Electrical Engineering
College of Science, Engineering and Technology
Department of Electrical & Computer Engineering and Technology
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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 prepares its graduates 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 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) examination. The electrical engineering program is accredited by the Engineering Accreditation Board for Engineering and Technology (ABET).

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. 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 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.

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 including the following:
- 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 in 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.

Petition to evaluate transfer credits must occur no later than the first semester the student is enrolled at Minnesota State University, Mankato.

P/N Grading Policy: A student who majors in EE must elect the grade option for all courses 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) or

**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 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, 240, 241, 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:

- EE 101 Introduction to Engineering I (1)
- ME 103 Computer Graphics Communications (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 Electronics I (4)
- EE 333 Electronics II (4)
- EE 334 Microprocessor Engineering (3)
- EE 337 Principles of Engineering Design I (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)
- ME 299 Thermal Analysis (2)
- ME 291 Engineering Analysis (3) or MATH 354 Concepts of Probability and Statistics (3)

Required Core for Major (Engineering, 48 credits):

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

Recommended Core for Major (Engineering, 48 credits):

- EE 201 Principles of Macroeconomics (3)
- ECON 202 Principles of Microeconomics (3)
- EE 250 Engineering Economics (2)

Choose one course from the following list:

- BLAW 200, FINA 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 as well as preparation of plan to graduation, and study techniques.

**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. Natural and step response of RL, RC, and RLC circuits.

Pre: PHYS 222 or concurrent, MATH 321 or concurrent

**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

**EE 240 (1) Evaluation of Circuits**

Prerequisites: Must be taken concurrently with EE 230.

**EE 244 (2) Introduction to Digital Systems**
Simple coding schemes, Boolean algebra fundamentals, elements of digital building blocks such as gates, flip-flops, shift registers, memories, etc.; basic engineering aspects of computer architecture.

**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, ratio analysis, cost of capital, depreciation, taxes, cash flow, rate of return and forecasting.

**EE 253 (1) Logic Circuits Lab**
Laboratory support to complement EE 244. Use of laboratory instrumentation to measure characteristics of various logic circuits and digital subsystems. Experimental evaluation of digital logic devices and circuits including logic gates, flip-flops, and sequential machines.

Prerequisite: EE 230 and concurrent with EE 244.

**EE 254 (1) Digital and Circuits Lab**
Laboratory support for EE 231 and EE 244. Experimental evaluation of AC and transient circuits, digital logic devices including logic gates, flip-flops, and sequential machines.

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

**EE 298 (1-4) Topics**
Varied topics in Electrical and Computer Engineering. May be repeated as topics change.

Prerequisite: to be determined by course topic.

**EE 303 (3) Introduction to Solid State Devices**
Introduction to crystal structure, energy band theory, conduction and optical phenomenon in semiconductors, metals and insulators. Study of 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

**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, BJF testing to extract its parameters, MOSFET testing and evaluating its parameters, cv-measurements of MOS structure, and familiarization with surface analysis tools.

**EE 332 (4) Electronics I**
Electronic amplifier concepts and real operational amplifier networks. Semiconductor device characteristics including diodes, BJF’s, JFET’s and MosFET’s. Analyzing DC bias circuits, large and small signal analysis, large and small parameter, MOSFET testing and evaluating its parameters, cv-measurements of MOS structure, and familiarization with surface analysis tools.

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design will be discussed.

EE 333 (4) Electronics II
This is the second course of the electronics sequence. Design and analysis skills will be developed by examining the 741 and related devices. Additional course topics include filters, tuned circuits, signal generators, and wave-shaping. Digital circuits including the basics of various forms of MOS and bipolar digital logic and memory will be studied.
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 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. Z-transform and discrete Fourier transforms.
Pre: MATH 321 F

EE 342 (1) Electronics Laboratory
This lab is designed to accompany EE 332. The lab covers the experimental measurement and evaluation of diode, BJT, and MOS characteristics; various feedback topologies; oscillator and op-amp circuits; and rectifiers and filter circuits.
Pre: EE 231 and 332 taken concurrently.

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.
Pre: Concurrent with EE 334 F

EE 350 (4) Engineering Electromagnetics
Pre: MATH 223 and PHYS 222 S

EE 353 (2) Communication Systems Engineering
Pre: EE 332 S

EE 358 (3) Control Systems
Pre: EE 341 S

EE 363 (1) Communication Systems Laboratory
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: EEE 341 and concurrent with EE 358 S

EE 380 (2) Logic Synthesis and Simulation using HDLs
Design of combinational and sequential systems and peripheral interfaces. Emphasis is placed on hardware description languages, computer-aided tools, simulations and implementation.

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 Variable

EE 453 (3) Advanced Communications Systems Engineering
Behavior of analog systems and digital systems in the presence of noise, principles of digital data transmission, baseband digital modulation, baseband demodulation/detection, bandpass modulation and demodulation of digital signals. Channel coding, modulation and coding trade-offs, spread spectrum techniques, probability and information theory.
Pre: EE 353 and 363 F

EE 462 (3) Computer Architecture
A study of various computer architectures including concepts of instruction, execution, instruction pipe lining, superscalar design, multiprocessor systems, memory system design, and I/O system design.

EE 463 (3) Advanced Digital System Design
Design of combinational and sequential systems and peripheral interfaces. Design techniques using MSI and LSI components in an algorithmic state machine; implementation will be stresses. Rigorous timing analysis transmission-line effects and metastability of digital systems will be studied.
Prerequisite: EE 244

EE 467 (2) Principles of Engineering Design I
The 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
This course is a continuation of EE 358. Techniques for the analysis of continuous and discrete systems are developed. These techniques include 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, 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 Variable

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

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 Variable

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

EE 481 (1) VLSI Design Laboratory
This laboratory accompanies EE 484. The laboratory covers the basics of layout rules, chip floor planning, the structure of standard cells and hierarchical design, parasitic elements, routing, and loading. Students will learn to design and layout standard cells as well as how to use these cells to produce complex circuits. The laboratory culminates with the individual design and layout of a circuit.
Pre: Concurrent with EE 484

EE 482 (3) Electromechanics
Electrical power and magnetic circuit concepts, switch-mode converters, mechanical electromechanical energy conversion, DC motor drives, feedback controllers, AC machines and space vectors, permanent magnet AC machines and drives, induction motors and speed control of induction motors, stepper motors.
Pre: EE 230

EE 483 (3) VLSI Design
Pre: EE 333

EE 487 (3) RF Systems Engineering
Pre: EE 353 and 363 Variable

EE 488 (2) Thermal Systems Engineering