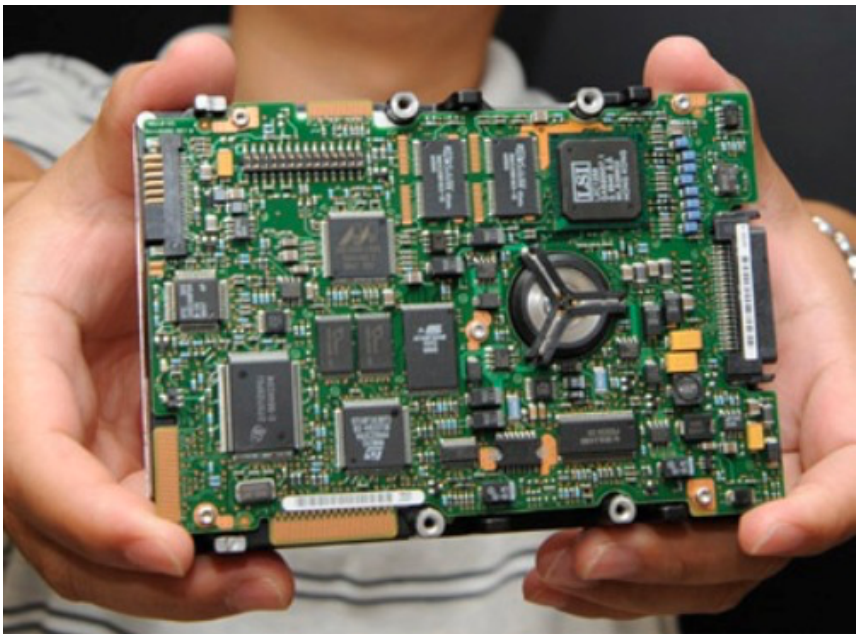
Electrical and Computer Engineering



Electrical and Computer Engineering Curriculum Guide
Hajim School of Engineering and Applied Sciences
University of Rochester
Fall/Spring 2026-2027
For the classes 2027, 2028, 2029 and 2030

Program Mission Statement

"Our mission is to empower our students to be leaders, pursue their academic and professional passions, and model partnerships with educational, civic, cultural, health, and business communities. We will teach our graduates how to create innovative connections with various sectors. We will also teach them to value ethics, and diverse perspectives. Our graduates will serve their communities by developing programs which will improve the world around them. We will strengthen our faculty so that they are dedicated to teaching, mentoring, researching, thinking creatively, and recognizing the role of engineering in modern society."

ECE Major Requirements

Students majoring in electrical and computer engineering (ECE) will complete a total of 128 credits in the following areas:

- Core Courses: 48 credits
- Advanced Electives : 12 credits
- Math: 20 credits
- Sciences: 12 credits
- Cluster: 12 credits
- Humanities/social sciences: 8 credits
- Primary writing/upper level writing: 6 credits
- Electives: 10 Credits

Introduction

The Department of Electrical and Computer Engineering at the University of Rochester (http://www.hajim.rochester.edu/ece/) was established as a department in 1958 offering undergraduate and graduate degrees. The department currently offers Bachelor of Science in Electrical and Computer Engineering, Masters and PhD's in Electrical Engineering along with an ECE Minor. Incoming freshman can apply for the Graduate Engineering at Rochester (GEAR) program. If accepted into this program, an undergraduate is given the assurance of admissions into the ECE Master's program provided that they maintain a grade point average (GPA) of 3.3 or higher.

The ECE B.S. curriculum provides students a rigorous background in all core areas of Electrical and Computer Engineering while still giving them the curricular flexibility to pursue interests in other areas spanning the spectrum of the humanities, social sciences, and the natural sciences. Training in ECE prepares students for a wide range of careers from traditional engineering, research & development to more non-traditional careers in law, finance, and other areas. Areas of focus in the Bachelor of Science in Electrical and Computer Engineering include signals, communications, and image processing, integrated circuits, computer engineering, waves and fields, semiconductor devices, and robotics.

Our students also have ample opportunities to participate in departmental research, working closely with faculty members and their research groups. Opportunities available include summer internships with faculty members for course credit or for pay, and independent study courses.

As described later in this guide, our B.S. degree requires one cluster in Humanities or Social Science. Many of our students also use their free electives to obtain a minor in another department.

Advisors

Each ECE student is assigned an ECE Faculty Advisor in their First Year who remains with them throughout their program. In addition to your Faculty advisor, students also should stay in frequent contact with the Department Undergraduate Coordinator (Barbara.Dick@rochester.edu) to ensure that they are making satisfactory progress towards meeting their degree requirements. All paperwork related to academic life is available from Barbara and should be reviewed by the department prior to submission.

In addition to their Faculty Advisors and the Undergraduate Coordinator, the ECE Undergraduate Committee Chair is also available to discuss student's plans, for completing major and minor declarations, drop/add forms, transfer credits, independent study, study abroad options, internships, fellowships, cluster exceptions, e5 and Take Five Scholars programs, etc. A College Advisor is also assigned to facilitate policy and curriculum.

Students transferring from other colleges and universities should meet with the Undergraduate Coordinator to discuss approval of all transfer courses.

Program Objectives

The Bachelor of Science in Electrical and Computer Engineering program at the University of Rochester focuses on six objectives.

1. Our graduates have the intellectual breadth and critical reasoning skills to enable them to successfully pursue diverse career paths, both within the engineering profession and in other areas, such as law, medicine, and business
2. Our graduates possess the skills to work productively in collaborative environments
3. Our graduates can communicate effectively both within the technical community and with the public at large
4. Our graduates appreciate the social impacts of engineering and the need to maintain the highest ethical standards in the practice of their chosen profession.
5. Our graduates are creative and passionate about research
6. Our graduates have an enthusiasm for lifelong inquiry

Professional Registration

In the State of New York, engineering degrees must be registered for either professional or general purposes. All degrees conferred by the Department of Electrical and Computer Engineering at the University of Rochester are registered for professional purposes. In contrast, all degrees granted through the Inter-departmental Program are registered for general purposes

The main difference between professional and general degrees is that students with the professional degree may take part A of the Professional Engineering Examination, also known as the Fundamentals of Engineering (FE) examination. This examination of fundamentals of engineering and science is the first step toward registration as a professional engineer. All ECE students should consider taking the FE examination in the spring of their senior year. Professional registration brings certain recognized benefits. Furthermore, entry-level engineering jobs with the State of New York, as well as many junior level federal positions, require successful completion of the FE. https://ncees.org/exams/fe-exam/.

ABET Accreditation

The BS degree program in electrical and computer engineering is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org/, under the commission's General Criteria and Program Criteria for Computer Engineering, Electrical and Electronics Engineering Programs. As such New York State automatically registers it for professional purposes. The current ABET accreditation criteria require that each electrical and computer engineering student complete a curriculum with the following minimum content:

- Humanities and Social Sciences
- Mathematics and Basic Science
- Engineering Science and Design

In the third item listed above, students must complete the ECE core and advanced course requirements given in this guide. This will give students a firm foundation in both Engineering Science and Engineering Design. The ECE Senior Design course provides the capstone design experience for our students. The required courses in the ECE curriculum that are listed in this document are intended to meet the requirements of the Engineering Accreditation Commission of ABET http://www.abet.org.

Admission to the Bachelor of Science in Electrical and Computer Engineering Program

Students wishing to formally declare a major in Electrical and Computer Engineering must submit the on-line Major Declaration Form ordinarily during the fourth semester of study. This form constitutes acceptance into the ECE program. The minimum requirements for admission to the ECE program are completion of the following:

- ECE 101, 112, 113, and 114 with a minimum cumulative GPA of 2.3 in these four courses
- MATH 161, 162, 164, and 165 or the equivalent mathematics sequence
- PHYS 121, 122, and 123 or the equivalent physics sequence
- University primary writing requirement, usually satisfied by taking WRTG 105

Students on Academic Probation in the College may not be admitted to the major. A submitted plan, which may be amended, is very useful in helping students to focus their interests within the field of electrical and computer engineering. Before preparing and submitting a course plan, each student should study this guide and then discuss the alternatives fully with their Faculty Advisor or The Undergraduate Coordinator. The Curriculum Planning Form, approved by the Undergraduate Coordinator, will accompany the on-line Major Declaration and be on file in the Undergraduate Coordinators office.

Under special circumstances, such as transfer from another institution or a change of intended major in the early years of study, students may not complete all the requirements for admission by the end of the sophomore year. Such circumstances might include lacking one of the four required ECE or one of the courses in mathematics or physics. Students finding themselves in this situation may qualify for **conditional admission** completing an ECE Curriculum Planning Form. The Curriculum Planning Form must present a realistic plan, approved by the Undergraduate Coordinator for completion of all ECE program admission requirements within one year. Upon successful completion of these requirements students will be formally accepted into the ECE major.

Only the Administrative Committee of the College of Arts, Sciences and Engineering can make exceptions from the general degree requirements published in the Official Bulletin of the University. Petition forms for Administrative Committee consideration are found on-line through the Registrar's Office under forms.

Bachelor of Science in Electrical and Computer Engineering Program Requirements

The BS in ECE program is built on a foundation of basic math, science, programming and includes advanced course work in fundamental engineering science. The Bachelor of Science in Electrical and Computer Engineering has four major requirements in basic science and mathematics, core, advanced, and design courses in electrical and computer engineering, writing courses, humanities and free electives. The course and credit hour requirements for the Bachelor of Science in Electrical and Computer Engineering degree are described in this section.

Basic Science and Mathematics Requirements

The basic science and mathematics requirement for the Bachelor of Science in Electrical and Computer Engineering program requires a mathematics sequence in calculus, differential equations, linear algebra, and probability. The mathematics requirements can be satisfied by one of the following sequences:

- MATH 161, MATH 162, MATH 164, and MATH 165
- MATH 141, MATH 142, MATH 143, MATH 164, and MATH 165
- MATH 171, MATH 172, MATH 173, and MATH 174

The MATH 160 sequence is the standard calculus sequence for students planning to major in mathematics, computer science, physics, chemistry, or engineering. The MATH 140 sequence covers the same material as the MATH 160 sequence but moves through the content of MATH 161 and MATH 162 over three semesters in MATH 141, MATH 142, and MATH 143. MATH 143 is taught at the University of Rochester over the summer, so students interested in pursuing the MATH 140 sequence will not fall behind in the Bachelor of Science in Electrical and Computer Engineering if MATH 143 is taken during the summer following the spring semester of their first year at the University of Rochester. Also note that an equivalent course at another university can be used in place of MATH 143 with prior approval. If interested in completing the MATH 140 sequence and taking MATH 143 at another university during the summer, contact your faculty advisor to discuss this option with them. The MATH 170 sequence is designed for students who have a strong background in mathematics and have an interest in the theoretical underpinnings of the field. More information about the mathematics sequences can be found at http://www.sas.rochester.edu/mth/undergraduate/calculus-sequences.html. A summary of mathematics requirements for the Bachelor of Science in Electrical and Computer Engineering can be seen below in Table 1.

Math Course Sequence Requirement	Number of Courses	Credit Hours
MATH 161-162, MATH 164-165	4	16
MATH 141-143, MATH 164-165	5	20
MATH 171-174	4	20

Table 1: A breakdown of the Bachelor of Science in Electrical and Computer Engineering program mathematics course requirements.

The science requirements of the Bachelor of Science in Electrical and Computer Engineering include PHYS 121, PHYS 122, and PHYS 123. PHYS 121 serves the introductory course on mechanics and imparts an understanding of motion, energy, and thermodynamics. PHYS 122 introduces concepts central to electrical and computer engineering such as electrostatics, electric fields, current and basic circuits, magnetism, and electromagnetic waves. PHYS 123 covers topics related to relativity, quantum mechanics, and waves. The PHYS 140 sequence is defined for students who have a strong background in physics. PHYS 113 is a suitable replacement for PHYS 121 for students who take the MATH 141-143 calculus sequence only. A summary of science requirements for the Bachelor of Science in Electrical and Computer Engineering can be seen below in Table 2.

Science Course Requirement	Credit Hours
PHYS 121, PHYS 122, PHYS 123	12
PHYS 141, PHYS 142, PHYS 143	12
PHYS 113 (MATH 140 series only), PHYS 122, PHYS 123	12

Table 2: A breakdown of the Bachelor of Science in Electrical and Computer Engineering program science course requirements.

Writing Requirements

“The primary and upper-level writing requirements are satisfied through WRTG 105, WRTG 273, and ECE core courses taken during the third and fourth years. The primary writing requirement is completed through WRTG 105. Many sections of WRTG 105 are taught on different topics but share a common curriculum that focuses on college level writing. The second course, WRTG 273, focuses on communicating your professional identity. WRTG 273 is typically taken during the second year of a four-year program. Significant experience in writing also occurs in ECE core courses during the third and fourth years. ECE core courses with significant laboratory components such as ECE 216, ECE 221, ECE 222, and/or ECE 230 require students to write laboratory reports based on their design choices and/or experimental observations. A summary of writing requirements for the Bachelor of Science in Electrical and Computer Engineering can be seen below in Table 3.

Course	Credit Hours
WRTG 105	4
WRTG 273	2
ECE Core Courses	8+

Table 3: A breakdown of the Bachelor of Science in Electrical and Computer Engineering program writing course requirements. Note: Writing Courses are not listed under "Required Core Courses" on website.

Humanities and Social Sciences Requirements

The humanities and social sciences requirements for the Bachelor of Science in Electrical and Computer Engineering program require a minimum of five humanities and/or social science courses equaling 20 credits. This includes the three courses taken to satisfy the University Cluster requirement and two additional courses either 2 or 4 credit courses. These five courses can be chosen from any recognized Humanities and/or Social Science field listed below.

Students also are expected to take some of these courses beyond the introductory level. Ordinarily, H or SS Clusters will count for three of the five required courses, but if questions arise, students should consult their advisors. Language courses at the 101 level are only accepted when followed by another, more advanced course in the same language. While it is preferred to have at least one course in each of H&SS, a minor of five or more courses in one area will satisfy the H&SS requirement. See the overlap policy for restrictions: https://www.rochester.edu/college/ccas/handbook/overlap.html

Acceptable Humanities Courses: Any humanities course as outlined by the School of Arts and Sciences: https://www.sas.rochester.edu/departments-programs.html
Acceptable Social Sciences Courses: Any social science course as outlined by the School of Arts and Sciences: https://www.sas.rochester.edu/departments-programs.html

Requirements for the Bachelor of Science in Electrical and Computer Engineering can be seen below in Table 4.

Course	Credit Hours
Three-course cluster in humanities or social sciences	12
Two additional courses in humanities and/or social sciences (2 or 4 cr. Courses)	8

Table 4: A breakdown of the Bachelor of Science in Electrical and Computer Engineering program humanities and social sciences course requirements

Electrical and Computer Engineering Requirements

The Electrical and Computer Engineering requirements for the Bachelor of Science include a total of seventeen courses. ECE 101, ECE 112, ECE 113, and ECE 114 are the four required pre-major courses in Electrical and Computer Engineering that provide a foundation in circuit analysis, digital logic, computer programming, and laboratory techniques. ECE 270 is a required course that provides the upper-level foundation in probability needed for several 200-level ECE courses. ECE 200, ECE 221, ECE 222, ECE 230, ECE 241, and ECE 216 are the required 200-level courses in each of the six areas of concentration in the Bachelor of Science in Electrical and Computer Engineering curriculum. ECE 348 and ECE 349 serves as the two-course sequence in engineering design and is typically taken during the fourth year of a four-year program in electrical and computer engineering. ECE 350 serves as a course in engineering ethics and is typically taken during the third year of a four-year program in electrical and computer engineering. Three additional 200-level ECE courses are also required from one or more of the seven areas of concentration in the electrical and computer engineering program. These areas include courses in signals, communication, and signal processing, integrated circuits, computer engineering, waves and fields, semiconductor devices, and robotics. A summary of electrical and computer engineering requirements for the Bachelor of Science in Electrical and Computer Engineering can be seen below in Table 5.

ECE Core Course	Credit Hours
ECE 101: Introduction to ECE	4
ECE 112: Digital Logic	4
ECE 113: Introduction to Signals and Circuits	4
ECE 114: C/C++ Programming	4
ECE 200: Computer Organization	4
ECE 216: Mechatronics and Embedded Systems	4
ECE 221: Electronic Devices and Circuits	4
ECE 222: Integrated Circuits Design and Analysis	4
ECE 230: Electromagnetic Waves	4
ECE 241: Signals	4
ECE 270: Probability for Electrical Engineers	4
ECE 348: ECE Design Seminar	2
ECE 349: ECE Design Capstone	4
ECE 350 – Ethics for Electrical and Computer Engineers	2
Three 200-level ECE advanced elective courses	12

Table 5: A breakdown of the Bachelor of Science in Electrical and Computer Engineering program electrical and computer engineering course requirements. A total of 128 credits are needed for the degree.

The three 4 credit 200-level ECE courses that comprise the advanced electives in the Bachelor of Science in Electrical and Computer Engineering program may be taken in a single area of concentration to provide additional depth or can be spread across multiple areas to provide additional breadth. 400-level courses can be accepted through Petitioning the ECE Undergraduate Committee. Example courses in each of the areas of concentration in the Bachelor of Science in Electrical and Computer Engineering program are listed below in Table 6. The undergraduate committee chair may approve additional 200-level courses not listed in this table as an ECE advanced elective for the BS in ECE degree requirements. Please contact Barbara Dick, your faculty advisor, or the undergraduate committee chair if interested in taking an advanced elective outside of the ones listed below.

Area of Concentration	Foundation Course	Advanced Elective Courses
Computer Engineering	ECE 200	ECE 201, ECE 204, ECE 205, ECE 213
Semiconductor and Superconducting Devices	ECE 221	ECE 223, ECE 225. ECE 227
Integrated Circuits	ECE 222	ECE 260, ECE 261
Signals, Communication and Image Processing	ECE 241	ECE 245, ECE 246, ECE 247
AI/Robotics	ECE 216	ECE 208, ECE 217, ECE 218

Table 6: A listing of 200-level foundation and advanced elective courses in electrical and computer engineering by area of concentration.

Bachelor of Science in Electrical and Computer Engineering Program Policies

The following outlines specific policies in the Bachelor of Science in Electrical and Computer Engineering Program.

Transfer Credits

If a student wishes to take a course at another institution to satisfy an ECE degree requirement, **prior approval** is mandatory. Proper supporting documentation about the course should be submitted to the ECE Department Undergraduate Coordinator before taking any courses for transfer. A Course Approval Form, available on-line through the Registrar's Office under forms is used for this purpose. Students are strongly advised to seek the guidance and feedback from their advisor before registering for a course at another institution. Completed forms will be forwarded to the Undergraduate Committee for action. Seeking approval after the fact may result in delays, and refusal to allow a student to take advanced courses for lack of prerequisites.

Internships and Practicum

ECE majors are strongly encouraged to participate in internships with local or nationally based engineering firms for professional development. Only in a few cases can internship experiences be used for academic credit. Students who wish to obtain such credit for an internship must obtain prior approval from the ECE Undergraduate Committee.

The Engineering Practicum program, supervised jointly by the Hajim School of Engineering and Applied Sciences and the Gwen M. Greene Career and Internship Center, is a way to gain valuable work experience. A student in this program takes one semester and the preceding or following summer to work for a company. Academic credit is not granted, but the work experience and references obtained are valuable in students' career development. Usually graduation will be delayed by one semester but students with Advanced Placement credit or summer classes may still graduate in four years. Additional information, including example programs, is available from the Hajim School of Engineering and Applied Sciences office in Lattimore Hall, or from the Gwen M. Greene Career and Internship Center.

Pre-Medical

ECE students interested in preparing for medical school are urged to obtain related materials from the Health Professions Advisor at the Center for Academic Support, Lattimore 312. It is essential that such students begin program planning very early and involve both their ECE advisor and the Health Professions Advisor.

Scheduling all of these courses with due regard for prerequisites may be complex and the workload demands strong commitment from the student. Thus, early consultation is strongly encouraged.

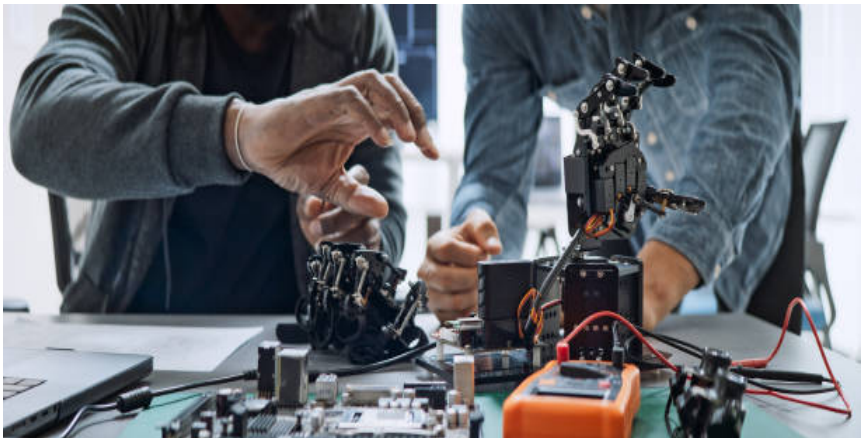
Education Abroad

The ECE Department believes that studying abroad is a valuable contribution to the undergraduate curriculum. The College offers study abroad programs in more than 40 countries in various semesters. Study abroad requires careful planning so students who are interested in studying abroad should meet with the Undergraduate Program Coordinator to discuss plans and attend a study abroad general information meeting to get started. After attending an information meeting, students can set up an appointment to meet with a study abroad adviser. Study abroad in ECE is usually for *one semester* in the sophomore or junior year.

For details and more information, please visit the education abroad program website at https://www.rochester.edu/college/abroad/.

Applying to the Master of Science in Electrical Engineering Program

ECE Seniors contemplating earning their Master's degree may wish to consider the Master's program offered by the department. This program provides the advantage of a smooth transition between undergraduate and graduate study. Program enrollment is competitive, and students are encouraged to apply for admission in their Senior year. Applicants may begin to take graduate level courses in their Senior year with the intent to transfer up to 10-credits of graduate level credits. These credits cannot be used toward the BS degree. (Transfer Credit Policy) Successful applicants will be granted a tuition scholarship for the Master's year of study. Conferral of the BS degree is required in order to matriculate into the Master's program. Please visit the Master's Program webpage for up-to-date information: https://www.hajim.rochester.edu/ece/graduate/ms.html



Bachelor of Science in Electrical and Computer Engineering Sample Schedules

Below in Table 7 is an example of a four-year program that satisfies the prerequisites of each required course.

Year	Semester	
	Fall	Spring
First	ECE 101: Introduction to ECE MATH 161: Calculus I WRTG 105 Cluster Elective	ECE 112: Digital Logic MATH 162: Calculus II PHYS 121: Mechanics Cluster Elective
Second	ECE 114: Introduction to C/C++ Programming MATH 165: Linear Algebra w/ Differential Equations PHYS 122: Electricity and Magnetism Cluster Elective WRTG 273: Communicating your Professional Identity in Engineering	ECE 113: Intro to Signals and Circuits MATH 164: Multidimensional Calculus PHYS 123: Waves and Modern Physics Elective
Third	ECE 221: Electronic Devices and Circuits ECE 241: Signals ECE 216 Mechatronics and Embedded Systems ECE 270: Probability for Electrical Engineers	ECE 200: Computer Organization ECE 222: Integrated Circuits Design and Analysis ECE 350: Ethics for Electrical and Computer Engineers ECE Advanced Elective Elective
Fourth	ECE 348: ECE Design Seminar ECE 230: Electromagnetic Waves ECE Advanced Elective Elective	ECE 349: ECE Design Capstone ECE Advanced Elective Elective Elective

Table 7: An example four-year program to complete the Bachelor of Science in Electrical and Computer Engineering. 128 credits are required for the ECE degree.

There are many ways to complete the Bachelor of Science in Electrical and Computer Engineering program and the approach outlined above in Table 7 is only one solution. In this proposed four-year course of study, students complete the ECE 101, ECE 112, ECE 113, and ECE 114 pre-major requirements in the first two years, finish the six 200-level foundation courses (ECE 200, ECE 221, ECE 222, ECE 230, ECE 241, and ECE 216) and ECE 270 across four semesters in the third and fourth years, and takes the capstone design sequence (ECE 348, ECE 350, ECE 349) and advanced electives in starting in the spring of the third year through the end of the fourth year. Cluster courses, electives, and advanced electives are distributed throughout the four-year program. An ECE advanced elective is defined as a 4-credit 200 level that is not a required course.

Minor in Electrical and Computer Engineering

The ECE minor gives students the opportunity to design a flexible program of study to achieve either breadth or depth in electrical and computer engineering. In addition to the following recommended programs of study, a student can arrange an individualized program with the guidance of an ECE advisor, normally requiring the equivalent of five four-credit hour courses in ECE. Recommendation programs of study are listed below in Table 8.

Topic	Five-Course Program of Study
Integrated Circuits	ECE 112, ECE 113, ECE 221, ECE 222, ECE 260
Waves, Fields, and Devices	ECE 113, ECE 221, ECE 222, ECE 223, ECE 230
Signals and Communications	ECE 113, ECE 114, ECE 241, ECE 245, ECE 246
Robotics	ECE 112, ECE 113, ECE 114, ECE 216, ECE 217
Computer Engineering	ECE 112, ECE 113, ECE 114, ECE 200, ECE 201

Table 8: A breakdown of the Bachelor of Science in Electrical and Computer Engineering program electrical and computer engineering course requirements.

Bachelor of Science in Electrical and Computer Engineering Course Descriptions

This section describes the required and elective courses in the Bachelor of Science in Electrical and Computer Engineering program. In addition to the name, prerequisites, semester offered, and a description of the course, the ECE elective course listing also include the area of concentration for advanced electives. ECE core courses are taught every academic year. Some ECE advanced elective courses are taught every year while others are taught every other year. If there are specific ECE advanced elective courses that you wish to take, please talk with your academic advisor to develop a plan to integrate this into the plan for your course of study.

ECE Core Courses

ECE 101: Introduction to ECE
Prerequisites: Co-requisite: MATH 161 or 141.
Instructor: Jack Mottley
Offered: Fall
Description: This course will introduce some of the things that Electrical and Computer Engineers do and the tools they use every day. Covers fundamental circuit concepts and components (voltage, current, resistance, switches, resistors, diodes, etc.), use of logic and microcontrollers to operate devices, spreadsheets and other tools to model engineering problems, measurement tools to verify operation, assembly and testing of circuits and devices. This is a required course for ECE majors. Introduction courses from other engineering disciplines accepted as an equivalent replacement.

ECE 112: Digital Logic
Prerequisites: MATH 161, MATH 141, or MATH 171
Instructor: Selcuk Kose
Offered: Spring
Description: Students are exposed to Combinational logic elements including all of the following: logic gates Boolean algebra, Karnaugh Maps, conversion between number systems, binary, tertiary, octal, decimal, and hexadecimal number systems, and arithmetic on signed and unsigned binary numbers using 1's and 2's complement arithmetic. Also covered are programmable logic devices, synchronous finite state machines, State Diagrams, FPGA's and coding logic in VHDL**.**

ECE 113: Intro to Signals and Circuits
Prerequisites: MATH 165**;** concurrent with MTH164
Instructor: Jack Mottley
Offered: Spring
Description: The principal focus of ECE113 is frequency domain representation of time signals, starting with phasors and ending with elements of Fourier series and Fourier transforms. Mathematics is introduced as needed for the specific material being covered, including: complex numbers, initial value problems, Laplace transform pairs, matrices, Fourier series, and Fourier transforms, including convolution. In addition, some effort is devoted to non-linear circuit analysis using loadlines. Workshop experience is an integral part of this course, students will be expected to attend a Workshop section (up to 2 hours each) almost every week of the semester. Days and times for these sections are arranged during the first week of classes, working with the Workshop Leaders and students.

ECE 114: Introduction to C/C++ Programming
Prerequisites: None
Instructor: Thomas Howard
Offered: Fall
Description: This course provides an introduction to the C and C++ programming languages and the key techniques of software programming in general. Students will learn C/C++ syntax and semantics, program design, debugging, and software engineering fundamentals, including object-oriented programming. In addition, students will develop skills in problem solving with algorithms and data structures. Programming assignments will be used as the primary means of strengthening and evaluating these skills.

ECE 124 – MATLAB for Electrical and Computer Engineering
Prerequisites: None
Instructor: Sarah Smith
Offered: Fall
Description: MATLAB serves as a fundamental tool for numerical analysis, data visualization, and algorithm development in electrical engineering. This course is specifically designed for electrical engineering students seeking to enhance their computational skills for solving real-world engineering problems. Topics in this course include

programming essentials including array and matrix manipulation, basic circuits and system simulation with Simulink, and methods for integrating MATLAB with other data sources and instrumentation. Efficient implementation of algorithms through vectorized computation and parallel processing is emphasized. **A basic understanding of electrical engineering concepts and prior exposure to programming in any language are beneficial, but not required.**

ECE 200: Computer Organization
Prerequisites: ECE 112 and ECE 114 or CSC 171, or permission of Instructor
Instructor: Hanan Dery
Offered: Spring
Description: Instruction set principles; processor design, pipelining, data and control hazards; datapath and computer arithmetic; memory systems; I/O and peripheral devices; internetworking. Students learn the challenges, opportunities, and tradeoffs involved in modern microprocessor design. Assignments and labs involve processor and memory subsystem design using hardware description languages (HDL).

ECE 216: Mechatronics and Embedded Systems
Prerequisites: ECE 112, ECE 113, and ECE 114
Instructor: Thomas Howard
Offered: Fall
Description: This course is designed to introduce mechatronics and embedded systems. The course covers topics including microcontroller architectures, digital I/O, analog I/O, timers, counters, interrupts, analog to digital conversion, digital to analog conversion, communication, sensors, actuators, mechatronics, mechanical and electrical system models, transient response, and compensator design using root locus methods, frequency response methods, and state-space models. Students will learn to write C programs for embedded systems using microcontroller development boards and apply such knowledge to control physical systems that interact with the world through sensors and actuators.

ECE 221: Electronic Devices and Circuits
Prerequisites: ECE 113, or ECE 210
Instructor: Stephen Wu
Offered: Fall
Description: This course discusses the fundamentals of semiconductor devices – how they are formed; how they function in circuits; how they "integrate" to make the "IC's" that drive all modern electronic technology. We will examine the basic properties of semiconductors, the design and analysis of basic electronic circuits, including PN junction diodes and diode circuits, bipolar junction transistors (BJT's), field effect transistors (FET's), single and multi-stage amplifiers, and differential amplifiers. We will study the small-signal characteristics of these circuits and their time and frequency responses. **PREREQUISITES: ECE 113, or ECE 210**

ECE 222: Integrated Circuits Design and Analysis
Prerequisites: ECE 221 or equivalent, or permission of instructor
Instructor: Hui Wu
Offered: Spring
Description: An introduction to the analysis and design of integrated circuits. IC process technologies (CMOS, bipolar, BiCMOS). SPICE simulation. High-frequency device models (diode, BJT, MOSFET). Frequency response of amplifiers. Cascode amplifiers. Source degeneration. Differential amplifier. Feedback. Frequency compensation. Operational amplifiers. Inverters. Logic gates. Pass-transistor logic. HSPICE simulation labs. Hands-on final design project.

ECE 230: Electromagnetic Waves
Prerequisites: MATH 164, MATH 165, PHYS 122, and ECE 113
Instructor: Roman Sobolewski
Offered: Fall
Description: Transverse Electromagnetic Waves (TEM) waves in transmission line structures, transient and steady-state solutions. Applications in electronic digital circuits and in communication networks. Maxwell's equations and wave equation in homogeneous media. Plane waves in homogenous loss-less and low-loss media. Linear and circular polarization. Wave propagation in lossy/conducting media and skin effect. Radiation, receiver, and transceiver antennas, and antenna arrays. Satellite communications and fiber optical communications. Quantum communications and quantum cryptography. Laboratory and RF equipment.

ECE 241: Signals
Prerequisites: ECE 113 and MATH 165 or ECE 210 or BME 210
Instructor: Irving Martinez Barron
Offered: Fall
Description: Introduction to continuous and discrete time signal theory and analysis of linear time-invariant systems. Signal representations, systems and their properties, LTI systems, convolution, linear constant coefficient differential and difference equations. Fourier analysis, continuous and discrete-time Fourier series and transforms, properties, inter-relations, and duality. Filtering of continuous and discrete time signals. Sampling of continuous time signals, signal reconstruction, discrete time processing of continuous time signals. Laplace transforms. Laboratory.

ECE 270: Probability for Electrical Engineers
Prerequisites: None
Instructor: Hanan Dery
Offered: Fall
Description: Logic, introduction to proofs, set operations, algorithms, introduction to number theory, recurrence relations, techniques of counting, graphs. Probability spaces, independence, discrete and continuous probability distributions, commonly used distributions (binomial, Poisson, and normal), random variables, expectation and moment generating functions, functions of random variables, laws of large numbers.

ECE 348: ECE Design Seminar
Prerequisites: Must have at least Junior standing and be taking the first course in a concentration sequence.
Instructor: Irvin Martinez Barron
Offered: Fall
Description: Students majoring in Electrical and Computer Engineering will explore ideas for Design Projects, form Teams, and prepare a proposal for the Design Project to be started in the Fall semester and completed in the Spring semester. Proposal will include presentations and documentation discussing some or all of the following: definition of project requirements and product specifications; clarification and verification of end user requirements; subsystem definition and interfaces; generation of project and testing plans including Gantt charts; reliability analysis, product safety, compliance issues, manufacturability, reverse engineering a related device, cost, and documentation. In addition, we will examine case studies on ethical, social, economic and safety considerations that can arise in engineering practice. Occasional presentations by outside speakers.

ECE 349: ECE Design Capstone
Prerequisites: MAJORS ONLY All required courses including an advanced elective in the ECE program. ECE 348 Requirement for all ECE students. Taken in the spring semester senior year .
Instructor: Jack Mottley, Irvin Martinez Barron
Offered: Spring
Description: Senior design course. Prior faculty approval required or design project proposal. **MAJORS ONLY All required courses including an advanced elective in the ECE program. ECE 348. Requirement for all ECE students. Taken in the spring semester senior year .**

ECE 350: Ethics for Electrical and Computer Engineers
Prerequisites: Must have junior standing
Instructor: Thomas Howard
Offered: Spring
An introduction to engineering ethics for electrical and computer engineers. Topics include responsibilities of engineers, codes of conduct, ethical theories, the ethical cycle, ethical aspects of design, technical risk, and innovation. Exercises will include design problems that require practice and application of ethical decision-making frameworks.

ECE Advanced electives

ECE 201/401: Advanced Computer Architecture
Prerequisites: ECE 200
Instructor: Michael Huang
Concentration: Computer Engineering
Offered: Spring
Description: Instruction set architectures. Advanced pipelining techniques. Instruction level parallelism. Memory hierarchy design. Multiprocessing. Storage systems. Interconnection network.

ECE 204/404: Multiprocessor Architecture
Prerequisites: ECE 200
Instructor: Michael Huang
Concentration: Computer Engineering
Offered: Fall
Description: Instruction set architectures. Advanced pipelining techniques. Instruction level parallelism. Memory hierarchy design. Multiprocessing. Storage systems. Interconnection network.

ECE 205/405: Ising Machines: Principles and Practices
Prerequisites: ECE 200
Instructor: Michael Huang
Concentration: Computer Engineering
Offered: Spring
Description: This course provides a systematic treatment of a number of related concepts in computing that are outside mainstream (von Neumann) approach. The primary goal is to help students understand the foundation of the on-going research of a particular type of von Neumann architecture: Ising machines. Topics include a basic review of thermodynamics (such as Gibbs-Boltzmann distribution, Langevin dynamics), computational methods inspired by it (such as Markov chain Monte Carlo methods, energy-based models: a subset of machine learning algorithms), and hardware design of Ising machines.

ECE 208/408: The Art of Machine Learning
Prerequisites: ECE 114; MATH 165, ECE 270.
Instructor Zhiyao Duan
Concentration: AI/Robotics
Offered: Spring
Description: Machine Learning (ML) is the branch of Artificial Intelligence dedicated to teaching computers how to solve tasks by learning from data. This class introduces basic concepts of machine learning through various real-world ECE applications. It will cover various learning paradigms such as supervised learning, semi-supervised learning, unsupervised learning, and reinforcement learning. It will also cover classical and state-of-the-art techniques such as linear models, support vector machines, Gaussian mixture models, hidden Markov models, matrix factorization, ensemble learning, principal component analysis, and various kinds of deep neural networks.

Students will learn the pros and cons of different methods and their suited application scenarios. This course is hands-on with multiple programming assignments and a final project to solve real ECE problems.

ECE 213/413: Intro to Hardware Security
Prerequisites: basic undergraduate math and physics
Instructor Selcuk Kose
Concentration: Computer Engineering
Offered: Fall
Description: The focus will be to provide background and insight into some of the most active security related research areas in the field of VLSI design methodologies, side-channel attacks and countermeasures, covert communication attacks and countermeasures, physical unclonnable functions, hardware Trojans, security versus power/performance/noise/area/cost tradeoffs for corresponding countermeasures, etc

ECE 217/417: Robot Motion Planning and Manipulation
Prerequisites: ECE 216
Instructor: Thomas Howard
Concentration: AI/Robotics
Offered: Spring (Biennially)
Description: This course covers control and planning algorithms with applications in robotics. Topics include motion planning, decision-theoretic planning, planning under differential constraints, kinematics, dynamics, control, and applications of such topics on mobile robots and robotic manipulators. It is expected by the end of the course that students will be able to demonstrate an understanding of how robots plan paths and trajectories in the context of their perceived environment. Performance is evaluated through four written exams.

ECE 218/418: Mobile Robot Estimation, Mapping, Navigation, and Interaction
Prerequisites: ECE 216, ECE 114
Instructor: Thomas Howard
Concentration: AI/Robotics
Offered: Spring (Biennially)
Description: This course is designed to introduce models and algorithms for autonomous mobile robots. Topics include probability, sensors, perception, state estimation, mapping, navigation, control, and interaction. It is expected by the end of the course that students will be able to demonstrate an understanding of how autonomous mobile robots select actions, sense the environment, and reason about uncertainty when making decisions.

ECE 223/423: Semiconductor Devices
Prerequisites: ECE 221, ECE 230, and PHYS 123
Instructor: Roman Sobolewski
Concentration: Semiconductor Devices
Offered: Fall
Description: Review of modern solid-state electronic devices, their principles of operation, and fabrication. Solid state physics fundamentals, free electrons, band structure, and transport properties of semiconductors. Nonequilibrium phenomena in semiconductors. P-N junctions, Schottky diodes, field-effect, and bipolar transistors. Modern,high-performance devices. Ultrafast devices.

ECE 225/425: Superconductivity and the Josephson Effect
Prerequisites: ECE 221, ECE 230, PHY 123.
Instructor: Ivan Komissarov
Concentration: Semiconductor Devices
Offered: Fall
Introduction to the basic description of superconductivity and superconducting materials, including high-temperature superconductors. The second half of the semester will focus on the physics of various types of Josephson junctions and their applications**.**

ECE 227/427: Superconductor Electronics
Prerequisites: ECE 225
Instructor: Roman Sobolewski
Concentration: Semiconductor Devices
Offered: Spring
Introduction to small-scale superconductor electronic devices, both analog and digital. Josephson junctions as digital circuit elements. Implementation of shunted Josephson junctions in the single flux quantum (SFQ) circuitry. SFQ circuit design and integration, simulations and appropriate simulation tools Finally, fabrication and testing of SFQ-based digital integrated circuits**.**

ECE 245/445: Wireless Communications
Prerequisites: ECE 241
Instructor: Irving Barron-Martinez
Concentration: Signals, Communication, and Image Processing
Offered: Spring
Description: This course teaches the underlying concepts behind traditional cellular radio and wireless data networks as well as design trade-offs among RF bandwidth, transmitter and receiver power and cost, and system performance. Topics include channel modeling, digital modulation, channel coding, network architectures, medium access control, routing, cellular networks, WiFi/IEEE 802.11 networks, mobile ad hoc networks, sensor networks and smart grids. Issues such as quality of service (QoS), energy conservation, reliability and mobility management are discussed. Students are required to complete a semester- long research project in order to obtain in-depth experience with a specific area of wireless communication and networking.

ECE 246/446: Digital Signal Processing
Prerequisites: ECE 241 or BME 230 and math programming skills
Instructor: Gaurav Sharma
Concentration: Signals, Communication, and Image Processing
Offered: Fall
Description: Analysis and design of discrete-time signals and systems, including: difference equations, discrete-time filtering, z-transforms, A/D and D/A conversions, mutli-rate signal processing, FIR and IIR filter design, the Discrete Fourier Transform (DFT), circular convolution, Fast Fourier Transform (FFT) algorithms, windowing, and classical spectral analysis.

ECE 247/447: Digital Image Processing
Prerequisites: ECE 241 and ECE 271
Instructor: Gaurav Sharma
Concentration: Signals, Communication, and Image Processing
Offered: Fall
Description: Fundamental concepts, including: two-dimensional Fourier transforms, sampling and quantization, Fourier slice theorem, image representation and modeling, Shot/Poisson noise in optical images, image perception, tone, color, and frequency response of the visual system, fidelity metrics, basic information theoretic concepts, overview of neural networks and deep learning. Sampling of applications from: compression, filtering, restoration/enhancement, reconstruction and inverse problems, texture modeling, classification, recognition, segmentation, and registration. Term project.

260/460: Digital Radio Engineering
Prerequisites: ECE 222 or equivalent, or permission of instructor.
Instructor: Hui Wu
Concentration: Integrated Circuits
Offered: Fall

Description: This is an introductory course on state-of-the-art radio engineering with an emphasis on digital implementation of software defined radio (SDR) systems. SDR utilizes cutting-edge digital technologies to enable versatile and agile RF and wireless devices for a wide range of applications, including 5G wireless communications and next-generation radars. The technology platform can also be applied to AI-related computing and instrumentation applications.

We begin with an overview of fundamental RF concepts and circuit techniques, followed by a discussion of several modern RF and wireless system architectures. Then we learn how to design basic RF circuits and subsystems using electronic design automation (EDA) tools. The main focus of the course is a project in which we design and implement an SDR using off-the-shelf RF components and an FPGA evaluation board. The project will be carried out in two phases: a) proposal and design, and b) build and tests. The course also covers RF test/measurement techniques related to the project. This project-based course will be structured in lectures and workshops in first 5 weeks, followed by the project in later 8 weeks.

ECE 261/461: Introduction to VLSI
Prerequisites: ECE 112 and ECE 222
Instructor: Eby Friedman
Concentration: Integrated Circuits
Offered: Fall
Description: Introduction to high performance integrated circuit design. Semiconductor technologies. CMOS inverter. General background on CMOS circuits, ranging from the inverter to more complex logical and sequential circuits. The focus is to provide background and insight into some of the most active high performance related issues in the field of high performance integrated circuit design methodologies, such as CMOS delay and modeling, timing and signal delay analysis, low power CMOS design and analysis, optimal transistor sizing and buffer tapering, pipelining and register allocation, synchronization and clock distribution, retiming, interconnect delay, dynamic CMOS design techniques, power delivery, on-chip regulators, 3-D technology and circuit design, asynchronous vs. synchronous tradeoffs, clock distribution networks, low power design, and CMOS power dissipation.

ECE 271/440: Introduction to Random Processes
Prerequisites: ECE 241
Instructor: Gonzalo Mateos
Concentration: Signals, Communication, and Image Processing
Offered: Fall
Description: The goal of this course is to learn how to model, analyze and simulate stochastic systems, found at the core of a number of disciplines in engineering, for example communication systems, stock options pricing and machine learning. This course is divided into five thematic blocks: Introduction, Probability review, Markov chains, Continuous-time Markov chains, and Gaussian, Markov and stationary random processes.

ECE 287/487: Entrepreneurship for Engineers
Prerequisites: none
Instructor: Irving Martinez Barron
Offered: Fall
Description: This course introduces engineering students to the fundamental principles of entrepreneurship, focusing on transforming technical ideas into real-world solutions that address people's needs. It emphasizes practical skills such as identifying potential users, understanding their challenges, and developing solutions that align with those needs. Students will learn how to communicate the value of their ideas effectively, explore different approaches to delivering their solutions, and understand what it takes to sustain and support them over time.

The course also covers essential aspects such as gathering the necessary tools and resources, organizing key tasks, and collaborating with others to move an engineering solution toward commercialization. Students will explore the importance of evaluating and refining early versions of their solutions, securing support for their work, and protecting their ideas. Through discussions, case studies, and projects, students will develop a broader problem-solving perspective, preparing them to create impact beyond the technical design of a product.

Contact Information and Class Faculty Advisors for Electrical and Computer Engineering

The contact information for the department chair, undergraduate coordinator, undergraduate committee chair, and the class faculty advisors are listed below in Table 9.

	Name	Office	Phone	Email
Department Chair	Selçuk Kose	CSB 518	5-4879	Selçuc.kose@rochester.edu
Undergraduate Coordinator	Barbara Dick	CSB 510	5-5719	barbara.dick@rochester.edu
Undergraduate Committee Chair	Thomas Howard	CSB 732	5-3755	thoward@ece.rochester.edu
Class of 2027 Faculty Advisor	T. Howard	CSB 732	5-3755	thoward@ece.rochester.edu
Class of 2028 Faculty Advisors	T. Howard S. Wu	CSB 732 CSB 610	5-3755 5-3497	thoward@ece.rochester.edu stephen.wu@rochester.edu
Class of 2029 Faculty Advisors	M. Huang H. Wu	CSB 414 CSB 416	5-2111 5-2112	michael.huang@rochester.edu hui.wu@rochester.edu
Class 2030 Faculty Advisors	H. Dery Z. Ignatovic	CSB 410 CSB 621	5-3870 5-3790	hanan.dery@rochester.edu zeljko.ignatovic@rochester.edu

Table 9: Contact information for the ECE department chair, undergraduate coordinator, undergraduate committee chair, and the class of 2027, 2028, 2029 and 2030 advisors.