

The Johns Hopkins University
Department of Electrical and Computer Engineering
Computer Engineering Program
Undergraduate Advising Manual for 2007-2008 (02/05/2008)

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1. Introduction

The Department of Electrical and Computer Engineering offers two bachelors degree programs: one in Electrical Engineering and one in Computer Engineering (with the close collaboration of the Computer Science Department). Computer Engineering is concerned with the design and application of analog and digital devices and systems, including computer systems. Topics in our program range from the design of integrated circuits to computer communications and networks and involve specific courses offered by the Department of Electrical and Computer Engineering and the Department of Computer Science. Under the guidance of his or her faculty advisor, each student may select electives in any of the areas of computer engineering according to their interests, talents, backgrounds, and goals to fulfill degree requirements. Students are strongly encouraged to participate in independent research and guided studies with a faculty member at least once during their undergraduate studies and to participate in a summer internship in an industrial setting to broaden their understanding of computer engineering as a field.

The facilities and resources available to students are considerable. Computing facilities include a departmental CAD laboratory and numerous workstations in addition to the Homewood Information Technology Services (Hopkins ITS) machines. Undergraduates may obtain accounts (called entitlement accounts) on any of the Hopkins ITS computers. Additional information is available from the Krieger Hall computing facility. Accounts on the departmental machines are usually established through ECE faculty members when usage is needed for courses or independent study. Students who need to use a computer for an ECE course may use the computers in Barton 120A with the instructor's permission.

2. Degree Requirements for the Bachelor of Science in Computer Engineering

2.1. ABET Criteria

The BS degree in Computer Engineering is accredited by the Accreditation Board for Engineering and Technology (ABET). As part of the ABET requirements, the Computer Engineering Program has established the following:

2.1.1. Mission Statement. The computer engineering program at Johns Hopkins is supported by faculty in the Department of Electrical and Computer Engineering and the Department of Computer Science, who are committed to providing a rigorous educational experience that prepares students for further study and to professionally and ethically practice engineering in a competitive global environment. The mission of the program is to provide students with a broad, integrated education in the fundamentals and advanced topics in computer engineering, basic sciences, mathematics, and humanities in an environment that fosters the development of analytical, computational, and experimental skills, and that involves students in design projects and research experiences, and to provide our computer engineering graduates with the tools, skills and competencies necessary to understand and apply today's technologies and become leaders in developing and deploying tomorrow's technologies.

From this mission statement, the Computer Engineering faculty has determined educational outcomes and objectives for the BS in Computer Engineering degree program.

2.1.2. Program Outcomes. Students graduating with a B.S. in Computer Engineering will have demonstrated the ability to

1. Understand advanced and discrete mathematics, probability and statistics, basic science, and computer science, and apply this knowledge to computer engineering disciplines,
2. Design, conduct, evaluate and report experiments, including analysis and statistical interpretation of data,
3. Identify, formulate and solve computer engineering problems,
4. Use basic concepts and modern engineering tools (laboratory instrumentation and computer hardware and software) to design computer engineering systems, components and processes to meet specifications, taking into account cost, safety, environmental and socio-political constraints,
5. Communicate effectively and work on multidisciplinary teams,
6. Be aware of professional and ethical responsibilities, and contemporary issues, and appreciate the societal, economic, and environmental impacts of engineering,
7. Enter professional practice or graduate school with the recognition of the need for life-long learning and the ability to pursue it.

2.1.3. Program Objectives. Educate students who, after graduation, will be successful engineers in industry, government laboratories and other organizations, or advanced students in the best graduate programs. In these endeavors, they will:

1. Apply their understanding of the fundamental scientific, engineering, and professional principles at the foundation of Computer Engineering,
2. Apply advanced mathematical, computational and experimental techniques to respond to technological demands in an economical and efficient manner,
3. Contribute to society as broadly educated, articulate, and ethical citizens who are at ease in multidisciplinary teams, and
4. Strive to continually update and renew their knowledge throughout their careers in order to meet the needs of a rapidly changing world.

Faculty members will assess student performance to ensure that our educational outcomes and objectives are met. Students will also have an opportunity to provide feedback on their educational experience, through course evaluations as well as by

meeting with internal (Academic Council) and external review boards (departmental advisory board, ABET review board). Before and after graduation, students will have the opportunity to assess their own educational progress and achievements by means of an exit interview and alumni surveys. The faculty will use the feedback obtained from these various assessment processes to improve the content and delivery of the program.

2.2. Faculty Advising

The success of each student's program will depend on effective faculty advising. Every undergraduate student in the Computer Engineering Program must follow a program approved by a faculty advisor. Each student and faculty advisor must consider our objectives and outcomes in planning a set of courses and projects that will satisfy degree requirements. The sample programs and the program checklist used by the faculty advisors illustrate course selections that will help students meet the program objectives and outcomes.

The faculty advisor must be a member of the program committee that supervises the Computer Engineering Program. The current faculty members in the Program Committee are:

Department of Electrical and Computer Engineering

Andreas G. Andreou, Professor and Director
Brint Cooper, Associate Research Professor
Frederick M. Davidson, Professor
Ralph R. Etienne-Cummings, Associate Professor
Robert Glaser, Lecturer Part Time
Frederic Jelinek, Professor
Robert Jenkins, Senior Lecturer Part Time
Sanjeev Khudanpur, Assistant Professor
Gerard G.L. Meyer, Professor
Louis Podrazik, Lecturer Part Time
Philippe Pouliquen, Lecturer Part Time

Department of Computer Science

Yair Amir, Professor
Randall Burns, Assistant Professor
Gregory D. Hager, Professor
Gerald M. Masson, Professor
Scott Smith, Professor
Andreas Terzis, Assistant Professor

Department of Mechanical Engineering

Gregory S. Chirikjian, Professor

A student may change faculty advisors. The Director of the Computer Engineering Program, Dr. Andreou, makes initial assignments, and the Undergraduate Advising Coordinator, Dr. Fred Davidson, arranges all changes.

The faculty advisor assists the student in developing an approved program, including assignment of credits to the proper categories and judging the appropriateness of area designators. However, it should be understood that satisfaction of degree requirements is ultimately the responsibility of the student. The student is expected to understand the degree requirements and engage in careful program planning with the faculty advisor. Students should also be familiar with requirements outlined in the University's Undergraduate Academic Manual. It is important that students remain in close contact with their advisors and consult with them before making changes in their program. The faculty advisor's signature is required for all registration and add/drop forms. Note that, unless prior arrangements have been made, no faculty member other than the student's own advisor can sign the required forms.

Faculty advisors may also help with other aspects of the student's academic career, such as admission to graduate and professional schools or career planning. They may be able to direct students to other advising and counseling resources provide information on internship opportunities, and direct students to independent research and guided independent studies. Faculty advisors are also a means for undergraduate students to provide valuable feedback on all aspects of their educational experiences to improve the undergraduate education for all students.

2.3. Bachelor of Science in Computer Engineering Degree

The Bachelor of Science degree in Computer Engineering requires a minimum of 126 credits, which must include the following:

1. Forty-two (42) credits in Computer Engineering, which must include:
 - A. Fifteen (15) credits of Electrical and Computer Engineering courses, which must include Digital System Fundamentals (520.142), and Circuits (520.213).
 - B. Fifteen (15) credits of Computer Science courses which must include Intermediate Programming in C/C++ (600.120), Data Structure (600.226) and Computer System Fundamentals (600.333).
 - C. The program must also contain a substantial advanced laboratory and design experience component, appropriate for the student's interests. This requirement can be met by taking twelve (12) credits of advanced laboratory, design intensive, or senior design project courses from those given in the attached advising

checklist. At least six (6) of these twelve credits must be from ECE or CS courses.

A GPA of at least 2.0 must be maintained in Computer Engineering courses. Courses in this category may not be taken Pass/Fail.

2. Six (6) credits of engineering courses from School of Engineering departments other than Computer Science, ECE, Applied Mathematics and Statistics, or General Engineering. Students must complete enough of the approved non-CS/ECE advanced design labs so that they have at least twelve (12) credits of advanced laboratory, design intensive, or senior design project courses. Courses in this group may not be taken Pass/Fail.

3. Twenty-four (24) credits in mathematics courses taken from the Mathematics Department or the Applied Mathematics and Statistics Department. Calculus II (110.109), Calculus III (110.202), Linear Algebra (110.201) or Linear Algebra and Differential Equations (550.291), Discrete Mathematics (550.171), Probability and Statistics (550.310/311) or Introduction to Probability (550.420) must be taken. Elementary or precalculus courses such as 110.105 or 550.111-112 are not acceptable. (Calculus I may be waived through an examination taken during freshman orientation. If not waived, it must be taken as a prerequisite to Calculus II.) Courses in this category may not be taken Pass/Fail.

4. Sixteen (16) credits of basic sciences (physics, chemistry, biology, earth and planetary sciences), which must include General Physics (171.101-102), General Physics Laboratory (173.111-112), and Introductory Chemistry (030.101). Courses in this category may not be taken Pass/Fail.

5. At least six (6), three-credit courses in humanities and social sciences. The humanities and social sciences courses are one of the strengths of the academic programs at Johns Hopkins. They represent opportunities for students to appreciate some of the global and societal impacts of engineering, to understand contemporary issues, and to exchange ideas with scholars in other fields. Some of the courses will help students to communicate more effectively, to understand economic issues, or to analyze problems in an increasingly international world. The selection of courses should not consist solely of introductory courses but should have both depth and breadth. Typically, this means that students should take at least three (3) courses in a specific area with at least one of them at an advanced level.

6. At least two (2) writing intensive (W) courses are required (at least 3 credits each). These courses may not be taken Pass/Fail and require a grade of C- or better. Students may wish to consider a course in Technical Communications to fulfill one of the W requirements.

This program fulfills the general distribution requirements of the University. The remaining credits are electives to be selected by the student in consultation with and approval by the faculty advisor. It should be noted that there is a University rule stating

that no more than eighteen (18) D or D+ credits can be counted towards the total credit requirements for a degree.

2.4. Bachelor of Arts Degree

To meet the requirements for the BA degree, the program must include:

1. Thirty (30) credits of ECE courses. Three credits of computer science courses may be counted towards this requirement.
2. Twenty (20) credits of mathematics or mathematical statistics courses. Typically these include Calculus I (110.108), Calculus II (110.109) and Calculus III (110.202), or equivalent, and Linear Algebra (110.201). Elementary or pre-calculus courses such as 110.105 or 550.111-112 are not acceptable.
3. Eighteen (18) credits of humanities and social sciences courses.
4. Four (4) writing intensive (W) courses.
5. Additional credits giving a total of at least one hundred twenty (120) credits.

Students should be aware that the BA degree program is not accredited by the Accreditation Board for Engineering and Technology (ABET).

2.5. Combined Degree Options

It is possible that, by completing more than 126 credit hours in their program of study, students may be able to satisfy the requirements of other degree programs offered by the University. These include the BA and BS degree programs offered in the Department of Electrical and Computer Engineering and the Department of Computer Science. Qualified students may also be eligible for admission to concurrent BS/MSE degree programs offered by both departments that will result in an MSE degree in either Electrical Engineering or Computer Science. Students are urged to consult with their advisors regarding these opportunities.

2.6. Bachelor of Science/Master of Science in Engineering Degree

1. Eight (8), one-semester graduate (400-799 level) courses approved by the advisor must be satisfactorily completed. These eight (8) courses cannot include Independent Study, Dissertation Research or Special Studies.
2. Further depth of understanding must be demonstrated by satisfactorily completing two (2) additional one-semester courses approved by the advisor, or by writing an MSE essay acceptable to a member of the ECE faculty, or by a special project acceptable to a member of the ECE faculty.

3. A course (including independent study) is satisfactorily completed if a grade of A, B, C, or P is obtained. No more than one C grade can be counted toward the requirements and a D or F or second C grade results in probation. A second D or F or a third C grade results in termination from the program.

4. At least six (6) one-semester courses in the MSE program must be ECE Department day-school courses that are not independent study, and no more than two (2) one-semester courses in the program can be from outside Johns Hopkins' full-time programs.

5. Every graduate course designated Independent Study, Dissertation Research, or Special Studies counted toward the MSE degree must include a written report. A copy of the report will become part of the student's permanent file.

The MSE portion of the program is to be designed in consultation with the MSE advisor, often the same faculty member as the undergraduate advisor. Students interested in the concurrent program should consider the advantages or disadvantages of such a program, particularly the financial aspects. For example, a qualified student interested in the PhD degree can often obtain full financial support for the MSE and PhD at Johns Hopkins or elsewhere.

The Electrical and Computer Engineering Department and the Computer Science Department offer a joint BS/MSE program in which candidates may seek a concurrent BS degree in ECE and an MSE degree in Computer Science. Applicants should apply directly to the Computer Science Department for admission to the MSE program. Students in this program will have two (2) advisors: one for the undergraduate degree program and one for the graduate degree program.

2.7. Short Courses

The purpose of short courses is to expose students to topics of current interest in the fields of computer science, electrical engineering, and computer engineering. Short courses are taught not only by faculty in the Department of Computer Science, Department of Electrical and Computer Engineering and Visiting Faculty from other universities, but also by individuals from local government organizations or industry who have demonstrable expertise in a given topic area and who are practicing the application of computer science/engineering theory and concepts.

Students should be aware that the availability of short courses might change from academic year to academic year depending on the commitments such individuals can make at any given time. It is therefore advisable for a student to seriously consider taking an offered short course when it is available if the topic looks interesting, as it cannot be guaranteed that the same course will be available in subsequent academic years. Students interested in getting more details about an offered short course can be put in contact with the instructor through the specified departmental office. Students should be aware that no more than 3 credits of short courses can be applied to the Computer

Engineering Degree. This limit does not apply to short course credits that are used to satisfy requirements in other areas of study.

3. Advanced Standing

Advanced standing credit is granted in two cases: for acceptable college-level work completed in a college setting, and for credits earned through the Advanced Placement Program. College courses taken in a high school setting, by correspondence or through the College Level Examination Program (CLEP), are not accepted for advanced standing credit. No more than twelve (12) credits from other institutions may be applied toward a Johns Hopkins degree for students entering from high school. Under current freshman grading procedures, first-semester courses satisfactorily completed at Johns Hopkins are listed on the permanent academic record without grades. However, a freshman who enters with 14 to 23 credits of advanced standing may receive advanced standing at the end of the first semester. All first semester grades are then entered on the permanent academic record.

A student who enters with 24 or more credits of advanced standing from Advanced Placement examinations and acceptable college-level courses completed before matriculation at Johns Hopkins is granted sophomore standing upon entering. Therefore, the student's first college level courses or any advanced placement reports must be filed with the Office of Undergraduate Affairs (Engineering) no later than the beginning of the sophomore year.

4. Academic and Professional Ethics

Students at The Johns Hopkins University are expected to uphold high ethical standards. The Constitution of the Undergraduate Academic Ethics Board of the Krieger School of Arts and Sciences and the GWC Whiting School of Engineering states that:

"Undergraduate students enrolled in the School of Arts and Sciences or the GWC Whiting School of Engineering at The Johns Hopkins University assume a duty to conduct themselves in a manner appropriate to the University's mission as an institution of higher learning. Students are obliged to refrain from acts, which they know, or under the circumstances have reason to know, violate the academic integrity of the University. Violations of academic ethics include, but are not limited to: cheating, plagiarism, submitting the same or substantially similar work to satisfy the requirements of more than one course without permission; submitting as one's own the same or substantially similar work of another; knowingly furnishing false information to any agent of the University for inclusion in academic records; falsification, forgery, alteration, destruction or misuse of official University documents or seal."

The constitution further states in Article IV that "It is the responsibility of each student to report to the professor in charge of the course or to the Ethics Board any suspected violations of academic ethics as outlined in Article III." Students may obtain a copy of

the Constitution of the Ethics Board from the JHU Office of Academic Advising, Garland Hall, Suite 3A.

Students should also be aware that professional societies, industries, and government agencies all have ethical codes and standards to ensure both good business practices and to maintain the public trust. The Institute of Electrical and Engineers (IEEE) represents the profession of Electrical Engineering, and students should read that organization's code of ethics published on the web site:

<http://www4.ncsu.edu/unity/users/j/jherkert/ethics.html>

5. Professional Societies, Honor Societies, and Awards

Undergraduates are encouraged to join the student chapter of the IEEE. Applications are available in 105 Barton Hall or at any of the regular meetings of the chapter.

The department sponsors a Chapter of Eta Kappa Nu, the Electrical Engineering honor society. Students with outstanding academic records are invited to join during their junior and senior years.

Each year, the ECE Department honors its outstanding graduating seniors with the Whitehead Award for excellence in academic achievements and with the W.H. Huggins Award. The latter award is based on service to the department and to fellow students and on academic achievements. An additional W.H. Huggins Award is given to an outstanding junior.

6. General Information

6.1. WSE Office of Academic Affairs

The Office of Academic Affairs (126 New Engineering Building) has general responsibilities for all engineering majors in the Whiting School of Engineering. The Associate Dean and his staff coordinate faculty advising, maintain student records, and handle academic problems that fall outside the scope of the faculty advisor. The office also provides support for non-department student organizations such as the Society of Women Engineers and the Johns Hopkins Organization for Minority Engineers and Scientists. In addition, the office maintains and distributes undergraduate advising manuals for each of the engineering majors. Additional responsibilities include:

- Informing students regarding leaves of absence and withdrawals.
- Determining advanced standing and acceptance of coursework done at another college/university.
- Advising students on graduation eligibility.
- Informing students regarding proper procedures for taking summer school courses.
- Reporting unsatisfactory course performance to freshman.

- Placing students on academic probation, monitoring students on probation and identifying students who are required to withdraw from the University.
- Interpreting University academic policy and departmental policy.
- Providing information about internship and study abroad opportunities in engineering.
- Coordinating tutoring for students in engineering courses.
- Informing students regarding the tutoring, study skills and pre-professional counseling services of the Office of Academic Advising.

6.2. JHU Office of Academic Advising

The Office of Academic Advising (Garland hall, Suite 3A) provides the following services for engineering students:

- Coordinating the premedical, pre-law and public health advising, as well as the recommendations committees for those areas.
- Assisting students with disabilities in meeting their academic needs.
- Teaching effective study skills.
- Offering tutoring in many required courses.
- Maintaining a reference library of graduate and professional school publications.
- Providing information about national and international scholarships and fellowships, as well as summer internships.
- Providing information on study abroad.

6.3. Notice of Nondiscriminatory Policy

The Johns Hopkins University admits students of any race, color, sex, religion, national or ethnic origin, age, disability or veteran status to all of the rights, privileges, programs, benefits and activities generally accorded or made available to students at the University. It does not discriminate on the basis of race, color, sex, religion, sexual orientation, national or ethnic origin, age, disability or veteran status in any student program or activity, including the administration of its educational policies, admission policies, scholarship and loan payments, and athletic and other University-administrated programs or in employment. Accordingly, the University does not take into consideration personal factors that are irrelevant to the program involved.

Questions regarding access to programs following Title VI, Title IX, and Section 504 should be referred to Peggy Hayeslip, Director, ADA Compliance & Disability Services, who is responsible for the coordination of equal opportunity programs, 130 Garland Hall, (410) 516-8075.

6.4. Policy on the Reserve Officer Training Corps

Present Department of Defense policy governing participation in University-based ROTC programs discriminates on the basis of sexual orientation. Such discrimination is inconsistent with The Johns Hopkins University non-discrimination policy. Because ROTC is a valuable component of the University that provides an opportunity for many

students to afford a Johns Hopkins education, to train for a career and to become positive forces in military, the University, after careful study, has decided to continue the ROTC program and to encourage a change in Federal policy that brings it into conformity with the University's policy.

7. Graduation Process: B.S. in Computer Engineering

1. The student obtains

- An "Application for Graduation, Baccalaureate Candidates" form from the registrar
- An "Assessment Questionnaire for the Computer Engineering Program", and an "Advising Check-List for the Computer Engineering B.S. Degree from the ECE Departmental office or the web (www.ece.jhu.edu)

2. The student completes the forms and

- Returns the "Application for Graduation, Baccalaureate Candidates" form to the registrar in the basement of Garland Hall. Note that the form is then used by the Office of the Associate Dean for Academic Affairs to generate a list of candidates for B.S./B.A degree that is sent to Dr. Davidson, the ECE Undergraduate Advising Coordinator
- Meets with his academic advisor to have the "Advising Check-List for the Computer Engineering B.S. Degree" approved
- Returns the "Assessment Questionnaire for the Computer Engineering Program" to Dr. Davidson
- Meets with the ECE chair to discuss his experience at Hopkins

3. The academic advisor

- Receives a "CANDIDATE FOR B.S./B.A." form and transcript for each of his advisees from Dr. Davidson, the ECE Undergraduate Coordinator
- Meets with his advisees to review and approve their "Advising Check-List for the Computer Engineering B.S. Degree". If necessary the advisor fills out a "SUBSTITUTION/EXCEPTION/Waiver FORM" to justify the request of an substitution and/or exception and/or waiver of a requirement
- The academic advisor returns the "Advising Check-List for the Computer Engineering B.S. Degree", "SUBSTITUTION/EXCEPTION/Waiver FORM" if applicable, transcript, and "CANDIDATE FOR B.S./B.A." form completed and signed to Dr. Davidson

4. Notes

- The deadline to apply for spring term graduation is January 31
- Departmental Honors are only given for first majors, and only when $GPA \geq 3.5$

8. Sample Programs

The following tables show four sample programs fulfilling the Computer Engineering Degree requirements with an emphasis in Microsystems, Computer Integrated Surgery, Software, and Robotics.

All programs are subject to the following guidelines:

1. All advanced placement credits must be applied to the category of the corresponding Homewood course.
2. Transfer students from other institutions must complete at least 21 credits from the Computer Science or Electrical and Computer Engineering Department at Johns Hopkins in order to be eligible for the BS degree.
3. Courses taken through the School of Professional Studies in Business and Education (either evening or summer session) or the GWC Whiting School's Part-Time Programs in Engineering and Applied Physics may be counted only if taken with the advisor's prior, written approval.
4. Courses taken without the faculty advisor's written approval on the registration add/drop form might not be counted.

The Computer Engineering Program faculty makes every effort to be available to their advisees, particularly during the scheduled fall and spring term advising periods. Students are encouraged to arrange meetings with their advisors in these scheduled periods to discuss their course programs for the coming semester and progress towards the completion of degree requirements. Unless prior arrangements have been made, faculty members can only approve registration or add/drop forms for their own advisees.

Students can use these courses to either strengthen their backgrounds in computer engineering or to concentrate their interests.

The following is a list of eligible elective courses:

Electrical and Computer Engineering Electives

- 520.137 Introduction of Electrical and Computer Engineering
- 520.214 Signals and Systems
- 520.216 Introduction to VLSI
- 520.219 Fields, Matter, and Waves I
- 520.220 Fields, Matter, and Waves II
- 520.345 Electrical and Computer Engineering Laboratory
- 520.349 Microprocessor Laboratory
- 520.372 Programmable Device Laboratory
- 520.401 Basic Communications

520.407 Introduction to the Physics of Electronic Devices
520.414 Image Processing and Analysis I
520.415 Image Processing and Analysis II
520.419 Theory of Iterative Algorithms I
520.420 Theory of Iterative Algorithms II
520.424 FPGA Synthesis Lab
520.426 Parallel Processing Systems
520.428 Introduction to Algorithms for Parallel Computers
520.429 Principles of Parallel Programming
520.435 Digital Signal Processing
520.448 Electronics Design Laboratory
520.454 Control Systems Design
520.460 Introduction to Error Control Coding
520.465 Digital Communications
520.475 Processing and Recognition of Speech
520.490 Analog and Digital VLSI Systems and Architectures
520.491 CAD Design of Digital VLSI
520.492 Mixed Signal VLSI Systems
520.493 Analog Integrated Circuits
520.495 Microfabrication Laboratory
520.496, 497 VLSI Design and Prototyping Workshop

Computer Science Electives

600.103 Introduction to Computer Science
600.107*Introduction to Programming in Java
600.109*Introduction to Programming in C/C++
600.120 Intermediate Programming
600.145 Introduction to Computer Integrated Surgery
600.211 UNIX Systems Programming
600.226 Data Structures
600.271 Automata and Computation Theory
600.312 Agent Based Systems
600.315*Database Systems
600.316 Transaction Processing Systems
600.318*Operating Systems
600.319 Storage Systems
600.321*Object-Oriented Systems
600.324 Network Security
600.333*Computer System Fundamentals
600.334*Computer System Architecture
600.335 Artificial Intelligence
600.337*Distributed Systems
600.344*Computer Network Fundamentals
600.348 Theory of Network Communication

600.349 Internet Protocols
600.356 Rendering Techniques
600.357 Computer Graphics
600.359 Projects in Graphics and Multimedia
600.363*Introduction to Algorithms
600.371 Modern Complexity Theory
600.415*Database Systems
600.416 Distributed Database Systems
600.416 Transaction Processing Systems
600.418*Operating Systems
600.419 Storage Systems
600.421*Object-Oriented Systems
600.422 Security Informatics Fundamentals
600.424 Network Security
600.426 Programming Languages
600.427 On-line Computing
600.428 Compiler Writing
600.433*Computer Systems
600.434*Computer System Architecture
600.435 Artificial Intelligence
600.436 High Assurance Systems
600.437*Distributed Systems
600.438 Advanced Topics in OS
600.439 Computational Biology
600.441 Vision Based Interaction
600.442 Cryptography and Network Security
600.443 Security and Privacy
600.444*Computer Networks
600.445 Computer Integrated Surgery I
600.446 Computer Integrated Surgery II
600.448 Theory of Network Communication
600.449 Internet Protocols
600.452 Computer Integrated Surgery Seminar
600.456 Rendering Techniques
600.457 Computer Graphics
600.460 Virtual Worlds
600.461 Computer Vision
600.463*Introduction to Algorithms
600.464 Randomized Algorithms
600.465 Introduction to Natural Language Processing
600.466 Information Retrieval and Web Agents
600.471 Modern Complexity Theory
600.475 Machine Learning
600.484 Approximation Algorithms

Note: * Courses

Either 600.107 or 600.109 may be counted but not both
Either 600.118 or 600.121 may be counted but not both
Either 600.315 or 600.415 may be counted but not both
Either 600.318 or 600.418 may be counted but not both
Either 600.321 or 600.421 may be counted but not both
Either 600.333 or 600.433 may be counted but not both
Either 600.334 or 600.434 may be counted but not both
Either 600.337 or 600.437 may be counted but not both
Either 600.344 or 600.444 may be counted but not both
Either 600.363 or 600.463 may be counted but not both

Other CS/ECE courses may be acceptable as electives with the approval of the faculty advisor.

Examples of elective courses outside ECE, Computer Science, and Applied Mathematics and Statistics include courses in Environmental Engineering, Mechanical Engineering, Materials Science and Engineering, and Civil Engineering. These represent good opportunities for students to broaden their studies and to become aware of approaches taken by engineers in other disciplines.

Advanced Laboratory and Design Intensive Courses in Electrical Engineering and Computer Science

520.424 FPGA Synthesis Laboratory
520.425 FPGA Projects Laboratory
520.448 Electronics Design Laboratory
520.450 Advanced Microprocessor Laboratory
520.454 Control Systems Design
520.483 Bio-Photonics Laboratory
520.484 Optoelectronics Laboratory
520.487 Introduction to MEMS Systems
520.490 Analog and Digital VLSI System
520.491 CAD Design of Digital VLSI Systems
520.492 Mixed Signal VLSI
520.493 Analog Integrated Circuits
520.495 Microfabrication Laboratory
520.496/497 VLSI Design and Prototyping Workshop
520.498 Senior Design Project I
520.499 Senior Design Project II
600.437 Distributed Systems
600.445 Computer Integrated Surgery I
600.446 Computer Integrated Surgery II
600.449 Internet Protocols
600.457 Computer Graphics
600.461 Computer Vision

Other Advanced Laboratory and Design Intensive Courses (non-EE and non-CS)

500.410 Surgery for Engineers (Summer Course)

530.420 Robot Sensors and Actuators

530.421 Mechatronics

530.487 Introduction to MEMS

580.471 Biomedical Instrumentation

Sample Bachelor of Sciences in Computer Engineering Program Microsystems Oriented Emphasis (Courses in Bold are required)					
Fall - Year 1			Spring -Year 1		
Number	Course	Credits	Number	Course	Credits
110.108	Calculus I	4	110.109	Calculus II	4
171.101	Physics I	4	171.102	Physics II	4
171.111	Physics Lab. I	1	171.112	Physics Lab. II	1
520.137	Intro to ECE	3	520.142	Digital System Fundamentals	3
	H&S Elective	3	600.109	Introduction to C/C++	3
Total Credits		15	Total Credits		15
Fall -Year II			Spring - Year II		
Number	Course	Credits	Number	Course	Credits
110.202	Calculus III	4	550.291	Linear Algebra and Differential Eq.	4
030.101	Intro. to Chemistry	3	600.226	Data Structures	3
520.213	Circuits	4	520.214	Signals & Systems	4
600.120	Intermediate Programming	3	520.216	Intro to VLSI	3
600.271	Automata and Computation Theory	3		H&S Elective	3
Total Credits		17	Total Credits		17
Fall – Year III			Spring – Year III		
Number	Course	Credits	Number	Course	Credits
550.171	Discrete Math	4	600.318	Operating Systems	3
600.333	Computer System Fundamentals	3	520.450	Advanced Microprocessor Lab	3
520.345	ECE Laboratory	3	600.344	Computer Networking Fund.	3
520.349	Microprocessor Lab	3		H&S Elective	3
	H&S Elective	3		Science Elective	3
Total Credits		16	Total Credits		15
Fall IV			Spring IV		
Number	Course	Credits	Number	Course	Credits
520.424	FPGA Synthesis Lab	3	550.310	Intro to Probability & Statistics	4
520.491	CAD Design of Digital VLSI	3	520.448	Electronics Device Laboratory	3
520.495	Microfabrication Lab.	3	520.492	Mixed Signal VLSI Systems	3
	Non ECE/CS/MathSci Eng. Elec.	3		Non ECE/CS/MathSci. Eng. Elec.	3
	H&S Elective	3		H&S Elective	3
Total Credits		15	Total Credits		16

Sample Bachelor of Sciences in Computer Engineering Program Computer Integrated Surgery Oriented Emphasis (Courses in Bold are required)					
Fall - Year 1			Spring -Year 1		
Number	Course	Credits	Number	Course	Credits
110.108	Calculus I	4	110.109	Calculus II	4
171.101	Physics I	4	171.102	Physics II	4
171.111	Physics Lab. I	1	171.112	Physics Lab. II	1
520.137	Intro to ECE	3	520.142	Digital System Fundamentals	3
	H&S Elective	3	600.109	Intro to Programming in C/C++	3
Total Credits		15	Total Credits		15
Fall -Year II			Spring - Year II		
Number	Course	Credits	Number	Course	Credits
110.202	Calculus III	4	550.291	Linear Algebra and Differential Eq.	4
030.101	Intro. to Chemistry	3	600.226	Data Structures	3
520.213	Circuits	4	520.214	Signals & Systems	4
600.120	Interm. Programming	3	520.216	Intro to VLSI	3
600.271	Automata and Computation Theory	3		H&S Elective	3
Total Credits		17	Total Credits		17
Fall – Year III			Spring – Year III		
Number	Course	Credits	Number	Course	Credits
550.171	Discrete Math	4	600.318	Operating Systems	3
	H&S Elective	3	520.450	Advanced Microprocessor Lab	3
600.333	Computer System Fundamentals	3	600.344	Computer Networking Fund.	3
520.345	ECE Lab.	3		H&S Elective	3
520.349	Microprocessor Lab.	3		Science Elective	3
Total Credits		16	Total Credits		15
Fall IV			Spring IV		
Number	Course	Credits	Number	Course	Credits
550.310	Intro to Probability & Statistics	4	520.448	Electronics Design Lab.	4
600.461	Computer Vision	3	600.446	CIS II	3
600.445	CIS I	3	520.472	Medical Imaging Systems	3
	Non ECE/CS/MathSci Eng. Elec.	3		Non ECE/CS/MathSci Eng. Elec.	3
	H&S Elective	3		H&S Elective	3
Total Credits		16	Total Credits		16

** Students may also take 600.145 Intro. To Computer Integrated Surgery (freshman year)

** Students may also take 500.410 Surgery for Engineers (summer, junior/Senior Year)

Sample Bachelor of Sciences in Computer Engineering Program Software Oriented Emphasis (Courses in Bold are required)					
Fall - Year 1			Spring -Year 1		
Number	Course	Credits	Number	Course	Credits
110.108	Calculus I	4	110.109	Calculus II	4
171.101	Physics I	4	171.102	Physics II	4
171.111	Physics Lab. I	1	171.112	Physics Lab. II	1
520.137	Intro to ECE	3	520.142	Digital System Fundamentals	3
	H&S Elective	3	600.109	Introduction to C/C++	3
Total Credits		15	Total Credits		15
Fall -Year II			Spring - Year II		
Number	Course	Credits	Number	Course	Credits
110.202	Calculus III	4	550.291	Linear Algebra and Differential Eq.	4
030.101	Intro. to Chemistry	3	600.226	Data Structures	3
520.213	Circuits	4	520.214	Signals & Systems	4
600.120	Intermediate Programming	3	520.216	Intro to VLSI	3
600.271	Automata and Computation Theory	3		H&S Elective	3
Total Credits		17	Total Credits		17
Fall – Year III			Spring – Year III		
Number	Course	Credits	Number	Course	Credits
550.171	Discrete Math	4	600.318	Operating Systems	3
600.333	Computer System Fundamentals	3	600.344	Computer Networking Fund.	3
520.345	ECE Laboratory	3		Non ECE/CS/MathSci Eng. Elec.	3
520.349	Microprocessor Lab	3		H&S Elective	3
	H&S Elective	3		Science Elective	3
Total Credits		16	Total Credits		15
Fall IV			Spring IV		
Number	Course	Credits	Number	Course	Credits
600.415	Database Systems	3	550.310	Intro to Probability & Statistics	4
600.447	Distributed Computing	3	520.448	Electronics Device Laboratory	3
600.457	Computer Graphics	3	520.426	Parallel Processing Systems	3
600.461	Computer Vision	3		Non ECE/CS/MathSci Eng. Elec.	3
	H&S Elective	3		H&S Elective	3
Total Credits		15	Total Credits		16

Sample Bachelor of Sciences in Computer Engineering Program Robotics Oriented Emphasis (Courses in Bold are required)					
Fall - Year 1			Spring - Year 1		
Number	Course	Credits	Number	Course	Credits
110.108	Calculus I	4	110.109	Calculus II	4
171.101	Physics I	4	171.102	Physics II	4
171.111	Physics Lab. I	1	171.112	Physics Lab. II	1
520.137	Intro to ECE	3	520.142	Digital System Fundamentals	3
	H&S Elective	3	600.109	Introduction to C/C++	3
Total Credits		15	Total Credits		15
Fall -Year II			Spring - Year II		
Number	Course	Credits	Number	Course	Credits
110.202	Calculus III	4	550.291	Linear Algebra and Differential Eq.	4
030.101	Intro. to Chemistry	3	600.226	Data Structures	3
520.213	Circuits	4	520.214	Signals & Systems	4
600.120	Intermediate Programming	3	520.216	Intro to VLSI	3
600.271	Automata and Computation Theory	3		H&S Elective	3
Total Credits		17	Total Credits		17
Fall – Year III			Spring – Year III		
Number	Course	Credits	Number	Course	Credits
550.171	Discrete Math	4	600.318	Operating Systems	3
600.333	Computer System Fundamentals	3	600.335	Artificial Intelligence and Robotics	3
520.345	ECE Laboratory	3	520.450	Advanced Microprocessor Lab	3
520.349	Microprocessor Lab	3		H&S Elective	3
	H&S Elective	3		Science Elective	3
Total Credits		16	Total Credits		15
Fall IV			Spring IV		
Number	Course	Credits	Number	Course	Credits
550.310	Intro to Probability & Statistics	4	520.448	Electronics Device Laboratory	4
600.461	Computer Vision	3	520.454	Control System Design	3
530.421	Mechatronics	3	520.420	Robot Sensors and Actuators	3
	Non ECE/CS/MathSci Eng. Elec.	3		Non ECE/CS/MathSci Eng. Elec.	3
	H&S Elective	3		H&S Elective	3
Total Credits		16	Total Credits		16