

# Department of Electrical and Computer Engineering

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The Department of Electrical and Computer Engineering offers degree programs in the closely related fields of electrical engineering and computer engineering. The electrical engineering program spans the subdisciplines of analog electronics, electric power, electromagnetics, computers, and communication and control systems. The computer engineering program focuses on the architecture, programming, and application of digital computers. Bachelor of Science, Master of Science, and Master of Engineering degrees are offered in both electrical engineering and computer engineering. The Doctor of Philosophy degree is offered in electrical engineering and encompasses research in both electrical and computer engineering.

The mission of the department is to educate students for the professional practice of electrical and computer engineering by offering undergraduate and graduate programs that encourage lifelong learning, foster teamwork and leadership, and promote creative discovery. The department is committed to maintaining the highest possible standards in teaching, scholarship, advising, and service.

The department uses a continuous improvement process to meet the electrical and computer engineering program objectives set forth below. Each of the broad program objectives is associated with a number of specific program outcomes that are measured by a variety of assessment tools. Programs are assessed annually to identify problems and initiate changes to ensure that program objectives are being met.

The department is proud of its over 100-year history and its more than 2,500 alumni. Our graduates have become productive engineers and industrial and community leaders all over the nation and the world, and are actively recruited by major employers of electrical and computer engineers. Both the Electrical and Computer Engineering programs are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, ph. 410-347-7700. Graduates of our program consistently score higher than the national average on the Fundamentals of Engineering examination administered by the National Council of Examiners for Engineering and Surveying.

The department offices and laboratories are located in the Buchanan Engineering Laboratory and the Gauss-Johnson Laboratory on the Moscow campus. Courses are also offered through branch campuses located in Boise, Idaho Falls, and Coeur d'Alene, and through the Engineering Outreach program.

**Electrical Engineering Undergraduate Program.** Electrical engineering involves the application of electrical phenomena for the benefit of society. Electrical engineers design and use circuits and systems for computers, instruments, communications devices, and power conversion equipment.

The objectives of the electrical engineering program are to produce graduates who (a) have a sound foundation in the principles of science and mathematics and can apply these principles to the solution of technological problems; (b) understand, and are proficient in the use of, the modern theory, techniques, and tools used to solve problems in electrical engineering; (c) can design new products and solve new problems in electrical engineering, and can enhance their technical skills through lifelong learning; (d) can work and communicate effectively, either independently or in a team, to solve technological problems using engineering principles; and (e) have a sound understanding of the human and social ramifications of technological solutions and apply their engineering skills for the overall benefit of society.

Students in the electrical engineering program are assigned a faculty advisor upon entry into the program. The advisor helps the student prepare appropriate class schedules each semester and provides guidance on other academic and professional issues. Students can take an electrical engineering course in their freshman year that introduces them to the field and helps prepare them for further study. Required courses in the freshman year help develop a solid foundation in physics, chemistry, mathematics, and writing. Foundation courses in science, mathematics, and engineering are continued in the sophomore year, including the first two courses in electrical circuits. The junior year exposes the student to a wide variety of electrical engineering courses to develop breadth in electrical engineering knowledge and skills. In the senior year, students specialize in specific areas of electrical engineering through the choice of technical electives. Students also take a two-semester sequence of design courses where students learn to design, test, and build an electrical engineering circuit or system. Additional courses in the humanities, social sciences, and English help prepare the graduate to become a well-rounded and productive member of society.

**Computer Engineering Undergraduate Program.** Computer engineering involves the application of the principles of electrical engineering and computer science for the benefit of society. Computer engineers design and use digital computers for instrumentation, control, communication, and power conversion systems.

The objectives of the computer engineering program are to produce graduates who (a) have a sound foundation in the principles of science and mathematics and can apply these principles to the solution of technological problems; (b) understand, and are proficient in the use of, the modern theory, techniques, and tools used to solve problems in computer engineering; (c) can design new products and solve new problems in computer engineering, and can enhance their technical skills through lifelong learning; (d) can work and communicate effectively, either independently or in a team, to solve technological problems using engineering principles;

and (e) have a sound understanding of the human and social ramifications of technological solutions and apply their engineering skills for the overall benefit of society.

Students in the computer engineering program are assigned a faculty advisor upon entry into the program. The advisor helps the student prepare appropriate class schedules each semester and provides guidance on other academic and professional issues. In the freshman year, students take introductory courses in physics, mathematics, and computer science to help develop a solid foundation based on these fundamental areas. The sophomore year continues with more physics and mathematics, but also introduces the students to more advanced courses in computer science, computer engineering, and electrical circuits. The junior year provides breadth in several areas of electrical and computer engineering and computer science including electronics, signals and systems, computer architecture, software engineering, and operating systems. The senior year allows the student to develop some depth of knowledge in selected areas through a variety of technical elective courses. In addition, the student takes a two-semester sequence of design courses where students learn to design, test, and build a computer engineering system. Additional courses in the humanities, social sciences, English, and public speaking help prepare the graduate to become a well-rounded and productive member of society.

Note: In addition to college requirements for admission to classes (see "Admission to Classes" under College of Engineering, Part 4), students majoring in electrical engineering or computer engineering must pass a qualifying examination as prerequisite to any upper-division course in electrical engineering or computer engineering. Advisor's approval is required for admission to all ECE courses.

## Courses

See Part 6 for courses in Electrical and Computer Engineering (ECE).

## Undergraduate Curricular Requirements

### COMPUTER ENGINEERING (B.S.Comp.E.)

Required course work includes the university requirements (see regulation J-3) and:

AmSt 301 Studies in American Culture or Phil 103 Ethics (3 cr)  
Comm 101 Fundamentals of Public Speaking (2 cr)  
CS 120 Computer Science I (4 cr)  
CS 121 Computer Science II (4 cr)  
CS 150 Computer Organization and Architecture (3 cr)  
CS 210 Computing Languages (3 cr)  
CS 240 Computer Operating Systems (3 cr)  
CS 270 System Software (3 cr)  
ECE 101 Foundations of Electrical and Computer Engineering (2 cr)  
ECE 210 Electrical Circuits I (3 cr)  
ECE 211 Electrical Circuits I Lab (1 cr)  
ECE 212 Electrical Circuits II (3 cr)  
ECE 213 Electrical Circuits II Lab (1 cr)  
ECE 240 Digital Logic (3 cr)  
ECE 241 Logic Circuit Lab (1 cr)  
ECE 292 Sophomore Seminar (0 cr)  
ECE 310 Fundamentals of Electronics (3 cr)  
ECE 311 Fundamentals of Electronics Lab (1 cr)  
ECE 340 Microcontrollers (3 cr)  
ECE 341 Microcontrollers Lab (1 cr)  
ECE 350 Signals and Systems Analysis (3 cr)  
ECE 351 Signals and System Lab (1 cr)  
ECE 440 Digital Systems Engineering (3 cr)  
ECE 482 CompE Senior Design I (3 cr)  
ECE 483 CompE Senior Design II (3 cr)  
ECE 491 Senior Seminar (0 cr)  
Econ 201 Principles of Economics, Econ 202 Principles of Economics, or Econ 272 Foundations of Economics (3-4 cr)  
Engl 317 Technical Writing (3 cr)  
Math 170 Analytic Geometry and Calculus I (4 cr)  
Math 175 Analytic Geometry and Calculus II (4 cr)  
Math 176 Discrete Mathematics (3 cr)  
Math 310 Ordinary Differential Equations (3 cr)  
Math 330 Linear Algebra (3 cr)  
Phys 211 Engineering Physics I (4 cr)  
Phys 212 Engineering Physics II (4 cr)  
Stat 301 Probability and Statistics (3 cr)  
Science elective selected from Chem 111, Geol 111, MMBB 154/155, or Phys 213 (4 cr)

Technical electives selected from upper-division computer engineering, electrical engineering, and computer science courses (15 cr)

The minimum number of credits for the degree is 128, not counting Engl 101, Math 143, and other courses that might be required to remove deficiencies.

Students majoring in computer engineering must earn a grade of C or better in each of the following courses for graduation, and before registration is permitted in upper-division engineering courses: ECE 210, 212, 240, 241, Math 170, 175, 310, Phys 211, and 212. Before registration is permitted in 200-level CS courses students majoring in computer engineering must earn a grade of C or better in CS 120, 121 and 150 and Math 176, and the grades earned in CS 120, 121 and 150 must average 2.50 or higher. Students majoring in computer engineering must earn a grade of C or better in CS 210, 240, 270, and Math 170, 175, 176 for graduation and before registration is permitted in upper-division CS courses.

Any student majoring in computer engineering who accumulates a total of five (5) letter grades of D's and F's in mathematics, science, or engineering courses that are used to satisfy graduation requirements will be required to undergo special advising as per the Department of Electrical and Computer Engineering's By-Laws (available in the ECE office).

## **ELECTRICAL ENGINEERING (B.S.E.E.)**

Required course work includes the university requirements (see regulation J-3) and:

AmSt 301 or Phil 103 (3 cr)  
Chem 111 Principles of Chemistry I (4 cr)  
CS 112 Introduction to Problem Solving and Programming or CS 120 Computer Science I (3-4 cr)  
ECE 101 Foundations of Electrical and Computer Engineering (2 cr)  
ECE 210 Electrical Circuits I (3 cr)  
ECE 211 Electrical Circuits I Lab (1 cr)  
ECE 212 Electrical Circuits II (3 cr)  
ECE 213 Electrical Circuits II Lab (1 cr)  
ECE 240 Digital Logic (3 cr)  
ECE 241 Logic Circuit Lab (1 cr)  
ECE 292 Sophomore Seminar (0 cr)  
ECE 310 Fundamentals of Electronics (3 cr)  
ECE 311 Fundamentals of Electronics Lab (1 cr)  
ECE 320 Energy Systems I (3 cr)  
ECE 321 Energy Systems I Lab (1 cr)  
ECE 330 Electromagnetic Theory (3 cr)  
ECE 331 Electromagnetics Lab (1 cr)  
ECE 340 Microcontrollers (3 cr)  
ECE 341 Microcontrollers Lab (1 cr)  
ECE 350 Signals and Systems I (3 cr)  
ECE 351 Signals and System Lab (1 cr)  
ECE 480 EE Senior Design I (3 cr)  
ECE 481 EE Senior Design II (3 cr)  
ECE 491 Senior Seminar (0 cr)  
Econ 201 Principles of Economics, Econ 202 Principles of Economics, or Econ 272 Foundations of Economics (3-4 cr)  
Engr 210 Engineering Statics (3 cr)  
Engr 220 Engineering Dynamics (3 cr)  
Engr 360 Engineering Economy (3 cr)  
Engl 317 Technical Writing (3 cr)  
Math 170 Analytic Geometry and Calculus I (4 cr)  
Math 175 Analytic Geometry and Calculus II (4 cr)  
Math 275 Analytic Geometry and Calculus III (3 cr)  
Math 310 Ordinary Differential Equations (3 cr)  
Math 330 Linear Algebra (3 cr)  
Phys 211 Engineering Physics I (4 cr)  
Phys 212 Engineering Physics II (4 cr)  
Stat 301 Probability and Statistics (3 cr)  
Upper-division engineering science elective chosen from Engr 320, 335, 350, or CE 402 (3 cr)  
Technical electives taken from upper-division Engineering, Math, Physics, and Computer Science courses. Of these eighteen credits a minimum of twelve credits must be selected from electrical engineering courses including at least nine credits from the follow courses: ECE 410, 420, 430, 440, 450 and 460. (18 cr)

The minimum number of credits for the degree is 128, not counting Engl 101, Math 143, and other courses that might be required to remove deficiencies.

Students majoring in electrical engineering must earn a grade of P in ECE 292 and a grade of C or better in each of the following courses before registration is permitted in upper-division electrical and computer engineering courses: Chem 111, CS 112 or 120, ECE 210, 211, 212, 213, 240 and 241; Engr 210, and 220; Math 170, 175, 275, and 310; and Phys 211, 212. Students majoring in electrical engineering or computer engineering must meet the college requirements for admission to classes (see "Admission to Classes" under College of Engineering, part four).

Any student majoring in electrical engineering who accumulate a total of five (5) letter grades of D's and F's in mathematics, science, or engineering courses that are used to satisfy graduation requirements will be required to undergo special advising as per the Department of Electrical and Computer Engineering's By-Laws (available in the ECE office).

Within the constraints on choice of technical electives noted above, students may choose sets of electives to develop proficiencies in certain areas of emphasis. Three such areas are currently available, one in communications, one in integrated circuit design, and one in power. The course requirements for each of these areas are described below.

The **Communications** emphasis prepares students for a variety of careers in the communications industry. Students should take a total of 18 credits from the following: (a) core courses: 9 credits from ECE 410, 430, 450, and (b) technical electives: 9 credits from ECE 413, 432, 445, 452, 455.

The **Integrated Circuit Design** emphasis prepares students for careers in the field of integrated circuit design. It includes courses in analog and digital integrated circuit at both the system and transistor level. Students should take a total of 18 credits from the following: (a) core courses: 13 credits from ECE 410, 411, 415, 445, 460 and (b) technical electives: 3 credits from ECE 412, 413, 416, 417, 440, 452, 470, 476.

The **Power** emphasis prepares students for a variety of careers with electric utilities, consulting firms, and with manufacturing and design firms. Students should take a total of 18 credits from the following: (a) 12 credits: ECE 420, 423, 427 and 450, and (b) 3 core credits from: 410, 430, 440, and (c) 3 additional credits of technical electives.

## **Graduate Academic Certificates Requirements**

### **ANALOG INTEGRATED CIRCUIT DESIGN ACADEMIC CERTIFICATE**

Note: A grade of 'B' or higher is required in all coursework for this academic certificate.

ECE 512 Analog Filter Design (3 cr)

ECE 515 Analog Integrated Circuit Design (3 cr)

ECE 517 Pulse and Digital Circuits (3 cr)

Electives (3 cr):

ECE 416 Applications of Linear Integrated Circuits (3 cr)

ECE 430 Microwave and Millimeter Wave Circuits (3 cr)

ECE 445 Introduction to VLSI Design (3 cr)

ECE 460 Semiconductor Devices (3 cr)

ECE 470 Control Systems (3 cr)

ECE 513 Communication Circuits (3 cr)

Credits to total 12 for this Academic Certificate

### **COMMUNICATION SYSTEMS ACADEMIC CERTIFICATE**

Note: A grade of 'B' or higher is required in all coursework for this academic certificate.

ECE 452 Communication Systems (3 cr)

ECE 455 Information and Coding Theory (3 cr)

Electives (6 cr):

ECE 554 Theory of Error Correcting Codes (3 cr)

ECE 555 Information Theory (3 cr)

ECE 556 Adaptive Signal Processing (3 cr)

ECE 557 Biological Signal Processing (3 cr)

Credits to total 12 for this Academic Certificate

### **ELECTRIC MACHINES AND DRIVES ACADEMIC CERTIFICATE**

Note: A grade of 'B' or higher is required in all coursework for this academic certificate.

ECE 427 Power Electronics and Drives (3 cr)

ECE 520 Advanced Electrical Machinery (3 cr)

ECE 527 Dynamics and Control of AC Drives (3 cr)

Electives (3 cr):

ECE 470 Control Systems (3 cr)

ECE 504 Special Topics (3 cr)

ECE 522 Induction Machines (3 cr)

Credits to total 12 for this Academic Certificate

### **POWER SYSTEM PROTECTION AND RELAYING ACADEMIC CERTIFICATE**

Note: A grade of 'B' or higher is required in all coursework for this academic certificate.

ECE 422 Power Systems Analysis (3 cr)  
ECE 525 Power System Protection and Relaying (3 cr)  
Electives (6 cr):  
    ECE 452 Communication Systems (3 cr)  
    ECE 476 Digital Filtering (3 cr)  
    ECE 504 Special Topics (3 cr)  
    ECE 523 Symmetrical Components (3 cr)  
    ECE 524 Transients in Power Systems (3 cr)  
Credits to total 12 for this Academic Certificate

## SEMICONDUCTOR THEORY AND DEVICES ACADEMIC CERTIFICATE

Note: A grade of 'B' or higher is required in all coursework for this academic certificate.

ECE 460 Semiconductor Devices (3 cr)  
ECE 562 Semiconductor Theory (3 cr)  
Electives (6 cr):  
    ECE 515 Analog Integrated Circuit Design (3 cr)  
    ECE 517 Pulse and Digital Circuits (3 cr)  
    ECE 545 Advanced VLSI Design (3 cr)  
    ME 526 Statistical Thermodynamics (3 cr)  
    Any 500-Level ECE course (except special topics, thesis credit, etc.) as approved by the certificate coordinator (3 cr)  
Credits to total 12 for this Academic Certificate

## Graduate Degree Programs

Candidates must fulfill the requirements of the College of Graduate Studies and of the Department of Electrical and Computer Engineering. See the College of Graduate Studies section of Part 4 for the general requirements applicable to each degree.

### COMPUTER ENGINEERING

The Computer Engineering Program offers both Master of Science and Master of Engineering degrees. Both degrees may be earned through the Engineering Outreach off campus program. These advanced degrees offer engineering students an opportunity to strengthen their knowledge of computer engineering by taking graduate courses that focus on advanced subject matter and by participating in research.

**Qualifications for Admittance.** Candidates must have a bachelor's degree in computer engineering, with an undergraduate GPA of 2.80 or higher. International students who are required to take the TOEFL examination by the College of Graduate Studies must have a TOEFL score of at least 79 for the Internet-based Test (iBT) version, 213 for the computer version, or 550 for the paper version. All candidates must submit scores from the general portion of the Graduate Record Examination.

Candidates who do not have a bachelor's degree in computer engineering may be admitted to the graduate program if, in addition to the requirements for candidates who have a B.S.Comp.E., they meet the following minimum requirements.

1. A bachelor's degree in electrical engineering, computer science, or another engineering discipline or in a supporting area of study such as mathematics or physics.
2. Demonstrated proficiency in the fundamentals of computer engineering emphasized in the undergraduate curriculum. Proficiency is demonstrated by successful completion of the following fundamental courses: Fundamentals of Electronics (ECE 310), Digital Logic (ECE 240), Computer Organization and Architecture (CS 150), Computer Science II (CS 121), Discrete Mathematics (Math 176), Differential Equations (Math 310), Linear Algebra (Math 330). Some deficiencies may be removed by taking background courses through Engineering Outreach. Students with undergraduate course deficiencies in the fundamentals of computer engineering must remove these deficiencies prior to admission for graduate work. Such deficiency courses cannot be used for graduate credit.
3. Two advanced undergraduate courses in electrical engineering, computer engineering, or computer science equivalent to Computer Operating Systems (CS 341), Digital Systems Engineering (ECE 440). Students with undergraduate course deficiencies in the advanced areas of computer engineering must remove these deficiencies either prior to admission or in the first three semesters of graduate work. Such deficiency courses cannot be used for graduate credit.

**Master of Science.** To be approved, programs must satisfy both the university requirements governing the M.S. degree and must be enrolled in ECE 591, Electrical Engineering Research Colloquium, during each semester of on-campus enrollment.

**Master of Engineering.** To be approved, programs must satisfy both the university requirements governing the M.S. degree and must be enrolled in ECE 591, Electrical Engineering Research Colloquium, during each semester of on-campus enrollment.

## ELECTRICAL ENGINEERING

**Master of Science.** General M.S. requirements apply, except that the department requires at least 24 credits of course work in addition to a thesis. The master's program may provide advanced preparation for professional practice, or it may serve as the first step in graduate study leading to the Ph.D. degree. Specific courses to be taken for the program are not prescribed by the faculty. Students, with the assistance of their major professor, prepare their own program as soon as possible during their first semester, and submit it to the faculty for approval.

1. At least 18 credits in electrical engineering courses numbered 500 or above.
2. Two or more electrical engineering courses numbered above 500 in a given area for depth.
3. At least one course in each of two areas (outside the areas selected under item 2) to provide breadth.
4. Enrollment in ECE 591, Electrical Engineering Research Colloquium, during each semester of on-campus enrollment.

**Master of Engineering.** General M.Engr. requirements apply, except that the department requires at least 30 credits of course work. Students, with the assistance of their major professor, prepare their own program as soon as possible during their first semester, and submit it to the faculty for approval. To be approved, programs must satisfy both the university requirements governing the M.Engr. degree and the following department requirements:

1. At least 18 credits in electrical engineering courses numbered 500 or above.
2. At least three electrical engineering courses in a given area for depth, two of which must be numbered 500 or above.
3. At least one course in each of two areas (outside the areas selected under item 2) to provide breadth.
4. Enrollment in ECE 591, Electrical Engineering Research Colloquium, during each semester of on-campus enrollment.

**Doctor of Philosophy.** General Ph.D. requirements apply. The preliminary examination consists of both a written and an oral examination. There is no foreign language requirement. Two semesters of ECE 591, Electrical Engineering Research Colloquium, will be required for on-campus doctoral students.