Computer Engineering BSCE

College of Science, Engineering & Technology
Department of Electrical and Computer Engineering and Technology
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Accreditation. The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET, www.ABET.org

Computer Engineering (CE) encompasses the research, development, design and operation of computers and computerized systems and their hardware and software components. This program leads to a Bachelor of Science in Computer Engineering. The primary objective of the Computer Engineering program is to educate engineering professionals who possess sound design and analytical background coupled with a strong laboratory experience supporting Computer Engineering concepts. This means that the department prepares its graduates for:

1. Entry into the engineering work environment with well-developed design and laboratory skills.
2. Further study toward advanced degrees in engineering and other related disciplines.
3. Advancement into managerial ranks and/or entrepreneurial endeavors.
4. Pursue personal growth and flexibility through their career.
5. Succeed in full time graduate and professional studies.
6. Provide foundational education that allows for personal growth and flexibility through their career.

The educational objectives for our Bachelor of Science in Computer 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 lifelong learning opportunities.
5. Pursue 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 lifelong 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.

In support of these objectives, the program provides a curriculum including the following components that will prepare students for excellent careers in Computer Engineering.

1. A strong background in the physical sciences; mathematics, including discrete math; and 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 sub-disciplines such as Internet of Things (IoTs), Application Specific Integrated Circuits (ASICs), in the junior/senior level electives.
4. Opportunities for students to develop sensitivity to the social and humanistic implications of technology and motivate them to make worthwhile contributions to the profession and society, while upholding the highest standards of professional ethics.
5. A course in engineering economics to promote awareness of the economic aspects of engineering.
6. Preparation for continuing study and professional development.

During the senior year, as allowed by the state, students will be required to take the Fundamentals of Engineering (FE) examination or its equivalent as described in GPA Policy below.

The curriculum offers students the opportunity to emphasize a number of specialized areas including advanced digital systems, communications, digital signal processing, networking and system design.

The recommended high school preparation is two years of algebra, one year of geometry, one-half year of trigonometry, one-year of college algebra, and a year each of physics and chemistry plus a programming language. Without this background it may take students longer than four years to earn a degree. During the first two years students take physics and mathematics courses common to all branches of engineering (pre-engineering), two programming language courses, a discrete mathematics course (specifically designed for computer engineers), as well as supporting work in English, humanities, and social sciences. Second-year computer engineering students complete physics, mathematics and 200-level engineering and object-oriented design and software development courses.

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.

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 Computer 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)

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 Computer Engineering must have:

1. completed a minimum of 20 semester credit hours of upper division EE and CS courses at Minnesota State Mankato.
2. have a cumulative GPA of 2.25 on all upper division EE and CS courses, and
3. have completed their senior design sequence at Minnesota State Mankato.
4. have taken the Fundamentals of Engineering (FE) exam or its equivalent and achieved the desired competency level.

GPA. A cumulative grade-point average of 2.5 for all science, math and engineering courses must have been maintained. Grades must be 1.65 (“C”) or better for course to be accepted. Minnesota State Mankato students should complete the pre-engineering courses listed under the major.

Petition to evaluate transfer credits must occur no later than the first semester the student is enrolled in or declared a major housed in the Department of Electrical and Computer Engineering Technology.

P/N Grading Policy. A student who majors in CE must elect the grade option for all required courses including courses offered by another department.
**COMPUTER ENGINEERING CONTINUED**

**COMPUTER ENGINEERING BSCE**
Degree completion = 128 credits

**Required General Education**
ENG 101 Composition (4)
ENG 271W Technical Communication (4)
MATH 121 Calculus I (4)
PHYS 221 General Physics I (4)

**Economics (choose 3 credits)**
- ECON 201 Principles of Macroeconomics (3)
- ECON 202 Principles of Microeconomics (3)

**Required Electives**

**Economics**
- ENG 271W Technical Communication (4)
- ECON 201 Principles of Macroeconomics (3)

**Major Restricted Electives**

**PHYS 223 General Physics III (3)**
- EE 299 Thermal Analysis (2)
- MATH 223 Calculus III (4)
- IT 214 Fundamentals of Software Development (4)
- MATH 321 Ordinary Differential Equations (4)
- EE 291 Engineering Analysis (3)
- PHYS 323 General Physics III Laboratory (1)
- CS 460 Operating Systems: Design and Implementation (3)
- EE 292 Digital System Design with Testability Lab (1)
- EE 332 Electronics I (3)
- EE 334 Microprocessor Engineering II (3)
- EE 336 Principles of Engineering Design I (1)
- EE 337 Principles of Engineering Design II (1)
- EE 341 Signals & Systems (3)
- EE 342 Electronics Laboratory I (1)
- EE 344 Microprocessor Laboratory I (1)
- EE 348 Control Systems (3)
- EE 348 Systems Laboratory I (1)
- EE 395 Computer Hardware and Organization (3)
- EE 450 Engineering Economics (3)
- EE 467W Principles of Engineering Design III (1)
- EE 477W Principles of Engineering Design IV (1)
- IT 214 fundamentals of Software Development (4)
- IT 310 Data Structures & Algorithms (4)
- MATH 180 Mathematics for Computer Science (4)
- MATH 223 Calculus III (4)
- ME 299 Thermal Analysis (2)
- PHYS 223 General Physics III (3)
- PHYS 323 General Physics III Laboratory (1)

**Major Common Core**
- CS 460 Operating Systems: Design and Implementation (3)
- EE 292 Digital System Design with Testability (3)
- EE 292 Digital System Design with Testability Lab (1)
- EE 332 Electronics I (3)
- EE 334 Microprocessor Engineering II (3)
- EE 336 Principles of Engineering Design I (1)
- EE 337 Principles of Engineering Design II (1)
- EE 341 Signals & Systems (3)
- EE 342 Electronics Laboratory I (1)
- EE 344 Microprocessor Laboratory I (1)
- EE 358 Control Systems (3)
- EE 368 Control Systems Laboratory I (1)
- EE 395 Computer Hardware and Organization (3)
- EE 450 Engineering Economics (3)
- EE 467W Principles of Engineering Design III (1)
- EE 477W Principles of Engineering Design IV (1)
- IT 214 fundamentals of Software Development (4)
- IT 310 Data Structures & Algorithms (4)
- MATH 180 Mathematics for Computer Science (4)
- MATH 223 Calculus III (4)
- ME 299 Thermal Analysis (2)
- PHYS 223 General Physics III (3)
- PHYS 323 General Physics III Laboratory (1)

**Major Electives**
Choose 14 credits: choose EE 333 (3) and then choose additional 11 credits e.g. CS 350, EE 481, EE 484, EE 475, and EE 480, or choose EE 390 (4) and then choose additional 10 credits e.g. CS 350, EE 470, and EE 489.
- CS 350 Network Architectures (3)
- EE 333 Electronics II (3)
- EE 390 Smart Sensor Systems (4)
- EE 453 Advanced Communications Systems Engineering (3)
- EE 470 Wireless Networking (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 a minimum of twelve (12) credits of Humanities (6 credits) and Social Sciences (6 credits). For example, ECON 201 is a Social Sciences course. For a complete listing of approved Humanities and Social Sciences courses please consult the department website. In general, graduation credits toward the humanities requirement is not allowed for any course in subject areas such as communication studies, writing, art, music or theater 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 299 Engineering Analysis (3)

**Required Minor:** None.

**COURSE DESCRIPTIONS**

**Computer and Information Science**

**CS 350 (3) Network Architectures**
An introduction to data communications and networks. The field encompasses local area networks, wide area networks, and wireless communication. Topics include digital signals, transmission techniques, error detection and correction, OSI model, TCP/IP model, network topologies, network protocols, and communications hardware. 
Prerequisite: CS 305 or EE 234

**Spring**

**CS 460 (3) Operating Systems: Design & Implementation**
This course studies historical and current concepts and implementations of computer operating systems. Basic operating systems topics include processes, interprocess communication, interprocess synchronization, deadlock, memory allocation, segmentation, paging, resource allocation, scheduling, file systems, storage, devices, protection, security, and privacy. 
Prerequisite: CS 210 and CS 320

**Electrical Engineering Courses**

**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**
The course presents algorithmic approaches to problem solving and computer program design using the C language. Student 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
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.
Prerequisite: 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.
Prerequisite: EE 230 and EE 240, MATH 321, PHYS 222
Spring
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
Corequisite: EE 233
Fall

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
Corequisite: EE 234

EE 240 (1) Evaluation of Circuits
Prerequisite: 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 supplement 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, PLAS, 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.
Corequisite: 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 phenomena in semiconductors, metals and insulators. Study of equilibrium and non-equilibrium charge distribution, generation, injection, and recombination. Analysis and design of P-N junctions, bipolar transistor, junction and MOS field-effect transistors. Introduction to transferrable 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, P/N 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 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

EE 333 (3) Electronics II
The second course of the electronics sequence presenting concepts of feedback, oscillators, filters, amplifiers, operational amplifiers, hysteresis, bistability, and non-linear functional circuits. MOS and bipolar digital 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.
Fall
EE 358 (3) Control Systems
Prerequisite: EE 341
Spring

EE 363 (1) Communication Systems Laboratory
Prerequisite: 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.
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, and then proceeds to explore the subject of sensor fusion, describe 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: EE334 & EE344

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

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 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.
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 radiowave propagation, scattering by rain, sea water propagation, guided wave propagation, periodic structures, transmission lines, microwave/millimeter wave amplifiers and oscillators, NWC & 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

EE 479 (3) Superconductive Devices
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: PNP, NMOS, CMOS, and BiCMOS 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
Fall

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, intertask communication and synchronization, real-time operating systems (RTOS), hard and soft real-time systems, distributed real-time systems, and needs 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