



Metropolitan State University of Denver

Computer Engineering (CPE)

The Computer Engineering (CPE) program offers the Bachelor of Science degree major.

The Bachelor of Science in Computer Engineering is a discipline with historical foundations in computer science and electrical engineering. It is concerned with the study of a variety of topics including circuit design, programmable logic, computer design, computer programming, data communication, machine intelligence, robotics, the algorithmic solutions of problems, and the various representations of information including numeric, alphabetic, visual, audio and sensory. In the modern society, the Computer Engineering discipline also deals with secure computing in Web information space and industry systems. This discipline deals with effective ways to represent and manipulate information, algorithms to process information, hardware systems and technologies to run software, design methodologies for hardware and software systems, and engineering techniques for ensuring the accuracy and cost effectiveness of these processes.

Students majoring in Computer Engineering must meet the following curriculum and are required to complete all general study courses, program pre-requisite courses, elective courses and core courses with a grade required for graduation. Technical elective courses must be approved by the program coordinator or department chair. Students who are considering a major in Computer Engineering are expected to consult with CPE faculty for advising.

Students are encouraged to enroll in an internship/cooperative education program through the University's Applied Learning Center to gain valuable work experience.

For every computer engineering course, a minimum grade of "C" is required for all prerequisites before a student can progress. A full-time student may complete the program in four years (eight semesters), referring to the suggested four year course sequencing plan.

Faculty – The top priority for faculty in the CPE program is teaching and advising. With many years of industrial experience, they bring their expertise, relevancy and currency to the classrooms.

Students – Faculty provide each student with individualized counseling, and advising in meeting graduation requirements. Many Computer Engineering students are working part-time or full-time. The program offers several evening courses to accommodate the working student. The CPE program's collaboration with the Internship Center of the college offers possibilities for students to gain industrial experience and earn technical elective credits at the same time. All students who are considering a major in CPE are expected to consult with CPE faculty advisor.

Computer Engineering
Department of Engineering & Engineering Technology
For Students Starting Fall 2019

- Any course identified in the CPE major must be passed with a grade of “C” or better.
- CPE majors must comply with all University General Studies requirements.
- This is an extended major, therefore a minor is not required to fulfill the degree requirements.
- The students may refer to program flowchart or consult with an advisor for degree planning.

General Studies Requirements

Written Communication (6 credits)

Oral Communication (3 credits)

Arts and Humanities (6 credits)

- See the General Studies section of the catalog for approved courses.

Historical (3 credits)

- See the General Studies section of the catalog for approved courses.

Social and Behavioral Sciences I (3 credits)

- See the General Studies section of the catalog for approved courses.

Social and Behavioral Sciences II (3 credits)

- See the General Studies section of the catalog for approved courses.

Global Diversity (0 or 3 credits)

Multicultural Requirement (0 or 3 credits)

The department recommends that this requirement be met along with the Arts & Humanities, Historical, or Social & Behavioral Sciences general studies choices. See the Global Diversity and Multicultural section of the catalog for approved courses.

General Studies Total: 24 credits

Program Prerequisites

		Prerequisites	Credit Hours
_____	CHE 1100 Principles of Chemistry	MTH 1110 or MTH 1120	4
_____	CHE 1150 Principles of Chemistry Lab	CoReq: CHE 1100	1
_____	PHY 2311 General Physics I	MTH 1410	4
_____	PHY 2321 General Physics I Lab	concurrent with PHY 2311	1
_____	PHY 2331 General Physics II	MTH 2410, PHY 2311/2321	4
_____	PHY 2341 General Physics II Lab	concurrent with PHY 2331	1
_____	MTH 1410 Calculus I	MTH 1110 & MTH 1120, or MTH 1400	4
_____	MTH 2410 Calculus II	MTH 1410 or MTH 1450 or HON 2100	4
_____	MTH 3140 Linear Algebra	MTH 3100 with a grade of “C” or better, or MTH 3170 with a grade of “C” or better, or permission of instructor	4
_____	MTH 3170 Discrete Math for Computer Science	MTH 2410 and CS 2050 and permission of the Department of Mathematical and Computer Sciences.	4

Required CPE Courses

		Prerequisites	Credit Hours
_____	CPE 1040 Introduction to Engineering	Minimum performance standard score on math placement test	3
_____	CS 1050 Computer Science I	CS 1030 with a grade of “C” or better	4
_____	CPE 1140 DC Circuit Fundamentals	MTH 1410, or MTH 2410 (with a grade of C” or better for all prerequisites)	4
_____	CPE 1150 AC Circuit Fundamentals	CPE 1140 (with a grade of “C” or better for all prerequisites)	4
_____	CS 1400 Computer Organization I	An intermediate algebra course or one and one-half years of secondary school algebra or equivalent and appropriate score	4

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		on the mathematics pre-assessment placement test or higher-level math course with a grade of "C" or better	
CS 2050	Computer Science II	CS 1050 and MTH 1110 (or equivalent) with a grade of "C" or better, or permission of instructor	4
CPE 2145	Solid State Electronics	CPE 1150 or EET 1150, and CHE 1100 or CHE 1800 (with a grade of "C" or better for all prerequisites)	3
CPE 2165	Solid State Electronics Lab	CPE 1150 or EET 1150, and CHE 1100 or CHE 1800 (with a grade of "C" or better for all prerequisites)	1
CPE 2310	Digital Systems I	MTH 1400 (with a grade of "C" or better for all prerequisites)	3
CPE 2350	C Programming for Engineer	MTH 1400 (with a grade of "C" or better for all prerequisites)	3
CS 2400	Computer Organization II	CS 1050, CS 1400, and MTH 1110 (or equivalent), each with a grade of "C" or better, or permission of instructor	4
CPE 3330	Digital Systems II	CPE 2310 with a grade of "C" or better	3
CPE 3400	Signals & Systems	CPE 1150, CPE 2310, and MTH 2410 (with a grade of "C" or better for all prerequisites)	3
CPE 3500	Semiconductor Device Fundamentals	CPE 2145, CPE 2165, CHE 1100 and CHE 1150 (with a grade of "C" or better for all prerequisites)	3
CPE 3620	A&D Communication	CPE 2145, CPE 2165 and MTH 2410 (with a grade of "C" or better for all prerequisites)	3
CPE 4020	Digital Systems III	CPE 2350 and CPE 3330 (with a grade of "C" or better for all prerequisites)	3
CPE 4320	Digital Filter Design	CPE 2350 and CPE 3400 (with a grade of "C" or better for all prerequisites)	3
CPE 4370	Embedded System Design I	CPE 2350 and CPE 3330 (with a grade of "C" or better for all prerequisites)	3
CPE 4390	Embedded System Design II	CPE 4370 (with a grade of "C" or better for all prerequisites)	3
CPE 4600	VLSI Circuits and Systems	CPE 3500 and CPE 4020 (with a grade of "C" or better for all prerequisites)	3
CPE 4700	Senior Design I*	JMP 2610, CPE 4370 and CS 2400 (with a grade of "C" or better for all prerequisites) and Senior standing	1
CPE 4800	Senior Design II*	CPE 4390, CPE 4600 and CPE 4700 (with a grade of "C" or better for all prerequisites)	2
	<i>*These courses satisfy the University's Senior Experience requirement.</i>		

Two of the following elective courses:

CS 3700	Computer Networks	CS 1400 and CS 2050 with grades of "C" or better, or permission of instructor	4
CPE 3715	Control Systems Analysis	CPE 2145 and CPE 3400 (with a grade of "C" or better for all prerequisites)	4
CS 3750	Computer & Network Security	CS 2050 with a grade of "C" or better, and CS 2400 with a grade of "C" or better, or permission of instructor	4
CS 4000	Computer System Reliability	CPE 3400, CS 2400, CPE 3330 with grade "C" or better	4
CPE 4330	Data Communication	CPE 2310 with a grade of "C" or better	3
CPE 4620	Advanced Communication Systems	CPE 3620 (with a grade of "C" or better for all prerequisites)	3
CPE 4710	Digital Control System Design	CPE 3715 (with a grade of "C" or better for all prerequisites)	4
CS 4760	Multimedia Technology	CS 2050, CS 2400, CPE 3400 with grade "C" or better	4

Total hours for Computer Engineering Major**128****General Studies** **24 credits****Program Prerequisites** **31 credits**

Required CPE Core *67 credits*
Electives *6 credits*

CPE 1040 Introduction to Engineering**Credits:** 3 (2+2)**Prerequisite(s):** Minimum performance standard score on math placement test**Description:** This course is an introductory engineering course exposing students to a cross section of topics in computer engineering discipline to assist them with their education career choices. Students are taught to work in teams, introduced to the design process, utilize math and computer programs to analyze raw data and properly display their results in a presentation to their peers. The history of the engineering profession and its relation to current national, social, industrial, ethical, and international issues and problems will be discussed.**CPE 1140 DC Circuit Fundamentals****Credits:** 4 (3+2)**Prerequisite(s):** MTH 1410 or MTH 2410 (with a grade of "C" or better for all prerequisites) **Description:** This course covers DC circuit analysis, including mesh analysis, nodal analysis, Thevenin conversion, Norton conversion, power, magnetism and magnetic circuits, capacitance, and inductance. An introduction to electrical laboratory procedures and the measurement of basic circuit parameters is also included.**CPE 1150 AC Circuit Fundamentals****Credits:** 4 (3+2)**Prerequisite(s):** CPE 1140 (with a grade of "C" or better for all prerequisites)**Description:** This course is a continuation of CPE 1140. Studies include single time constant circuits, phasors, and the *j* operator, RLC circuits with sinusoidal, steady-state sources, impedance and admittance, AC formulation of classic network theorems, complex network equations, complex power, frequency response, transformers, and two-port network models.**CPE 2145 Solid State Electronics****Credits:** 3 (3+0)**Prerequisite(s):** CPE 1150 or EET 1150, and CHE 1100 or CHE 1800 (with a grade of "C" or better for all prerequisites) **Corequisite(s):** CPE 2165**Description:** Students in this course will study the theory, modeling and application of semiconductor based electronic circuits. Devices studied include: diodes, bipolar junction transistors, MOS field effect transistors, thyristors, voltage regulators and operational amplifiers.**CPE 2165 Solid State Electronics Laboratory****Credits:** 1 (0+2)**Prerequisite(s):** CPE 1150 or EET 1150, and CHE 1100 or CHE 1800 (with a grade of "C" or better for all prerequisites) **Corequisite(s):** CPE 2145**Description:** The student will develop the laboratory skills necessary for integration of electronic devices in applications such as filtering, amplification, and voltage regulation. The student will integrate the lecture content of CPE2145 in the practical, hands-on laboratory exercises developed in this course.**CPE 2310 Digital Systems I****Credit Hours:** 3 (2+2)**Prerequisite(s):** MTH 1400 (with a grade of "C" or better for all prerequisites)**Description:** This course covers the analysis and design of logic circuits using Boolean algebra, Karnaugh maps and truth tables. It provides an introduction to the student to the basic concepts of computer architecture. In addition, it covers number systems, operation and codes. Combinational digital circuits are also studied. The students will use the basic logic gates, Flip-flop, memories, integrated circuit chips, etc., to design digital systems.**CPE 2350 C Programming for Engineer****Credits:** 3 (3+0)**Prerequisite(s):** MTH 1400 (with a grade of "C" or better for all prerequisites)**Description:** This is an advanced-level programming course using the C programming language. Methods for solving computer engineering problems using the C programming language are studied. The fundamental of UNIX Operation System and shell scripts are also introduced.**CPE 3330 Digital Systems II****Credits:** 3 (2+2)**Prerequisite(s):** CPE 2310 with a grade of "C" or better**Description:** This course is a continuation of CPE 2310. It covers the analysis and design of sequential (counters and shift registers) logic systems. Programmable Logic Devices (PLD) and associated Computer Aided Design (CAD) software are used to implement digital circuits by using the schematic design entry method. Johnson counter and Ring counter are studied. The general methods of analysis and design for Finite State Machine (FSM) is also introduced.**CPE 3400 Signals and Systems****Credits:** 3 (3+0)**Prerequisite(s):** CPE 1150, CPE 2310, and MTH 2410 (with a grade of "C" or better for all prerequisites)**Description:** This course provides an introduction to the student to the basic concepts of signals and system modeling. The students will develop and understand time-domain and frequency-domain analysis of both continuous and discrete systems and signals.**CPE 3500 Semiconductor Device Fundamentals****Credits:** 3 (3+0)**Prerequisite(s):** CPE 2145, CPE 2165, CHE 1100 and CHE 1150 (with a grade of "C" or better for all prerequisites)**Description:** This course will provide the fundamental knowledge of semiconductor physics, materials, devices and fabrication technology. The students will learn semiconductor band theory, semiconductor materials and statistics, pn junction, bipolar transistor, heterojunction, Schottky junction and solar cells. The course will focus on the MOSFET designs for advanced Very Large Scale Integrated Circuit (VLSI) technology from its physical structure, accurate modeling, manufacturability and applications by using computer simulation.**CPE 3620 A&D Communications****Credits:** 3 (3+0)**Prerequisite(s):** CPE 2145, CPE 2165 and MTH 2410 (with a grade of "C" or better for all prerequisites)**Description:** This course is an introduction to communication systems. Topics include: information theory, channel capacity, A/D and D/A techniques, modulation (AM, FM, and digital), noise sources, quantization, and transmission lines including Smith Charts.**CPE 3715 Control Systems Analysis****Credits:** 4 (3+2)**Prerequisite(s):** CPE 2145 and CPE 3400 (with a grade of "C" or better for all prerequisites)**Description:** This course analyzes classical, linear, continuous-time control systems. Analysis and design will be done using Laplace transforms, Bode plots. Topics discussed include: stability, transient response, steady-state response, and the design of P, PI, PD, and PID, Lag and Lead compensators. The laboratory section of the course uses the classical approach to the analysis and design of control systems.**CPE 4020 Digital Circuits III – Hardware Description Language****Credits:** 3 (2+2)**Prerequisite(s):** CPE 2350 and CPE 3330 (with a grade of "C" or better for all prerequisites)**Description:** Students in this course will learn a Hardware Description Language (HDL) which is used to design and simulate very large scale digital integrated circuits. Different modeling and design approaches will be covered as well as different simulation techniques.**CPE 4320 Digital Filter Design****Credits:** 3 (2+2)**Prerequisite(s):** CPE 2350 and CPE 3400 (with a grade of "C" or better for all prerequisites)**Description:** This course introduces digital filters as applied in digital signal processing and sampled data control systems. Complex algorithms will be introduced for the design of digital filters.**CPE 4330 Data Communication****Credits:** 3 (2+2)**Prerequisite(s):** CPE 2310 with a grade of "C" or better**Description:** This course covers methods of local and distant digital communications including: systems, standards, and hardware used for transmitting digital data either synchronously or asynchronously. In addition, limitations and problems will be discussed along with the solutions and areas that are being improved.**CPE 4370 Embedded System Design I****Credits:** 3 (2+2)**Prerequisite(s):** CPE 2350 and CPE 3330 (with a grade of "C" or better for all prerequisites)**Description:** This class will explore the fundamentals of embedded system hardware and firmware design. The following issues will be discussed, such as embedded processor selection, hardware/firmware partitioning, number conversion, computer hardware structure, memory technology, logic circuits, development tools, firmware architecture, firmware design, and firmware debugging. An industry standard microcontroller will be studied, and its architecture and instruction set will be covered. The students will apply a microcontroller demo board for their designs. The programming will be implemented in *Assembly* and *C* languages.**CPE 4390 Embedded System Design II****Credits:** 3 (2+2)**Prerequisite(s):** CPE 4370 (with a grade of "C" or better for all prerequisites)**Description:** This course is a continuation of CPE 4370 and will cover embedded system design by interfacing with computers, peripherals, and other digital circuits. It provides the knowledge of designing microcontroller-based embedded computer systems by using *assembly* and *C* programs. In addition, the course will also examine the Real-time Operating Systems and their impact on performance. Computer engineering applications will also be emphasized.**CPE 4600 VLSI Circuits and Systems****Credits:** 3 (2+2)Metropolitan State University of Denver, Department of Engineering And Engineering Technology
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assembly language programming and create software using a contemporary development environment.

CS 3700 - Computer Networks

Credits: 4

Prerequisite(s): CS 1400 and CS 2050 with grades of "C" or better, or permission of instructor

Description: This course provides a comprehensive study of computer networks, from the physical aspects to the high-level application protocols with which most people interact. The software that provides the communication is emphasized. The methods for creating connections, making sure they are error-free and in order, performing routing, and creating client/server interactions are discussed.

CS 3750 - Computer and Network Security

Credits: 3

Prerequisite(s): CS 2050 with a grade of "C" or better, and CS 2400 with a grade of "C" or better, or permission of instructor

Description: This course will cover how computers are compromised, what one needs to do to build security into every program, how cryptography assists in securing data, how operating systems affect computer security, how networks are secured, and the social and ethical aspects of computer security.

CS 4000 - Computer System Reliability

Credits: 4

Prerequisite(s): CPE 3400, CS 2400, CPE 3330 with grade "C" or better

Description: The course covers theoretical and practical achievements oriented to make computing reliable and fault tolerant. Errors models are explained that are used both in production and in computer testing. Testing methodologies in production and the structure of the automatic test systems (ATS) are presented. Algorithmic explanation of the error detection and correcting codes is provided. formal definitions and practical measure of reliability, fault tolerance and computer security are described.

CS 4760 - Multimedia Technologies

Credits: 4

Prerequisite(s): CS 2050, CS 2400, CPE 3400 with grade "C" or better

Description: The course addresses the scientific areas related to multimedia (image processing, computer graphics, video processing, speech and audio processing, text processing and networking) to a depth that enables the students to build up a thorough understanding of the technical issues associated with multimedia technologies. Topics cover how to present the different media types in multimedia stream, some theoretical foundations, multimedia standards (JPEG, MPEG)

Prerequisite(s): CPE 3500 and CPE 4020 (with a grade of "C" or better for all prerequisites)

Description: This course will explore the fundamentals of Very Large Scale Integrated Circuit (VLSI) design. The following design specifications will be addressed, such as functionality, performance, reliability, manufacturability, testability, cost, design layout rules and checking, circuit extraction, simulation, and verification.

CPE 4620 Advanced Communication Systems

Credits: 3 (3+0)

Prerequisite(s): CPE 3620 (with a grade of "C" or better for all prerequisites)

Description: This is a senior research course which requires student analysis of VHF, UHF, microwave, spread spectrum, optical, video, and satellite systems. Analog and digital cellular and personal communications services, including AMPS, GSM, CDMA, wireless LAN microwave satellite communications systems will be examined.

CPE 4700 Senior Design I

Credits: 1 (0+2)

Prerequisite(s): JMP 2610, CPE 4370 and CS 2400 (with a grade of "C" or better for all prerequisites) and Senior standing

Description: This is a Senior Experience, capstone course designed to teach engineering design skills to students through project based learning. The course will focus on team project incorporating the application of fundamental engineering knowledge and skills. Projects requires planning and design in consultation with faculty advisors and industry contacts. Through this course the students will learn the design process in a hands on way through conceptualization, construction, testing and presenting a deliverable project.

University Requirement(s): Senior Experience

CPE 4710 Digital Control System Design

Credits: 4 (4+0)

Prerequisite(s): CPE 3715 (with a grade of "C" or better for all prerequisites)

Description: Students in this course will learn the process and theory of the design of digital control systems, using classical and modern control theory. Analysis of differences between continuous and discrete control systems will be discussed. State variable feedback control and other optimal control theories will be covered.

CPE 4800 Senior Design II

Credits: 2 (0+4)

Prerequisite(s): CPE 4390, CPE 4600 and CPE 4700 (with a grade of "C" or better for all prerequisites)

Description: This is the second half of the Senior Experience for this major. In this course, the student completes the project started in CPE 4700. The project is built, tested and demonstrated. Written technical reports and oral presentations on the project are required. Part of this course involves the student working with a faculty member who acts as a consultant.

University Requirement(s): Senior Experience

CS 1050 - Computer Science 1

Credits: 4

Prerequisite(s): CS 1030 with a grade of "C" or better, or readiness for MTH 1110

Description: This is the first course in the computer science core sequence. Students learn a modern programming language and the basic skills needed to analyze problems and construct programs for their solutions. The emphasis of the course is on the techniques of algorithm development, correctness, and programming style. Students are also introduced to the fundamentals of software engineering and the software-development life cycle.

CS 1400 - Computer Organization 1

Credits: 4

Prerequisite(s): An intermediate algebra course or one and one-half years of secondary school algebra or equivalent and appropriate score on the mathematics pre-assessment placement test or higher-level math course with a grade of "C" or better

Description: In this course, students will study the internal organization, characteristics, performance and interactions of a computer system's functional components. Binary codes and binary arithmetic, digital logic, central processor organization, instruction set architecture, input/output fundamentals, and memory architecture are covered.

CS 2050 - Computer Science 2

Credits: 4

Prerequisite(s): CS 1050 and MTH 1110 (or equivalent) with a grade of "C" or better, or permission of instructor

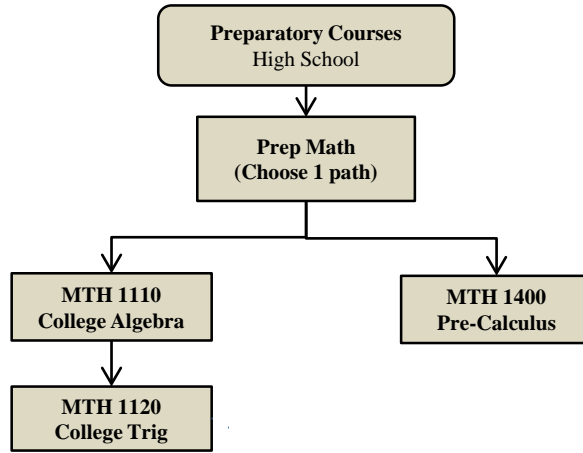
Description: This course, a continuation of CS 1050, further emphasizes the concepts of the software development cycle and introduces the concept of an abstract data type (ADT). The topics covered include linked-lists, trees, stacks, queues, classes, recursion, and a variety of data representation methods. Further topics in software engineering and programming style as well as algorithms for sorting and searching are included.

CS 2400 - Computer Organization 2

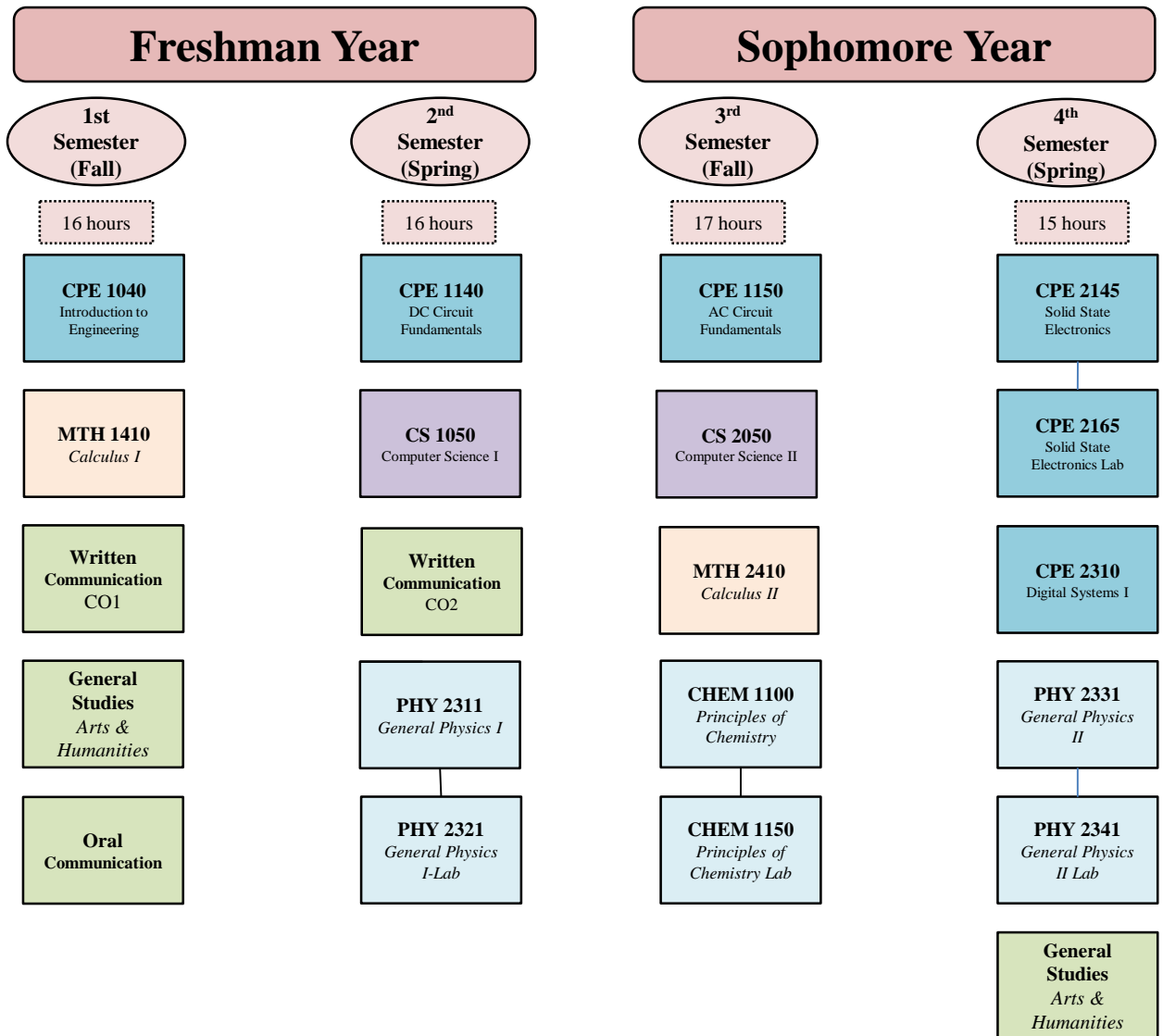
Credits: 4

Prerequisite(s): CS 1050, CS 1400, and MTH 1110 (or equivalent), each with a grade of "C" or better, or permission of instructor

Description: The course presents the functional organization of computers, multicore and multithreaded processors, high-performance storage, multiprocessor and multicomputer parallel architectures, and error detecting/correcting codes. Students learn



Recommended course rotation:



Junior Year

5th
Semester
(Fall)

16 hours

CPE 3330
Digital Systems II

CPE 2350
C Programming for
Engineer

CS 1400
Computer
Organization I

**General
Studies**
History

General Studies
*Social & Behavioral
Science I*

6th
Semester
(Spring)

16 hours

CS 2400
Computer
Organization II

CPE 4370
Embedded System
Design I

CPE 3500
Semiconductor
Device
Fundamentals

CPE 4020
Digital Systems III

General Studies
*Social & Behavioral
Science II*

7th
Semester
(Fall)

17 hours

CPE 4700
Senior Design I

CPE 4390
Embedded System
Design II

CPE 4600
VLSI Circuits and
Systems

CPE 3400
Signals & Systems

MTH 3170
Discrete Math for
Computer Science

CPE 3620
A&D
Communication

Senior Year

8th
Semester
(Spring)

15 hours

CPE 4800
Senior Design II

CPE Elective

CPE Elective

CPE 4320
Digital Filter Design

MTH 3140
Linear Algebra