

# Computer Science

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## Associate Head and Coordinator for Graduate Programs in

**Computer Science:** Gregory W. Jones, Main 420,  
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**Undergraduate Advisor:** Myra Cook, Main 424,  
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**Degrees offered:** Bachelor of Science (BS), Bachelor of Arts (BA), Master of Science (MS), and Doctor of Philosophy (PhD) in Computer Science; Master of Computer Science (MCS)

**Undergraduate emphases:** BS, BA—Science, Digital Systems, Information Systems, Bioinformatics, Information Technology

**Graduate specializations:** MS—Artificial Intelligence, Parallel Systems, Software Engineering

**Accreditation:** The Computer Science undergraduate program is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

## Undergraduate Programs

### Objectives

The core objective of the department is to fulfill its mission, as defined in its mission statement. A detailed description of all department objectives is given under the department's web site: <http://www.cs.usu.edu/>. The outcome objectives for undergraduates are as follows:

### Undergraduate Outcomes

All students graduating with a Bachelor of Science in Computer Science from Utah State University will be expected to show mastery as follows:

1. Graduates will be proficient in programming in at least two programming languages which have significance in industry.

2. Graduates will master the core curriculum in:

- a. Data Structures and Algorithms
- b. Computer Architecture and Organization
- c. Programming Languages
- d. Operating Systems
- e. Software Engineering

3. Graduates will understand the practices and dynamics required to develop software, whether it be a single program or a major software product developed in a team environment.

4. Graduates will gain proficiency in the use of mathematical tools, including calculus, elementary statistics, and probability.

5. Graduates will have sufficient mastery of fundamental knowledge to be lifelong learners in computer science.

6. Graduates will understand the social and ethical issues which face computer scientists, and thus be able to contribute in a positive and productive manner to society.

7. Graduates will be able to communicate information effectively, both in writing and orally.

The course of study offered by the Department of Computer Science is directed primarily toward developing the problem solving skills of its students. This, in conjunction with the understanding of computers and computer systems provided by coursework, will enable a graduate of the program to apply his or her knowledge to finding solutions to problems that arise in the science, business, industry, government, and education sectors.

Students who have the ability to think analytically and creatively will find a challenging and exciting future in computer science.

Opportunities for practical applications of computer science skills are available with members of the computer science faculty who are engaged in research and consultation work both on and off campus.

### Computer Science

Computer Science deals with information structures and processes as they are represented and implemented in modern high-speed digital computers, and with information processing systems designed to implement useful applications of computing.

The program in computer science attempts to provide a solid foundation of knowledge about computers and to teach a mode of thinking which will permit continuing growth on the part of graduates. Prospective students should have an aptitude for mathematics and logic and an interest in analysis and deduction.

Computer science is one of the fastest growing fields of study in our society. Excellent employment opportunities are available to computer science graduates. All of the major corporations hire computer science graduates. Graduates in Computer Science work for numerous Utah-based corporations, as well as Microsoft, IBM, Hewlett-Packard, etc.

The Computer Science bachelor's degree is a four-year degree with areas of emphasis in Science, Digital Systems, Information Systems, Bioinformatics, and Information Technology. In addition, by working with a departmental advisor, students may develop a plan of study tailored to their own unique career objectives.

### Science Emphasis

The Science Emphasis is designed for those who plan to pursue scientific or technical careers, research, or graduate education in computer science. Students choosing the science emphasis will take courses in programming languages, advanced algorithms, and math courses in calculus, linear analysis, and multi-variable calculus. Additional courses include a variety of upper-division computer science courses, chosen in consultation with an advisor.

### Digital Systems Emphasis

The Digital Systems Emphasis is available for those interested in both the hardware and software aspects of computer systems. In addition to computer science and mathematics courses, students in this emphasis will take electrical engineering courses in electronics, circuits, digital fundamentals, microcomputer systems, and digital system design. The curriculum for students in this emphasis is similar to that for students in the computer engineering major in the Electrical and Computer Engineering Department.

### Information Systems Emphasis

The Information Systems program at Utah State University offers a common core of courses through two department majors: (1) **Computer Science** and (2) **Business Information Systems**. The curricula of the individual departments differ substantially in emphasis.

**The Computer Science major with an Information Systems emphasis** is designed for students interested in a career as a Computer Scientist with a background in Information Sciences and Systems. Majors in this emphasis are trained in all phases of the analysis, design, and implementation of information systems. As part of this emphasis, students also receive training in the theory and application of information. Students select an application area such as business, accounting, or economics. Other application areas can be developed by working closely with an advisor. This program of study, offered within the College of Science, leads to a Bachelor of Science, Bachelor of Arts, or Master of Science degree in Computer Science.

**The Business Information Systems major, Management Information Systems emphasis**, is offered in the Business Information Systems Department, College of Business (see page 156). The Bachelor of Science or Bachelor of Arts program is designed for students interested in business careers as information specialists, systems analysts, network managers, application programmers, and information systems managers in business and industry. BIS majors take required courses in analysis and design, Internet management, telecommunications, decision support systems, spreadsheet and database applications, and information systems projects. All graduates are required to complete a common core of business subjects. The College of Business is accredited by the American Assembly of Collegiate Schools of Business. The department also offers a Master of Science in Business Information Systems with a specialization in Management Information Systems. See page 158 for additional details.

### Bioinformatics Emphasis

The Bioinformatics Emphasis is designed for students who wish to pursue careers in the computer science aspects of bioinformatics. Students in this emphasis gain a strong background in core computer science areas, such as programming, theory of computing, and software development. In addition, they

follow a course of study in biology, chemistry, and statistics. Through this background and course of study, students are provided with the computational skills and the scientific understanding necessary for work in bioinformatics.

### Information Technology Emphasis

The Information Technology Emphasis trains students in all phases of analysis, design, and implementation of information technology. It also gives students expertise in the theory and application of information technology. At the same time, this emphasis provides students with a strong background in business principles, including accounting, finance, marketing, and human resource management. Students in the Information Technology emphasis are prepared for careers which straddle information technology and business, in both the private and public sectors.

### Department and General College of Science Requirements

To fulfill the University Studies requirements, majors in computer science must complete a total of at least 30 semester credits in writing, languages, humanities, arts, and/or social sciences. Courses taken to meet the University Studies requirements, if applicable, may also be counted to meet this departmental requirement. Students must work closely with their advisor to meet both these requirements.

**Bachelor of Science Core Requirements.** Students working toward the Bachelor of Science degree in Computer Science must complete the following:

1. One year of calculus, including MATH 1210 and 1220. *Students in the Information Technology Emphasis must substitute MATH 1100.*
2. MATH 3310 (Discrete Mathematics). *Not required for students in the Information Technology Emphasis.*
3. One of the following year-long science sequences: (1) BIOL 1210, 1220 (required for Bioinformatics Emphasis); (2) CHEM 1210, 1220, 1230, 1240; (3) PHYX 2210, 2220; (4) PHYX 2110, 2120 (available for Information Technology Emphasis only); or (5) GEOL 1150, 3200. The sequence chosen must be outside the student's department.

Except for students enrolled in the Information Technology Emphasis, all Computer Science majors must complete at least 12 science credits.

### Requirements

#### Summary of Departmental Admission and Retention Requirements

Admission requirements of the Department of Computer Science for freshmen are the same as those described for the University on pages 15-18. Transfer students with a 2.5 GPA may apply for admission to the department.

Before a student can register for a Computer Science course, he or she must earn a grade of C- or better in all prerequisite courses. All required classes for the major must be completed with a grade of C- or better. Required courses, regardless of department, may not be taken pass-fail, and a Computer Science major must have advanced standing or written permission to register for a Computer Science course at the 3000-level or above.

For a more complete statement of requirements, please contact the department directly. Requirements may change from time to time.

### Bachelor of Science Degree

The department offers a degree program with emphases in Science, Digital Systems, Information Systems, Bioinformatics, and Information Technology. The objectives are to train computer scientists who can relate to science, computer design, or information-based business disciplines. Other areas of emphasis will be considered on an individual basis.

#### COMPUTER SCIENCE REQUIRED COURSES

##### Science Emphasis

CS 1700, 1710, 1720, 2200, 2370, 2550, 3000, 3100, 3550, 4700, 5050; STAT 3000 or MATH 5710; MATH 1210, 1220, 2210, 2250, 3310; MATH 4630 or 5610; PHIL 2400 or 2500 or 3520 or 4530 or 4540; SPCH 1050; at least 13 credits of advisor-approved computer science classes numbered 5000 or above. In addition, students must complete 6 credits at the 3000 level or higher, appropriate to the degree.

##### Digital Systems Emphasis

CS 1700, 1710, 1720, 2200, 2370, 3000, 3100, 4700, 5050; STAT 3000; MATH 1210, 1220, 2250, 3310; ECE 2410, 2420, 2530, 2540, 3710, 3720; PHIL 2400 or 2500 or 3520 or 4530 or 4540; SPCH 1050; at least 13 credits of advisor-approved computer science classes numbered 5000 and above. In addition, students must complete 3 credits at the 3000 level or higher, appropriate to the degree.

##### Information Systems Emphasis

CS 1700, 1710, 1720, 2200, 2370, 2550, 3000, 3100, 3550, 4700, 5050; STAT 2300; MATH 1210, 1220, 3310; ACCT 2010, 2020; ECON 1500; MHR 3110; BA 3080; PHIL 2400 or 2500 or 3520 or 4530 or 4540; SPCH 1050; at least 13 credits of advisor-approved computer science classes numbered 5000 and above. In addition, students must complete 6 credits at the 3000 level or higher, appropriate to the degree.

##### Bioinformatics Emphasis

CS 1700, 1710, 1720, 2200, 2370, 2550, 3000, 3100, 3550, 4700, 5050, 5620, 5630, 5800; STAT 3000; MATH 1210, 1220, 2250 or 2270, 3310; BIOL 3100, 3200; CHEM 1110 or 1210; SPCH 1050; PHIL 2400 or 2500 or 3520 or 4530 or 4540; Statistical Methods in Bioinformatics course (currently being developed); at least 3 credits of advisor-approved computer science classes numbered 5000 or above. In addition, students must take 12-13 credits of advisor-approved electives. Students are strongly encouraged to take BIOL 5730 and its prerequisites to fill this elective requirement.

##### Information Technology Emphasis

CS 1010, 1700, 1710, 1720, 2200, 2370, 2550, 3000, 3010, 3100, 3550, 4700, 4720, 5050, 5800, 5850; MATH 1100; STAT 2300; ACCT 2010, 2020; BIS 3100; BA 3080, 3400, 3500; ECON 1500; MHR 3110, 3710; PHIL 2400 or 2500 or 3520 or 4530 or 4540; at least 10 credits of advisor-approved computer science classes numbered 5000 or above. In addition, students must take 1-2 credits of advisor-approved electives.

### Minor

Requirements for a minor in computer science are listed below. Before beginning any minor, a student must meet with a departmental advisor and file an approved minor application form with the Computer Science Department.

#### Computer Science Minor

CS 1700, 1710, 1720, 2200; two additional CS classes selected from the following list: CS 2370, 2550, 3100, 3550, 4700, or any CS class numbered 5000 or above.

## Graduate Programs

Computer science deals with the programming, use, management, and organization of computers. Graduate students specialize in many different areas, several of which have strong ties to other disciplines such as mathematics, computer engineering, statistics, accounting, and business administration.

### Admission Requirements

Applicants for admission to the graduate program should have a bachelor's degree in computer science **or** extensive experience in computing. Normally, a score of at least 640 on the quantitative test of the general GRE is required for admission to the MS, and a score of at least 700 is required for admission to the PhD or MCS. For scores less than these, applicants must show other strengths in their backgrounds to be considered for admission. The GRE computer science subject exam is not required for admission. Those who do take the GRE computer science subject exam will have preference in consideration for the award of financial aid. Decisions on financial aid are made on or near March 15 for the following fall semester.

### Course Requirements

In addition to the specific departmental admission and degree requirements described in this section, students are advised that they must also meet all Graduate School requirements as described in the Graduate School section of this catalog. Please note that departmental requirements change from time to time, so students should work closely with their advisor in designing their graduate program. Graduate-level courses outside the department *may* be acceptable for the graduate degree. In all cases, approval of the candidate's graduate committee should be obtained *before* registering for such courses.

Graduate students who have not taken or passed at the 50th percentile the computer science GRE subject exam are required to meet departmental placement requirements before completion of their first year. Students who have not met this requirement after the first year, as a minimum, will not be eligible for department-funded financial aid and cannot submit their program of study. In some circumstances, students will be terminated in the program. The department placement requirement is met in one or a combination of the following three ways:

1. Pass three of six placement exams: Computer Architecture and Organization, Algorithms and Data Structures, Operating Systems, Automata, Programming Languages/Compilers, and Software Engineering.
2. Complete with a grade of at least *B-* three of the following departmental placement courses: CS 3550 or ECE 5750 (architecture); CS 2200 (algorithms and data structures); CS 3100 or 5200 (operating systems); CS 4700 or 5300 (programming languages); and CS 2370, 5370, or 6370 (software engineering).
3. Show on an official transcript from an accredited college or university the completion of three courses deemed by the department to be equivalent to its placement courses. These must be semester-based courses of at least 3 credits, and the corresponding grade must be at least a *B-*.

**Master of Science (MS).** Whether Plan A, Plan B, or Plan C (see School of Graduate Studies general requirements), all MS/CS students must meet the following general requirements:

1. Complete four Computer Science courses numbered between 6000 and 6950. CS 6250 and 6900 are *not accepted* for these four courses. CS 6950 can count as *only one* of these four courses, and in that case must be taken for at least 3 credits in a single semester.

2. Complete 1 credit of CS 6900.

No more than 3 total credits in *both* CS 5950 and 6950 and 1 credit of CS 6900 may be used to satisfy the MS degree requirements. CS 6250 cannot be used to meet MS coursework requirements. A maximum of 15 credits of committee-approved coursework below the 6000-level may be used for the MS degree.

Students completing a **Plan A MS degree** must fulfill the following requirements:

1. Complete at least 24 credits of graduate coursework. The total GPA must be at least 3.0, and no more than two class grades below *B-* and none below *C* may be included.

2. Successfully meet the departmental placement requirement.

3. Successfully complete and submit a graduate thesis proposal.

4. Successfully complete and defend a graduate thesis, based on original work (CS 6970, 6 credits).

Students completing a **Plan B MS degree** must fulfill the following requirements:

1. Complete at least 32 credits of graduate coursework. The total GPA must be at least 3.0, and no more than two class grades below *B-* and none below *C* may be included.

2. Successfully meet the departmental placement requirement.

3. Successfully complete and submit a graduate report proposal.

4. Successfully complete and defend a graduate report (CS 6970, 2 credits).

Students completing a **Plan C MS degree** must fulfill the following requirements:

1. Complete at least 37 credits of graduate coursework. The total GPA must be at least 3.0, and no more than two class grades below *B-* and none below *C* may be included.

2. Successfully meet the departmental placement requirement.

3. In addition to the four 6000-level courses required of all MS/CS students, successfully complete one pair of courses representing a sequence offered by the department: CS 5200 and 6200; CS 5300 and 6300; CS 5600 and 6600; CS 5650 and 6650; CS 5700 and 6700.

**Master of Computer Science (MCS).** The Master of Computer Science (MCS) is a terminal degree with coursework requirements similar to the PhD, but lacking the PhD's requirement for original research. Students completing an MCS degree must fulfill the following requirements:

1. Complete at least 60 credits of graduate coursework beyond the BS/CS or 30 credits of graduate coursework beyond the MS/CS with a minimum class grade of *B-* and a minimum cumulative GPA of 3.2.

2. No more than 15 credits of coursework numbered below 6000 may be used for the MCS.

3. Complete at least 12 credits of 7000-level computer science coursework.

4. Successfully meet the departmental placement requirement.

5. Successfully complete and submit a research report proposal.

6. Successfully complete and defend a research report, based on original work (CS 7970, 6 credits).

7. Complete 1 credit of CS 6900.

**Doctor of Philosophy (PhD).** The Doctor of Philosophy in Computer Science is, above all else, a degree of quality. Simply completing a number of graduate courses or years of study is not sufficient to receive the degree. The successful candidate must demonstrate a breadth of understanding in computer science, as well as a depth of understanding in his or her chosen area(s) of emphasis. Also, students must show an ability to do creative research. This research should be carried out over a significant period of time (i.e., at least one year or three semesters). Thus, each successful PhD candidate will produce a significant piece of original research, presented in a written dissertation and defended in an oral examination. This work should be of such quality that one or more journal or conference articles can be derived from it.

Students completing a PhD/CS must fulfill the following requirements:

1. Complete at least 90 credits of graduate coursework (including at least 27 credits of dissertation/research) beyond a BS/CS or at least 60 credits beyond an MS/CS with a minimum class grade of *B* and a minimum cumulative GPA of 3.5.

2. Successfully meet the departmental placement requirement.

3. If an MS/CS is completed first, then no more than 15 credits of the 60 credits required for the PhD may be taken in coursework numbered below the 6000 level. If an MS/CS is not completed first, then no more than 21 credits of the 90 credits required for the PhD may be taken in coursework numbered below the 6000 level.

4. Complete at least 12 credits of 7000-level computer science coursework.

5. Complete 2 credits of PhD Seminar (CS 7900).

6. Complete 9 credits of department-approved business administration or business management courses.

7. Pass a set of comprehensive written examinations and an oral examination showing depth and breadth of knowledge in computer science and the student's area(s) of emphasis.

8. Successfully complete and defend a research proposal.

9. Successfully complete and defend a dissertation (CS 7970, for at least 27 credits).

10. Complete 1 credit of CS 6900.

### ***Financial Assistance***

Applicants for admission will automatically be considered for financial aid, with no need for additional application procedures. Continuing students will be requested to apply for aid during the spring semester. Acceptance into the program does not guarantee financial assistance.

## ***Computer Science Faculty***

### **Professors**

*Scott R. Cannon*, parallel processing, real-time systems, biomedical applications

*Heng-Da Cheng*, image processing, artificial intelligence, parallel processing, computer vision, fuzzy logic, VLSI algorithms and architectures, neural networks

*Donald H. Cooley*, fuzzy logic, evolutionary algorithms, neural networks, multimedia systems

### **Professors Emeritus**

*Rex L. Hurst*, statistical computation, information systems

*Wendell L. Pope*, data structures, automatic software generation, programming languages

### **Associate Professors**

*Stephen J. Allan*, parallel processing, parallel programming, recognition of parallelism, program optimization

*Vicki H. Allan*, instruction-level parallelism, register allocation, software pipelining, program optimization

*Stephen W. Clyde*, software engineering, object orientation, distributed systems, database theory, multimedia systems

*Hugo de Garis*, artificial intelligence, neural networks, genetic algorithms

*Nelson T. Dinerstein*, analysis and construction of information systems, database management systems, applications of small computers

*Nicholas S. Flann*, machine learning, artificial intelligence

*Gregory W. Jones*, computability, GUIs, software engineering

*Daniel W. Watson*, parallel and heterogeneous computing, interconnection networks

### **Associate Professor Emeritus**

*Larre N. Egbert*, scientific computing, computer graphics

### **Assistant Professors**

*Robert F. Erbacher*, computer graphics, visualization, computer security, bioinformatics, GUIs, systems

*Vladimir Kulyukin*, cognitive robotics, speech and language processing

*Seungjin Lim*, data mining, semi-structured databases, bioinformatics

*Xiaojun Qi*, image processing, data mining

### **Lecturers**

*Kendra S. Dinerstein*, introductory programming

*Linda Duhadway*, computer science education

*Mary Veronica Kolesar*, introductory computing

### **Temporary Lecturer**

*Dean Mathias*, computer graphics

## ***Course Descriptions***

Computer Science (CS), pages 372-375