

# Electrical Engineering

*College of Science, Engineering and Technology*  
*Department of Electrical & Computer Engineering and Technology*

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Web site: [www.ee.mnsu.edu](http://www.ee.mnsu.edu)

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Electrical Engineering (EE) encompasses research, development, design and operation of electrical and electronic systems and their components. This program leads to a Bachelor of Science in Electrical Engineering (BSEE). The primary objective of the Electrical Engineering program is to educate engineering professionals who possess a sound design and analytical background coupled with a strong laboratory experience. This means that the department expects to prepare its graduates equally for:

1. Entry into the engineering work environment with well developed design and laboratory skills.
2. Further study toward advanced degrees in engineering and other related disciplines.
3. Advancement into managerial ranks and/or entrepreneurial endeavors.

In support of this objective, the program provides a curriculum including the following components that follow the guidelines set forth by ABET:

1. A strong background in the physical sciences, mathematics, and the engineering sciences including extensive hands-on laboratory instruction.
2. An integrated design component to the curriculum including instruction in basic practices and procedures, creativity, control, economics, and synthesis. The process begins with basic instruction during the freshman year and concludes with a capstone design project.
3. A choice of several subdisciplines in their senior level elective offerings (digital, controls, communications, microelectronics design and fabrication).
4. Opportunities for students to develop sensitivity to the social and humanistic implications of technology and motivate them to make worthwhile contributions to the profession and society, while upholding the highest standards of professional ethics.
5. Courses in business and economics to promote awareness of management and the economic aspects of engineering.
6. Preparation for continuing study and professional development.

The curriculum offers students the opportunity to emphasize a number of specialized areas including digital systems, wireless communications, controls, and material sciences. During the senior year, students must take the first step toward registration as a professional engineer by taking the Fundamentals of Engineering, FE or EIT, examination. The electrical engineering program is accredited by the Engineering Accreditation Board for Engineering and Technology.

MSU offers a 3/2 program with regional Liberal Arts colleges. Contact the department for more information.

Recommended high school preparation is two years of algebra, one year of geometry, one-half year of trigonometry, one-half year of college algebra, and a year each of physics and chemistry. Without this background it may take longer than four years to earn the degree. The first two years students take science and mathematics courses common to all branches of engineering (pre-engineering), as well as supporting work in English, humanities and social sciences. Second-year electrical engineering students complete physics, mathematics and 200-level engineering science courses. Some specialization for a particular engineering major occurs in the second year.

**Admission to Major.** Admission to the college is necessary before enrolling in 300- and 400-level courses. Admission to the college is granted by the department. Minimum college admission requirements are:

- a minimum of 32 earned semester credit hours.
- a minimum cumulative GPA of 2.00 (C).

Contact the department for application procedures.

During the sophomore year, students should submit an application form for admission to the junior-level electrical engineering program. Admission to the program is selective and, following application to the department, subject to approval of the faculty. The department makes a special effort to accommodate transfer students and has joint admissions agreements with most community colleges. Only students admitted to the program are permitted to enroll in upper-division EE courses. No transfer credits are allowed for upper-division EE courses except by faculty review followed by special written permission.

Before being accepted into the program and admitted to 300-level electrical engineering courses (typically in the fall semester), a student must complete a minimum of 46 semester credits as follows:

- General Physics (calculus-based) (10 credits)
- Calculus and Differential Equations (16 credits)
- Electrical Engineering Circuit Analysis I and II (including laboratory) (7 credits)
- Chemistry (5 credits)
- English Composition (4 credits)
- Computer Sciences (FORTRAN, C, or C++) (2 credits)
- Statics and/or Dynamics (3 credits)

A cumulative grade-point average of 2.5 for all science, math and engineering courses must have been maintained. Grades must be C or better for courses to be

accepted. MSU students should complete the pre-engineering courses listed under the major.

**GPA Policy:** Students graduating with a degree in Electrical Engineering must have 1) completed a minimum of 20 semester credit hours of upper division EE course work; 2) have a cumulative GPA of 2.25 or higher on all upper division MSU EE coursework; 3) have completed their senior design sequence at MSU; and 4) have taken the FE exam and achieved the competency level set by the department.

**P/N Grading Policy:** A student who majors in EE must elect the grade option for all required courses including general education courses listed by number even if offered by another department.

## ELECTRICAL ENGINEERING BSEE

### Required for Major (Prerequisites, 47 credits):

CHEM	201	General Chemistry I (5)
COMS	171	Intro. to C++ Programming (2)
EE	230	Circuit Analysis I (3)
EE	231	Circuit Analysis II (3)
EE	240	Evaluation of Circuits (1)
ENG	101	Composition (4)
MATH	121	Calculus I (4)
MATH	122	Calculus II (4)
MATH	223	Calculus III (4)
MATH	321	Ordinary Differential Equations (4)
ME	212	Statics (3)
PHYS	221	General Physics I (5)
PHYS	222	General Physics II (5)

### Required for Major (General Studies, 19 credits):

ENG	271	Technical Communication (4) <b>or</b>
SPEE	233	Public Speaking for Technical Professionals (3)

\* SPEE 102 Public Speaking (3) may be substituted. Choose a minimum of 13 credits from Humanities and Social Sciences courses:

### Humanities (6-7 credits)

HUM xxx    HUM xxx    HUM xxx

In general, graduation credit toward the humanities requirement is not allowed for any course in subject areas such as speech communication, writing, art, music, or theatre that involve performance or practice of basic skills. Courses acceptable by department or program include: ART 160, 260, 261, 413, 416, 419, 460, 462, 463, 466, 469; ENG 112, 113, 114, 271, 320, 321, 325, 327, 328, 331, 332, 400, 401, 402, 403, 405, 406, 416, 478, 479, 481; FOREIGN LANGUAGE 200 level or above; HIST all except 490 and higher; HUM 150, 155, 250, 251\*, 280, 281, 282; MASS 110, 411, 412; MUS 120, 125, 126, 220, 221, 222, 422, 423, 424, 425, 426, 429, 432; PHIL all except 490 and higher; SPEE 100-203, 300, 315-403, 412, 413; THEA 100, 252, 283, 285, 481, 482. For other acceptable courses, please consult with your advisor.

\*Note: EET 125 may be substituted for HUM 250

## Social Sciences (6-7 credits)

SS    xxx    SS    xxx    SS    xxx

Courses acceptable by department or program include: ANTH all courses except 480 and above; GEOG 100, 101, 103, 340, 341, 425, 430, 435, 437, 445, 446, 450, 454, 456; POL all except 420, 421, 422, 490 and above; PSYC all except 201, 202, 291, 303, 390, 391, 473 and above; SOC all except 201, 202, 466, 469, 470, 485 and above; URBS all except 301, 302, 481 and above; WOST all except 260, 277, 290, 320, 430, 460 and above. For other acceptable coursework, please consult your advisor.

At least 3 credits of the courses selected to complete the above requirements must be 300 level or above. At least one 300 level course must follow a lower level course in the same subject area.

Choose one course from the following:

ECON	201	Principles of Macroeconomics (3)
ECON	202	Principles of Microeconomics (3)

### Required Core for Major (Engineering, 48 credits):

EE	101	Introduction to Engineering I (1)
ME	103	Introduction to Engineering III (1)
EE	244	Introduction to Digital Systems (2)
EE	254	Digital and Circuits Lab (1)
EE	303	Introduction to Solid State Devices (3)
EE	304	Introduction to Solid State Devices Lab (1)
EE	332	Electronic Circuits and Devices (4)
EE	333	Digital and Analog Electronic Systems (4)
EE	334	Microprocessor Engineering (3)
EE	337	Principles of Engineering Design (1)
EE	341	Signals and Systems (3)
EE	342	Electronics Design Laboratory (1)
EE	344	Design and Evaluation of Microprocessors (1)
EE	350	Engineering Electromagnetics (4)
EE	353	Communication Systems Engineering (2)
EE	358	Control Systems (3)
EE	363	Communication Systems Laboratory (1)
EE	368	Control Systems Laboratory (1)
EE	467	Principles of Engineering Design I (2)
EE	477	Principles of Engineering Design II (2)
EE	482	Electromechanics (3)
EE	488	Thermal Systems Engineering (2) <b>or</b>
ME	299	Thermal Analysis (2)
ME	291	Engineering Analysis (3) <b>or</b> MATH 354
Concepts of Probability and Statistics (3)		

### Required for Major (Business, 5 credits):

EE	250	Engineering Economics (2)
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Choose one course from the following list:

BLAW 200, FIRE 362, MGMT 330 or 440, MRKT 310

### Required Electives for Major (9 credits):

Choose a minimum of 9 credits from the following courses. Two courses must be in sequence (same subject area):

EE	453	EE	462	EE	471
EE	472	EE	475	EE	476
EE	479	EE	480	EE	481
EE	484	EE	487		

**Required Minor: None.**

**No minor or other major accepted toward degree.**

## COURSE DESCRIPTIONS

### EE 101 (1) Introduction to Engineering I

Discussion of historical, educational, and professional aspects of engineering. Problem solving, study approaches and techniques, and the motivation behind modern engineering education and practices. Lab sessions cover the basics of word processing, spreadsheets, databases, drawing, and graphing programs.

F

### EE 230 (3) Circuit Analysis I

This course is meant to develop Electrical Engineering Circuit Analysis skills in DC and AC circuits. It includes circuit laws and theorems, mesh and node analysis, sinusoidal steady state analysis, impedance/ admittance concepts, resonant circuits, frequency response, and first order circuit transients.

Pre: PHYS 222 or concurrent, MATH 321 or concurrent F

### EE 231 (3) Circuit Analysis II

Continuation of Circuit Analysis I to include special topics in circuit analysis.

Pre: EE 230 and 240, MATH 321, PHYS 222 S

### EE 240 (1) Evaluation of Circuits

Laboratory support for EE 230. Experimental evaluation of circuits including operational amplifier circuits. Verification of the theoretical concepts covered in EE 230 will be realized in the laboratory.

Pre: Must take concurrently with EE 230 F

### EE 244 (2) Introduction to Digital Systems

A study of theoretical and practical aspects of digital systems including Boolean algebra, number systems, logic devices, Karnaugh maps, and sequential machines.

Pre: MATH 122 S

### EE 250 (2) Engineering Economics

Overview of accounting and finance and their interactions with engineering, manufacturing, marketing, R&D and sales. Lectures include the development and analysis of financial statements, time value of money, decision making tools (stochastic and non-stochastic), ratio analysis, cost of capital, cash flow, rate of return and forecasting techniques.

F

### EE 253 (1) Logic Circuits Lab

Laboratory support to complement EE

244. Experimental evaluation of digital logic devices including logic gates, flipflops, sequential machines, and other devices as needed. Some simulation and testing of PAL devices and memory IC's will be attempted.

Pre: EE 230 and concurrently with EE 244 S

### EE 254 (1) Digital and Circuits Lab

Laboratory support for EE 231 and EE 244. Experi-

mental evaluation of AC and transient circuits, digital logic devices including logic gates, flip flops, and sequential machines. Some simulation and testing of PAL devices and memory IC's.

Pre: EE 230, 240 and concurrently with EE 231 and 244 S

### EE 303 (3) Introduction to Solid State Devices

Crystal structure, energy band theory, conduction and optical phenomenon in semiconductors, metals and insulators. Equilibrium and non-equilibrium charge distribution, generation, injection, and recombination. Analysis and design of PN-junctions, (bipolar transistor, junction) and MOS field-effect transistors. Introduction to transferred electron devices and semiconductor diode laser.

Pre: PHYS 222, and MATH 321 F

### EE 304 (1) Lab: Introduction to Solid State Devices

Laboratory support for EE 303. Experiments include resistivity and sheet resistance measurements of semiconductor material, probing material, probing of IC chips, PN-junction IV and CV measurements, BJT testing to extract its parameters, MOSFET testing and evaluating its parameters, cv-measurements of MOS structure, and familiarization with surface analysis tools.

F

### EE 332 (4) Electronic Circuits and Devices

Electronic amplifier concepts and real operational amplifier networks. Semiconductor device characteristics including Diodes, BJT's, JFET's, MOSFET's, and GaAsFET's. Also discuss DC bias circuits, along with small signal, large signal, and PSPICE device modeling and analysis. Small-signal amplifiers (single and multistage), power amplifiers, differential amplifiers, and feedback amplifiers, concepts and design will all be discussed.

Pre: EE 231, admission to EE program F

### EE 333 (4) Digital and Analog Electronic Systems

EE electronics sequence with EE

332. Feedback systems/ stability; oscillator concepts and systems. Filters and tuned amplifiers. Design of IC operational amplifier. Hysteresis, bi-stability and nonlinear functional circuits; 555 timer. A/D and D/A converters. MOS and bipolar digital electronic circuits; memory. Electronic noise. Power switching devices.

Pre: EE 332 S

### EE 334 (3) Microprocessor Engineering

Use of microprocessors and microcontrollers in engineering applications. Topics include assembly language programming, smart and programmable controllers, memory design including dynamic memory and direct memory access, bus standards and protocol, serial and parallel I/ O, interfacing with other programmable systems, maskable and non-maskable interrupts.

Pre: EE 244 F

### EE 337 (1) Principles of Engineering Design

Application of the design techniques in the engineering

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profession. Electrical engineering project and program management and evaluation including computer assisted tools for planning and reporting, design-to-specification techniques and economic constraints.

Pre: Admission to EE program S

### **EE 341 (2) Signals & Systems**

Analysis of linear systems and signals in the time and frequency domain. Laplace and Fourier transforms. Ztransform and discrete Fourier transform.

Pre: MATH 321 F,D

### **EE 342 (1) Electronics Design Laboratory**

Properties of materials; measurement of electronic device characteristics. Experimental evaluation of electronic amplifier designs. Experimental characteristics of feedback topologies; oscillator and op-amp circuit design and design verification. Power amplifier graphical design.

Pre: EE 231 and 332 taken concurrently F

### **EE 344 (1) Design & Evaluation of Microprocessors**

Laboratory support for EE 334. Study of various single board computers through assembly language programming. Basic input/output, ports, memory, addressing, timers, A/D converters, serial and parallel communication protocol, and interrupt processing. One half design credit.

Pre: Concurrent with EE 334 F

### **EE 350 (4) Engineering Electromagnetics**

Vector fields. Electrostatic charges, potential and fields; displacement. Steady current/current density; magnetostatic fields, flux density. Materials properties. Faraday's Law and Maxwell's equations. Skin effect. Wave propagation, plane waves, guided waves. Radiation and antennas. Transmission line theory.

Pre: MATH 223 and PHYS 222 S

### **EE 353 (2) Communication Systems Engineering**

Signals and Systems, Fourier transforms, Parseval's theorem. Autocorrelation functions and spectral density functions. Information theory. Noise and noise figure, probability and statistics. Transformation of random variables, probability of error and bit error rate. Modulation and demodulation. Overview of analog, sampled analog and digital communication systems. Spread spectrum systems.

Pre: EE 332 S

### **EE 358 (3) Control Systems**

Theory and principles of linear feedback control systems. Analysis of linear control systems using conventional techniques like block diagrams, Bode plots, Nyquist plots and root-locus plots. Introduction to cascade compensation: proportional, derivative and integral compensation. State space models.

Pre: EE 341 S

### **EE 363 (1) Communication Systems Laboratory**

Measurement techniques using the oscilloscope, spectrum analyzer and network analyzer. Signals and spectra. Frequency response. Noise and noise figure measurements. Intermodulation products. Amplitude and frequency modulation/demodulation. Sampling, aliasing, and intersymbol interference. Bit error measurement.

Pre: Concurrent with EE 353 S

### **EE 368 (1) Control Systems Laboratory**

Laboratory support for EE 358. Experimental evaluation of basic control system concepts including transient response and steady state performance. Analog and digital computers.

Pre: EE 341 and concurrent with EE 358 S

### **EE 380 (2) Advanced Digital**

Combinatorial circuit design with Karnaugh map and tabular method; using MSI chip as building blocks in a digital system; circuits of latches, flip-flops, and registers; design of counters; types of sequential circuits; design process of sequential circuits; minimization of sequential circuit design by performing state reduction and state encoding optimization; syntax and semantics of VHDL language; using VHDL in modeling and simulation digital circuits; implementation of digital system in complex programmable logic devices (CPLDs).

F

### **EE 439 (3) Electronics for Non-Electrical Engineering Majors**

Topics covered include power supplies, operational amplifiers and feedback circuits, linear and nonlinear circuits and applications, analog switches, digital logic gates and devices, A/D and D/A converters, microprocessors, and basic control systems.

Pre: PHYS 221 and 222 V

### **EE 453 (3) Advanced Communications Systems Engineering**

Fundamentals of RF, microwave, and optical communication systems. Advanced information theory. Digital modulation techniques. Phase-lock loop receivers and frequency synthesizers. Characterization of digital data transmission systems. Equalization. Synchronization. Coding. Data compression. Nonlinear systems analysis. Amplitude and phase distortion. AM-PM conversion. Intermodulation and cross-modulation. Advanced spread spectrum systems.

Pre: EE 353 and 363 F

### **EE 462 (3) Advanced Digital Systems**

A study of finite state machine design, hardware description language, principles of instruction execution, instruction pipe lining, superscalar processor design, multiprocessor systems and memory system design.

Pre: EE 333 and 334 F

### **EE 467 (2) Principles of Engineering Design I**

Design and organization of engineering projects. Project proposals, reporting, feasibility studies, and interpretation. Specification preparation, interpretation, and control. Issues involving creativity, project planning and control, and intellectual property rights. Students enrolled in this course must initiate and complete a design project in a small team format.

Pre: EE 337 and senior standing F

### **EE 471 (3) Advanced Control Systems**

Develop design and analysis techniques for continuous

and discrete time control systems including pole placement, state estimation and optimal control.

Pre: EE 358 and 368 F

### **EE 472 (3) Digital Signal Processing**

Develop design and analysis techniques for discrete signals and systems via Z-transforms, Discrete Fourier Transforms, implementation of FIR and IIR filters. The various concepts will be introduced by the use of general and special purpose hardware and software for digital signal processing.

Pre: EE 341 S

### **EE 475 (3) Integrated Circuit Engineering**

Introduction to theory and techniques of integrated circuit fabrication processes, oxidation, photolithography, etching, diffusion of impurities, ion implantation, epitaxy, metallization, material characterization techniques, and VLSI process integration, their design and simulation by SUPREM. Same as PHYS 467.

Pre: EE 303 and 332 F

### **EE 476 (3) Antennas, Propagation, & Microwave Engineering**

Principles of electromagnetic radiation, antenna parameters, dipoles, antenna arrays, long wire antennas, Microwave antennas, Mechanisms of radiowave propagation, scattering by rain, sea water propagation, guided wave propagation, periodic structures, transmission lines, microwave/millimeter wave amplifiers and oscillators, MIC & MMIC technology.

Pre: EE 350 V

### **EE 477 (2) Principles of Engineering Design II**

Completion of design projects and reports. Lectures on ethics, issues in contracting and liability, concurrent engineering, ergonomics and environmental issues, economics and manufacturability, reliability and product lifetimes. Lectures by faculty and practicing engineers.

Pre: EE 467 S

### **EE 479 (3) Superconductive Devices**

Magnetic and superconducting properties of materials, microscopic theory of superconductivity and tunneling phenomenon. Josephson and SQUID devices, survey of computer memories, memory cell and shift register, A/D converters and microwave amplifiers. Integrated circuit technology and high temperature superconductors.

Pre: EE 303 V

### **EE 480 (1) Integrated Circuit Fabrication Lab**

Introduction to integrated circuit fabrication processes, device layout, mask design, and experiments related to wafer cleaning, etching, thermal oxidation, thermal diffusion, photolithography, and metallization. Fabrication of basic integrated circuit elements pn junction, resistors, MOS capacitors, BJT and MOSFET in integrated form. Use of analytic tools for in process characterization and simulation of the fabrication process by SUPREM. Same as PHYS 468.

Pre: Concurrent with EE 475 F

### **EE 481 (1) VLSI Design Lab**

Laboratory to accompany EE 484 VLSI design. Individual IC design projects will be assigned using IC layout tools and simulation software. Culminates in a group project fabricatable under MOSIS.

Pre: Concurrent with EE 484 S

### **EE 482 (3) Electromechanics**

An introduction to the processes, devices, and systems of electromechanical energy conversion. Transformers, dc machines, induction, and synchronous machines.

Pre: EE 230 F

### **EE 484 (3) VLSI Design**

VLSI technology. MOS and Bipolar transistor theory, SPICE models. Transistor structure and IC fabrication processes; layout design rules. Custom CMOS/BICMOS logic design and layout topologies; cell layout/chip partitioning/ clocking. Bipolar/MOS analog circuit design and layout. Group design project. Library research study.

Pre: EE 333 S

### **EE 487 (3) RF Systems Engineering**

Overview of wireless communication and control systems. Characterization and measurements of two-port RF/IF networks. Transmission lines. Smith chart. Scattering parameters. Antenna-preselector-preamplifier interface. Radio wave propagation. Fading. RF transistor amplifiers, oscillators, and mixer/modulator circuits. Multiple access techniques. Transmitter/receiver design considerations. SAW matched filters.

Pre: EE 353 and 363 V

### **EE 488 (2) Thermal Systems Engineering**

Thermodynamic concepts, properties and laws. Thermodynamic cycles and energy conversion; control volume analysis. Heat transfer by conduction, convective flow and radiation. Heat sink design. Design problems in electronics packaging, reliability, thermoelectric effects and cooling devices. Environmental property sensors.

Pre: PHYS 222 and EE 333 V

### **EE 491 (1-4) In-Service**

### **EE 497 (1-6) Internship**

### **EE 499 (1-6) Individual Study**