Electrical Engineering
College of Science, Engineering and Technology
Department of Electrical & Computer Engineering and Technology
242 Trafton Science Center N • 507-389-5747
Website: www.cset.mnsu.edu/ecet

Chair: Vincent Winstead, P.E., Ph.D.
Program Coordinator: Harry Jones, Ph.D.

Gale Allen, Nannan He, Tom Hendrickson, Han-Way Huang, Harry Jones, Rajiv Kapadia, Muhammad Kha1iq, Julio Mandojana, Vincent Winstead, Qun Zhang


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. Provide professional registration.
6. Provide foundational education that allows for personal growth and flexibility through their career.

Our metrics for determining success in meeting these objectives will 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:

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 first year and concludes with a capstone design project.
3. A choice of several sub-disciplines 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 worth while 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, communications, controls, and microelectronic 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 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 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 faculty. 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 faculty review followed by written permission.

Before being accepted into the program and admitted to 300-level engineering courses (typically in the fall semester), a student must complete a minimum of 62 semester credits including the following:

- General Physics (calculus-based) (12 credits)
- Calculus and Differential Equations (16 credits)
- Electrical Engineering Circuit Analysis I and II (including lab) (7 credits)
- Chemistry (3 credits)
- English Composition (4 credits)
- Statics (3 credits)
- Introduction to Electrical and Computer Engineering (6 credits)
- Technical Communication (4 credits)
- Microprocessor course and lab (3 credits)
- Digital Systems and Test (including 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 course work;
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; and
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.
## Electrical Engineering

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 first semester at Minnesota State 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

Degree completion = 128 credits

#### Required General Education

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 191</td>
<td>Chemistry Applications (3)</td>
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<tr>
<td>ENG 101</td>
<td>Composition (4)</td>
<td></td>
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<tr>
<td>ENG 271W</td>
<td>Technical Communication (4)</td>
<td></td>
</tr>
<tr>
<td>MATH 121</td>
<td>Calculus I (4)</td>
<td></td>
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<tr>
<td>PHYS 221</td>
<td>General Physics I (4)</td>
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</tbody>
</table>

Economics (choose 3 credits from one of the following)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ECON 201</td>
<td>Principles of Macroeconomics (3)</td>
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<tr>
<td>ECON 202</td>
<td>Principles of Microeconomics (3)</td>
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#### Prerequisites to the Major

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EE 106</td>
<td>Introduction to Electrical/Computer Eng. I (3)</td>
<td></td>
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<tr>
<td>EE 107</td>
<td>Introduction to Electrical/Computer Eng. II (3)</td>
<td></td>
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<tr>
<td>EE 230</td>
<td>Circuit Analysis I (3)</td>
<td></td>
</tr>
<tr>
<td>EE 231</td>
<td>Circuit Analysis II (3)</td>
<td></td>
</tr>
<tr>
<td>EE 234</td>
<td>Microprocessor I (2)</td>
<td></td>
</tr>
<tr>
<td>EE 235</td>
<td>Microprocessor Engineering Laboratory I (1)</td>
<td></td>
</tr>
<tr>
<td>EE 240</td>
<td>Evaluation of Circuits (1)</td>
<td></td>
</tr>
<tr>
<td>EE 281</td>
<td>Digital System Design with Testability (3)</td>
<td></td>
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<tr>
<td>EE 282</td>
<td>Digital System Design with Testability Lab (1)</td>
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<tr>
<td>MATH 122</td>
<td>Calculus II (4)</td>
<td></td>
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<tr>
<td>MATH 223</td>
<td>Calculus III (4)</td>
<td></td>
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<tr>
<td>MATH 321</td>
<td>Ordinary Differential Equations (4)</td>
<td></td>
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<tr>
<td>ME 212</td>
<td>Statics (3)</td>
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<tr>
<td>PHYS 222</td>
<td>General Physics II (3)</td>
<td></td>
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<tr>
<td>PHYS 223</td>
<td>General Physics III (3)</td>
<td></td>
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<tr>
<td>PHYS 232</td>
<td>General Physics II Lab (1)</td>
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<tr>
<td>PHYS 233</td>
<td>General Physics III Lab (1)</td>
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#### Major Common Core

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<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EE 303</td>
<td>Introduction to Solid State Devices (3)</td>
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<tr>
<td>EE 304</td>
<td>Lab: Introduction to Solid State Devices (1)</td>
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<tr>
<td>EE 332</td>
<td>Electronics I (3)</td>
<td></td>
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<tr>
<td>EE 333</td>
<td>Electronics II (3)</td>
<td></td>
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<tr>
<td>EE 336</td>
<td>Principles of Engineering Design I (1)</td>
<td></td>
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<tr>
<td>EE 337</td>
<td>Principles of Engineering Design II (1)</td>
<td></td>
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<tr>
<td>EE 341</td>
<td>Signals and Systems (3)</td>
<td></td>
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<tr>
<td>EE 342</td>
<td>Electronics Laboratory (1)</td>
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<tr>
<td>EE 350</td>
<td>Engineering Electromagnetics (3)</td>
<td></td>
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<tr>
<td>EE 353</td>
<td>Communications Systems Engineering (3)</td>
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<tr>
<td>EE 358</td>
<td>Control Systems (3)</td>
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<tr>
<td>EE 363</td>
<td>Communication Systems Laboratory (1)</td>
<td></td>
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<tr>
<td>EE 368</td>
<td>Control Systems Laboratory (1)</td>
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<tr>
<td>EE 450</td>
<td>Engineering Economics (3)</td>
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<tr>
<td>EE 467</td>
<td>Principles of Engineering Design III (1)</td>
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<tr>
<td>EE 477</td>
<td>Principles of Engineering Design IV (1)</td>
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<tr>
<td>EE 482</td>
<td>Electromechanics (3)</td>
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<tr>
<td>ME 299</td>
<td>Thermal Analysis (2)</td>
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#### Major Restricted Electives

(choose seven (7) credits from the following list)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>EE 334</td>
<td>Microprocessor Engineering II (3)</td>
<td></td>
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<tr>
<td>EE 344</td>
<td>Microprocessor II Laboratory (1)</td>
<td></td>
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<tr>
<td>EE 453</td>
<td>Advanced Communications Systems Engineering (3)</td>
<td></td>
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<tr>
<td>EE 471</td>
<td>Advanced Control Systems (3)</td>
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</tbody>
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### Other Graduation Requirements

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 & Statistics (choose 3 credits)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 354</td>
<td>Concepts of Probability &amp; Statistics (3)</td>
<td></td>
</tr>
<tr>
<td>ME 291</td>
<td>Engineering Analysis (3)</td>
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</tbody>
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#### Business/Finance (choose 3 credits)

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<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BLAW 200</td>
<td>Legal, Political, and Regulatory Environment of Business (3)</td>
<td></td>
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<tr>
<td>FINA 362</td>
<td>Business Finance (3)</td>
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<tr>
<td>MGMT 330</td>
<td>Principles of Management (3)</td>
<td></td>
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<tr>
<td>MGMT 340</td>
<td>Human Resource Management (3)</td>
<td></td>
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<tr>
<td>MKT 310</td>
<td>Principles of Marketing (3)</td>
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</tr>
</tbody>
</table>

#### Required Minor: None.

No minor or other major accepted toward degree.

### COURSE DESCRIPTIONS

#### EE 100 (1) Explorarion 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

#### 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.

Pre: 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.

Pre: EE 106

Spring

#### 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

Fall
EE 231 (3) Circuit Analysis II
Continuation of Circuit Analysis I to include special topics in circuit analysis.
Pre: EE 230 and EE 240, MATH 321, PHYS 222
Spring

EE 234 (2) 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.
Pre: EE 106, EE 107
Coreq: EE 235
Fall

EE 235 (1) Microprocessor Engineering Laboratory I
Use of development boards and assembly language programming to handle inter-
rupts, interface with parallel I/O ports, memory, and timers. Experiments will in-
volve signal and frequency measurements, data conversions, and interface design.
Pre: EE 106, EE 107
Coreq: EE 234
Fall

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 measure-
ment data. Measurements of series, parallel and series-parallel DC and AC circuits.
Measurement of properties for circuits using operational amplifiers. Measurement
of transient responses for R-L and R-C circuits. Simulation of DC and AC circuits
using PSPICE. Concepts covered in EE 230 will be verified in the laboratory.
Pre: Must be taken concurrently with 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. Ex-
perimental evaluation of digital logic devices and circuits including logic gates,
flip-flops, and sequential machines.
Pre: 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.
Pre: 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.
Pre: 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.
Coreq: EE 281

EE 298 (1-4) Topics
Varied topics in Electrical and Computer Engineering. May be repeated as
topics change.
Pre: to be determined by course topic

EE 303 (3) Introduction to Solid State Devices
Introduction to crystal structure, energy band theory, conduction and optical phe-
nomenon 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
Fall

EE 304 (1) Lab: Introduction to Solid State Devices
Laboratory support for EE 303. Experiments include resistivity and sheet re-
 sistance 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.
Fall

EE 332 (3) Electronics I
Introduction to discrete and microelectronics circuits including analog and digital
electronics. Device characteristics including diodes, BJT’s, JFET’s, and MOS-
FET’s will be studied. DC bias circuits, small and large signal SPICE modeling
and analysis and amplifier design and analysis will be discussed.
Pre: 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 digital electronic circuits,
memory, electronic noise, and power switching devices will be studied.
Pre: 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.
Fall

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 ap-
propriate tools for planning, evaluation, and reporting on electrical and computer
engineering projects.
Pre: 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.
Pre: 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.
Pre: 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 mea-
surement and evaluation of diode, BJT, and MOS characteristics; various feedback
topologies; oscillator and op-amp circuits; and rectifiers and filter circuitry.
Pre: 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.
Pre: Concurrent with EE 334
Fall

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 350 (3) Engineering Electromagnetics
Pre: EE 231, MATH 223, MATH 321 and PHYS 222
Spring

EE 353 (3) Communications Systems Engineering
Pre: EE 341 & MATH 223
Spring

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

EE 363 (1) Communication Systems Laboratory
Pre: Concurrent with EE 353
Spring

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
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.
Pre: 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.
Pre: 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.
Pre: 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.
Pre: 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.
Pre: EE 244

EE 467 (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.
Pre: EE 337 and senior standing
Fall

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.
Pre: EE 337 and senior standing
Fall

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 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.
Pre: 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.
Pre: 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 switching 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.
Pre: 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.
Pre: 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 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 (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.
Pre: EE 467 and Senior Standing
Spring

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.
Pre: EE 467 and Senior Standing
Spring
W1

EE 479 (3) Superconductive Devices
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.
Pre: 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.
Pre: 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.
Pre: EE 230
Fall

EE 483 (3) VLSI Design
Pre: EE 333
Spring

EE 484 (3) RF Systems Engineering
Pre: EE 353 and EE 363
Variable

EE 485 (3) RF Systems Engineering
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.
Pre: EE 107, EE 334, EE 395
Variable

EE 491 (1-4) In-Service
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