COMPUTER ENGINEERING

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Program Description
Computer Engineering is a field, which in some sense, resides between the long-established fields of Computer Science and Electrical Engineering. It is concerned with topics such as analog and digital circuit design, embedded controllers, computer hardware, system software, computer system design, data communication, signal processing, computer networks, robotics, computer vision, graphics and image processing, and other topics in computing where hardware plays an important role. Computer engineers often work with other engineers, physical scientists, and software engineers.

Requirements for the Bachelor of Science Degree in Computer Engineering

Total Units Required to Graduate 180 units
Major Requirements 114 units
CENG/CMPS Courses 71
Cognates 43
Other University Requirements 65-72 units
CSUB 101 2
American Institutions 5
Area A1, A2 10*
Area B2 5*
Area C 15
Area D 15
Theme 1 0*
Theme 2 5**
Theme 3 5
GRE 3-5
GWAR (Exam) or Class 0-5
Additional Units 1 unit
*A3, B1, B3, B4, Theme 1 satised in major or cognate
**PHIL 316 is required

Major Requirements for the Bachelor of Science Degree in Computer Engineering

1. Lower Division (21 units):
CMPS 150, 221, 223, 224, 295
2. Upper Division required (40 units):
CENG 304, 307, 320, 322, 420, 490, CMPS 321, 360
3. Upper Division Electives CENG (2 courses) (10 units)

Choose one course from two of the three areas:
Communications, Signal Processing, Networking:
CENG 422, 423
Embedded Systems, Computer Control, Robotics:
CENG 457, 432
Computer Vision and Image Processing:
CENG 446, 447

Information on General Education Courses
- CSUB 101 is required for entering Freshmen with no transfer credit.
- PHYS 221 will satisfy Areas B1 and B3.
- Any of the Calculus courses (MATH 201, 202, 203, 204 or MATH 231, 232, 233, 234, PHYS 221, 222, 223, 207) will satisfy AreaB4.
- Theme 1 is waived for Computer Engineering.
- Area A3 is waived for Computer Engineering.
- PHIL 316 (Professional Ethics) must be taken and will satisfy Theme 2.

Requirements for the Bachelor of Science Degree in Computer Engineering with a Concentration in Electrical Engineering

Total Units Required to Graduate 204 units
Major Requirements 139 units
CENG/CMPS Courses 91
Cognates 48
Other University Requirements 65 units
CSUB 101 2
American Institutions 5
Area A1, A2 10*
Area B2 5*
Area C 15
Area D 15
Theme 1 0*
Theme 2 5**
Theme 3 5
GRE 3-5
GWAR (Exam) or Class 0-5
*A3, B1, B3, B4, Theme 1 satised in major or cognate
**PHIL 316 is required

1. Lower Division (21 units)
CMPS 150, 221, 223, 224, 295
2. Upper Division required (50 units)
CENG 304, 307, 320, 322, 420, 490, CMPS 321, 360
3. Upper Division Electives CENG (4 courses) (20 units)
Choose two courses from one area and at least one course from each of the remaining two areas:

**Communications, Signal Processing, Networking:**
CENG 422, 423

**Embedded Systems, Computer Control, Robotics:**
CENG 432, 434, 457,

**Computer Vision and Image Processing:**
CENG 446, 447

4. **Cognate Requirements** (48 units):
   MATH 201, 202, 203, 204 or MATH 231, 232, 233, 234 and 330, PHYS 221, 222, 223, 207

**Information on General Education Courses**
- CSUB 101 is required for entering Freshmen with no transfer credit.
- PHYS 221 will satisfy Areas B1 and B3.
- Any of the Calculus courses (MATH 201, 202, 203, 204) will satisfy Area B4.
- Theme 1 is waived for Computer Engineering.
- Area A3 is waived for Computer Engineering.
- PHIL 316 (Professional Ethics) must be taken and will satisfy Theme 2.

**COURSE DESCRIPTIONS**

**Note:** Most of the courses required for Computer Engineering are listed under the Computer Science Program. Additional upper division engineering courses are as follows:

**Lower Division**

**CENG 277 Special Topics in Computer Engineering**
(1-5)
This course will be used to supplement regularly scheduled courses with additional material at the beginning level.

**Upper Division**

**CENG 304 Linear Systems**
(5)
Time and frequency domain techniques for signal and system analysis. Fourier series and transforms, and Laplace transforms. Topics in differential equations and probability. Use of a numerical computing environment such as MATLAB. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: MATH 204 or consent of the instructor.

**CENG 306 Complex Analysis in Engineering**
(5)
The complex number field, harmonic and analytic functions, conformal mapping, integration, Cauchy’s Theorem, singularities, calculus of residues, applications to elliptic systems arising in engineering. Use of a numerical computing environment such as Matlab. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: MATH 204 or consent of the instructor.

**CENG 307 Analog Circuits**
(5)
Design, construction, and debugging of analog electronic circuits. Diodes, filters, oscillators, transistors, JFETs, op-amps, and basic analog circuit design. Broadband applications in networking and communications. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: ENGR 207 or PHYS 207 or consent of the instructor.

**CENG 320 Digital Circuits**
(5)
An introduction to the logical design of digital computers including the analysis and synthesis of combinatorial and sequential circuits, and the use of such circuits in building processor components and memory. The course will apply the circuit theory to the design of an elementary processor with a small instruction set with absolute addressing and a hard-wired control unit. An assembly language for this processor will also be developed. This course includes a laboratory which will cover a mix of actual circuit work together with circuit synthesis and testing using software. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: One course in programming or permission of the instructor.

**CENG 322 Digital Design with VHDL**
(5)
This course uses a hardware description language (HDL) to design application-specific integrated circuits. The continuation of CMPS 320 includes modern digital design technology, in-depth treatment of algorithms and architectures for digital machines and comprehensive treatment of behavioral modeling in advanced digital design. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CENG 320 or CMPS 320.

**CENG 330 Signals and Systems**
(5)
Analysis of both continuous-time and discrete-time signals, convolution, frequency domain analysis, Fourier series, Fourier transforms, and z-transforms, filters, applications to communications and control systems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: MATH 204 and ENGR 207 or PHYS 207.
CENG 377 Special Topics in Computer Engineering (1-5)
This course will be used to supplement regularly scheduled courses with additional material at the intermediate level.

CENG 420 Embedded Systems (5)
Built on logic designs, using assembly and C languages to study embedded systems with regard to their software, hardware, theories and implementation methodology. Various embedded system development tools, such as assemblers, debuggers and cross compilers, will be introduced and used in the course. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 224 and CENG 320 or CMPS 320.

CENG 422 Digital Signal Processing (5)
Introduction to principles of Digital Signal Processing (DSP) including sampling theory, aliasing effects, frequency response, Finite Impulse Response filters, Infinite Impulse Response filters, spectrum analysis, Z transforms, Discrete Fourier Transform and Fast Fourier Transform. Emphasis on hardware design to achieve high-speed real and complex multiplications and additions. Pipelining, Harvard, and modified Harvard architectures. Overviews of modern DSP applications such as modems, speech processing, audio and video compression and expansion, and cellular protocols. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: PHYS 221, MATH 203, and CENG 320 or CMPS 320.

CENG 423 Digital Communications (5)
Principles and techniques fundamental to the analysis and design of digital communication systems. The basic building blocks of a digital communication system including channel encoders/decoders, digital modulators/demodulators and channel characteristics. Channel impairments such as signal-to-noise ratios, distortion, interference, transmission errors and fading. Wired and wireless systems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CENG 320 or CMPS 320.

CENG/EENG 424 Microprocessor System Design (5)
Architecture and hardware design of microprocessor-based systems, including bus structure, interrupts handling, I/O ports, control signal, and peripherals. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 224 and CENG 320 or CMPS 320.

CENG 432 Instrumentation, Control, and Data Acquisition (5)
Study of analog (and computer-controlled) systems, classical and modern system design methods, s-domain (and z-domain) transfer function models, state space, dynamics of linear systems, and frequency domain analysis and design techniques. Introduction to controllability and observability. Implementation of PID controllers. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: MATH 203 and CMPS 223 or consent of the instructor.

CENG 434 Introduction to Control Theory (5)
This course is an introduction to the analysis and design of feedback control systems, including classical control theory in the time and frequency domain. Modeling of physical, biological and information systems using linear and nonlinear differential equations. Stability and performance of interconnected systems, including use of block diagrams, Bode plots, Nyquist criterion, and Lyapunov functions. Robustness and uncertainty management in feedback systems through stochastic and deterministic methods. Introductory random processes, Kalman filtering, and norms of signals and systems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CENG 304, 306, 330, and MATH 340.

CENG 446 Image Processing (5)
Digital image acquisition, image enhancement and restoration, image compression, computer implementation and testing of image processing techniques. Students gain hands-on experience of complete image processing systems, including image acquisition, processing, and display through laboratory experiments. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 223 and CENG 304.

CENG 447 Computer Vision (5)
Imaging formation, early vision processing, boundary detection, region growing, two-dimensional and three-dimensional object representation and recognition techniques. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 223.
CENG 457 Robotics (5)
The course will provide an opportunity for students to understand intelligent robot system architecture and to design algorithms and programs for control and planning of intelligent robot systems based on analytical modeling and behavior modeling. Students will use simulation software (Webots) and hardware test-bed (Kheraper II) to verify their algorithm and program performance during their project work. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CENG 477 Special Topics in Computer Engineering (1-5)
This course will be used to supplement regularly scheduled courses with additional material at the advanced level.

CENG 490 Senior Project (5)
After consultation with the instructor and investigation of relevant literature, the student shall prepare a substantial project with significance in Computer Engineering. In addition, an oral presentation and a written report of the project will be required. Prerequisites: Major in Computer Engineering and upper division standing.