Twin Cities Campus

Computer Engineering B.Comp.E.

Electrical and Computer Engineering

College of Science and Engineering

- Program Type: Baccalaureate
- Requirements for this program are current for Spring 2019
- Required credits to graduate with this degree: 124
- Required credits within the major: 104
- Degree: Bachelor of Computer Engineering

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

The field of computer engineering resulted from the tremendous development of computers and, in particular, the evolution of microprocessors. The design process for almost every electronic system includes the specification and development of the control program for the system's microprocessor. A particular computer engineering job can be more closely related to hardware or software, to functional design or detailed design. The B.Comp.Eng. degree provides the background necessary for persons, with continuing study, to work in many computer engineering subfields. The bachelor's degree itself does not, however, provide highly specialized knowledge in any particular subfield.

Program Delivery

This program is available:

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

Admission Requirements

Students must complete 8 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 1271 - Calculus I [MATH] (4.0 cr)
or MATH 1371 - CSE Calculus I [MATH] (4.0 cr)
or MATH 1571H - Honors Calculus I [MATH] (4.0 cr)
MATH 1272 - Calculus II (4.0 cr)
or MATH 1372 - CSE Calculus II (4.0 cr)
or MATH 1572H - Honors Calculus II (4.0 cr)
MATH 2243 - Linear Algebra and Differential Equations (4.0 cr)
or MATH 2373 - CSE Linear Algebra and Differential Equations (4.0 cr)
or MATH 2573H - Honors Calculus III (4.0 cr)

Physics

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)

Lower Division Core Courses Required for Admission to Upper Division

Alternative paths to learning the basics of programming and computer systems may be available in replacement of CSCI 1913 (and the non required for admission course EE 1301). Consult your academic advisor as to other situations as needed.
CSCI 1913 - Introduction to Algorithms, Data Structures, and Program Development (4.0 cr)
EE 2001 *{Inactive}*(3.0 cr)
EE 2301 - Introduction to Digital System Design (4.0 cr)

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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

All freshmen in the College of Science and Engineering must complete CSE 1001: First-Year Experience.

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)

ECE Courses

EE 1301 - Introduction to Computing Systems (4.0 cr)
or CSCI 1113 - Introduction to C/C++ Programming for Scientists and Engineers (4.0 cr)
CSCI 2011 - Discrete Structures of Computer Science (4.0 cr)
EE 2002 *{Inactive}*(1.0 cr)
EE 2011 *{Inactive}*(3.0 cr)
EE 2361 - Introduction to Microcontrollers (4.0 cr)

Upper Division Required Courses

Computer Science Core

CSCI 4041 - Algorithms and Data Structures (4.0 cr)
CSCI 4061 - Introduction to Operating Systems (4.0 cr)

Electrical Engineering Core

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 4363 - Computer Architecture and Machine Organization (4.0 cr)
or CSCI 4203 - Computer Architecture (4.0 cr)

CompE Technical Electives

Students must complete 28 technical elective credits, with a minimum of 22 coming from EE 4xxx/5xxx or CSCI 4xxx/5xxx courses.
Take 28 or more credit(s) from the following:

Department Electives

Take 22 or more credit(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 or CSCI 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)
•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 5373 - Data Modeling Using R (1.0 cr)

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- 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 5657 - Physical Principles of Thin Film Technology (4.0 cr)
- EE 5707 - Electric Drives in Sustainable Energy Systems Laboratory (1.0 cr)
- EE 5811 - Biological Instrumentation (3.0 cr)
- CSCI 4511W - Introduction to Artificial Intelligence [WI] (4.0 cr)
- CSCI 5511 - Artificial Intelligence I (3.0 cr)
- CSCI 5551 - Introduction to Intelligent Robotic Systems (3.0 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).

Computer Architecture

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

- EE 4389W - Introduction to Predictive Learning [WI] (3.0 cr)
- EE 5340 - Introduction to Quantum Computing and Physical Basics of Computing (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 5391 *{Inactive}*(3.0 cr)
- EE 5393 - Circuits, Computation, and Biology (3.0 cr)
- CSCI 5204 - Advanced Computer Architecture (3.0 cr)

Robotics and Embedded System Design

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 4341 - Embedded System Design (4.0 cr)
- EE 5340 - Introduction to Quantum Computing and Physical Basics of Computing (3.0 cr)
- EE 5391 *{Inactive}*(3.0 cr)
- CSCI 4511W - Introduction to Artificial Intelligence [WI] (4.0 cr)
- CSCI 5143 - Real-Time and Embedded Systems (3.0 cr)
- CSCI 5511 - Artificial Intelligence I (3.0 cr)
- CSCI 5512 - Artificial Intelligence II (3.0 cr)
- CSCI 5521 - Machine Learning Fundamentals (3.0 cr)
- CSCI 5525 - Machine Learning: Analysis and Methods (3.0 cr)
- CSCI 5551 - Introduction to Intelligent Robotic Systems (3.0 cr)
- CSCI 5552 - Sensing and Estimation in Robotics (3.0 cr)
- CSCI 5561 - Computer Vision (3.0 cr)

VLSI and CAD

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

- EE 4301 - Digital Design With Programmable Logic (4.0 cr)
- 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)

Networks and Communication

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

- EE 4501 - Communications Systems (3.0 cr)
- CSCI 4131 - Internet Programming (3.0 cr)
- CSCI 4211 - Introduction to Computer Networks (3.0 cr)
- CSCI 5117 - Developing the Interactive Web (3.0 cr)
- CSCI 5211 - Data Communications and Computer Networks (3.0 cr)
- CSCI 5221 - Foundations of Advanced Networking (3.0 cr)
- CSCI 5231 *{Inactive}*(3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5471 - Modern Cryptography (3.0 cr)

Systems and Software Design

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

- EE 5355 - Algorithmic Techniques for Scalable Many-core Computing (3.0 cr)
- CSCI 4011 - Formal Languages and Automata Theory (4.0 cr)
- CSCI 4707 - Practice of Database Systems (3.0 cr)
- CSCI 5103 - Operating Systems (3.0 cr)
- CSCI 5105 - Introduction to Distributed Systems (3.0 cr)

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- CSCI 5106 - Programming Languages (3.0 cr)
- CSCI 5117 - Developing the Interactive Web (3.0 cr)
- CSCI 5125 - Collaborative and Social Computing (3.0 cr)
- CSCI 5161 - Introduction to Compilers (3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
- CSCI 5451 - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- CSCI 5707 - Principles of Database Systems (3.0 cr)
- CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)
- CSCI 5801 - Software Engineering I (3.0 cr)
- CSCI 5802 - Software Engineering II (3.0 cr)

Computational Science

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

- CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
- CSCI 5304 - Computational Aspects of Matrix Theory (3.0 cr)
- CSCI 5451 - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
- CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
- CSCI 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5609 - Visualization (3.0 cr)
- CSCI 5715 - From GPS, Google Maps, and Uber to Spatial Data Science (3.0 cr)

- **Graphics, Virtual Reality and User Interface Design**

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

- CSCI 4611 - Programming Interactive Computer Graphics and Games (3.0 cr)
- CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
- CSCI 5127W - Embodied Computing: Design & Prototyping [WI] (3.0 cr)
- CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
- CSCI 5611 - Animation & Planning in Games (3.0 cr)
- CSCI 5619 - Virtual Reality and 3D Interaction (3.0 cr)

- **Other Approved Technical Electives**

Up to 6 credits can count from the following courses, fulfilling a portion of the required 28 technical elective credits (additional electives). 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 - 6 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 5411 - Neural Engineering (3.0 cr)
- BMEN 5412 - Neuromodulation (3.0 cr)
- BMEN 5421 - Introduction to Biomedical Optics (3.0 cr)
- CEGE 3501 - Introduction to Environmental Engineering [ENV] (3.0 cr)
- CEGE 3502 - Fluid Mechanics (4.0 cr)
- CHEM 1062 - Chemical Principles II [PHYS] (3.0 cr)
- CHEM 1066 - Chemical Principles II Laboratory [PHYS] (1.0 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 4xxx
- CSCI 5xxx
- EE 2701 - Sustainable Electricity Supply: Renewables and Conservation [TS] (3.0 cr)
- IE 5111 - Systems Engineering I (2.0 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)

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- IE 5531 - Engineering Optimization I (4.0 cr)
- IE 5541 - Project Management (4.0 cr)
- IE 5551 - Production and Inventory Systems (4.0 cr)
- IE 5553 - Simulation (4.0 cr)
- INET 4021 - Dev Ops I: Network Programming (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 2303 - Physics III: Physics of Matter (4.0 cr)
- PHYS 2311 *{Inactive}*(4.0 cr)
- PHYS 2503 - Physics III: Intro to Waves, Optics, and Special Relativity (4.0 cr)
- PHYS 2503H - Honors Physics III (4.0 cr)
- PHYS 2601 - Quantum Physics (4.0 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 6 credits of co-op courses in partial fulfillment of technical elective requirements (additional electives).

  Take 0 - 6 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 6 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 - 6 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 6 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 math, physics, 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:
- CSCI 4511W - Introduction to Artificial Intelligence [WI] (4.0 cr)

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- CSCI 5127W - Embodied Computing: Design & Prototyping [WI] (3.0 cr)
- 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)
- MATH 3283W - Sequences, Series, and Foundations: Writing Intensive [WI] (4.0 cr)
- MATS 3851W - Materials Properties Lab [WI] (4.0 cr)
- MGMT 4080W - Applied Technology Entrepreneurship [WI] (4.0 cr)

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