



# **Computer Engineering**

**Undergraduate Handbook**

**2011 - 2012**



# Computer Engineering Undergraduate Handbook

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## 2011-2012 Academic Year

The School of Computing and the Department of Electrical and Computer Engineering jointly offer a Bachelor of Science Degree in Computer Engineering. Accredited by ABET in 1998, the program begins with a pair of two-course sequences. One sequence consists of introductory computer science classes that give students solid programming skills, while exposing them to the breadth of issues that arise in computer science. The other consists of introductory electrical engineering classes that cover the basics of analog circuits.

Students then take nine core courses in electric circuits, electronics, digital system design, computer organization, software engineering, software systems, computer design, and embedded systems. They build on this background by choosing 18 credit hours of electives from the breadth of the course offerings in the School of Computing or the Department of Electrical and Computer Engineering. Possibilities include advanced courses in communications, controls, digital signal processing, computer architecture, operating systems, computer networks, integrated circuit design, microwaves, optics, robotics, intelligent systems, and semiconductor devices. Each student's undergraduate program is capped with a senior project or a senior thesis. Along with an in-depth study of computer engineering, the curriculum encompasses a general education in mathematics (including discrete math, probability, and statistics), science, and the humanities.

The University of Utah is committed to policies of equal opportunity, affirmative action and non-discrimination. The University seeks to provide equal access to its programs, services, and activities for people with disabilities. Reasonable prior notice is needed to arrange accommodations.

# Computer Engineering Program Administration

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# **The Computer Engineering Major**

Computer Engineering includes the design, implementation and programming of digital computers and computer-controlled electronic systems. The School of Computing and the Department of Electrical and Computer Engineering jointly offer a Bachelor of Science degree in Computer Engineering. The program is administered by the Computer Engineering Committee, which consists of faculty members from both departments.

Computer Engineering is a hardware-oriented degree whose requirements include courses offered by the School of Computing and/or the Department of Electrical and Computer Engineering. A student must be admitted as a major in the program in order to take advanced courses (computer science courses numbered 3000 or higher and electrical engineering courses numbered 2000 or higher) and to pursue the Computer Engineering degree.

## **1.1 Goals of the Computer Engineering Program**

The Computer Engineering program is designed with the following objectives:

- To give students, through an undergraduate education grounded in the principles and applications of computer and engineering science, the ability to solve computer engineering problems.
- To prepare students for competent, responsible, and rewarding careers in the computer engineering profession.
- To prepare students for admission and successful completion of a graduate degree, if they choose to continue on to graduate school.

The Computer Engineering curriculum provides students with a sufficient background in mathematics, computer science, and engineering sciences to analyze and design complex software and hardware systems. The curriculum is designed to ensure that graduates consistently meet the above objectives and that they demonstrate the following program outcomes:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software
- an ability to design a system, component, process, or software package to meet desired needs
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve computer engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively in both written and oral form
- the broad education necessary to understand the impact of engineering solutions in a global and societal context
- a recognition of the need for, and an ability to engage in, life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for modern computer engineering practice

## **1.2 Becoming a Computer Engineering Major**

Any student may become a Computer Engineering pre-major by informing the University Registrar or the Computer Engineering Undergraduate Academic Counselor. It is advisable to do this early to ensure receiving program information and staying advised of any changes that may be made in degree requirements. Declaration as a pre-major will also enable participation in activities associated with the degree program such as the Undergraduate Student Advisory Committee.

If you qualify for the University Honors Program (whether or not you actually choose to join that program), you can be admitted directly to the Computer Engineering Program. Please discuss this with the CE Advisor.

Otherwise, before you are formally admitted to the Computer Engineering Program, you must complete certain pre-major courses. You may apply for full major status during the semester in which you are finishing the required pre-major courses, and applications for admission can be obtained from the Computer Engineering web page or the Electrical and Computer Engineering office. Students may not pre-register for any upper division classes in Computer Engineering without first being admitted as a full major or a minor. Applications for major status will only be evaluated and processed at the end of every semester beginning the day final grades become available, and ending on the last day to add classes for the upcoming semester. These dates may be found on the U's Academic Calendar:

<http://www.sa.utah.edu/regist/calendar/datesDeadlines/calendar.htm>.

**To be admitted to full major status, a student must have:**

- 1. An average grade of at least 2.8 and a minimum grade of “C-“ in all of the following classes or their equivalents:**

*None of these classes may be taken on a credit/no-credit basis.*

- Math 1210, and 1220
- Physics 2210
- Computer Science 1410 and 2420
- Electrical and Computer Engineering 1250
- University English writing requirement (WRTG 2010 or ESL 1060)

- 2. A cumulative University of Utah grade point average of 2.5 or higher.**

No pre-major class may be taken more than twice. If a class is repeated, the grade received the second time is used. If credit is granted for any of the above classes based on advanced placement test scores or courses taken at other schools, appropriate grades will be assigned for our use in calculating the admission to major GPA. Check with the Computer Engineering Undergraduate Academic Advisor for details.

### **1.3 Undergraduate Advising**

The Computer Engineering Program has an Undergraduate Academic Advisor, Arlene Padilla Arenaz (MEB 3313, 801-581-4657 [arlene.arenaz@utah.edu](mailto:arlene.arenaz@utah.edu)). Arlene is available to answer questions regarding schedule plans, registration for Computer Engineering classes, degree requirements, recent Computer Engineering Committee actions, or any problems the student may be experiencing. Students should make an appointment with the Undergraduate Academic Advisor at least once a year to verify that they are on track for graduation. To set up an appointment, send an email to [ugadvisor@ece.utah.edu](mailto:ugadvisor@ece.utah.edu). Include purpose of the appointment requested student ID, telephone number, and days/times student is available.

The program also has a Faculty Advisor, who can answer questions about any of the above, as well as more technical issues such as career decisions, course content, and equivalence of transfer classes. Contact the Undergraduate Academic Advisor to find out how to arrange an appointment with the Faculty Advisor.

### **1.4 Requirements for the Bachelor of Science Degree**

The Computer Engineering degree can be completed in four full-time years of study if the student is capable of completing the two-course calculus, computer science and electrical engineering sequences, along with physics and English writing, during the freshman year. Only strong training in high school will allow a student to begin at this level. If a student must instead take preparatory classes as a freshman, more than four years may be required for earning a degree. In any event, it is important to take the required pre-major classes early to allow advancement to full major status as soon as possible.

- 1. General Education:** The General Education requirements are described in the University of Utah General Catalog. The requirements for Computer Engineering majors are more specific.



- (a) The University writing requirement is satisfied by either Writing 2010 or ESL 1060 (for students who speak English as a second language).
- (b) The quantitative reasoning requirement is satisfied by Math 1210 and 1220, which are required for Computer Engineering pre-majors.
- (c) Students must take two intellectual explorations courses in each of fine arts, humanities, and social/behavioral sciences. (The two-course requirement in physical and life sciences is automatically satisfied by classes that are required for the major.) These six courses must include an ethics course (covered by LEAP) and two upper division courses. For students admitted to CE before Fall 2008: Courses satisfying the ethics requirement are:

|           |   |                                  |
|-----------|---|----------------------------------|
| Phil 3500 | 3 | Ethics                           |
| Phil 3510 | 3 | Business and Professional Ethics |
| Phil 3520 | 3 | Bioethics                        |
| Phil 3530 | 3 | Environmental Ethics             |
| Phil 4540 | 3 | Engineering Ethics, and Society  |

The American Institutions requirement can be satisfied by taking one of the following:

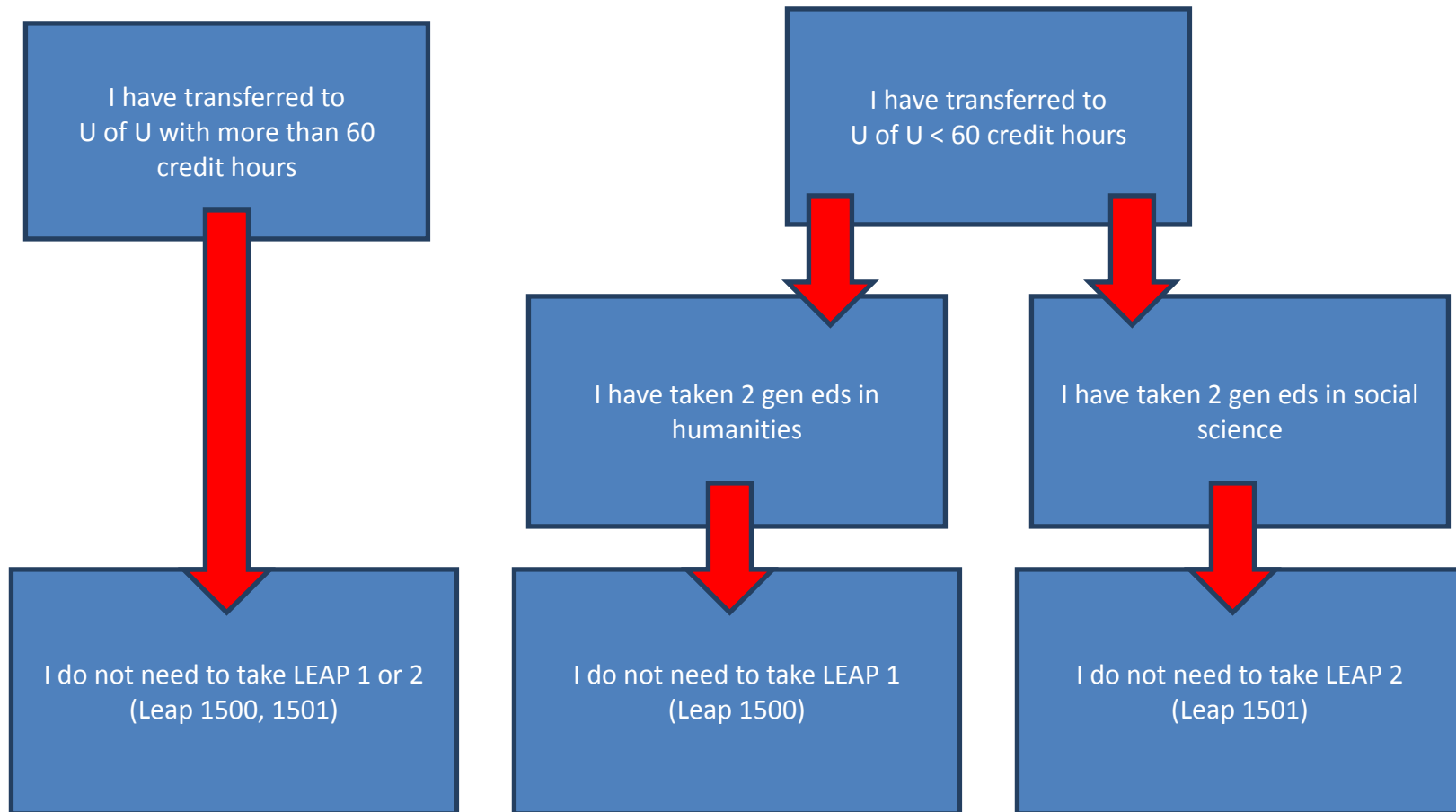
|             |   |                        |
|-------------|---|------------------------|
| Econ 1740   | 3 | US Economic History    |
| Hist 1700   | 3 | American Civilization  |
| PolS 1100   | 3 | US National Government |
| Honors 2212 | 3 | American Institutions  |

- (e) The LEAP 1501 course is required for all students who enter the program Fall 2008 or after. LEAP 1501 is offered during fall semester and satisfies both the University Social and Behavioral Science (BF) requirement and the Departmental Ethics requirement. LEAP is organized by the office of Undergraduate Studies. While the CE program only requires LEAP 1501 (one semester duration, offered during Fall), LEAP is designed as a year-long cohort program set up to allow students to take several classes together during their first year on campus. These second of these classes, LEAP 1500, is offered during spring semester and satisfies the university Humanities (HF) and Diversity (DV) requirements. The program also includes sections of Writing, Calculus, and Physics. For more information on E-LEAP, contact the College of Engineering Undergraduate Academic Advisor at 801-581-4657.

Computer engineering students should also consider CS 1050, Computers in Society, as one of their Social/Behavioral Science General Education Classes. The course focuses on the social issues that surround the increasingly pervasive roles that computers play in society.

# Do I Have to Take LEAP?

Effective Fall 2010



**2. University Graduation Requirements:** The University graduation requirements for the Bachelor of Science Degree are described in the University of Utah General Catalog.

- (a) To satisfy the communication/writing requirement, Computer Engineering majors must take WRTG 3014 Writing in the Sciences or WRTG 3015 Professional/Technical Writing. Honors 3200 Writing at a Research University may be taken by students participating in the University Honors Program. This course must be taken prior to taking the Computer Engineering Senior Project course.
- (b) The quantitatively intensive course requirement is satisfied by CS/ECE 3700 Fundamentals of Digital System Design and 3810 Computer Organization, which are required for Computer Engineering majors.
- (c) The diversity requirement can be satisfied by taking a course from the approved list as part of the intellectual explorations requirement.
- (d) Students must complete a minimum of 122 semester hours of course work. At least 40 of the 122 hours must be upper division classes. (Upper division classes are numbered 3000 or above. Credits from two-year colleges will not count toward University upper division hours.) At least 30 of the total credit hours and 20 of the last 30 hours must be taken at the University.
- (e) The International Requirement can be satisfied by taking a course from the approved list as part of the intellectual explorations requirement.

**3. Mathematics and Science:** A minimum of nine math and science courses must be taken.

- (a) One year of calculus (Math 1210 and 1220 )
- (b) One year of physics for scientists and engineers (Physics 2210/2220)
- (c) A course in discrete mathematics (CS 2100)
- (d) A course in differential equations and linear algebra (Math 2250)
- (e) A course in advanced calculus (Math 2210)
- (f) A course in probability and statistics (ECE 3530)
- (g) One additional class, chosen from among Biology 1210, Chemistry 1210, Math 3150 (Partial Differential Equations), Math 5600 or Computer Science 3200 (Numerical analysis), and Physics 3740 (Modern Physics)

**4. Computer Engineering:** A minimum of 22 computer engineering classes must be taken. Figure 1.1 gives an example four-year degree program leading to a Bachelor's Degree in Computer Engineering. Figure 1.2 summarizes the prerequisites for Computer Engineering courses.

(a) Required classes:

|            |  |
|------------|--|
| ECE 1900   | Freshman Seminar                         |
| ECE 1250   | Electrical & Computer Engineering Design |
| CS 1410    | Object Oriented Programming              |
| or CS 2000 | Program Design in C                      |

|             |  |
|-------------|--|
| CS 2420     | Introduction to Algorithms & Data Structures |
| ECE 2260    | Introduction to Electric Circuits            |
| ECE 2280    | Fundamentals of Engineering Electronics      |
| CS 3500     | Software Practice                            |
| CS/ECE 3700 | Digital System Design                        |
| CS/ECE 3710 | Computer Design Laboratory                   |
| CS/ECE 3810 | Computer Organization                        |
| CS/ECE 3991 | CE Junior Seminar                            |
| CS/ECE 3992 | CE Pre-Thesis/Pre-Project                    |
| CS 4400     | Computer Systems                             |
| CS/ECE 5780 | Embedded System Design                       |

- (b) Technical electives: Eighteen (18) credit hours of additional Computer Science or Electrical Engineering classes numbered 3000 or above. CS 5010/20 and seminars may not be counted. Only one independent study class may be counted. Also, labs that are directly associated with classes (e.g., ECE 5211) may not be counted as one of the six required classes.
- (c) Capstone Requirement: One of the following must be completed.
- |                               |  |
|-------------------------------|--|
| CS/ECE 3992 & 4710            | CE Pre-thesis/Pre-project & Senior Project |
| CS/ECE 3992 & ECE 4900 & 4910 | CE Pre-thesis/Pre-project & Clinic         |
| CS/ECE 3992 & 4991 & 4992*    | CE Pre-thesis/Pre-project & Senior Thesis  |

*\* Students choosing the thesis option must get special permission from the CE faculty. Such approval is usually obtained by finding a faculty advisor and completing a thesis proposal in CS/ECE 3992 in the spring of the junior year. This option is intended for students who are considering graduate school. The Senior Thesis can also be used toward a portion of the thesis requirements for a BS/MS program in Electrical Engineering or in Computer Science. For more information about the joint BS/MS program, please see the director of the BS/MS program in the Department of Electrical and Computer Engineering or in the School of Computing.*

- (d) Duplication of credit: No single class may be counted toward more than one of the requirements listed above.

**5. Suggested elective grouping:** Some students wish to take technical elective classes that provide a depth of experience in one area of Computer engineering. Any of the following groups of classes would provide such depth.

- (a) Communications/Controls/Digital Signal Processing  
 ECE 3510 Introduction to Feedback Systems  
 5000 level or higher courses numbered ECE x5xx or ECE x6xx
- (b) Computer Architecture/Software Systems  
 CS/ECE 6810 Computer Architecture  
 5000 level or higher courses number CS x4xx or CS/ECE x8xx
- (c) Integrated Circuit Design  
 CS/ECE 6710 Digital VLSI Design  
 5000 level or higher courses numbered CS/ECE x7xx

- (d) Microwaves/Optics  
ECE 3300 Fundamentals of Electromagnetics and Transmission Lines  
5000 level or higher courses numbered ECE x3xx or ECE x4xx
- (e) Robotics/Intelligent Systems  
CS 5310 Robotics  
5000 level or higher courses numbered CS x3xx
- (f) Semiconductor Devices (both classes and labs must be taken)  
ECE 3110 Electronics II  
5000 level or higher courses numbered ECE x1xx or x2xx

**6. Continuing Performance:** *All Computer Engineering, mathematics, science, and writing courses taken to satisfy the requirements listed above must be taken for a grade and must be passed with a "C-" or better (except for ECE 1900, in which a grade of CR (credit) is required). A student may repeat such courses only one time.*

In order to remain in good standing and to graduate, a student must maintain a cumulative grade point average at the University of Utah of 2.5 or higher and also maintain a grade point average of 2.5 in technical classes (CS and ECE courses) that count toward CE graduation and are taken at the University. Students whose grade point average in either of these two categories falls below 2.5 are put on probation. Students on probation must raise their GPAs (cumulative and technical) above 2.5 within 12 months (3 semesters) or they will be dropped from the program.

In order to be reinstated from being dropped due to a low GPA, students must petition the Computer Engineering Committee. Reinstated students may be required to proceed under the latest graduation requirements.

Classes numbered 4000 and above will not count toward graduation if they are more than seven years old at the time you graduate. For example, if you graduate in 2006-07, 4000-level and higher classes taken in 1999-2000 and later would count; those taken before that would not count. All classes, including lower-level classes numbered below 4000, must be the equivalent of semester requirements current at the time of your graduation. The University of Utah General Catalog states: "All students graduating after Spring Semester 2005 must complete semester requirements". If you have quarter classes on your transcript, see the academic advisor to determine their semester equivalent.

## 1.5 Undergraduate Scholarships

Computer Engineering students are eligible for several different scholarships. Most of these are awarded through either the School of Computing or the Department of Electrical and Computer Engineering. Recipients are selected based upon academic performance, rather than financial need. Most are awarded to CE full majors or those students who will become full majors during the following academic year. The following scholarships are available:

**School of Computing Scholarships:** Cash awards are given to Computer Science and Computer Engineering majors each year. Tuition scholarships are available to Utah residents and cover up to 16 credit hours of resident tuition for two semesters; to be eligible; students must take at least 12 credit hours per semester.

Cash scholarships are available to all CE majors and range in value from \$1,000 to \$4,000. They are made possible by generous donations from the School of Computing faculty, the Eccles Foundation, Kiri Wagstaff, and others. To be eligible, students must take at least 12 credit hours per semester.

**Department of Electrical and Computer Engineering Scholarships:** Cash awards are given to Computer Engineering majors each year. Tuition scholarships are available to Utah residents and cover up to 16 credit hours of resident tuition for two semesters. Cash scholarships are available to all CE majors and range in value from \$1,000 to \$4,000; they are made possible by generous donations from the Robert G. & Mary Jane Engman Foundation and others. To be eligible for any of these awards, students must take at least 12 credit hours per semester.

The College of Engineering also awards several scholarships (Kennecott, Ariel Berrier, Simon Ramo, and others) to the top students in the college. Students may also apply for financial aid from the College, which each year awards a number of Josephine Beam Educational Scholarships. These are worth approximately \$500 and are based on need.

Students apply for scholarships online at <http://www.ece.utah.edu/scholarships>. The applications are available in late December each year, and are due by February 15<sup>th</sup>, for the following academic year.

## **1.6 Employment Opportunities**

The University Office of Career Services offers an internship program which allows qualified students to work in their fields of interest for all or part of their junior and/or senior years. This can be done on a full or part time basis, either in Salt Lake City or elsewhere. Students generally are paid for their work but receive no academic credit.

The benefits of such experience include exposure to ideas which could help with career decisions, making contacts which may be useful sometime in the future, and valuable experience in an area that is pertinent to current studies. Among the corporations participating are IBM, Hewlett Packard, L-3 Communications Systems, Intel, and Micron. Many of our majors take advantage of this valuable opportunity. Students seeking employment should register with the University Office of Career Services.

Both the school of Computing and the Department of Electrical and Computer Engineering employ a number of junior and senior students as computer operators and as teaching assistants. These jobs involve no more than 20 hours of work per week at an appropriate hourly wage. Appointments are made each semester based on student applications, which should be submitted prior to the start of each term. These applications are available on the ECE website. In addition, general inquiries are received periodically from local industry and from University of Utah research groups for students who are interested in working part or full time. These are posted on a computer bulleting board which is accessible to majors. More information may be obtained from the Academic Counselor.

Students seeking employment upon graduation should contact the University Office of Career Services in order to be included on a list supplied to employers. Students not planning to work towards an advanced degree should register with Career Services during their junior year, since most companies begin interviewing in the fall semester.

## **1.7 Student Participation in School Affairs**

Opportunities for students to develop their organizational and leadership abilities are available through participation in the Computer Engineering Undergraduate Student Advisory Committee (CESAC), which plays an active role in the program and coordinates the following:

- Course and faculty teaching evaluations
- Announcements to all declared pre-majors and minors
- Representation on the College Student Advisory Committee
- Organization of Engineering Week activities in February
- Organization of lunch meetings for pre-majors and majors
- Feedback on school issues affecting students, such as scheduling, curriculum changes, and graduation requirements

Anyone interested in joining this organization should contact CESAC at [cesac@cs.utah.edu](mailto:cesac@cs.utah.edu). Participation, suggestions, and criticism are solicited.

## **1.8 Other Information**

More information concerning faculty, facilities, and services in the School of Computing and the Department of Electrical and Computer Engineering can be found in the handbooks for those departments. A listing of courses applicable to the Computer Engineering program is in the next chapter.

Figure 1.1

## Sample Computer Engineering Degree Program 2011-2012

### First Year

| <b>Fall Semester</b>                   |            |  | <b>Spring Semester</b> |            |   |
|--|------------|--|------------------------|------------|---|
| ECE 1900                               | 0.5        | Freshman Seminar   | <b>ECE 1250</b>        | 4.0        | <b>Electrical &amp; Computer Engineering Design</b> |
| <b>CS 1410</b><br>or CS 2000           | 4.0        | <b>Object Oriented Programming<br/>Program Design in C</b> | <b>CS 2420*</b>        | 4.0        | <b>Intro Alg &amp; Data Structures</b>              |
| <b>Math 1210*</b>                      | 4.0        | <b>Calculus I</b>  | <b>Math 1220*</b>      | 4.0        | <b>Calculus II</b>                                  |
| <b>Wrtg 2010</b><br>or <b>ESL 1060</b> | 3.0        | <b>Intermediate Writing<br/>Expository Writing for ESL</b> |                        |            |   |
| <b>LEAP 1501**</b>                     | <u>3.0</u> | <b>Ethical Implications of Engineering</b>                 | <b>Phys 2210</b>       | <u>4.0</u> | <b>Physics for Scientists &amp; Engineers I</b>     |
|  | 14.5       |  |                        | 16.0       |   |

\* Take Math 1270 & 1280 if you have a Math AP AB score of 3 or 4 or a Math ACT score of 30. Those not eligible take Math 1210, 1220, and 2210. Math 2210 is not required if you take Math 1270 and 1280.

\*\* Engineering LEAP is required (beginning Fall 2008) unless students have 60 or more transfer hours. However, an ethics course is still needed.

### Second Year

| <b>Fall Semester</b> |            |  | <b>Spring Semester</b> |            |   |
|----------------------|------------|--|------------------------|------------|---|
| ECE 2240             | 4.0        | Fundamentals of Electric Circuits                | ECE 2280               | 4.0        | Fundamentals of Engineering Electronics |
| CS 3500              | 4.0        | Software Practice I                              | CS/ECE 3700            | 4.0        | Digital System Design                   |
| CS/ECE 3810          | 4.0        | Computer Organization                            | Math 2250              | 4.0        | Differential Equat & Linear Algebra     |
| Phys 2220            | <u>4.0</u> | <b>Physics for Scientists &amp; Engineers II</b> | Wrtg 3014              | <u>3.0</u> | Writing in the Sciences                 |
|                      | 16.0       |  |                        | 15.0       |   |

### Third Year

| <b>Fall Semester</b> |            |                            | <b>Spring Semester</b> |            |                              |
|----------------------|------------|----------------------------|------------------------|------------|------------------------------|
| CS/ECE 3710          | 3.0        | Computer Design Laboratory | CS/ECE 3992            | 1.0        | Pre-Thesis/Pre-Project       |
| CS/ECE 3991          | 0.5        | CE Junior Seminar          | CS/ECE 5780            | 4.0        | Embedded System Design       |
| CS 2100              | 3.0        | Discrete Structures        | ECE 3530               | 3.0        | Eng Probability & Statistics |
| CS 4400              | 4.0        | Computer Systems           | CE                     | 3.0        | Technical Elective           |
| Math 2210            | 3.0        | Calculus III               | Math/Science           | 3.0        | Elective                     |
| Gen Ed               | <u>3.0</u> |                            | Gen Ed                 | <u>3.0</u> |                              |
|                      | 16.5       |                            |                        | 17.0       |                              |

### Fourth Year

| <b>Fall Semester</b> |            |                    | <b>Spring Semester</b> |            |                       |
|----------------------|------------|--------------------|------------------------|------------|-----------------------|
| CS/ECE 4710          | 3.0        | CE Senior Project  | CE                     | 3.0        | Technical Elective    |
| CE                   | 3.0        | Technical Elective | CE                     | 3.0        | Technical Elective    |
| CE                   | 3.0        | Technical Elective | CE                     | 3.0        | Technical Elective    |
| Gen Ed               | 3.0        | Elective           | Gen Ed                 | 3.0        | Elective              |
| Gen Ed               | <u>3.0</u> | Elective           |                        | <u>3.0</u> | American Institutions |
|                      | 15.0       |                    |                        | 15.0       |                       |

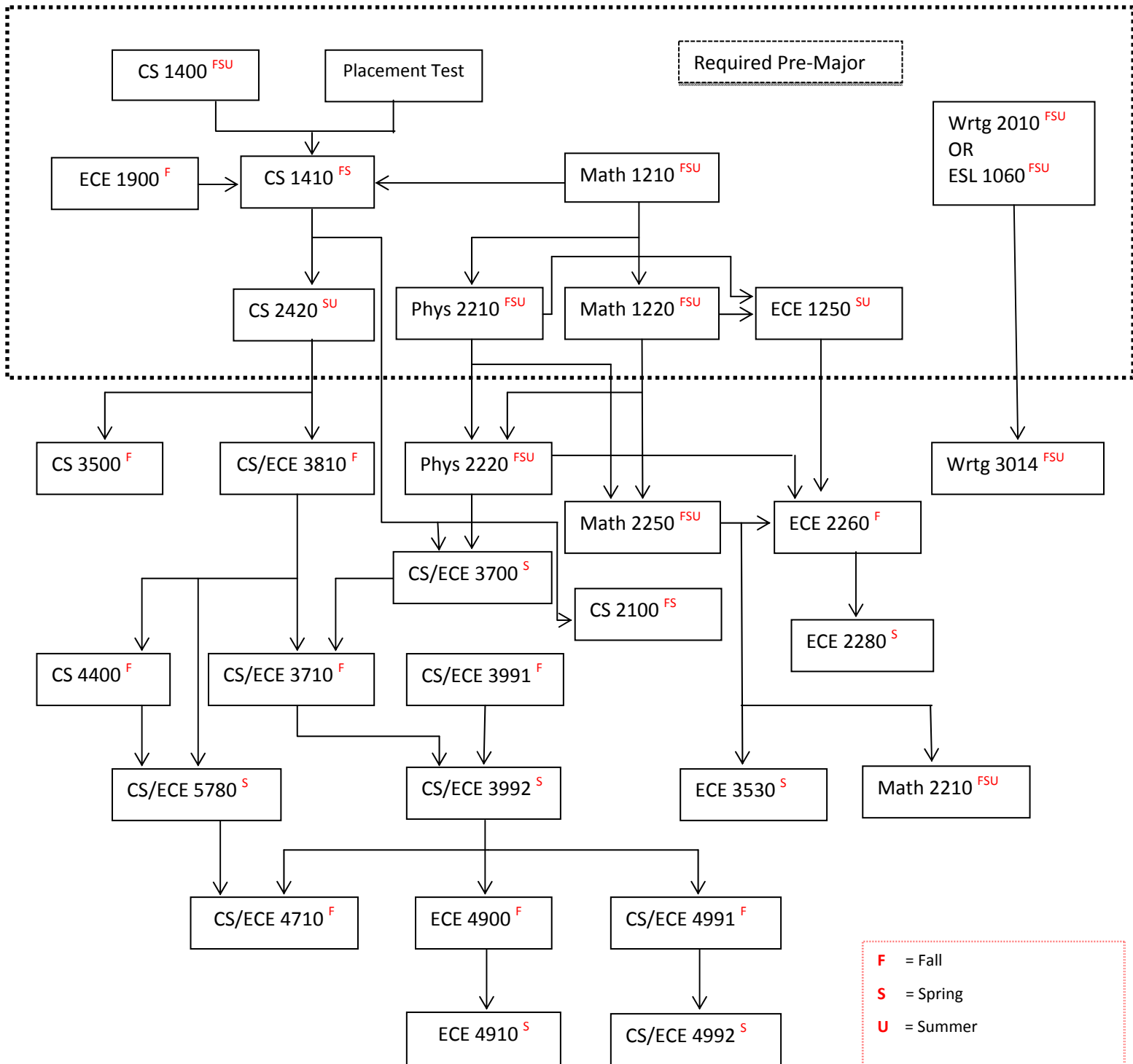
This table gives an eight (8) semester example program leading to a B.S. in Computer Engineering. It is meant only as a guide, since the scheduling of electives and General Education Classes depends upon which ones are selected. This schedule assumes adequate high school preparation in mathematics; it is not advisable to take Physics 2210 without some previous training in calculus.

Students may apply for major status during any semester in which all pre-major classes (highlighted above) are completed. The current GPA for admission to major status is 2.5 for all University of Utah classes, and a 2.8 on for all pre-major classes. Students must also have a minimum grade of "C-" in all pre-major courses.



# Computer Engineering Prerequisites

Figure 1.2



**F** = Fall  
**S** = Spring  
**U** = Summer

This graph shows the order in which classes must be taken to satisfy prerequisite and co-requisite requirements in Computer Engineering. Prerequisites are connected bottom-to-top; co-requisites are connected side-to-side.

Students must also satisfy the General Education/University requirements, take one course that satisfies the math/science elective, complete 18 credit hours of CE electives, and satisfy the CE capstone requirement.

## ADVANCED PLACEMENT CREDIT

You must arrange to have your Advanced Placement scores on your University of Utah record. AP scores on subjects that will count toward classes required for the EE degree are shown below and may be used toward major admission and graduation requirements. The grades listed are used only for admission to major status and do not affect your University of Utah GPA or your ECE GPA for graduation.

| <b>AP Test</b>                    | <b>AP Score</b> | <b>Equivalent Classes</b> | <b>Credit Hours</b> | <b>Grade</b> |
|-----------------------------------|-----------------|---------------------------|---------------------|--------------|
| Calculus AB                       | 5               | Math 1210                 | 4                   | A            |
|                                   | 4               | Math 1210                 | 4                   | B-           |
| Calculus BC                       | 5               | Math 1210, Math 1220      | 8                   | A            |
|                                   | 4               | Math 1210, Math 1220      | 4, 4                | B+, B-       |
|                                   | 3               | Math 1210                 | 4                   | B-           |
| Physics C Mechanics               | 5               | Phys 2210                 | 4                   | A            |
|                                   | 4               | Phys 2210                 | 4                   | B            |
| Physics C Electricity & Magnetism | 5               | Phys 2220                 | 4                   | A            |
|                                   | 4               | Phys 2220                 | 4                   | B            |
| Computer Science A                | 5               | CS 2000 or 2010           | 4                   | A            |
|                                   | 4               | CS 2000 or 2010           | 4                   | B            |
| Computer Science AB               | 5               | CS 2000 or 2010, 2020     | 8                   | A            |
|                                   | 4               | CS 2000 or 2010, 2020     | 4, 4                | B+, B-       |
|                                   | 3               | CS 2000 or 2010           | 4                   | B-           |
| English                           | 5               | Wrtg 2010                 | 3                   | A            |
|                                   | 4               | Wrtg 2010                 | 3                   | B            |
| Chemistry                         | 5               | Chem 1210                 | 4                   | A            |
|                                   | 4               | Chem 1210                 | 4                   | B+           |

CE Articulation 2011-12

| U of U    | Descrip               | SLCC              | CEU                       | Dixie            | UVU               | Snow              | Weber     | SUU              | USU                       | BYU           | BYU Id    | Westmin  | LDS BC   |
|-----------|-----------------------|-------------------|---------------------------|------------------|-------------------|-------------------|-----------|------------------|---------------------------|---------------|-----------|----------|----------|
| Yr 1 Fall |                       |                   |                           |                  |                   |                   |           |                  |                           |               |           |          |          |
| ECE 1900  | Freshman Seminar      |                   |                           |                  |                   |                   |           |                  |                           |               |           |          |          |
| CS 1400   | Intro CS              | CS 1400           | CS 1400 & 1405            | CS 1400          | CS 1400           | CS 1400           | CS 1400   | CSIS 1400        | CS 1400                   | CS 100 or 124 | CS 124    | CMPT 201 |          |
| CS 1410   | Object Orient Prog    | CS 1410 or 1600   | CS 1410                   | CS 1410          | CS 1410           | CS 1410 & 1415    | CS 1410   | CSIS 1410        | CS 1410                   | CS 142        | CS 165    | CMPT 202 |          |
| MATH 1210 | Calc I                | MATH 1210         | MATH 1210                 | MATH 1210        | MATH 1210         | MATH 1210         | MATH 1210 | MATH 1210        | MATH 1210                 | MATH 112      | FDMAT 112 | MATH 201 | MATH 111 |
| WRTG 2010 | Int Writing           | ENGL 2010 or 2100 | ENGL 2010                 | ENGL 2010        | ENGL 2010 or 2020 | ENGL 2010 or 2014 | ENGL 2010 | ENGL 2010        | ENGL 2010                 | ENG 150       | ENG 311   | ENGL 110 | ENG 201  |
| Yr 1 Spr  |                       |                   |                           |                  |                   |                   |           |                  |                           |               |           |          |          |
| ECE 1250  | ECE Design            | EE 1270           | ECE 1000 or (2250 & 2255) | ENGR 2250 & 2255 | EENG 2270 & 2275  | ENGR 2250 & 2255  | EE 1270   | ENGR 2270 & 2275 | ECE 1000 or (2250 & 2255) | ECEN 212      | ECEN 150  |          |          |
| MATH 1220 | Calc II               | MATH 1220         | MATH 1220                 | MATH 1220        | MATH 1220         | MATH 1220         | MATH 1220 | MATH 1220        | MATH 1220                 | MATH 113      | MATH 113  | MATH 202 |          |
| PHYS 2210 | Physics I Mech        | PHYS 2210         | PHYS 2210                 | PHYS 2210        | PHYS 2210         | PHYS 2210         | PHYS 2210 | PHYS 2210        | PHYS 2210                 | PHSCS 121     | PH 121    | PHYS 211 |          |
| CPSC 2420 | Alg & Data Structures | CS 2420           | CS 2420                   | CS 2420          | CS 2420           | CS 2420           | CS 2420   | CSIS 2420        | CS 2420                   | CS 235        | CS 235    | CMPT 306 |          |

CE Articulation 2011-12 (cont.)

| U of U      | Descrip              | SLCC      | CEU              | Dixie            | UVU              | Snow             | Weber     | SUU              | USU       | BYU                   | BYU Id          | Westmin        | LDS BC |
|-------------|----------------------|-----------|------------------|------------------|------------------|------------------|-----------|------------------|-----------|-----------------------|-----------------|----------------|--------|
| Yr 2 Fall   |                      |           |                  |                  |                  |                  |           |                  |           |                       |                 |                |        |
| CS/ECE 3810 | Comp Architec        | CS 2810   |                  | CS 2810          | CS 4380          | CS 2810          |           | CSIS 3500        | CS 2810   |                       | ECEN 324 & 360  | CMPT 328       |        |
| ECE 2240    | Electric Circuits    | EE 2260   |                  |                  |                  |                  | EE 2260   |                  | ECE 3620  | ECEN 212 & 313        |                 |                |        |
| MATH 2250   | Diff Eq & Linear Alg | MATH 2250 | MATH 2270 & 2280 | MATH 2270 & 2280 | MATH 2270 & 2280 | MATH 2270 & 2280 | MATH 2250 | MATH 2270 & 2280 | MATH 2250 | MATH 334 & 313        | MATH 341 & 371  | MATH 311 & 363 |        |
| PHYS 2220   | Physics II E&M       | PHYS 2220 | PHYS 2220        | PHYS 2220        | PHYS 2220        | PHYS 2220        | PHYS 2220 | PHYS 2220        | PHYS 2220 | PHSCS 123 & PHSCS 220 | PH 123 & PH 220 | PHYS 212       |        |
| Yr 2 Spr    |                      |           |                  |                  |                  |                  |           |                  |           |                       |                 |                |        |
| CS 2100     | Discrete Structs     | CS 2430   |                  | MATH 3310        | CS 2300          | MATH 1630        | MATH 1630 | MATH 1630        | MATH 3310 | CS 236                | CS 237          | MATH 210       |        |
| CS/ECE 3700 | Digital Design       | EE 2700   |                  |                  | EENG 2700 & 2705 | ENGR 2700 & 2705 | EE 2700   |                  | ECE 5530  | ECEN 320              | ECEN 224 & 340  |                |        |
| ECE 2280    | Electronics          | EE 2280   |                  |                  |                  |                  |           |                  | ECE 3410  | ECEN 313              |                 |                |        |
| MATH 2210   | Calc III             | MATH 2210 | MATH 2210        | MATH 2210        | MATH 2210        | MATH 2210        | MATH 2210 | MATH 2210        | MATH 2210 | MATH 314              | MATH 214        | MATH 203       |        |

CE Articulation 2011-12 (cont.)

| U of U     | Descrip                   | SLCC      | CEU       | Dixie     | UVU       | Snow      | Weber     | SUU       | USU       | BYU     | BYU Id           | Westmin  | LDS BC |
|------------|---------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------|------------------|----------|--------|
| Tech Elect |                           |           |           |           |           |           |           |           |           |         |                  |          |        |
| BIOL 1210  | General Biology           | BIOL 1610 | BIOL 1610 | BIOL 1610 | BIOL 1610 | BIOL 1610 |           | BIOL 1610 | BIOL 1610 | BIO 100 | BIO 200          | BIO 105  |        |
| CHEM 1210  | General Chemistry         | CHEM 1210 | CHEM 1210 | CHEM 1210 | CHEM 1210 | CHEM 1210 | CHEM 1210 | CHEM 1210 | CHEM 1210 |         | CHEM 105 or 105H | CHEM 111 |        |
| ECE 3110   | Eng Electronics II        |           |           |           |           |           |           |           | ECE 5430  |         |                  |          |        |
| ECE 3300   | Fund E&M and Trans Lines  |           |           |           |           |           |           |           | ECE 3870  |         |                  |          |        |
| ECE 3500   | Fund Signals & Systems    |           |           |           |           |           |           |           | ECE 3640  |         | ECEN 380         |          |        |
| ECE 3510   | Intro to Feedback Systems |           |           |           |           |           |           |           | ECE 5310  |         |                  |          |        |
| ECE 5320   | Microwave Eng             |           |           |           |           |           |           |           | ECE 5810  |         |                  |          |        |
| ECE 5324   | Antenna Theory & Design   |           |           |           |           |           |           |           | ECE 5850  |         |                  |          |        |