Twin Cities Campus

Electrical Engineering B.E.E.

Electrical and Computer Engineering

College of Science and Engineering

- Program Type: Baccalaureate
- Requirements for this program are current for Fall 2017
- Required credits to graduate with this degree: 124
- Required credits within the major: 104
- Degree: Bachelor of Electrical Engineering

The mission of the electrical engineering program is to educate students in core topics, as well as in a broad set of specialties of electrical engineering. The program will impart students with professional attributes that characterize a well-schooled engineer and citizen and provide opportunities for research experience in one of the leading electrical engineering centers of scholarship.

Electrical engineers work in highly diverse areas such as computers, telecommunications, semiconductors, electric energy, consumer and entertainment electronics, biomedical technology, defense and aerospace systems, and automotive electronics. They design and develop components, software, and systems, and work in research, management, and sales. The bachelor of electrical engineering prepares students for immediate entry into professional work, for graduate study and further specialization in engineering, for advanced work in business and management, or for study in a different direction such as medicine.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Admission Requirements

Students must complete 10 courses before admission to the program.

Freshman and transfer students students are usually admitted to pre-major status before admission to this major

Students interested in pursuing a degree in computer engineering or electrical engineering are encouraged to take EE 1001 in their first year.

For information about University of Minnesota admission requirements, visit the Office of Admissions website.

Required prerequisites

Mathematics

MATH 1371 - CSE Calculus I [MATH] (4.0 cr)
or MATH 1271 - Calculus I [MATH] (4.0 cr)
MATH 1372 - CSE Calculus II (4.0 cr)
or MATH 1272 - Calculus II (4.0 cr)
MATH 2373 - CSE Linear Algebra and Differential Equations (4.0 cr)
or MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)

or **Honors Curriculum**

For those students pursuing Latin Honors
MATH 1571H - Honors Calculus I [MATH] (4.0 cr)
MATH 1572H - Honors Calculus II (4.0 cr)
MATH 2573H - Honors Calculus III (4.0 cr)

Chemistry and Physics

CHEM 1061 - Chemical Principles I [PHYS] (3.0 cr)
or CHEM 1071H - Honors Chemistry I [PHYS] (3.0 cr)
CHEM 1065 - Chemical Principles I Laboratory [PHYS] (1.0 cr)
or CHEM 1075H - Honors Chemistry I Laboratory [PHYS] (1.0 cr)
PHYS 1301W - Introductory Physics for Science and Engineering I [PHYS, WI] (4.0 cr)
or PHYS 1401V - Honors Physics I [PHYS, WI] (4.0 cr)
PHYS 1302W - Introductory Physics for Science and Engineering II [PHYS, WI] (4.0 cr)
or PHYS 1402V - Honors Physics II [PHYS, WI] (4.0 cr)

Computer Science

EE 1301 - Introduction to Computing Systems (4.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.

Lower Division Core Courses
EE 2001 *{Inactive}*(3.0 cr)
EE 2301 - Introduction to Digital System Design (4.0 cr)

General Requirements

All students are required to complete general University and college requirements including writing and liberal education courses. For more information about University-wide requirements, see the liberal education requirements.Required courses for the major or minor in which a student receives a D grade (with or without plus or minus) do not count toward the major or minor (including transfer courses).

Program Requirements

Lower Division Required Courses
Mathematics
MATH 2374 - CSE Multivariable Calculus and Vector Analysis (4.0 cr)
or MATH 2263 - Multivariable Calculus (4.0 cr)
or MATH 2574H - Honors Calculus IV (4.0 cr)
or MATH 3584H *{Inactive}*(5.0 cr)
Physics or Chemistry
PHYS 2303 - Physics III: Physics of Matter (4.0 cr)
or PHYS 2311 *{Inactive}*(4.0 cr)
or PHYS 2503 - Physics III: Intro to Waves, Optics, and Special Relativity (4.0 cr)
or PHYS 2503H - Honors Physics III (4.0 cr)
or **Chemistry 2**
CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
or CHEM 1072H - Honors Chemistry II [PHYS] (3.0 cr)
CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 cr)
or CHEM 1076H - Honors Chemistry II Laboratory [PHYS] (1.0 cr)
ECE Courses
EE 2002 *{Inactive}*(1.0 cr)
EE 2011 *{Inactive}*(3.0 cr)
EE 2361 - Introduction to Microcontrollers (4.0 cr)

Upper Divison Required Courses
EE 3015 - Signals and Systems (3.0 cr)
EE 3025 - Statistical Methods in Electrical and Computer Engineering (3.0 cr)
EE 3101 - Signals, Circuits and Electronics Laboratory (1.0 cr)
EE 3102 *{Inactive}*(2.0 cr)
EE 3115 - Analog Electronics (3.0 cr)
EE 3161 - Semiconductor Devices (3.0 cr)
EE 3601 - Transmission Lines, Fields, and Waves (3.0 cr)

EE Technical Electives
Students must complete 34 technical elective credits, with a minimum of 22 coming from EE 4xxx/5xxx courses.
Take 34 or more credit(s) from the following:
Department Electives
Take 22 or more credit(s) including 0 or more sub-requirements(s) from the following:
Senior Design Project
A senior design project is required.
•EE 4951W - Senior Design Project [WI] (4.0 cr)
or EE 4981H - Senior Honors Project I (2.0 cr)
EE 4982V - Senior Honors Project II [WI] (2.0 cr)
•**Lab Courses**
Two additional EE lab courses are required. Senior honors project students only need to take one.
Take 2 or more course(s) from the following:
•EE 4111 - Advanced Analog Electronics Design (4.0 cr)
•EE 4163 - Energy Conversion and Storage Laboratory (1.0 cr)
•EE 4235 - Linear Control Systems Laboratory (1.0 cr)
•EE 4237 - State Space Control Laboratory (1.0 cr)
•EE 4301 - Digital Design With Programmable Logic (4.0 cr)
•EE 4341 - Embedded System Design (4.0 cr)
•EE 4505 - Communications Systems Laboratory (1.0 cr)
•EE 4703 - Electric Drives Laboratory (1.0 cr)
•EE 4722 - Power System Analysis Laboratory (1.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.

- EE 4743 - Switch-Mode Power Electronics Laboratory (1.0 cr)
- EE 4930 - Special Topics in Electrical and Computer Engineering Laboratory (1.0 - 2.0 cr)
- EE 5141 - Introduction to Microsystem Technology (4.0 cr)
- EE 5173 - Basic Microelectronics Laboratory (1.0 cr)
- EE 5327 - VLSI Design Laboratory (3.0 cr)
- EE 5545 - Digital Signal Processing Design (3.0 cr)
- EE 5613 - RF/Microwave Circuit Design Laboratory (2.0 cr)
- EE 5622 - Physical Optics Laboratory (1.0 cr)
- EE 5628 *{Inactive}*(1.0 cr)
- EE 5657 - Physical Principles of Thin Film Technology (4.0 cr)
- EE 5707 - Electric Drives in Sustainable Energy Systems Laboratory (1.0 cr)

•Breadth and Depth Requirements (Specialty Areas)

Take one course in 4 Breadth and Depth Requirement categories below (breadth). Within one of those categories, take a total of 2 courses (depth).

Communications, Signal Processing, and Biomedical

Take 0 or more course(s) from the following:

- EE 4501 - Communications Systems (3.0 cr)
- EE 4541 - Digital Signal Processing (3.0 cr)
- EE 5381 *{Inactive}*(3.0 cr)
- EE 5501 - Digital Communication (3.0 cr)
- EE 5505 - Wireless Communication (3.0 cr)
- EE 5531 - Probability and Stochastic Processes (3.0 cr)
- EE 5542 - Adaptive Digital Signal Processing (3.0 cr)
- EE 5545 - Digital Signal Processing Design (3.0 cr)
- EE 5549 - Digital Signal Processing Structures for VLSI (3.0 cr)
- EE 8551 - Multirate Signal Processing and Applications (3.0 cr)
- EE 5561 - Image Processing and Applications: From linear filters to artificial intelligence (3.0 cr)
- EE 5581 - Information Theory and Coding (3.0 cr)
- EE 5583 - Error Control Coding (3.0 cr)
- EE 5585 - Data Compression (3.0 cr)

Controls

Take 0 or more course(s) from the following:

- EE 4231 - Linear Control Systems: Designed by Input/Output Methods (3.0 cr)
- EE 4233 - State Space Control System Design (3.0 cr)
- EE 5231 - Linear Systems and Control (3.0 cr)
- EE 5235 - Robust Control System Design (3.0 cr)
- EE 5239 - Introduction to Nonlinear Optimization (3.0 cr)

Digital Systems and Computer Architecture

Take 0 or more course(s) from the following:

- EE 4301 - Digital Design With Programmable Logic (4.0 cr)
- EE 4341 - Embedded System Design (4.0 cr)
- EE 4363 - Computer Architecture and Machine Organization (4.0 cr)
- EE 4389W - Introduction to Predictive Learning [WI] (3.0 cr)
- EE 5351 - Applied Parallel Programming (3.0 cr)
- EE 5364 - Advanced Computer Architecture (3.0 cr)
- EE 5371 - Computer Systems Performance Measurement and Evaluation (3.0 cr)
- EE 5393 - Circuits, Computation, and Biology (3.0 cr)
- CSCI 4203 - Computer Architecture (4.0 cr)
- CSCI 5204 - Advanced Computer Architecture (3.0 cr)

VSLI and CAD

Take 0 or more course(s) from the following:

- EE 5301 - VLSI Design Automation I (3.0 cr)
- EE 5302 - VLSI Design Automation II (3.0 cr)
- EE 5323 - VLSI Design I (3.0 cr)
- EE 5324 - VLSI Design II (3.0 cr)
- EE 5327 - VLSI Design Laboratory (3.0 cr)
- EE 5329 - VLSI Digital Signal Processing Systems (3.0 cr)
- EE 5333 - Analog Integrated Circuit Design (3.0 cr)

Electronics, Microelectronics, and Semiconductor Devices

Take 0 or more course(s) from the following:

- EE 4111 - Advanced Analog Electronics Design (4.0 cr)
- EE 4161W - Energy Conversion and Storage [WI] (3.0 cr)
- EE 5121 - Transistor Device Modeling for Circuit Simulation (3.0 cr)
- EE 5141 - Introduction to Microsystem Technology (4.0 cr)
- EE 5163 - Semiconductor Properties and Devices I (3.0 cr)
- EE 5164 - Semiconductor Properties and Devices II (3.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.

- EE 5171 - Microelectronic Fabrication (3.0 cr)
- EE 5181 - Micro and Nanotechnology by Self Assembly (3.0 cr)
- EE 5657 - Physical Principles of Thin Film Technology (4.0 cr)

Power and Energy

Take 0 or more course(s) from the following:

- EE 4161W - Energy Conversion and Storage [WI] (3.0 cr)
- EE 4701 - Electric Drives (3.0 cr)
- EE 4721 - Introduction to Power System Analysis (3.0 cr)
- EE 4741 - Power Electronics (3.0 cr)
- EE 5705 - Electric Drives in Sustainable Energy Systems (3.0 cr)
- EE 5721 - Power Generation Operation and Control (3.0 cr)
- EE 5725 *{Inactive}*(3.0 cr)
- EE 5741 - Advanced Power Electronics (3.0 cr)
- EE 5745 - Wind Energy Essentials (2.0 cr)

Magnetics, Optics, and RF

Take 0 or more course(s) from the following:

- EE 4607 - Wireless Hardware System Design (3.0 cr)
- EE 5601 - Introduction to RF/Microwave Engineering (3.0 cr)
- EE 5602 - RF/Microwave Circuit Design (3.0 cr)
- EE 5611 - Plasma-Aided Manufacturing (4.0 cr)
- EE 5616 - Antennas: Theory, Analysis, and Design (3.0 cr)
- EE 5621 - Physical Optics (3.0 cr)
- EE 5624 - Optical Electronics (4.0 cr)
- EE 5627 - Optical Fiber Communication (3.0 cr)
- EE 5629 *{Inactive}*(2.0 cr)
- EE 5653 - Physical Principles of Magnetic Materials (3.0 cr)
- EE 5655 - Magnetic Recording (3.0 cr)

Other Approved Technical Electives

Up to 12 credits can count from the following courses, fulfilling a portion of the required 34 technical elective credits (additional electives). CSCI 1913 only viable if additional CSCI 4xxx/5xxx class taken which requires CSCI 1913 as a pre-requisite. Excludes CSCI 4921. Additional options may be available each semester, including Learning Abroad courses and Grand Challenges courses. Consult with ECE Department as needed.

Take 0 - 12 credit(s) from the following:

- AEM 2011 - Statics (3.0 cr)
- AEM 2012 - Dynamics (3.0 cr)
- AEM 2021 - Statics and Dynamics (4.0 cr)
- AEM 3031 - Deformable Body Mechanics (3.0 cr)
- AEM 4601 - Instrumentation Laboratory (3.0 cr)
- BBE 3013 - Engineering Principles of Molecular and Cellular Processes (3.0 cr)
- BIOC 3021 - Biochemistry (3.0 cr)
- BMEN 5101 - Advanced Bioelectricity and Instrumentation (3.0 cr)
- BMEN 5111 - Biomedical Ultrasound (3.0 cr)
- BMEN 5151 - Introduction to BioMEMS and Medical Microdevices (2.0 cr)
- BMEN 5401 - Advanced Biomedical Imaging (3.0 cr)
- BMEN 5421 - Introduction to Biomedical Optics (3.0 cr)
- CEGE 3502 - Fluid Mechanics (4.0 cr)
- CHEM 2301 - Organic Chemistry I (3.0 cr)
- CHEM 2302 - Organic Chemistry II (3.0 cr)
- CHEM 2311 - Organic Lab (4.0 cr)
- CHEM 4501 - Introduction to Thermodynamics, Kinetics, and Statistical Mechanics (3.0 cr)
- CHEM 4502 - Introduction to Quantum Mechanics and Spectroscopy (3.0 cr)
- CSCI 1913 - Introduction to Algorithms, Data Structures, and Program Development (4.0 cr)
- CSCI 4xxx
- CSCI 5xxx
- EE 2701 - Sustainable Electricity Supply: Renewables and Conservation [TS] (3.0 cr)
- GCC 3011 - Pathways to Renewable Energy [TS] (3.0 cr)
- GCC 5011 - Pathways to Renewable Energy [TS] (3.0 cr)
- IE 5111 - Systems Engineering I (2.0 cr)
- IE 5112 *{Inactive}*(3.0 cr)
- IE 5113 - Systems Engineering II (4.0 cr)
- IE 5441 - Financial Decision Making (4.0 cr)
- IE 5511 - Human Factors and Work Analysis (4.0 cr)
- IE 5513 - Engineering Safety (4.0 cr)
- IE 5522 - Quality Engineering and Reliability (4.0 cr)
- IE 5531 - Engineering Optimization I (4.0 cr)
- IE 5541 - Project Management (4.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.

- IE 5551 - Production and Inventory Systems (4.0 cr)
- IE 5553 - Simulation (4.0 cr)
- MATS 3011 - Introduction to Materials Science and Engineering (3.0 cr)
- MATS 3012 - Metals and Alloys (3.0 cr)
- MATS 3013 - Electrical and Magnetic Properties of Materials (3.0 cr)
- MATS 3851W - Materials Properties Lab [WI] (4.0 cr)
- MATH 3283W - Sequences, Series, and Foundations: Writing Intensive [WI] (4.0 cr)
- MATH 4xxx
- MATH 5xxx
- ME 3324 - Introduction to Thermal Science (3.0 cr)
- ME 3331 - Thermodynamics (3.0 cr)
- ME 3332 - Fluid Mechanics (3.0 cr)
- ME 3333 - Heat Transfer (3.0 cr)
- PHSL 3061 - Principles of Physiology (4.0 cr)
- PHYS 2601 - Quantum Physics (4.0 cr)
- PHYS 2605 *{Inactive}*(3.0 cr)
- PHYS 4101 - Quantum Mechanics (4.0 cr)
- PHYS 4201 - Statistical and Thermal Physics (3.0 cr)
- STAT 5101 - Theory of Statistics I (4.0 cr)
- STAT 5102 - Theory of Statistics II (4.0 cr)
- Students must complete EE 3041 and EE 4043W to receive co-op credit. The third course in the sequence, EE 4044, is optional. Students may take a maximum of 8 credits of co-op courses in partial fulfillment of technical elective requirements (additional electives).

  Take 0 - 8 credit(s) from the following:
  - EE 3041 *{Inactive}*(2.0 cr)
  - EE 4043W - Industrial Assignment II [WI] (4.0 cr)
  - EE 4044 - Industrial Assignment III (2.0 cr)
- **Other Business, Law, and Entrepreneurial Related Courses**

  Students may take a maximum of 4 credits from the following courses in partial fulfillment of technical elective requirements (additional electives).

  Take 0 - 4 credit(s) from the following:
  - BLAW 3058 *{Inactive}*(4.0 cr)
  - MGMT 4080W - Applied Technology Entrepreneurship [WI] (4.0 cr)
  - MOT 4001 - Leadership, Professionalism and Business Basics for Engineers (2.0 cr)
- **Management Minor**

  Students can choose to complete the Management Minor alongside this degree program. Up to 12 credits of the Minor coursework count toward the Technical Electives requirement (additional electives). Students must complete the Management Minor to receive any credit. Only those from the following courses can be counted.

  Take 0 - 12 credit(s) from the following:
  - ACCT 3001 - Strategic Management Accounting (3.0 cr)
  - FINA 3001 - Finance Fundamentals (3.0 cr)
  - HRIR 3021 - Human Capital Management (3.0 cr)
  - IDSC 3001 - Information Systems & Digital Transformation [TS] (3.0 cr)
  - MGMT 3001 - Fundamentals of Management (3.0 cr)
  - MGMT 3015 - Introduction to Entrepreneurship (4.0 cr)
  - MKTG 3001 - Principles of Marketing (3.0 cr)
  - PA 3003 - Nonprofit and Public Financial Management (3.0 cr)
  - PA 4101 - Nonprofit Management and Governance (3.0 cr)
  - SCO 3001 - Sustainable Supply Chain and Operations (3.0 cr)
- **Other Relevant Minors**

  Up to 12 credits of additional specified Minor coursework taken by students may help fulfill coursework requirements and count toward the Technical Electives requirement (additional electives) as determined by consultation with the ECE Department. These Minor options may include Product Design, Interdisciplinary Design, Accounting, Biochemistry and Biology Minors among others.

Upper Division Writing Intensive within the major

Students are required to take one upper division writing intensive course within the major; students must choose one course from the following list. Some of these courses may also fulfill other major requirements including additional writing intensive requirements.

Take 0 - 1 course(s) from the following:
- EE 4043W - Industrial Assignment II [WI] (4.0 cr)
- EE 4161W - Energy Conversion and Storage [WI] (3.0 cr)
- EE 4389W - Introduction to Predictive Learning [WI] (3.0 cr)
- EE 4951W - Senior Design Project [WI] (4.0 cr)
- EE 4982V - Senior Honors Project II [WI] (2.0 cr)
- MATS 3851W - Materials Properties Lab [WI] (4.0 cr)
- MATH 3283W - Sequences, Series, and Foundations: Writing Intensive [WI] (4.0 cr)
- MGMT 4080W - Applied Technology Entrepreneurship [WI] (4.0 cr)

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.

Program Sub-plans

A sub-plan is not required for this program.

© 2005 by the Regents of the University of Minnesota
The University of Minnesota is an equal opportunity educator and employer.