed ENGR:2730 Computers in Engineering and ECE:3330 Introduction to Software Design are considered to have satisfied the minor's requirement for CS:2820 Object-Oriented Software Development.

Students may declare the computer science minor on ISIS, and they may request an audit for the minor through ISIS.

**Minor: Informatics**

The minor in informatics requires a minimum of 16 s.h., including at least 12 s.h. in courses taken at the University of Iowa. Students must maintain a g.p.a. of at least 2.00 in all courses for the minor and in all UI courses for the minor. Course work in the minor may not be taken pass/nonpass.

Students earning a major in computer science or in management information systems (Tippie College of Business) may not earn the minor in informatics.

The informatics minor requires the following course work.

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS:1110 Introduction to Computer Science</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>CS:2110 Programming for Informatics</td>
<td>4 s.h.</td>
</tr>
</tbody>
</table>

One of these:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS:2420 Databases for Informatics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>MSCI:3200 Database Management</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

One of these:
Applicants must submit an application for admission to the program, a statement of purpose, three letters of recommendation, and transcripts from all colleges attended; they also must apply to the Graduate College. Graduate Record Examination scores are not required. For more detailed information, see Prospective Students on the Department of Computer Science web site.

**Related Certificate: Large Data Analysis**

The Certificate in Large Data Analysis can be earned in addition to a B.A. or B.S. degree in computer science. The certificate focuses on handling, processing, and extracting information from large data sets. As computers have become faster and smaller, more information can be gathered and used for a large range of applications, such as for weather forecasting; identifying people and trends utilizing Facebook or other social media; understanding the genome; and searching for disease causes and cures, as well as many other areas of study. The certificate is interdisciplinary, requiring courses from three areas of study—computer science, mathematics and statistics. Computer science teaches students how to handle large amounts of data and how to implement the algorithms to process them while statistics helps students to understand what can and cannot be legitimately inferred from the data. Mathematics focuses on algorithms and methods for connecting these important areas of data collection.

**Graduate Programs of Study**

- Master of Computer Science
- Master of Science in computer science
- Doctor of Philosophy in computer science

The Master of Computer Science (M.C.S.) is a course-based, nonresearch program for students who wish to enhance their careers with advanced knowledge of computer science. The Doctor of Philosophy program emphasizes preparation for research and teaching in academic settings or for research in private, industrial, or government laboratories. The Master of Science is granted only to students working toward the Ph.D. in computer science.

Admission decisions are based on prior academic performance, letters of reference, the applicant's statement about background and purpose, and for Ph.D. applicants, scores on the Graduate Record Examination (GRE) General Test. Students need not have a master’s degree to begin the Ph.D. program or to be granted the doctoral degree. A student admitted without a master's degree may choose to be granted an M.S. or the M.C.S. while working toward the doctorate.

Applicants must meet the admission requirements of the Graduate College; see the Manual of Rules and Regulations of the Graduate College.

Current and prospective graduate students should consult the Computer Science Graduate Handbook, available from the department's office and its web site. The handbook provides detailed information about specific degree requirements, such as required courses, examinations, and dissertation requirements. For general information about the department, faculty, and research activities, contact the Department of Computer Science or visit its web site.

**Master of Computer Science**

The Master of Computer Science (M.C.S.) requires a minimum of 32 s.h. of graduate credit, including at least 24 s.h. earned at the University of Iowa. Basic M.C.S.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS:2520</td>
<td>Human-Computer Interaction</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>CS:2620</td>
<td>Networking and Security for Informatics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:1020</td>
<td>Elementary Statistics and Inference</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:1030</td>
<td>Statistics for Business</td>
<td>4 s.h.</td>
</tr>
<tr>
<td>STAT:2010</td>
<td>Statistical Methods and Computing</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:2020</td>
<td>Probability and Statistics for the Engineering and Physical Sciences</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:3120</td>
<td>Probability and Statistics</td>
<td>4 s.h.</td>
</tr>
<tr>
<td>STAT:3510</td>
<td>Biostatistics</td>
<td>3 s.h.</td>
</tr>
<tr>
<td>STAT:4143</td>
<td>Introduction to Statistical Methods</td>
<td>3 s.h.</td>
</tr>
</tbody>
</table>

Students may declare the informatics minor on ISIS, and they may request an audit for the minor through ISIS.

**Joint B.A./M.C.S. and B.S./M.C.S.**

The joint Bachelor of Arts/Master of Computer Science and Bachelor of Science/Master of Computer Science programs allow qualified students to obtain an undergraduate and a graduate degree in computer science in five years. The B.A./M.C.S. and B.S./M.C.S. each require a total of 140 s.h., which is 12 s.h. less than the total number of s.h. required for both degrees earned separately.

Students in the joint programs must complete all requirements for each degree. They may count a maximum of 12 s.h. (four courses) toward both degrees. The four courses must be taken during the fourth year of undergraduate study, after admission to the joint program, and must satisfy degree requirements of both the B.A. or B.S. and the M.C.S.

When a student withdraws from the joint program before completing his or her bachelor's degree, credit earned in the four courses is counted only toward the undergraduate degree.

Students are granted a B.A. or B.S. when they complete all requirements for the undergraduate degree.

Students apply for admission to the joint program during their third year as undergraduates and enter the program at the beginning of their fourth year. They usually complete the joint program comfortably in one year after completing the B.A. or B.S. requirements.

Applicants to the joint program must:
- be enrolled as B.A. or B.S. students majoring in computer science at the University of Iowa;
- have completed a minimum of 80 s.h. at the time of admission to the joint program, with at least 30 s.h. earned at the University of Iowa; and
- have a cumulative University of Iowa g.p.a. of at least 3.25 and a g.p.a. of at least 3.25 in the computer science major (computed on math prerequisites and core computer science course work taken at the University of Iowa).

Applicants must meet the admission requirements of the Graduate College; see the Manual of Rules and Regulations of the Graduate College.

Applicants must submit an application for admission to the program, a statement of purpose, three letters of recommendation, and transcripts from all colleges attended; they also must apply to the Graduate College. Graduate Record Examination scores are not required. For more detailed information, see Prospective Students on the Department of Computer Science web site.
requirements are as follows. Consult the Computer Science Graduate Handbook for detailed information about M.C.S. requirements and graduate study policies.

**FOUNDATIONS**

One of these:
- CS:4330 Theory of Computation 3 s.h.
- CS:4340 Limits of Computation 3 s.h.
- CS:5350 Design and Analysis of Algorithms 3 s.h.

**SYSTEMS**

One of these:
- CS:5610 High Performance Computer Architecture 3 s.h.
- CS:5620 Distributed Systems and Algorithms 3 s.h.
- CS:5810 Formal Methods in Software Engineering 3 s.h.
- CS:5850 Programming Language Foundations 3 s.h.

**COLLOQUIUM**

M.C.S. students must earn at least 2 s.h. in the following.
- CS:6000 Research Seminar: Colloquium Series 2 s.h. (must enroll at least twice for 1 s.h. each)

**ELECTIVES**

M.C.S. students complete the remaining 24 s.h. with a combination of computer science graduate courses, reading and project courses, and non-computer science graduate courses approved by their advisor. They must complete at least six computer science graduate courses (18 s.h.) numbered 4000 or above, which may not include the following courses:

- CS:5990 Individualized Research or Programming Project
- CS:6000 Research Seminar: Colloquium Series
- CS:6990 Readings for Research, and

The remaining 6 s.h. of electives may include technical or quantitative graduate courses outside of computer science, with the advisor's approval. Students also may include up to 3 s.h. earned in independent study courses (CS:5990 Individualized Research or Programming Project or CS:6990 Readings for Research).

**Master of Science**

The Master of Science in computer science is offered only to students working toward the Ph.D. in computer science. Students who are interested primarily in a master's degree and who do not intend to pursue a more advanced degree should apply to the M.C.S. program.

**Doctor of Philosophy**

The Doctor of Philosophy program in computer science requires a minimum of 72 s.h. of graduate credit, three examinations (qualifying, comprehensive, and final), and a written dissertation. Basic Ph.D. requirements are as follows. Consult the Computer Science Graduate Handbook for detailed information about Ph.D. requirements and graduate study policies.

**CORE REQUIREMENT**

Both of these:
- CS:4330 Theory of Computation 3 s.h.
- CS:5350 Design and Analysis of Algorithms 3 s.h.

**BREADTH**

Ph.D. students must complete at least three of the following courses, with at least one course selected from each area (9 s.h.).

Systems and software:
- CS:4640 Computer Security 3 s.h.
- CS:4980 Topics in Computer Science II (section approved by advisor) 3 s.h.
- CS:5610 High Performance Computer Architecture 3 s.h.

Networks and distributed systems:
- CS:4980 Topics in Computer Science II (section approved by advisor) 3 s.h.
- CS:5620 Distributed Systems and Algorithms 3 s.h.

Programming languages and compilers:
- CS:4980 Topics in Computer Science II (section approved by advisor) 3 s.h.
- CS:5810 Formal Methods in Software Engineering 3 s.h.
- CS:5850 Programming Language Foundations 3 s.h.

**PRACTICE**

Ph.D. students must complete at least one course (3 s.h.) with significant practical or implementation-oriented content. Each semester the department designates courses that satisfy this requirement. The following are typical selections.

- CS:4400 Database Systems 3 s.h.
- CS:4420 Artificial Intelligence 3 s.h.
- CS:4440 Web Mining 3 s.h.
- CS:4460 Introduction to Computational Linguistics 3 s.h.
- CS:4520 Computer Graphics 3 s.h.
- CS:4700 High Performance and Parallel Computing 3 s.h.
- CS:4720 Optimization Techniques 3 s.h.
- CS:4980 Topics in Computer Science II (section approved by advisor) 3 s.h.
- CS:5520 Advanced Computer Graphics 3 s.h.
- CS:5800 Fundamentals of Software Engineering 3 s.h.
- CS:5990 Individualized Research or Programming Project 3 s.h.

**COGNATE AREA**

Ph.D. students are required to select, in consultation with their advisor, graduate course work totaling 9 s.h. that constitutes coherent coverage of an external cognate area; the courses need not be offered by the same department. Choices include, but are not limited to, mathematics, statistics, genetics, biology, and engineering disciplines.

**COLLOQUIUM**

Ph.D. students must earn at least 4 s.h. in the following.


**Lower-Level Undergraduate**

CS:1000 First-Year Seminar

Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.  

CS:1001 CLAS Master Class

Exploration of a single topic in a series of lectures by faculty presenting divergent perspectives; illuminates intellectual adventure inherent in liberal arts and sciences; encourages discovery of majors and other areas of study within the College of Liberal Arts and Sciences. Same as CLAS:1001, RELS:1010, THTR:1001, CSD:1001, PHIL:1001, ENGL:1001, BIOC:1001, ARTS:1001.

CS:1020 Principles of Computing

Introduction to computing; broad overview of discipline; necessary skills and concepts for effective application of computing resources in student's profession. Recommendations: no credit for students who have completed a higher-numbered CS course. GE: Quantitative or Formal Reasoning.

CS:1110 Introduction to Computer Science

Introduction to computer science and the study of algorithms; foundational ideas, computer organization, software concepts (e.g., networking, databases, security); programming concepts using Python. Recommendations: closed to students who have completed CS:2230 or a higher-numbered computer science course. GE: Quantitative or Formal Reasoning.

CS:1210 Computer Science I: Fundamentals

Introduction to programming using Python; programming constructs, data types, problem-solving strategies, data structures, object-oriented programming. Requirements: MATH:1020 or MATH:1340 or MATH:1440 or math placement to a calculus course. GE: Quantitative or Formal Reasoning.

CS:2110 Programming for Informatics

Computing fundamentals for informatics students, including practical programming skills (e.g., in Perl, other scripting languages) and introduction to algorithms, data structures, databases. Prerequisites: CS:1110. Corequisites: MATH:1020 or MATH:1340 or MATH:1440, if not taken as a prerequisite.

CS:2111 Programming Practice

Review of introductory Python programming concepts taught in CS:1210 and CS:2110; enhance mastery of introductory programming. Prerequisites: CS:1210 or CS:2110.

CS:2210 Discrete Structures

Mathematical methods used in computer science, including logic, proof techniques (with induction), functions, relations, algorithm analysis, recurrence relations, counting methods, combinatorics, graphs, trees. Corequisites: CS:1210, if not taken as a prerequisite. Recommendations: calculus I.

CS:2230 Computer Science II: Data Structures

Design, implementation, and application of data structures (e.g., linked lists, stacks, queues, hash tables, trees); complexity analysis; recursion; introduction to object-oriented programming concepts; abstract data types and their realization using generic interfaces and classes; software design patterns (e.g., iterators, comparators). Prerequisites: CS:1210 or ENGR:2730. Corequisites: CS:2210, if not taken as a prerequisite.

CS:2420 Databases for Informatics

Design and implementation of relational database systems: introduction to the relational model, database design, database normalization, use of database query and manipulation languages such as SQL. Prerequisites: CS:2110.
CS:2520 Human-Computer Interaction 3 s.h.
Basic theories, principles, and guidelines for design and evaluation of human-computer interactions; design methodologies (e.g., participatory design, low- and high-fidelity prototyping), user interface technologies (e.g., input and output devices, interaction styles), quantitative and qualitative evaluation of user interfaces (e.g., expert reviews, usability testing). Corequisites: CS:2110, if not taken as a prerequisite.

CS:2620 Networking and Security for Informatics 3 s.h.
Introduction to computer networking, overview of network organization and management; basic understanding of encryption and network security; practical experience in network programming. Prerequisites: CS:2110.

CS:2630 Computer Organization 3 s.h.
Computer building blocks: representing data, computer arithmetic, instruction sets, assembly language, digital logic, control units, ALU design, register operations, memory organization, IO. Prerequisites: CS:2230.

CS:2820 Object-Oriented Software Development 4 s.h.
Object-oriented design and software development methodology; team programming projects; GUIs, event handling, network programming, concurrency, data representation, IO programming. Prerequisites: CS:2230.

Upper-Level Undergraduate and Graduate

CS:3110 Introduction to Informatics 3 s.h.
Fundamentals of computer science: algorithms, complexity, relational databases, systems concepts, programming in Python. Requirements: CS:1110 or graduate standing. Same as IGI:3110.

CS:3210 Programming Languages and Tools arr.
Varied programming languages and tools. Prerequisites: CS:1210 or CS:2110 or CS:3110.

CS:3330 Algorithms 3 s.h.
Algorithm design techniques (e.g., greedy algorithms, divide-and-conquer, dynamic programming, randomization); fundamental algorithms (e.g., basic graph algorithms); techniques for efficiency analysis; computational intractability and NP-completeness. Prerequisites: CS:2230 and (MATH:1550 or MATH:1850).

CS:3620 Operating Systems 3 s.h.
Introduction to modern operating systems, including device control, memory management and addressing, process scheduling, interprocess communication, interrupts, synchronization, security. Prerequisites: CS:2630.

CS:3640 Introduction to Networks and Their Applications 3 s.h.
Introduction to networks and the development of network applications; basic concepts of network communication common to applications such as simulation and web services. Prerequisites: CS:2630.

CS:3700 Elementary Numerical Analysis 3 s.h.
Computer arithmetic, root finding, polynomial approximation, numerical integration, systems of linear equations, ordinary differential equations; use of higher-level computer language such as Matlab, Maple, Mathematica. Prerequisites: MATH:1560 or MATH:1860. Same as MATH:3600.

CS:3820 Programming Language Concepts 3 s.h.
Imperative, functional, and logical programming languages, and differences between them; syntax specification, types, control structures, recursion, data abstraction. Prerequisites: CS:2230 and (CS:2630 or CS:2820 or ECE:3330).

CS:3910 Informatics Project 3 s.h.
Experience designing, implementing, documenting, and testing a system using appropriate software tools (e.g., a project working with an information management tool consisting of a database system with a Web-based front end); typically done in small groups; capstone project for informatics majors. Prerequisites: CS:2420 and CS:2520 and CS:2620.

CS:3980 Topics in Computer Science I 3 s.h.
Complement to material in other courses. Prerequisites: CS:1210 or CS:2110 or CS:3110.

CS:3990 Honors in Computer Science or Informatics arr.
Individual projects. Requirements: computer science or informatics major, and honors standing.

CS:4330 Theory of Computation 3 s.h.
Finite automata; regular sets and expressions; context-free and context-sensitive grammars, their properties; push-down automata; standard, universal, and linear-bounded Turing machines; relationships between formal languages and automata; undecidability and its consequences. Prerequisites: CS:3330.

CS:4340 Limits of Computation 3 s.h.
Turing machines, undecidability and complexity: reductions, Cook's theorem and NP-completeness, approximation algorithms and randomized algorithms. Prerequisites: CS:3330.

CS:4350 Logic in Computer Science 3 s.h.
Applications of symbolic logic in computer science; symbolic logic as a powerful tool for modeling computation and computational devices and reasoning formally about them; introduction to several logics (i.e., propositional, predicate, temporal, modal) differing in their expressive power and focus, their uses in computer science; how to represent knowledge in these logics, what represents a valid argument, and how to prove or disprove, possibly automatically, the validity of a logical statement. Prerequisites: CS:2210. Recommendations: computer science, math, or engineering major.

CS:4400 Database Systems 3 s.h.
Introduction to database systems including querying using SQL, design using ER diagrams, developing relational databases, programming web applications using PHP or JDBC. Prerequisites: CS:2230 and CS:3330.
CS:4420 Artificial Intelligence 3 s.h.
Introduction to artificial intelligence covering problem-solving methods, heuristic search, knowledge representation, automated reasoning, planning, game playing, machine learning, and neural networks. Prerequisites: CS:3330.

CS:4440 Web Mining 3 s.h.
Core methods underlying development of applications on the Web; examples of relevant applications, including those pertaining to information retrieval, summarization of Web documents, and identifying social networks. Prerequisites: CS:2230 and CS:2820. Recommendations: CS:4400 strongly recommended.

CS:4460 Introduction to Computational Linguistics 3 s.h.
Introduction to computational linguistics; focus on theory and practice of natural language processing and syntactic and semantic analysis. Same as LING:4030.

CS:4500 Research Methods in Human-Computer Interaction 3 s.h.
Survey of recent research in the field of human-computer interaction; research methods and current readings. Prerequisites: CS:2520.

CS:4520 Computer Graphics 3 s.h.
Introduction to computer graphics algorithms and techniques, with emphasis on interactive 3-D graphics; coordinate systems and frames, modeling and viewing transformations, rendering, shading, lighting, texture, bump, environment mapping, animation, ray tracing, radiosity. Prerequisites: CS:3330 and MATH:2700.

CS:4640 Computer Security 3 s.h.
Mechanism versus policy; authentication, access control, security domains; perimeter security, defense in depth; cryptographic protocols; key management and distribution; security assessment. Prerequisites: CS:2630.

CS:4700 High Performance and Parallel Computing 3 s.h.
Parallel scientific computing methods such as parallel algorithms for dense and sparse matrices; implementation using libraries such as MPI; current topics such as grid computing. Prerequisites: CS:2630 and MATH:2700. Same as MATH:4860.

CS:4720 Optimization Techniques 3 s.h.
Basic theory of optimization, use of numerical algorithms in solution of optimization problems; linear and nonlinear programming, sensitivity analysis, convexity, optimal control theory, dynamic programming, calculus of variations. Prerequisites: MATH:2700 and MATH:2850 and MATH:3800. Same as MATH:4820.

CS:4740 Large Data Analysis 3 s.h.
Current areas that deal with problem of Big Data; techniques from computer science, mathematics, statistics; high performance and parallel computing, matrix techniques, cluster analysis, visualization; variety of applications including Google PageRank, seismology, Netflix-type problems, weather forecasting; fusion of data with simulation; projects. Prerequisites: CS:1210 and MATH:2700 and (STAT:2010 or STAT:2020). Same as MATH:4740, STAT:4740.

CS:4980 Topics in Computer Science II 3 s.h.
Complements material in other courses. Prerequisites: CS:2110 or CS:2230 or CS:2820 or CS:3110.

Graduate

Competence and exposure to computer science are not only useful, they often are prerequisite to advanced study and research in many disciplines. For most graduate students from other disciplines, an appropriate first course is CS:3110 Introduction to Informatics.

CS:5350 Design and Analysis of Algorithms 3 s.h.
Review of design and analysis techniques; advanced data structures (binomial and Fibonacci heaps, disjoint sets); graph algorithms (network flows, matching, min-cut); NP-completeness, randomization and approximation algorithms; special topics (string matching, computational geometry, number theoretic algorithms). Prerequisites: CS:3330 or CS:4340.

CS:5520 Advanced Computer Graphics 3 s.h.
Topics such as global illumination and rendering; volume rendering; animation; curves and surfaces, advanced modeling and mapping techniques; graphics hardware; real-time graphics for virtual environments. Prerequisites: CS:4520.

CS:5610 High Performance Computer Architecture 3 s.h.
Problems involved in designing and analyzing current machine architectures using hardware description language (HDL) simulation and analysis, hierarchical memory design, pipeline processing, vector machines, numerical applications, multiprocessor architectures and parallel algorithm design techniques; evaluation methods to determine relationship between computer design and design goals. Prerequisites: CS:3620 or ECE:3350. Same as ECE:5320.

CS:5620 Distributed Systems and Algorithms 3 s.h.
Models of distributed systems, program correctness—safety and liveness properties, causality, logical and vector clocks, mutual exclusion, distributed snapshot, leader election, distributed algorithms for graph-theoretic problems, fault-tolerance—masking versus nonmasking types, checkpointing, stabilization, consensus—byzantine generals problem, fault-tolerant broadcast and multicast, management of replicated data. Prerequisites: CS:3330 and CS:3620. Requirements: some interest in networking.

CS:5710 Numerical Analysis: Nonlinear Equations and Approximation Theory 4 s.h.
Root finding for nonlinear equations; polynomial interpolation; polynomial approximation of functions; numerical integration. Prerequisites: (MATH:2700 and MATH:2850) or MATH:3550. Requirements: knowledge of computer programming. Same as MATH:5800.

**CS:5720 Numerical Analysis: Differential Equations and Linear Algebra**  
4 s.h.

Numerical methods for initial value problems for ordinary differential equations; direct and iterative methods for linear systems of equations; eigenvalue problems for matrices. Prerequisites: ((MATH:2700 and MATH:2850) or (MATH:3550)) and MATH:3600. Requirements: knowledge of computer programming. Same as MATH:5810.

**CS:5800 Fundamentals of Software Engineering**  
3 s.h.

Problem analysis, requirements definition, specification, design, implementation, testing/maintenance, integration, project management; human factors; management, technical communication; design methodologies; software validation, verification; group project experience. Prerequisites: CS:2820 or ECE:3330. Same as ECE:5800.

**CS:5810 Formal Methods in Software Engineering**  
3 s.h.

Models, methods, and their application in all phases of software engineering process; specification methods; verification of consistency, completeness of specifications; verification using tools. Prerequisites: CS:2820 or ECE:3330. Recommendations: CS:4350. Same as ECE:5810.

**CS:5820 Software Engineering Languages and Tools**  
3 s.h.

Modern agile software development practices for cloud and web-based applications, using state-of-the-art software engineering languages, tools, and technologies; agile software development practices, software-as-a-service (SAAS), and the Ruby on Rails Development Framework. Requirements: ECE:5800 or CS:5800; or graduate standing with solid understanding of object-oriented design and programming, and facility with at least one object-oriented programming language. Same as ECE:5820.

**CS:5830 Software Engineering Project**  
3 s.h.

Team software development project using concepts and methodologies learned in earlier software engineering classes; practical aspects of large-scale software development. Prerequisites: ECE:5800 and ECE:5820. Same as ECE:5830.

**CS:5850 Programming Language Foundations**  
3 s.h.

Introduction to formal foundations of programming languages using a variety of models, including attribute grammars, operational, axiomatic, denotational, and algebraic techniques; proofs of program equivalence, correctness, termination. Prerequisites: CS:3330 and CS:3820.

**CS:5980 Topics in Computer Science III**  
arr.

Individualized research and/or programming projects in computer science, guided by a faculty member.

**CS:6000 Research Seminar: Colloquium Series**  
1 s.h.

Graduate colloquium. Requirements: graduate standing in computer science.

**CS:6421 Knowledge Discovery**  
3 s.h.

Knowledge discovery process, including data reduction, cleansing, transformation; advanced modeling techniques from classification, prediction, clustering, association; evaluation and integration. Same as MSCI:6421.

**CS:6990 Readings for Research**  
arr.

Requirements: Ph.D. standing in computer science.

**CS:7990 Research for Dissertation**  
arr.

Requirements: Ph.D. candidacy (postcomprehensive exam) in computer science.