COMPUTER ENGINEERING HANDBOOK

for UNDERGRADUATES

1992–1993

Department of Computer Science and Engineering
University of Washington
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1 Introduction

Computer engineers design and implement computer hardware and software systems to solve a variety of problems in such diverse areas as communications, manufacturing, robotics, computer graphics, databases, and many others. A computer engineer might be involved in fundamental research, hardware design and fabrication, software creation, or systems integration.

The Computer Engineering (CompE) program, offered by the Department of Computer Science and Engineering, leads to the degree of Bachelor of Science in Computer Engineering. The program provides an in-depth education in Computer Engineering, stressing digital hardware, software, and architecture, while retaining a strong foundation in traditional Electrical Engineering. A total of 192 credits is required, with an emphasis on mathematics, engineering design, laboratory work, and developing communications skills. The CompE program is accredited by the Accreditation Board for Engineering and Technology.

The purpose of this handbook is to acquaint prospective majors with our undergraduate program in Computer Engineering, to provide information about the application procedure, to list the requirements for our majors, and to present some basic background on our Department.

The Department of Computer Science and Engineering began in 1967 when a small group of faculty from a number of departments were authorized to grant graduate degrees in Computer Science. In 1975, the Department of Computer Science was formed and began offering a Bachelor of Science degree in Computer Science, with the first B.S. degree awarded in 1978. In 1985, the department moved from the College of Arts and Sciences into the College of Engineering. It changed its name to the Department of Computer Science and Engineering, and assumed responsibility for the undergraduate Computer Engineering program, previously offered by the Department of Electrical Engineering.

Today the Department of Computer Science and Engineering includes over 30 faculty members, 150 graduate students, and 250 undergraduate majors. The emphasis in the Department is divided equally among undergraduate instruction, graduate instruction, and research. In a recent study of graduate departments of computer science and engineering, our Department was ranked among the top ten in the nation. While no similar study has been performed concerning undergraduate education, this study is a good indication of the high overall quality of our Department. In addition, our ratio of undergraduate students to faculty is excellent; we generally aim for a maximum class size of 40 students for our majors courses.

1.1 The B.S. Degree

The courses in the Computer Engineering curriculum can be divided into four categories: hardware, systems, applications, and theory.

- The hardware courses are concerned with digital logic and its specification, design, simulation, implementation, and testing. They include a significant laboratory component, culminating in a digital system design course that involves designing, simulating, constructing, and debugging a substantial project of the student’s choosing. In addition to the hardware courses offered
by the Computer Science and Engineering Department, the curriculum includes a substantial number of Electrical Engineering courses.

- Courses in the systems area are concerned with the logical structure ("architecture") of computer systems and with the design and implementation of computer system software, such as operating systems and compilers. Many courses in this area include projects.
- Courses in the applications area deal with computers as tools to solve problems. Examples of topics in this area are artificial intelligence, computer graphics, and databases.
- The theory courses are concerned with abstract notions of computing that are for the most part independent of any specific computing technology. Topics include designing efficient algorithms, and analyzing the basic computational requirements of any algorithm for solving a particular class of problem.

Our Department produces Computer Engineers, as contrasted with computer users. The undergraduate programs are designed to prepare students for professional careers or graduate study. We are especially concerned with providing our students with a foundation that will not become obsolete as technology advances.

Upon graduation, our students are well prepared for either of two possible futures. One is graduate study. Our students are regularly accepted by the best graduate departments in the country. Another is a career requiring persons highly skilled in designing, analyzing, implementing, and maintaining hardware and software systems. Typical employers for such people include computer hardware and software manufacturers (Digital Equipment Corporation, Intel, Microsoft, Apple, IBM, Xerox, Boeing, Bell Communications Research, Tektronix, U.S. West, Weyerhaeuser, and Hewlett-Packard, to name a few), companies relying heavily on the development of computerized systems (e.g., Tektronix, Weyerhaeuser, John Fluke, Bell Northern Research, Boeing, and LucasFilms), and myriad other companies that are involved with computer consulting or that own substantial computing facilities. In short, the student is prepared for jobs requiring a thorough understanding of both computing and electronics.

1.2 Computing and Laboratory Facilities

The focus of our program is to teach concepts and principles that go beyond any individual class of hardware devices or computers. However, we also realize that providing our students with state-of-the-art equipment is an essential part of the curriculum, as well as being motivational and fun. We currently have a variety of equipment available for use in undergraduate classes. The primary lab for instructional computing contains approximately four dozen X-terminals, backed by two DECstation 5000s (RISC-based systems) running Unix. The X-terminals include Tektronix grayscale and color terminals and VAXstations 2000 workstations configured to operate as monochrome X-terminals. To support our hardware courses, the department operates a design laboratory consisting of 16 Macintosh IIs and Tektronix logic analyzers and other test equipment. Students working on senior and honors projects may have access to more advanced equipment in the department, including parallel processors, VLSI design tools, and graphics and image processing equipment. All Computer Engineering students have access to campus, national and international networks.

1.3 Relation between the Computer Engineering and Computer Science Degrees

This handbook contains information about the undergraduate program in Computer Engineering, offered through the College of Engineering. The department also offers an undergraduate program in Computer Science (CS), through the College of Arts and Sciences. Both programs lead to a Bachelor of Science degree. For detailed information on the CS degree, please refer to the handbook entitled "Computer Science Handbook for Undergraduates."

Computer Engineering and Computer Science are closely related. Many of the Department's junior-level courses are required of both CompE and CS majors, and many of the senior courses are taken by students in both majors. However, there are a number of differences between the two degree programs. The key differences are as follows:

1. CompE students must satisfy the College of Engineering distribution requirements; CS students must satisfy the College of Arts and Sciences distribution requirements. There is a total of 192 credits required for the CompE degree, and 180 for the CS degree.
2. CompE requires substantially more courses in computer hardware and electrical engineering than CS (25 additional credits).
3. CS requires more theory than CompE (3 additional required credits, and up to 6 additional credits in the "outer core" of the CS curriculum).
4. Both degrees require a certain number of credits of senior elective courses in the major or a closely related field (21 credits for CompE; 9 for CS). The list of CompE required and elective courses includes all the electives on the CS elective list, plus any 400-level majors course in Electrical Engineering (EE). Given the larger number of such elective credits, and the addition of all senior-level EE courses to the approved list, CompE majors can take a substantial number of EE courses as part of their degree.

The CompE major is more appropriate for students interested in building systems that include both custom hardware and software components, who have strong interests in EE, or who specifically want an Engineering degree. The CS major is more appropriate for students who want to have a double major with another Arts and Sciences program (for example, Mathematics or Economics), who want the additional flexibility of the CS requirements (the CompE major has more required courses and fewer electives), or who want more theory of computation.

Both CompE and CS graduates have had excellent success in finding positions after graduation. Many positions are equally suitable for graduates with either degree. A CompE degree would be an advantage for a position involving designing and building systems with a combination of software and custom hardware. Also, some larger, engineering-oriented manufacturing companies favor CompE over CS degrees. A CS degree would be an advantage for a position needing the knowledge of a double major with another Arts and Sciences area (for example, CS and Economics, or CS and Mathematics), or additional liberal arts background. For graduate study in Computer Science, or in Computer Science and Engineering, either degree is suitable—the quality of the applicant would be the determining factor for admission.
Due to the large overlap, a double major of Computer Engineering with Computer Science is not allowed. Admissions for CompE and CS are handled separately. Both are competitive, with more qualified applicants than spaces available.

1.4 Further Information and Advice

Handouts concerning the undergraduate programs are available in the Computer Science and Engineering main office, 114 Sieg Hall. The Department also holds monthly orientation meetings for prospective Computer Engineering applicants. Further information about these meetings, including a time schedule, can be obtained from the receptionist in the main office. In addition, the receptionist can make an appointment for you to see the Computer Engineering Undergraduate Staff Advisor, whose office is also in 114 Sieg, and who is responsible for day-to-day advice and information pertinent to curriculum. The Undergraduate Staff Advisor may also refer you to the Undergraduate Faculty Advisor, a faculty member in the Department who is responsible for the overall direction of the undergraduate program.

2 Admissions Procedures

The Department can enroll only a limited number of undergraduate students in the Computer Engineering program due to limited faculty, staff, laboratories, space, and budget. To ensure that all who apply will be evaluated equitably, applicants must follow the procedures and requirements set forth below. Prospective students should also understand the Satisfactory Progress Policy (Section 3.2), which permits the Department to serve the greatest number of students with its limited resources.

2.1 Prerequisites for Application

The minimum requirements to apply for admission are as follows:

1. Transfer students must have applied to and be regularly admissible to the University. Students currently enrolled must be in good standing.

2. The student must have completed at least 64 credits applicable to the degree with a grade point average (GPA) of at least 2.5 (on a possible 4.0).

3. The student must have successfully completed the following courses or their equivalents:
   (a) Mathematics 124, 125, 126, and 307
   (b) Physics 121, 122, 123, 131, 132, and 133
   (c) Chemistry 140 and 141
   (d) CSE/Engineering 142

   (e) 5 credits of composition selected from English 111, 121, 131, 197, 198, 199, or Comparative Literature 240

CSE 210 may be substituted for ENGR 142. (CSE 210 is no longer offered, but some students may have taken it in previous years.)

The student’s GPA in these courses must be at least 2.5. Computations of GPA for admission purposes include all repeats.

Applicants who have satisfied these minimum requirements are qualified to apply for admission, and are assured that their applications will be given thorough consideration by the Admissions Committee. Unfortunately, due to its limited facilities, the Department cannot offer admission to all applicants who meet these minimum qualifications. Applications by students who have not satisfied the minimum requirements will not be considered.

2.2 Application Information

New students are accepted twice a year, for Autumn and Spring Quarters. The deadlines for applications are July 1 for Autumn admissions and February 1 for Spring admissions.

Students must submit to the Department of Computer Science and Engineering photocopies of their transcripts for all college-level work. These transcripts are in addition to those submitted to the University Admissions Office. Transcripts for the most recent quarter (Spring for Autumn admissions and Autumn for Spring admissions) must be included.

1. Students enrolled at the University of Washington must submit a College of Engineering Application for Departmental Admission which may be obtained from the department’s main office.

2. Students formerly majoring in Computer Engineering at the University of Washington should consult with the Undergraduate Staff Advisor.

3. Transfer students must be admitted to the University of Washington through the Office of Undergraduate Admissions, 320 Schmitz Hall. They should indicate their interest in Computer Engineering on their UW application and submit the application to the University Admissions Office early enough to meet both University and Department deadlines. The Admissions office recommends you allow at least four weeks. It is your responsibility to verify that your application has been received in the Department before the deadline. Any questions regarding these deadlines may be directed to the Undergraduate Staff Advisor. Transfer students should also submit the College of Engineering Application form which may be obtained from the department’s main office.

2.3 Selection Process

The Admissions Committee evaluates the qualifications of applicants exclusively on the basis of written material submitted by each applicant. Because of the large number of applications, it is
not possible to include personal interviews in the selection process. Students are encouraged to consult the Undergraduate Staff Advisor prior to filing their applications. (See Section 1.4.)

Admission to any of the College of Engineering’s undergraduate degree programs is competitive, and is based on an assessment of each applicant’s chances for success in engineering as indicated by academic performance, work experience, and other factors. To promote diversity in its student body and in recognition of the under-representation of certain minority groups in the field of engineering, the College may consider racial, ethnic or economically disadvantaged backgrounds as additional positive factors in determining admission for those applicants who meet minimum program entrance requirements.

In conformity with a standing policy of the University, the Department provides equal opportunity in education without regard to race, color, national origin, sex, age or handicap in accordance with Title VI of the Civil Rights Act of 1964, Title IX of the Education Amendments, Section 504 of the Rehabilitation Act of 1973, and the Age discrimination Act of 1975.

Applicants will be notified of their admissions status directly by the Department.

2.4 Appeals Procedure

If a student is denied admission to the program, he or she may wish to consult with the Undergraduate Staff Advisor for additional information and guidance. Such a student may request a review of the Admissions Committee decision by writing a letter to the Computer Engineering Undergraduate Staff Advisor, citing the reasons for his or her appeal. This letter must be submitted within two weeks after notification of denial is mailed. The only legitimate basis for an appeal is that there was an error in the data considered by the Admissions Committee. Incomplete or inaccurate records submitted by the applicant will not be considered as a basis for an appeal.

3 Information for Majors

3.1 Computer Engineering Curriculum

The CompE curriculum requires the successful completion of at least 102 credit hours of course work, as described in the following tables. Regardless of the number of courses taken at another institution, a minimum of 45 credits in the Required and Elective Computer Engineering courses listed below must be taken at the University of Washington.

<table>
<thead>
<tr>
<th>Category</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>CompE Required</td>
<td>55</td>
</tr>
<tr>
<td>CSE 140 (5)</td>
<td>Computer Programming II</td>
</tr>
<tr>
<td>CSE 321 (4)</td>
<td>Discrete Structures</td>
</tr>
<tr>
<td>CSE 326 (4)</td>
<td>Data Structures</td>
</tr>
<tr>
<td>CSE 341 (5)</td>
<td>Languages</td>
</tr>
<tr>
<td>CSE 375 (4)</td>
<td>Intro to Digital Design</td>
</tr>
<tr>
<td>CSE 451 (4)</td>
<td>Intro to Operating Systems</td>
</tr>
<tr>
<td>CSE 471 (4)</td>
<td>Computer Design and Organization</td>
</tr>
<tr>
<td>CSE 477 (5)</td>
<td>Digital System Design</td>
</tr>
<tr>
<td>EE 243 (5)</td>
<td>Circuit Theory</td>
</tr>
<tr>
<td>EE 301 (5)</td>
<td>Circuits &amp; Devices I</td>
</tr>
<tr>
<td>EE 332 (5)</td>
<td>Circuits and Devices II</td>
</tr>
</tbody>
</table>

CompE Electives: 21

See the CompE elective list in Section 3.1.2.

Engineering Fundamentals: 24

Required:

- ENGR 142 (4) Computer Programming I
- ENGR 215 (4) Fundamentals for Electrical Engineering

Plus 16 credits from the following list:

- ENGR 123 (4) Graphics and Computer Aided Design
- ENGR 170 (4) Fundamentals of Materials Science
- ENGR 210 (4) Engineering Statics
- ENGR 220 (4) Introduction to Mechanics of Materials
- ENGR 230 (4) Kinematics and Dynamics
- ENGR 235 (4) Linear System Analysis
- ENGR 241 (4) Numerical Methods in Engineering
- ENGR 250 (4) Fundamentals of Engineering Economy
- ENGR 260 (4) Thermodynamics
- ENGR 275 (4) Fundamentals of Computer Organization & Operation
- ENGR 290 (4) Introduction to System Engineering
- ENGR 290 (4) Electronics and Instrumentation

Science and Mathematics: 50

Mathematics: 25

- MATH 124 (5) Calculus I
- MATH 125 (5) Calculus II
- MATH 126 (5) Calculus III
- MATH 307 (3) Linear Analysis I (ordinary differential eq)
- MATH 308 (3) Linear Analysis (linear algebra)
- STAT 390 (4) Probability and Statistics in Engineering

Physics: 15

- PHYS 121 (4) Mechanics
- PHYS 122 (4) E & M and Oscillation
- PHYS 123 (4) Waves
- PHYS 131 (1) Experimental Physics I
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 132 (1)</td>
<td>Experimental Physics II</td>
</tr>
<tr>
<td>PHYS 133 (1)</td>
<td>Experimental Physics III</td>
</tr>
<tr>
<td>Chemistry: 10</td>
<td></td>
</tr>
<tr>
<td>CHEM 140 (4)</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>CHEM 150 (4)</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>CHEM 141 (1)</td>
<td>General Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 151 (1)</td>
<td>General Chemistry Laboratory</td>
</tr>
</tbody>
</table>

**Humanities and Social Sciences:** 30

**Written and Oral Communications:** 12

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 231 (3)</td>
<td>Introduction to Technical Writing</td>
</tr>
<tr>
<td>ENGR 333 (4)</td>
<td>Adv Tech Writing &amp; Oral Presentation</td>
</tr>
</tbody>
</table>

Total 192

The "basic writing course" is also required for admission to the Department; see Section 2.1 for the list of acceptable courses. CSE 210 may be substituted for CSE/ENGR 142, and CSE 211 may be substituted for CSE 143 for any requirement or prerequisite. (CSE 210 and 211 are no longer offered, but some students may have taken these courses in previous years.)

### 3.1.1 Other Requirements

In order to be awarded a CompE degree, a student must accumulate 50 credits of Math and Basic Sciences, 50 credits of Engineering Science, and 26 credits of Engineering Design, in addition to completing all the required courses listed above. Each engineering course has been evaluated for its Engineering Science and Engineering Design content. The Engineering Science and Engineering Design credits awarded to each course changes from time to time. The list of current credit assignments can be obtained from the Undergraduate Staff Advisor.

Courses graded S/NS may not be applied to any distribution or major requirement. Courses graded CR/NC may be applied where appropriate.

### 3.1.2 Computer Engineering Electives

Any 400 level majors course in CSE or EE may be used toward the CompE elective requirement, except CSE 410, 413, or 470, or CSE 322 and EE 478. EE 335, 381, and 383 will receive credit if the student subsequently completes the 400 level senior elective course that requires the 300 level course as a prerequisite. Not more than 5 credits of EE 499 are allowed as a CompE elective. At least 8 credits must be from the CompE electives list, as follows:

### 3.2 Satisfactory Progress

Due to limited resources and the need to maintain program quality, we are not able to accept all students who apply to study Computer Engineering. The Satisfactory Progress Policy has been developed to use the available resources effectively and to best serve our students.

Our program is designed to be pursued on a full-time basis. Students admitted to the CompE degree program should plan to engage in full time study. In addition, certain levels of academic performance are required to continue in the program. The criteria and procedures below will be used in administering the Satisfactory Progress Policy of the Department. These criteria and procedures are in addition to those of the University and the College of Engineering.
1. All students must complete 12 or more credit hours applicable toward their degree program in residence except summer quarter. Students who have not completed their English as a Second Language (ESL) requirements must enroll in and satisfactorily complete at least one ESL class each quarter starting with their first quarter in the CompE program and continue to take ESL course(s) each quarter until all ESL requirements are completed. Such students are required to complete 10 credits in non-ESL courses toward the CompE degree each quarter they are enrolled in an ESL course.

2. In exceptional circumstances students may petition to take fewer than the 12 credit minimum stated in item 1 above. Petition forms are available from the Undergraduate Staff Advisor. Petitions must be filed no later than 10 days prior to the start of the applicable quarter and must contain a plan for completing all degree requirements. Students who are given permission to take fewer than 12 credits must complete the program approved in their petition. The Department reserves the right to limit the number of students who are allowed to take fewer than 12 credits.

3. The minimum acceptable grade for any required or elective CompE course is 2.0. (A course may be repeated if necessary to meet this requirement.)

4. The student's overall grade point average must not fall below 2.0. If a course is taken more than once, all grades will be used in computing the grade point average.

5. Graduation applications must be filed in accordance with University rules and regulations so that graduation takes place once all the requirements are satisfied.

6. A student who withdraws from the University without prior written approval of the Department, or is dropped for non-payment of fees, will have forfeited his/her place in the program. Such a student must reapply for admission and, if re-admitted, must fulfill the requirements in effect at the time of re-admission.

3.3 Review Process

Each student's progress is reviewed at the conclusion of each quarter to insure compliance with the criteria set forth above. In the event that a student fails to meet the criteria for satisfactory progress, a letter will be sent to the last address on record requesting that the student contact the Undergraduate Staff Advisor within 10 days.

3.4 Probation and Dismissal

A student who fails to comply with the criteria set forth above will have his/her case reviewed for possible probationary action. In the absence of compelling extenuating circumstances such a student will be placed on probation for failing to make satisfactory progress. The probationary quarter will be the quarter in residence that immediately follows the one in which the noncompliance occurred. The student will be notified in writing of the reasons for his/her probationary status and the steps required in order to be removed from probation.

A student who fails to meet the criteria for satisfactory progress for two consecutive quarters in residence will be dismissed from the program. In addition, any student who accumulates three probationary quarters will also be dismissed from the program. Such action will be communicated in writing to the student at the last address on record and any current registrations or preregistrations in Departmental courses will be canceled.

3.5 Academic Misconduct

Academic misconduct is any form of deception by which the student claims as his or her own work that which actually belongs to another. This includes such actions as cheating on class assignments or examinations and plagiarism as well as more severe offenses, such as theft or alteration of other persons' academic materials for purposes of acquiring academic credit or enhancing grades.

All incidents of alleged academic misconduct will be reported to the Office of Academic Affairs. Unless the incident has been resolved to the satisfaction of the student and instructor involved, the Dean's Office will conduct a hearing. While the deposition of each case will be determined on the basis of its particular circumstances, the following general guidelines may be stated:

1. Any proven instance of cheating or plagiarism will at minimum result in disciplinary probation for the student(s) involved. Such probation will carry with it the possibility of dismissal if there is an additional proven act of academic misconduct on the part of the student(s).

2. If it is proven that a student has stolen or altered academic materials belonging to another student or an instructor for the purposes of achieving academic credit or enhancing a grade, the College will normally initiate proceedings to have the student dismissed from the University for at least one year and be permanently dropped as an engineering major.

In all considerations of academic misconduct, the College of Engineering will carefully follow the letter and the spirit of the University's Student Conduct Code. This code has been separately printed in pamphlet form and is available to any interested student at the College of Engineering's Office of Academic Affairs, Room 371, Loew Hall. The Student Conduct Code is made a part of this document by reference. Each student who accepts admission into the CompE degree program agrees to be bound by the provisions of this section.

3.6 Co-op

The Engineering Co-op Office in 313 Loew Hall coordinates Co-op jobs and minority student internships. This program gives students the opportunity to investigate the practice of the profession and define their own career goals, by spending one or more quarters in an engineering job while enrolled in the degree program. Students going on Co-op should notify the Undergraduate Staff Advisor and plan a tentative schedule for their returning quarter. The Co-op Office will register them for classes. The quarters they spend off campus are exceptions to the Department's Continuation Policy. The credits earned through Co-op do not apply to any degree requirements.
3.7 Graduation

In order to be awarded the CompE degree, each candidate for the degree must fulfill the appropriate Accreditation Board for Engineering and Technology requirements (Section 3.1.1), as well as the specific degree requirements set forth in this Handbook. It is the responsibility of the student to ensure that he or she meets all of these requirements. Assistance in the program planning is available from the Undergraduate Staff Advisor. Application for graduation should be made with the advisor at least one quarter prior to the quarter that a student wishes to graduate.

3.8 Center for Career Services

The University's Center for Career Services, located in 301 Loew Hall, offers extensive services for students searching for career and job opportunities. Many local, national, and international companies send recruiters to campus each year to interview students in Computer Engineering and other disciplines.

3.9 Applicability

The requirements contained in this Handbook apply to all students admitted in or after Autumn 1992 and until such time as a new Handbook is issued. Students admitted while this Handbook is current will not be subject to additional requirements that might be issued in the future, except those found necessary to comply with accreditation requirements.

Changes to policy and administrative procedures can be applied to students admitted prior to the effective date of this Handbook as long as such changes do not modify the degree requirements. In the context of this Handbook, “degree requirements” specifically means the total number of credits and the distribution of those credits required to earn the CompE degree.

4 Computer Science and Engineering Courses for Majors

The curriculum is subject to change, since it is regularly updated to reflect a rapidly changing field.

CSE 143 Computer Programming II (5)

See the listing in Section 5.

CSE 321 Discrete Structures (4)

Fundamentals of set theory, graph theory, enumeration, and algebraic structures, with applications in computing. Prerequisite: Math 126 and CSE 143.

CSE 322 Introduction to Formal Models in Computer Science (3)

Finite automata and regular expressions; context free grammars and pushdown automata; nondeterminism; Turing machines and the halting problem. Emphasis on understanding models and their applications and on rigorous use of basic techniques of analysis. Induction proofs, simulation, diagonalization and reduction arguments. Prerequisites: CSE 321.

CSE 326 Data Structures (4)

Data types, abstract data types, and data structures. Efficiency of algorithms. Sequential and linked implementation of lists. Binary tree representations and traversals. Searching; dictionaries, priority queues, hashing. Directed graphs, depth-first algorithms. Garbage collection. Dynamic storage allocation, internal and external sorting. Prerequisite: CSE 321. No credit if CSE 373, CSE 374, or CSE 374 has been taken.

CSE 341 Programming Languages (5)

Designed to make the student reasonably fluent in several radically different languages, such as Lisp, Prolog, and Smalltalk. Prerequisite: CSE 143. No credit if CSE 413 has been taken.

CSE 370 Introduction to Digital Design (4)

Introductory course in digital logic and its specification, simulation, and testing. Boolean algebra, combinational and sequential digital circuits including arithmetic circuits and programmable logic devices. Laboratory sessions, three hours per week, to design, simulate, construct, and debug circuits based on concepts presented in lectures. Prerequisite: 321 or permission of instructor.

CSE 375 Machine Organization and Assembly Language (4)

Difference and similarities in machine organization; central processors; fundamentals of machine language and addressing; assembly language programming, including macro; operating system interfaces. Prerequisite: CSE 143. No credit if CSE 410 has been taken.

CSE 401 Introduction to Compiler Construction (3)

Fundamentals of compilers and interpreters; symbol tables, lexical analysis, syntax analysis, semantic analysis, code generation, and optimization for general purpose programming languages. Prerequisites: CSE 326, CSE 341, and CSE 376. No credit if CSE 413 has been taken.

CSE 403 Software Engineering (4)

This course presents the fundamentals of software engineering using a group project as the basic vehicle. Topics covered include the software crisis, managing complexity, requirements specification, architectural and detailed design, testing and analysis, software process, and tools and environments. Prerequisites: CSE 321, CSE 341, CSE 375. Either CSE 401 or CSE 453 is recommended.

CSE 421 Introduction to Algorithms (3)

Techniques for design of efficient algorithms. Methods for showing lower bounds on computational complexity. Particular algorithms for sorting, searching, set manipulation, arithmetic, graph problems, pattern-matching, etc. Prerequisites: CSE 322 and CSE 320.

CSE 431 Introduction to Theory of Computation (3)

Models of computation, computable and non-computable functions, space and time complexity, tractable and intractable functions. Prerequisite: CSE 322.

CSE 440 Computer Based Simulation (3)

Computer based simulation is a valuable tool with wide varying application. In this course, Monte Carlo, continuous time, and discrete event simulations are presented. The design of appropriate simulation experiments and the interpretation of their results is considered. Students will implement simulations using Pascal, DYNAMO, and GPSS. Prerequisite: CSE 326. Some familiarity with probability and/or statistics may be helpful.

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CSE 444 Introduction to Database Systems (3)
Fundamental concepts, system organization and implementation of database systems will be covered. Topics include the relational, hierarchical and network data models, file organizations and data structures, query languages, query optimization, database design, concurrency control, security, and issues involving distributed database systems. Prerequisite: CSE 326.

CSE 451 Introduction to Operating Systems (4)
Principles of operating systems. Process management, memory management, auxiliary storage management, resource allocation. Prerequisites: CSE 326 and CSE 378. No credit if CSE 410 or EE 474 has been taken.

CSE 467 Computer Graphics (3)
Techniques of computer image synthesis, including both hardware and software. Line drawing and color raster graphics; geometric transformations, hidden surface and smooth shading algorithms. Prerequisite: CSE 326.

CSE 461 Introduction to Computer-Communication Networks (3)
Computer network architectures, protocol layers. Transmission media, encoding systems, error detection, multiplexing, switching. Data link, multiple access channel protocols. Methods for network routing, congestion control, flow control, end-to-end transport services, protocols. Network security, privacy, applications including electronic mail, virtual terminals, distributed operating systems. Prerequisite: Senior standing. Joint with EE 461.

CSE 470 Computer Design (4)
Fundamental circuitry is developed into large logic gate structures. The use of these structures in the design of central processing units, memories, and peripheral equipment is illustrated. Prerequisite: CSE 378.

CSE 471 Computer Design and Organization (4)
CPU instruction addressing models, CPU structure and functions, computer arithmetic and logic units, register transfer level design, hardware and microprogram control, memory hierarchy design and organization, I/O and system components interconnection. Laboratory project involving design and simulation of an instruction set processor. Prerequisite: CSE 370 and CSE 378.

CSE/Ling 472 Introduction to Computational Linguistics (3)
Introduction to computer applications of linguistic theory, including syntactic processing, semantic, and pragmatic interpretation and natural language generation. Prerequisite: Ling 471, or permission of Instructor.

CSE 473 Introduction to Artificial Intelligence (3)
Principal ideas and developments in artificial intelligence: theorem proving, problem-solving methods; representation of knowledge, natural language analysis and synthesis, programming languages for artificial intelligence. Prerequisites: CSE 326, CSE 344 recommended.

CSE 477 Digital System Design (5)
Students use the laboratory to design, simulate, construct, and debug a substantial project of their choosing. Lectures focus on issues in composing large digital systems ranging from memory subsystems and interface logic to communication protocols and controllers. Prerequisite: CSE 370 and assembly language programming.

CSE 490 Special Topics in Computer Science & Engineering (3)
Lectures and discussions on topics of current interest in computer science and engineering not covered by other CSE undergraduate courses.

CSE 498, 499 Summer Project (1-6) Honors (3)
Consists of a report (and perhaps demonstration) describing a development, survey, or small research project completed by the student in an area of specialization. Objectives are: (1) applying and integrating the classroom material from several courses, (2) introducing the professional literature, (3) gaining experience in writing a technical document, and (4) enhancing employability through the evidence of independent work. The project may cover an area in computer science and engineering or an application to another field. The work normally extends over more than one quarter. Prerequisite: Senior standing and permission of instructor.

CSE 499 Reading and Research (1-24)
Available in special situations for advanced Computer Engineering majors to do reading and research in the field. Subject to approval of the undergraduate advisor and a Computer Science and Engineering faculty member. Usable as a free elective, but not in place of a core course or Computer Engineering elective. Prerequisite: Senior standing and permission of Instructor. Credit/no credit.

CSE 211 (which is no longer offered) may be used in place of CSE 143 as a prerequisite for any course.

The Department of Computer Science and Engineering offers a wide range of advanced, graduate level courses. Computer Engineering undergraduate majors may petition for entry to these courses, which are listed in the Computer Science Graduate Handbook and the University General Catalog.

5 Computer Science and Engineering Courses for Pre-majors and Non-majors

CSE/ENGR 142 Computer Programming I (4)
Computer programming in a high-level language. Emphasizes algorithms (variables, expressions, statements); abstraction (data types, subroutines, packages, generics); analysis (correctness, efficiency, numerics). Program design and analysis: specification, coding, documentation, testing, debugging, evaluation. Mostly in Ada, including FORTRAN, using software tools.

CSE 143 Computer Programming II (5)
Continuation of CSE/ENGR 142. New topics include analyzing algorithms; using/writing standard software components (queues, stacks, and tables) implemented by private types, generic packages, and dynamic data structures (lists and trees); recursive data-and-control structures. The last 2 weeks survey topics in computer science. Prerequisite: CSE/ENGR 142.

CSE 373 Data Structures and Algorithms (3)
Fundamental algorithms and data structures for their implementation. Techniques for solving problems by programming. Linked lists, stacks, queues, directed graphs. Trees: representations and traversals. Searching (hashing, binary search trees, multiway trees). Garbage collection, memory management. Internal and external sorting. Prerequisite: CSE 134. No credit if CSE 326, CSE
CSE 374 Data Structures for Engineers (3)
Fundamental algorithms, and data structures for their implementation. Techniques for solving problems by programming. Sorting, searching, linked lists, binary search trees, balanced trees, hashing. Prerequisite: CSE/ENGR 142 or equivalent knowledge of programming. For EE majors only.

CSE 410 Computer Systems (3)
Structure and components of hardware and software systems. Machine organization, including central processor and input-output architectures; assembly language programming; operating systems, including process, storage, and file management. Prerequisite: CSE 373. No credit if CSE 378 or CSE 451 has been taken.

CSE 413 Programming Languages and Their Implementation (3)
Concepts and implementation strategies for Algol-class languages, including Pascal, Modula, Algol 60, Ada. Compilers for Algol-class languages. Languages with late binding times, including Lisp, APL, Smalltalk. Prerequisite CSE 373. No credit if CSE 341 or CSE 401 has been taken.

CSE 415 Introduction to Artificial Intelligence (5)
Principles and programming techniques of artificial intelligence: LISP, symbol manipulation knowledge representation, logical and probabilistic reasoning, learning, language understanding, vision, expert systems, and social issues. Prerequisites: CSE 373, or CSE 143 and permission of instructor. No credit if CSE 473 has been taken.

CSE 211 (which is no longer offered) may be used in place of CSE 143 as a prerequisite. CSE 210 may be used in place of CSE 142.

6 Computer Science and Engineering Faculty


Jean-Loup Baer, Professor and Chair, Adjunct Professor of Electrical Engineering (1969). Diplômes d’Ingenieur, 1969, Doctorat 3e Cycle, 1963, Grenoble; Ph.D., 1968, UCLA. Parallel processing, system architecture.


Theodore H. Kehl, Professor, Professor of Physiology and Biophysics, DE/CW Professor of Computer Design (1961). B.S., 1956, M.S. 1958, Ph.D., 1961, Wisconsin. Real-time hardware and software systems, computer design, VLSI.


ing programming through formal and heuristic methods, debugging.


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### A CompE Prerequisite Course Descriptions

**CHEM 140 General Chemistry (4)**

For science and engineering majors. Atomic nature of matter, nuclear chemistry, stoichiometry, periodic table, quantum concepts, gas laws.

**CHEM 141 General Chemistry Laboratory (1)**

Introduction to laboratory work, including experiments to illustrate analytic techniques, stoichiometry, and gas laws. Designed to complement CHEM 140.

**ENGR 142 Computer Programming I (4)**

See Section 5.

**English Composition (5)**

Any English composition course that focuses on the study and practice of good writing; the course content should cover expository writing based on materials derived from a variety of sources such as poetry, literature and humanities to topics of personal and academic nature or to topics of social science and natural science; course content can also include the study and practice of good writing as it pertains to the study of library resources, the analysis of reading materials, and writing preparatory papers as basic to writing a reference or research paper.

**MATH 124 Calculus with Analytic Geometry I (5)**

Differentiation, applications of derivative, integration. Calculus for natural sciences and engineering students.

**MATH 125 Calculus with Analytic Geometry II (5)**

Applications of integration, transcendental functions, methods of integration and improper integrals, introduction to first order ordinary differential equations.

**MATH 126 Calculus with Analytic Geometry III (5)**

Vectors and vector functions in space, functions of several variables and applications, multiple integrals.

**MATH 307 Introduction to Differential Equations (3)**

Taylor series, first and second order ordinary differential equations.

**PHYS 121 Mechanics (4)**

Basic principles of mechanics.

**PHYS 122 Electromagnetism and Oscillatory Motion (4)**

Basic principles of electromagnetism, the mechanics of oscillatory motion.

**PHYS 123 Waves (4)**

Electromagnetic waves, optics, and waves in matter.

**PHYS 131,132,133 Experimental Physics (1,1,1)**

Experimental topics in physics for science and engineering majors.