Electrical Engineering

College of Science, Engineering and Technology
Department of Electrical & Computer Engineering and Technology
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Chair: Qun Zhang
Program Coordinator: Qun Zhang

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Accreditation. The Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET. The Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET. www.ABET.org.

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 Electrical Engineering 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.

The educational objectives for our Bachelor of Science in Electrical Engineering degree are to prepare our graduates to:

1. Function as responsible members of society with an awareness of the social, ethical, and economic ramifications of their work.
2. Become successful practitioners in engineering and other diverse careers.
3. Succeed in full time graduate and professional studies.
4. Pursue continuing and life-long learning opportunities.
5. Pursue professional registration.
6. Provide educational foundation that allows for personal growth and flexibility through their career.

Our metrics for determining success in meeting these objectives include:

1. Assessment of societal, economic awareness, and ethical performance of our graduates by the graduate and employer.
2. Monitoring of the success of our graduates in the work force.
3. Monitoring of the success of our graduates in graduate and professional programs.
4. Assessment of continuing and life-long learning by the graduate (and their employer as applicable).
5. Reviewing the number and success of our students completing professional registration to advance their careers.

The Electrical Engineering degree curriculum includes the following components:

- Technical Communication (4 credits)
- Circuit Analysis I and II (including lab) (7 credits)
- General Physics I and II (calculus-based) (8 credits)
- Calculus I, Calculus II and Differential Equations (12 credits)
- Introduction to Electrical/Computer Engineering I and II (6 credits)
- Circuit Analysis I and II (including lab) (7 credits)
- English Composition (4 credits)
- Technical Communication (4 credits)
- Microprocessor course and lab (4 credits)

A cumulative GPA of 2.5 for all science and math courses must have been achieved for program admittance. Grades must be 1.65 ("C-") or better for courses to be accepted.

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 coursework;
2. have a cumulative GPA of 2.25 or higher in all upper division Minnesota State Mankato EE coursework;
3. have completed their senior design sequence at Minnesota State Mankato;
4. have taken the FE exam and achieved the competency level set by the department;
5. Grades must be 1.65 ("C-") or better for courses taken at Minnesota State Mankato to be accepted

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

All international students wishing to have transfer credits granted from non-U.S. schools will be required to use the ECE evaluation service to be completed no later than the first semester 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.

The curriculum offers students the opportunity to emphasize a number of specialized areas including power, digital systems, controls, signal processing, communications, microelectronics design and fabrication. During the senior year, students must take the first step toward registration as a professional engineer by taking the Fundamentals of Engineering (FE) examination as described in the GPA Policy below.

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

Recommended high school preparation is mathematics up to and including at least pre-calculus and a year each of physics and chemistry. Without this background it may take longer than four years to earn the degree. In 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, and the foundational electrical engineering courses in the curriculum. Second-year electrical engineering students complete remaining physics, mathematics and 200-level engineering science courses prior to starting the upper level core coursework.

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Academic Map/Degree Plan at www.mnsu.edu/programs/##All

POLICIES/INFORMATION

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

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

Please contact the department for application procedures.

During the spring semester of the sophomore year, students should submit an application form for admission to the Electrical Engineering program. Admission to the program is selective and, following applications to the department, subject to approval from the department chair. The department makes a special effort to accommodate transfer students. Only students admitted to the program are permitted to enroll in upper-division electrical engineering courses. No transfer credits are allowed for upper-division engineering courses except by department chair review and approval.

Before being accepted into the program and admitted to 300-level engineering courses (typically in the fall semester), a student must complete the following courses including all necessary prerequisites:

- General Physics I and II (calculus-based) (8 credits)
- Calculus I, Calculus II and Differential Equations (12 credits)
- Introduction to Electrical/Computer Engineering I and II (6 credits)
- Circuit Analysis I and II (including lab) (7 credits)
- English Composition (4 credits)
- Technical Communication (4 credits)
- Microprocessor course and lab (4 credits)

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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

Degree completion = 128 credits

#### Required General Education

- **CHEME 191**: Chemistry for Engineers (3)
- **ENG 101**: Composition (4)
- **ENG 271W**: Technical Communication (4)
- **MATH 121**: Calculus I (4)
- **PHYS 221**: General Physics I (4)

**ECON 201**: Principles of Macroeconomics (3)

**ECON 202**: Principles of Microeconomics (3)

#### Prerequisites to the Major

- **EE 106**: Introduction to Electrical/Computer Engineering I (3)
- **EE 107**: Introduction to Electrical/Computer Engineering II (3)

#### Major Common Core

- **EE 230**: Circuit Analysis I (3)
- **EE 231**: Circuit Analysis II (3)
- **EE 234**: Microprocessor Engineering I (2)
- **EE 235**: Microprocessor Engineering Laboratory I (1)
- **EE 240**: Evaluation of Circuits (1)

**MATH 122**: Calculus II (4)

**PHYS 222**: General Physics II (3)

**PHYS 232**: General Physics II Laboratory (1)

#### Major Restricted Electives

- **EE 334**: Microprocessor Engineering II (3)
- **EE 344**: Microprocessor Laboratory I (1)
- **EE 453**: Advanced Communications Systems Engineering (3)
- **EE 471**: Advanced Control Systems (3)
- **EE 472**: Digital Signal Processing (3)
- **EE 473**: Electrical Power Systems Analysis and Design (3)
- **EE 474**: Power Electronics (4)
- **EE 475**: Integrated Circuit Engineering (3)
- **EE 476**: Antennas, Propagation, & Microwave Engineering (3)
- **EE 479**: Superconductive Devices (3)
- **EE 480**: Integrated Circuit Fabrication Lab (1)
- **EE 481**: VLSI Design Laboratory (1)
- **EE 484**: VLSI Design (3)
- **EE 487**: RF Systems Engineering (3)
- **EE 489**: Real-Time Embedded Systems (4)

#### Other Graduation Requirements

Choose seven (7) credits from Major Restricted Electives. Choose a minimum of twelve (12) credits from Humanities (6 credits) and Social Sciences (6 credits) courses. For a complete listing of approved Humanities and Social Science courses, please consult the department website. In general, graduation credit toward the Humanities requirement is not allowed for any course in subject areas such as communication studies, writing, art, music, or theatre that involve performance or practice of basic skills. At least three (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.

#### Analysis/Probability and Statistics

Choose 3 Credits.

- **MATH 354**: Concepts of Probability & Statistics (3)
- **ME 291**: Engineering Analysis (3)

#### Business/Finance

Choose 3 Credits.

- **BLAW 200**: Legal, Political, and Regulatory Environment of Business (3)
- **FINA 362**: Business Finance (3)
- **MGMT 330**: Principles of Management (3)
- **MGMT 340**: Human Resource Management (3)
- **MKRT 310**: Principles of Marketing (3)

#### Required Minor: None.

No minor or other major accepted toward degree.

### Course Descriptions

**EE 100 (1) Explorations in Engineering**

This course offers an introduction to the various disciplines of engineering and their relationship to the principles of physics and mathematics. Students are prepared for academic success and the transition into an engineering program.

- **Fall**
- **GE-12**

**EE 106 (3) Introduction to Electrical/Computer Engineering I**

This introductory course covers digital systems topics including binary numbers, logic gates, Boolean algebra, circuit simplification using Karnaugh maps, flip-flops, counters, shift registers and arithmetic circuits. Problem solving methods, study skills and professional development will be addressed throughout the course.

- **Prerequisite:** MATH 112
- **Fall & Spring**

**EE 107 (3) Introduction to Electrical/Computer Engineering II**

This course presents algorithmic approaches to problem solving and computer program design using the C language. Students will explore Boolean expressions, implement programs using control structures, modular code and file input/output, and interface with external hardware using robots and sensors.

- **Prerequisite:** EE 106
- **Co-requisite:** EE 106

**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.

- **Prerequisite:** 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.

- **Prerequisite:** EE 230 and EE 240, MATH 321, PHYS 222

**EE 234 (3) Microprocessor Engineering I**

A course that teaches how to write computer assembly language programs, make subroutine calls, perform I/O operations, handle interrupts and resets, interface with a wide variety of peripheral chips to meet the requirements of applications.

- **Prerequisite:** EE 106, EE 107
- **Co-requisite:** EE 235

**EE 235 (1) Microprocessor Engineering Laboratory I**

Use of development boards and assembly language programming to handle interrupts, interface with parallel I/O ports, memory, and timers. Experiments will involve signal and frequency measurements, data conversions, and interface design.

- **Prerequisite:** EE 106, EE 107
- **Co-requisite:** EE 234

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

Laboratory support for EE 230. Use of laboratory instrumentation to measure currents and voltages associated with DC and AC circuits. Statistical analysis of measurement data. Measurements of series, parallel and series-parallel DC and AC circuits.

- **Prerequisite:** EE 230

- **Fall**
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 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. Spring

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. Prerequisite: EE 230, EE 240 and concurrently with EE 231 and EE 244 Spring

EE 281 (3) Digital System Design with Testability
Introduction to representing digital hardware using a hardware description language. Introduction to implementation technologies such as PAL’s, PLA’s, FPGA’s and Memories. Analysis, synthesis and design of sequential machines; synchronous, pulse mode, asynchronous and incompletely specified logic. Prerequisite: EE 106, EE 107 Variable

EE 282 (1) Digital System Design with Testability Lab
Laboratory support for EE 282 practical aspects of design and analysis of different types of sequential machines will be presented through laboratory experience. Co-requisite: EE 281

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. Prerequisite: PHYS 222, and MATH 321 Fall

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. Fall

EE 332 (3) Electronics I
Introduction to discrete and microelectronics circuits including analog and digital electronics. Device characteristics including diodes, BJTs, JFETs, and MOSFET’s will be studied. DC bias circuits, small and large signal SPICE modeling and analysis and amplifier design and analysis will be discussed. Prerequisite: EE 231 Fall

EE 333 (3) Electronics II
The second course of the electronics sequence presenting concepts of feedback, oscillators, filters, amplifiers, operational amplifiers, hysteresis, bi-stability, and non-linear functional circuits. MOS and bipolar electronic circuits, memory, electronic noise, and power switching devices will be studied. Prerequisite: EE 332 Spring

EE 334 (3) Microprocessor Engineering II
A more advanced study of microprocessors and microcontrollers in embedded system design. Use of C language in programming, interrupt interfaces such as SPI, I2C, and CAN. External memory design and on-chip program memory protection are also studied. Prerequisite: EE 341 and concurrent with EE 358 Spring

EE 336 (1) Principles of Engineering Design I
Electrical and computer engineering project and program management and evaluation techniques will be studied. Emphasis will be placed on the use of appropriate tools for planning, evaluation, and reporting on electrical and computer engineering projects. Prerequisite: Junior Standing Fall

EE 337 (1) Principles of Engineering Design II
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. Prerequisite: EE 336 Spring

EE 341 (3) Signals & Systems
Analysis of linear systems and signals in the time and frequency domain. Laplace and Fourier transforms. Z-transform and discrete Fourier transforms. Prerequisite: EE 230, MATH 321 and PHYS 222 Fall

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

EE 344 (1) Microprocessor II Laboratory
Laboratory support for EE 334. Use of development boards and C Programming language to handle I/O devices, interrupts, and all peripheral functions. Multiple functions such as timers, A/D converters, I/O devices, interrupts, and serial modules will be used together to perform desired operations. Prerequisite: Concurrent with EE 334 Fall

EE 350 (3) Engineering Electromagnetics

EE 353 (3) Communications Systems Engineering
Signals and Systems; Fourier transforms, Parseval’s theorem. Auto-correlation 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. Prerequisite: EE 341 & MATH 223 Spring

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. Prerequisite: EE 341 Spring

EE 363 (1) Communication Systems Laboratory

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. Prerequisite: EE 341 and concurrent with EE 358 Spring
EE 390 (4) Smart Sensor Systems
This course explains the interfacing method between a sensor and the microcontroller, describes the features and functions of several frequently used sensors, it then proceeds to explore the subject of sensor fusion, describes the algorithms how multiple sensors are used to extract correct and more useful information than each individual single sensor; finally the course also explores how a large number of sensor nodes are connected together via the wireless or wired networking technology using one of the few possible topologies to enable the monitoring and control of our environment to improve our life.
Prerequisite: EE 334, EE 344
Spring

EE 395 (3) Computer Hardware and Organization
High-level language constructs using a selected assembly language, design alternatives of computer processor datapath and control, memory hierarchy/management unit, use of HDL in describing and verifying combinational and sequential circuits. Design of Computer processor and memory system.
Prerequisite: EE 234, EE 235, EE 281
Spring

EE 398 (0) CPT: Co-Operative Experience
Curricular Practical Training: Co-Operative Experience is a zero-credit full-time practical training experience for one summer and on adjacent fall or spring term. Special rules apply to preserve full-time student status. Please contact an advisor in your program for complete information.
Prerequisite: EE 235. At least 60 credits earned; in good standing; instructor permission; co-op contract; other prerequisites may also apply.
Fall, Spring, Summer

EE 450 (3) Engineering Economics
Overview of accounting and finance and their interactions with engineering. Lectures include the development and analysis of financial statements, time value of money, decision making tools, cost of capital, depreciation, project analysis and payback, replacement analysis, and other engineering decision making tools.
Prerequisite: Advanced standing in the program
Fall

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.
Prerequisite: EE 353 and EE 363
Fall

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 467W (1) Principles of Engineering Design III
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.
Prerequisite: EE 337 and senior standing
Fall
WI

EE 470 (3) Wireless Networking
The features, data rate, frequency range, and operation of several wireless networking protocols such as Wi-Fi, Low Energy/Bluetooth, Near Field Communication, Radio frequency Identifier (RFID), Threads, and ZigBee that can be used to implement Internet of Things (IoT) are introduced. The electrical, functional, and procedural specifications of Wi-Fi are then examined in detail. The programming and data transfer using the hardware Wi-Fi kit are carried out to demonstrate the versatility of this protocol.
Prerequisite: EE 344
On Demand: Fall, Spring

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.
Prerequisite: EE 358 and EE 368
Fall

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.
Prerequisite: EE 341
Spring

EE 473 (3) Electrical Power Systems Analysis and Design
Power generation, transmission and consumption concepts, electrical grid modeling, transmission line modeling, electric network power flow and stability, fault tolerance and fault recovery, economic dispatch, synchronous machines, renewable energy sources and grid interfacing.
Prerequisite: EE 231 or via permission from instructor
Variable

EE 474 (4) Power Electronics
This course is designed to provide students with knowledge of the design and analysis of static power conversion and control systems. The course will cover the electrical characteristics and properties of power semiconductor switches, devices, converter power circuit topologies, and the control techniques used in the applications of power electronic systems. Laboratories consist of computer-based modeling and simulation exercises, as well as hands-on laboratory experiments on basic converter circuits and control schemes.
Prerequisite: EE 333
Spring

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.
Prerequisite: EE 303 and EE 332
Fall

EE 476 (3) Antennas, Propagation, & Microwave Engineering
Principles of electromagnetic radiation, antenna parameters, dipoles, antenna arrays, long wire antennas, microwave antennas, mechanisms of radio wave propagation, scattering by rain, sea water propagation, guided wave propagation, periodic structures, transmission lines, microwave/millimeter wave amplifiers and oscillators, MUC & MMIC technology.
Prerequisite: EE 350
Variable

EE 477W (1) Principles of Engineering Design IV
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.
Prerequisite: EE 467 and Senior Standing
Spring
WI

EE 479 (3) Superconductive Devices
Magnetic and superconducting properties of materials, microscopic theory of superconductivity and tunneling phenomena, 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.
Prerequisite: 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, BJTs and MOSFET in integrated form. Use of analytic tools for in process characterization and simulation of the fabrication process by SUPREM.
Prerequisite: Concurrent with EE 475
Fall
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.
Prerequisite: Concurrent with EE 484
Spring

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.
Prerequisite: EE 230
Fall

EE 484 (3) VLSI Design
Prerequisite: EE 333
Spring

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

EE 489 (4) Real-time Embedded Systems
This course introduces students the recent advances in real-time embedded systems design. Topics cover real-time scheduling approaches such as clock-driven scheduling and static and dynamic priority driven scheduling, resource handling, timing analysis, inter-task communication and synchronization, real-time operating systems (RTOS), hard and soft real-time systems, distributed real-time systems, concepts and software tools involved in the modeling, design, analysis and verification of real-time systems.
Prerequisite: EE 107, EE 334, EE 395
Variable

EE 491 (1-4) In-Service

EE 494 (1) Global Experience in Engineering and Technology
This class provides students pursuing a minor in "Global Solutions in Engineering and Technology" with an opportunity to explore a set of topics related to achieving success in advance of and following an international experience (internship, study abroad, etc.). Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Returning students will be required to participate in mentoring of students preparing for their international experience and provide written and/or oral presentations of various topics during the semester. This course is required both before and after participation in the international experience (min. 2 cr.).
Variable

EE 497 (1-6) Internship

EE 498 (1-4) Topics
Varied topics in Electrical and Computer Engineering. May be repeated as topics change. Prerequisite: to be determined by course topic

EE 499 (1-6) Individual Study