# ELECTRICAL ENGINEERING

Electrical Engineering

Electrical Engineering Major - Required Courses and Recommended Course Sequence

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td><strong>First Semester</strong></td>
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<tr>
<td></td>
<td>MTH-111</td>
<td>Calculus I</td>
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<td></td>
<td>CHM-117</td>
<td>Introductory Chemistry Lab for Engineers</td>
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<td></td>
<td>CHM-118</td>
<td>Chemistry for Engineers</td>
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<td>ME-180</td>
<td>CADD Lab</td>
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<td>ENG-101</td>
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<td>FYF-101</td>
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<td></td>
<td>MTH-112</td>
<td>Calculus II</td>
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<td>PHY-201</td>
<td>General Physics I</td>
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<tr>
<td></td>
<td>EGR-140</td>
<td>Scientific Programming</td>
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<td></td>
<td>EGR-200</td>
<td>Introduction to Materials Science</td>
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<tr>
<td></td>
<td>MTH-211</td>
<td>Intro. to Differential Equations</td>
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<td></td>
<td>PHY-202</td>
<td>General Physics II</td>
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<td></td>
<td>EE-211</td>
<td>Electrical Circuits and Devices</td>
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<td>EE-283</td>
<td>Electrical Measurements Lab</td>
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<td>ME-231</td>
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<td>MTH-212</td>
<td>Multivariable Calculus</td>
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<td>EE-251</td>
<td>Electronics I</td>
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<td>EGR-222</td>
<td>Mechatronics</td>
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<td>EE-241</td>
<td>Digital Design</td>
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<td><strong>Fifth Semester</strong></td>
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<td></td>
<td>EE-252</td>
<td>Electronics II</td>
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<td></td>
<td>EE-271</td>
<td>Semiconductor Devices</td>
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<td></td>
<td>EE-381</td>
<td>Microfabrication Lab</td>
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**Sixth Semester**

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<tr>
<td>PHY-214</td>
<td>Modeling of Physical Systems</td>
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<tr>
<td>Distribution Requirement</td>
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**Seventh Semester**

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<td>EGR-399</td>
<td>Cooperative Education** OR</td>
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<tr>
<td>Technical Electives*</td>
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<td>PHY-203</td>
<td>Modern Physics</td>
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<td>PHY-206</td>
<td>Modern Physics Lab</td>
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<td>EGR-201</td>
<td>Professionalism and Ethics</td>
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<tr>
<td>Distribution Requirements</td>
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<tr>
<td>EGM-320</td>
<td>Engineering Project Management &amp; Analysis</td>
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<td><strong>Total</strong></td>
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**Eighth Semester**

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<th>Course Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EE-339</td>
<td>Engineering Electromagnetics II</td>
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<tr>
<td>EE-382</td>
<td>Modern Communication Systems</td>
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<td>EE-392</td>
<td>Senior Projects II</td>
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<td>Technical Elective*</td>
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<td>Free Elective</td>
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*Technical electives may be chosen from any advisor-approved math, science, or engineering course numbered 200 or above.

**Students must consult with the Cooperative Education Coordinator to determine availability and proper scheduling of the Cooperative Education experience.

## Minor in Computer Engineering

A 20 to 22-credit Computer Engineering minor is a special and highly focused option for students majoring in Engineering and other related disciplines. The minor consists of the following course requirements:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CS-125</td>
<td>Computer Science I or EGR-140 - Scientific Programming</td>
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<tr>
<td>CS-126</td>
<td>Computer Science II or EE-247 Programming for Embedded Applications</td>
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<tr>
<td>EE-241</td>
<td>Digital Design</td>
<td></td>
</tr>
<tr>
<td>EE-345</td>
<td>Computer Organization</td>
<td></td>
</tr>
<tr>
<td>EE-342</td>
<td>Microcontroller Based System Design</td>
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EE. ELECTRICAL ENGINEERING

EE-211. ELECTRICAL CIRCUITS AND DEVICES
Credits: 3

Co-Requisites
MTH-112

EE-241. DIGITAL DESIGN
Credits: 3
The electronics of digital devices, including Bipolar TTL and CMOS, digital logic functions (e.g., AND, OR, INVERT), Boolean algebra, combinational logic, minimization techniques, digital storage devices, synchronous sequential design, state machines, programmable logic. Three one-hour lectures and one two-hour lab per week.

EE-247. PROGRAMMING FOR EMBEDDED APPLICATIONS
Credits: 3
Microcontroller hardware structures. Basic software concepts such as constants, variables, control structures and subroutine calls, based on the 'C' language and as translated to machine language. Mapping of compiled software to the memory of a microcontroller. Embedded programming principles. Basic interactions with peripherals. Interrupts and their use. Debugging. Three hours of lecture and lab per week.

Pre-Requisites
EGR-140 or CS-125.

EE-251. ELECTRONICS I
Credits: 3
Circuit concepts involving nonideal components, particularly diodes, bipolar transistors, and MOS transistors. Bias, load line and signal amplification principles. Analysis and design of power supply and amplifier circuits, including power amplifiers. Simulation of circuits for design and analysis.

Pre-Requisites
EE-211.

EE-252. ELECTRONICS II
Credits: 4
Multi-transistor amplifiers, operational amplifiers. Frequency response and the design of filters and amplifiers to meet frequency specifications. Feedback in amplifier design and oscillators. Three one-hour lectures and one three-hour lab per week.

Pre-Requisites

EE-271. SEMICONDUCTOR DEVICES
Credits: 3
Basic properties of semiconductors and their conduction processes, with special emphasis on silicon and gallium arsenide. Physics and characterizations of p-n junctions. Homojunction and heterojunction bipolar transistors. Unipolar devices including MOS capacitor and MOSFET. Microwave and photonic devices.

Pre-Requisites

EE-283. ELECTRICAL MEASUREMENTS LAB
Credits: 1
A laboratory for the development of measurement techniques and use of electrical instruments for the measurement of various electrical quantities. One two-hour lab per week.

EE-298. TOPICS IN ELECTRICAL ENGINEERING
Credits: 1-3
Selected topics in the field of electrical engineering. Requirements: Sophomore standing and permission of the instructor.

Pre-Requisites
Sophomore standing and permission of the instructor.

EE-314. CONTROL SYSTEMS
Credits: 3

Pre-Requisites
EE-211 and EGR-214 (or PHY-214)

EE-325. ENERGY CONVERSION DEVICES
Credits: 3
Magnetic circuit calculations. Principle of operation and applications of transformers, DC machines, synchronous machines, and induction motors. Applications of power electronics. Direct energy conversion schemes. Lecture and lab.

Pre-Requisites
EE-251.

EE-337. ENGINEERING ELECTROMAGNETICS I
Credits: 3
Waves and phasors; concepts of flux and fields; transmission line, Smith chart, and impedance matching; vector calculus; Maxwell’s equations for electrostatic and magnetostatic fields.

Pre-Requisites
EE-339. ENGINEERING ELECTROMAGNETICS II  
**Credits:** 4  
Maxwell’s equation for time-varying fields; boundary conditions and boundary value problems; plane wave propagation; reflection, refraction, and wave guides; stripline; s-parameters and microwave devices; directional coupler, attenuator; radiation and antennas; satellite communication systems and radar sensors. Three hours of lecture and one three-hour lab per week.  
[Click here for course fees.]

**Pre-Requisites**  
EE-337

EE-342. MICROCONTROLLER BASED SYSTEM DESIGN  
**Credits:** 3  
Microprocessor architecture, the microcontroller based system design context, and peripheral interfacing. C and machine language programming and debugging, and embedded applications. Associated laboratory exercises include topics such as stand-alone system programming, interfacing to peripherals, interrupts, timers, analog data acquisition, and intercomputer communications. Two hours of lecture and one two-hour lab per week.  
[Click here for course fees.]

**Pre-Requisites**  
EE-241, and either EE-247 or CS-126 as corequisites.

EE-345. COMPUTER ORGANIZATION  
**Credits:** 3  
Number representation, digital storage devices, and computational units, bus structures; execution sequences and assembly language concepts; control units with horizontal and vertical microcoding; addressing principles and sequencing; microprocessors; basic input and output devices; interrupts; survey of RISC principles including pipelined execution. Lecture and lab.  
[Click here for course fees.]

**Pre-Requisites**  
EE-241.

EE-381. MICROFABRICATION LAB  
**Credits:** 3  
The theoretical and practical aspects of techniques utilized in the fabrication of bipolar junction transistors (BJTs). Includes crystal characteristics, wafer cleaning, oxidation, lithography, etching, deposition, diffusion, metallization, process metrics, and device characterization. One-and-a-half hour lecture and one four-hour lab per week. Requirement: Junior engineering standing  
[Click here for course fees.]

EE-382. MODERN COMMUNICATION SYSTEMS  
**Credits:** 4  
Introduction to probability and statistics and their use in communication systems. Fundamental properties of signals, principles of signal processing, multiplexing, modulator-demodulator design, noise and its effects. Sampling theorem and Nyquist’s criteria for pulse shaping; signal distortion over a channel; line coding; signal to noise ratios, and performance comparison of various communication systems.  
[Click here for course fees.]

**Pre-Requisites**  
EE-252, EE-337, EGR-214 (or PHY-214)

EE-391. SENIOR PROJECTS I  
**Credits:** 1  
Design and development of selected projects in the field of electrical engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. A professional paper and detailed progress report are required. Requirement: Senior standing in engineering.  
[Click here for course fees.]

**EE-392. SENIOR PROJECTS II**  
**Credits:** 2  
Design and development of selected projects in the field of electrical engineering under the direction of a staff member. Technical as well as economic factors will be considered in the design. This is a continuation of the EE-391. A professional paper to be presented and discussed in an open forum is required.  
[Click here for course fees.]

**Pre-Requisites**  
EE-391.

EE-398. TOPICS IN ELECTRICAL ENGINEERING  
**Credits:** 3  
Requirement: Junior standing in engineering.

**PHY. PHYSICS**

PHY-198-298-398. TOPICS IN PHYSICS  
**Credits:** variable  
Selected topics in the field of physics. These may include one or more of the following: astronomy; geophysics; biophysics; nuclear power and waste; relativity; quantum mechanics; semi-conductors; cryogenics; health physics. May be repeated for credit.

**Pre-Requisites**  
Varies with topic studied.

PHY-395-396. INDEPENDENT RESEARCH  
**Credits:** 1 - 3  
Independent study and research for advanced students in the field of physics under the direction of a staff member. A research paper at a level significantly beyond a term paper is required.  
**Pre-Requisites**  
Senior standing and approval of the department chairperson.

PHY-105. CONCEPTS IN PHYSICS  
**Credits:** 3  
Basic concepts of physical science, including the scientific method, will be studied. Theories, laws, and experiments from mechanics, electricity and magnetism, thermodynamics, optics, and atomic and nuclear physics may be included. Viewpoints will be classical and modern, including quantum and relativistic. Class meets for four hours per week: two hours of lecture and one two-hour lab each week.  
[Click here for course fees.]

**Pre-Requisites**  
No previous background in either science or college-level mathematics is required.
Electrical Engineering

PHY-170. CONCEPTS IN PHYSICS AND CHEMISTRY
Credits: 4
An overview of Classical Mechanics, Thermodynamics, and the elementary principles of modern physics, including selected topics in basic chemistry and applications to human health. Emphasis is placed on basic physical and chemical principles and on algebraic calculations, scaling, units conversions, Cartesian graphing, acid and base reactions, and numerical problem solving. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week.
Click here for course fees.

Pre-Requisites
Previous courses in chemistry, algebra, and geometry.

PHY-171. PRINCIPLES OF CLASSICAL AND MODERN PHYSICS
Credits: 4
An introductory course designed to promote and understanding of the more important fundamental laws and methods of mechanics and electricity and magnetism. Laboratory work to emphasize basic principles and to acquaint the student with measuring instruments and their use, as well as the interpretation of experimental data. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: MTH-111
Click here for course fees.

PHY-174. APPLICATION OF CLASSICAL AND MODERN PHYSICS
Credits: 4
An introductory course designed to promote an understanding of the more important fundamental laws and methods of heat, optics, and modern physics. Laboratory work to emphasize basic principles and to acquaint the student with measuring instruments and their use, as well as the interpretation of experimental data. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: MTH-111
Click here for course fees.

PHY-201. GENERAL PHYSICS I
Credits: 4
A thorough grounding in the concepts, principles, and laws of mechanics, thermodynamics, and wave motion. Instruction by demonstration and lecture, recitation, problem solving, and experimental work. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week. Co-requisite: MTH-111
Click here for course fees.

PHY-202. GENERAL PHYSICS II
Credits: 4
Electricity and magnetism, optics and light. Three hours of demonstration and lecture, one hour of recitation, and two hours of lab per week.
Click here for course fees.

Pre-Requisites
PHY-201, Co-requisite MTH-112.

PHY-203. MODERN PHYSICS
Credits: 3
Modern physics including the experimental basis, concepts, and principles of atomic and nuclear physics. Three hours of demonstration and lecture per week.

Pre-Requisites
PHY-202.

PHY-206. MODERN PHYSICS LAB
Credits: 1
Experiments leading to the development of relativity and quantum theory to reinforce abs expand upon the learning of fundamental concepts in EM theory, relativity, statistical mechanics, quantum mechanics, solid state physics, and nuclear physics.
Click here for course fee.

Pre-Requisites
PHY-202.
Co-Requisites
PHY-203

PHY-214. MODELING OF PHYSICAL SYSTEMS
Credits: 3
Modeling of various problems in physical, chemical, biological, and environmental sciences, particularly physical dynamical systems; includes application of ordinary differential equations, and Laplace, Fourier, and Z transforms to continuous and discrete processes, matrix mechanics and eigenvalue problems, statistics and probability, random processes and distribution functions.
2 hours of lecture and 2 hours of laboratory per week
Click here for course fee.

Pre-Requisites
MTH-211, EGR-140 or CS-125

PHY-311. THERMODYNAMICS & STATISTICAL MECHANICS
Credits: 3
This course focuses on the laws of thermodynamics and other thermodynamic concepts including entropy, free energy, equilibrium, and fluctuations as well as their pivotal role in physics and other scientific disciplines. Topics in statistical mechanics will be covered including partition functions, ensembles, kinetic theory, and phase transitions. Three hours of lecture per week.

Pre-Requisites
PHY-203 and MTH-211.
**PHY-312. ANALYTICAL MECHANICS**  
**Credits:** 3  
Employs advanced mathematical tools to study applications in complex mechanical systems. It offers an advanced differential reformulation of Newton's laws to study dynamical systems in multiple dimensions, conservative force fields, damped and driven oscillations, two-body problem, central forces and planetary motion, and the rotational dynamics of rigid bodies. Additionally, the course delivers a thorough grounding on the calculus of variations, Lagrange's formalism and Hamiltonian mechanics, all being the essential foundations for the development of modern physics (relativity, quantum mechanics, and quantum field theory). Three hours of lecture per week.

**Pre-Requisites**  
PHY-202 and MTH-211.

**PHY-314. QUANTUM MECHANICS**  
**Credits:** 3  
This course presents an intermediate level of Quantum Mechanics using the abstract formulation of linear vector spaces in the Dirac formalism. Topics covered include: spin, addition of angular momentum, scattering and bound particles, the harmonic oscillator, two-body problem and central potential wells in 3D, H-atom and H-like atoms, time-independent perturbation theory, identical particles and the He-atom. In addition to the foundations of Quantum Mechanics, the course offers a selection of advanced and modern topics like entanglement and quantum teleportation. Three hours of lecture per week.

**Pre-Requisites**  
PHY-203, CHM-115, MTH-211, and MTH-212.

**PHY-374. IMAGING IN BIOMEDICINE**  
**Credits:** 3  
This course will cover different aspects of imaging important to medicine and biomedicine including optical microscopy, scanning probe microscopy, scanning electron microscopy, magnetic resonance, ultrasound X-ray, nuclear radiation, microwave and electro-/magneto-encephalographic techniques as well as image processing. Three hours of lecture and three hours of lab per week.

**Pre-Requisites**  
PHY-201 & PHY-202 or PHY-171 & PHY-174, MTH-112.

**PHY-377. BIOPHYSICS**  
**Credits:** 3  
This course presents an overview of the important physical principles governing the behavior of cells and macromolecules. Upper-level mathematics that are useful to understand these phenomena are introduced in a way that is comprehensible to biology majors lacking background beyond basic calculus. In addition to the physical models governing the most ubiquitous molecular and cellular processes, the physics behind the most common experimental techniques used in biology, bioengineering, and biophysics are covered. Three hours of lecture and two hours of lab per week.

**Pre-Requisites**  
PHY-201 & PHY-202 or PHY-171 & PHY-174, MTH-112.

**PHY-391. SENIOR PROJECT I**  
**Credits:** 1  
Students will plan and execute a research project in the field of physics or at the intersection of physics and another related discipline. Projects can be theoretical, experimental or both and can include the design of unique experiments and simulations. A detailed progress report and presentation are required. Students pursuing a dual degree or double major may be eligible to combine this project with the capstone project of another program (subject to the approval of their advisors in both programs).

**Pre-Requisites**  
Senior standing in Physics

**PHY-392. SENIOR PROJECT II**  
**Credits:** 2  
Students will plan and execute a research project in the field of physics or at the intersection of physics and another related discipline. This is a continuation of PHY 391. A professional paper and progress report are required. Students will present the results of their work in an open-forum. Students pursuing a dual degree or double major may be eligible to combine this project with the capstone project of another program (subject to the approval of their advisors in both programs).

**Pre-Requisites**  
PHY-391