Department of Computer and Electrical Engineering and Computer Science
School of Natural Sciences, Mathematics, and Engineering
Department Chair: Marc Thomas
Program Office: Science Building III, 317
Telephone: (661) 654-3082
email: ceecs@cs.csubak.edu
Website: www.cs.csubak.edu
Faculty: M. Danforth, S. Garcia, S. Jafarzadeh, W. Li, H. Mehrpoyan, T. Meyer, D. Meyers, L. Niu, M. Thomas, H. Wang, A. Wani

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		**180-186 units**
Major Requirements		**139 units**
ECE/CMPS Courses	81	
Cognates	58	
Minor Requirement		**0 units**
Other University Requirements		**40-47 units**
CSUB 101	2	
American Institutions	5	
Area A	10*	
Area B	0*	
Area C	10	
Area D	10**	
Theme 1	0*	
Theme 2	0**	
Theme 3	0**	
GRE	3-5	
GWAR (Exam) or Class	0-5	
Additional Units		**0-1 units**

*A3, B1, B2, B3, B4, Theme 1, Theme 2 satisfied in major.
**Computer Engineering General Education ABET Reductions (see Notes).

Requirements for the Major in Computer Engineering
1. **Lower Division** (24 units):
   ECE 160, CMPS 150, 221, 223, 224, 295
2. **Upper Division required** (42 units):
   ECE 304, 307, 320, 321, 322, 360, 420, 490A, 490B
3. **Upper Division Electives ECE** (3 courses) (15 units):
   Choose one course from each of the three areas:
   Communications, Signal Processing, Networking:
   ECE 422, 423, 425, 426
   Embedded Systems, Computer Control, Robotics:
   ECE 457, 432
   Computer Vision and Image Processing:
   ECE 446, 447
4. **Cognate Requirements** (53 units):
   MATH 201, 202, 203, 204 or MATH 231, 232, 233, 234, MATH 230 or 330, and MATH 340, PHYS 221, 222, 223, PHYS or ENGR 207

General Education Courses and Notes:
- ECE 490A or 490B satisfies Theme 1.
- PHIL 316 must be taken and will satisfy Theme 2 and the Computer Engineering Ethics requirement.
- For Computer Engineering majors, A3 is waived.
- PHYS 221 will satisfy Areas B1 and B3.
- Area B2 is waived for Computer Engineering majors.
- For Computer Engineering majors, HIST 231 or 232 will (double) count for both 5 units of Area C as well as for American Institutions.
- The Computer Engineering ABET 3c. and 3h. Student Outcomes waive 5 units in Area D and waive 5 units of Theme 3.

Requirements for the Bachelor of Science Degree in Computer Engineering with a Concentration in Electrical Engineering (This concentration has been elevated to a Degree Program. Please see Electrical Engineering).

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Program Description
Computer Science is a constantly evolving discipline. To quote the Association for Computing Machinery, "Computer Science is not simply concerned with the design of computing devices-nor is it just the art of numerical calculation. . . . Computer Science is concerned with information in much the same sense that Physics is concerned with energy; it is devoted to the representation, storage, manipulation, and presentation of information in an environment permitting automatic information systems."

The Computer Science major at CSUB has three tracks. The Computer Science track follows the guidelines recommended by the Association for Computing Machinery (ACM) and the Accreditation Board for Engineering and Technology (ABET). The Computer Information Systems track is intended for training application programmers or for those who wish to apply computer science in another discipline. The Information Security Track is intended for students who wish to pursue a career in information assurance and security, either with government agencies or with industry. Students in the three tracks will take different advanced courses of their choice. A Computer Science minor is also offered.

The Hardware track has been replaced by the Computer Engineering degree, effective Fall 2011. New students will no longer be allowed to declare this track. Existing students should consult the catalog that they entered under or a department advisor for the graduation requirements of this track.

The Computer and Electrical Engineering and Computer Science Department moved into a new building in Fall 2008 together with the Mathematics Department and have received almost a threefold increase in space. The department administers its own local area network which includes multiple Unix/Linux servers, two software programming labs, a walk-in lab, one advanced workstation lab, an isolated network lab, an AI/isolation lab, a DSP/communications lab, one digital electronics hardware lab, and a robotics lab. There is also a departmental library available to students. An important goal of the department is to enable students to work much more closely with faculty than they would be able to at larger universities. A detailed description of student learning goals and objectives can be found at http://www.cs.csub.edu/index.php?t=1&p=academic_info/program_info/index.

Requirements for the Bachelor of Science Degree in Computer Science

A. **Computer Science Track**
This track follows the guidelines of the Association for Computing Machinery (ACM) and the Accreditation Board for Engineering and Technology (ABET). Students in this track will take advanced courses of their choice.

Total Units Required to Graduate		**180-181 units**
Major Requirements		**129 units**
CMPS Courses	87	
Cognates	42	
Minor Requirement		**0 units**
Other University Requirements		**47-52 units**
CSUB 101	2	
American Institutions	5	
Area A	15	
Area B1, B2, B3	0*	
Area C	10	
Area D	10**	
Theme 1	0*	
Theme 2	0*	
Theme	0**	
GRE	5	
GWAR (Exam) or Class	0-5	
Additional Units		**0-4 units**

*B1, B2, B3, B4, Theme 1, Theme 2 satisfied in major
**Computer Science General Education ABET Reductions (see Notes)

See http://www.csub.edu/schedules.shtml for current list of courses satisfying university-wide requirements.
Note: One (1) quarter unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Requirements for the Major in Computer Science Track
1. **Introductory courses** (16 units):
   CMPS 150 (or 215), 221, 222, 223
2. **Intermediate courses** (55 units):
   CMPS 224, 295, 312, 320, 321, 335, 342, 350, 356, 360, 376
3. **Advanced courses** (16 units):
   CMPS 490A, 490B

Two courses from the following:
Algorithms and Complexity
CMPS 411
Architecture and Organization
CMPS 420, 421, 422
Intelligent Systems
CMPS 432, 456, 457
Programming Languages
CMPS 410, 450

Operating Systems, Security and Computer Networks
CMPS 445, 451, 460, 475, 476
Software Engineering and Database Systems
CMPS 435, 442, 465
Visual Computing
CMPS 371, 471, 472, 473
CMPS 477 Special Topics in Computer Science
Depending on topic, this course may count for one of the sub-areas above.

4. **The following math/physics courses** (37 units):
   MATH 201, 202, 203 or MATH 231, 232, 233, MATH 230 or 330, and MATH 340, PHYS 221, 222.
5. **General Education Courses and Notes:**
   - CMPS 490A, 490B satisfies Theme 1.
   - PHIL 316 must be taken and will satisfy Theme 2 and the Computer Science Ethics requirement.
   - PHYS 221 will satisfy Areas B1 and B3.
   - Area B2 is waived for Computer Science majors.
   - For Computer Science majors, HIST 231 or 232 will (double) count for both 5 units of Area C as well as for American Institutions.
   - The Computer Science ABET 3c. and 3h. Student Outcomes waive 5 units in Area D and waive 5 units of Theme 3.

B. **Computer Information Systems Track**
This track is intended for training application programmers or for those who wish to apply computer science in another discipline.

Total Units Required to Graduate		**180 units**
Major Requirements		**112 units**
CMPS Courses	102	
Cognates	10	
Minor Requirement		**0 units**
Other University Requirements		**52-57 units**
CSUB 101	2	
American Institutions	5	
Area A	15	
Area B	5*	
Area C	10	
Area D	10**	
Theme 1	0*	
Theme 2	0*	
Theme 3	0**	
GRE	5	
GWAR (Exam) or Class	0-5	
Additional Units		**11-16 units**

*B2, B4, Theme 1, Theme 2 satisfied in major
**Computer Science General Education ABET Reductions (see Notes)

See http://www.csub.edu/schedules.shtml for current list of courses satisfying university-wide requirements.
Note: One (1) quarter unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Requirements for the Major in Computer Information Systems Track

1. **Introductory courses** (21 units):
   CMPS 150 (or 215), 211, 221, 222, 223
2. **Intermediate courses** (50 units):
   CMPS 295, 312, 335, 342, 350, 356, 360, 371, 376, 394
3. **Advanced courses** (11 units):
   CMPS 435 or 442 or 450 or 456 or 460 or 471 or 476 and CMPS 490A, 490B
4. **Required Mathematics courses** (10 units):
   MATH 140, 192
   Higher level mathematics courses (MATH 201 or higher) may be used for either of the mathematics requirements.
5. **Electives from** (20 units):
   CMPS 215, 216, 280, or any other 300-400 level computing course taken with the consent of the program advisor. Courses from other departments relevant to CIS (not exceeding 10 units) may be taken with the written consent of the program advisor. A minor in another department can be used to offset some electives upon approval of a Computer Science Department advisor.
6. **General Education Courses and Notes:**
   - CMPS 490A, 490B satisfies Theme 1.
   - PHIL 316 must be taken and will satisfy Theme 2 and the Computer Science Ethics requirement.
   - Area B2 is waived for Computer Science majors.
   - For Computer Science majors, HIST 231 or 232 will (double) count for both 5 units of Area C as well as for American Institutions.
   - The Computer Science ABET 3c. and 3h. Student Outcomes waive 5 units in Area D and waive 5 units of Theme 3.

C. **Computer Information Security Track**
This track is intended for students who wish to pursue a career in information assurance and security, either with government agencies or with industry.

Total Units Required to Graduate		**180 units**
Major Requirements		**127 units**
CMPS Courses	67	
Cognates	60	
Minor Requirement		**0 units**
Other University Requirements		**52-57 units**
CSUB 101	2	
American Institutions	5	
Area A	15	
Area B	5*	
Area C	10	
Area D	10**	
Theme 1	0*	
Theme 2	0*	
Theme 3	0*	
GRE	5	
GWAR (Exam) or Class	0-5	
Additional Units		**1 unit**

*B2, B4, Theme 1, Theme 2, Theme 3 satisfied in major.
**Computer Science General Education ABET Reductions (see Notes).

Requirements for the Major in Computer Information Security Track

1. **Introductory courses** (16 units):
   CMPS 150 (or 215), 221, 222, 223
2. **Intermediate courses** (30 units):
   CMPS 295, 312, 335, 350, 360, 376
3. **Advanced courses** (21 units):
   CMPS 490A, 490B
   Choose at least 15 units from the following list (one course must be 400-level):
   (CMPS 215 and 216) or 340 or 342 or 445 or 451 or MATH/CMPS 475, or CMPS 476
   Another 300-/400-level CMPS, ECE or MATH elective may be taken with the consent of a program advisor.
4. **Required Cognate courses** (30 units):
   PHIL 316 must be taken and will satisfy General Education Theme 2 and the Computer Science Ethics requirement. MATH 201, 202, 203 or MATH 231, 232, 233, MATH 230 or 330 and MATH 340
5. **Global Intelligence and National Security (GINS) Cognate Courses** (30 units):
   PLSI 304 and CRJU 440
   One GINS Intelligence Analytical Tools course selected from the following list:
   GEOL 450 or CRJU 494
   If a Geographical Information Systems (GIS) Tools course is not available, CMPS 371 or 471 or ECE 446 or 447 may be substituted for the GIS course.
   At least 15 units of GINS Focus Area courses selected from the following list:
   Up to 10 units of GINS strategic language courses, HIST 325 or 340 or 358 or 413 or 426 or PLSI 302 or 303 or 308 or 309 or 323 or 328 or 376 or SOC 450
   Other GINS Focus Area courses may be used with the consent of a program advisor.
6. **General Education Course and Notes:**
   - CMPS 490A, 490B satisfies Theme 1.
   - PHIL 316 must be taken and will satisfy Theme 2 and the Computer Science Ethics requirement.
   - PLSI 304 must be taken and will satisfy Theme 3.
   - Area B2 is waived for Computer Science majors.
   - For Computer Science majors, HIST 231 or 232 will (double) count for both 5 units of Area C as well as for American Institutions.
   - The Computer Science ABET 3c. and 3h. Student Outcomes waive 5 units in Area D.

D. **Computer Science Hardware Track**
   The Hardware Track has been replaced by the Computer Engineering degree, effective Fall 2011. New students will no longer be allowed to declare this track. Existing students should consult the catalog that they entered under or a department advisor for the graduation requirement of this track.

Requirements for a Minor in Computer Science

A Minor in Computer Science will require the student to take a total of at least 20 units of 200-level or higher course work as well as satisfy the additional requirements:

a. CMPS 223 (which requires CMPS 221 or the equivalent).
b. One course chosen from the following: CMPS 215, 222, 224 or 295.
c. At least 10 units of upper division course work in computer science (normally two courses) chosen with the help of a computer science advisor. MATH 305 may be substituted for one computer science course.

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Program Description
Electrical Engineering is a large and expanding field which is concerned with the following fundamental areas: digital signal processing, semiconductor electronics, microprocessors and embedded systems, VSLI design, cyber-physical systems, data communications, energy systems and power electronics, transmission and distribution, RF and microwave, robotics and control system design, electromechanics and mechatronics, computer networks, digital design, image processing and computer vision. If computer science can be regarded to be on the information processing side of computer engineering, then electrical engineering can be regarded to be on the side which builds upon the fundamental physical properties of electricity and magnetism. Electrical engineers often work with other engineers, physical scientists, and computer scientists.

Requirements for the Bachelor of Science Degree in Electrical Engineering

Total Units Required to Graduate		**180 units**
Major Requirements		**133 units**
CMPS/ECE Courses	70	
Cognates (includes PHIL 316)	63	
Other University Requirements		**42-47 units**
CSUB 101	2	
American Institutions	5	
Area A	10*	
Area B	0*	
Area C	10	
Area D	10**	
Theme 1	0*	
Theme 2	0*	
Theme 3	0**	
GRE	5	
GWAR (Exam) or Class	0-5	
Additional Units		**0-5 units**

*A3, B1, B2, B3, B4, Theme 1, Theme 2 satisfied in major or cognate
**Electrical Engineering General Education ABET Reductions (see Notes)

Requirements for the Major in Electrical Engineering
1. **Lower Division** (14 units):
   ECE 160, CMPS 150, 221, 224
2. **Upper Division required** (41 units):
   ECE 304, 307, 320, 330, 332, 337, 423, 490A, 490B
3. **Upper Division Electives** (3 courses) (15 units):
   Select three courses from: ECE 322, 336, 420, 422, 424, 432, 433, 434, 446, 447, 457, 464
4. **Cognate Requirements** (58 units):
   MATH 201 or 231, MATH 202 or 232, MATH 203 or 233, MATH 204 or 234, MATH 230 or 330, and MATH 340, CHEM 211, PHYS 221, 222, 223, PHYS/ENGR 207

General Education Courses and Notes:
- ECE 490A, 490B satisfies Theme 1.
- PHIL 316 must be taken and will satisfy Theme 2 and the Electrical Engineering Ethics requirement.
- For Electrical Engineering majors, A3 is substituted by PHYS/ENGR 207.
- PHYS 221 will satisfy Areas B1 and B3.
- Area B2 is waived for Electrical Engineering majors.
- For Electrical Engineering majors, HIST 231 or 232 will (double) count for both 5 units of Area C as well as for American Institutions.
- The Electrical Engineering ABET 3c. and 3h. Student Outcomes waive 5 units in Area D and waive 5 units of Theme 3.

COURSE DESCRIPTIONS
Note: All Computer Engineering and Electrical Engineering courses descriptions are listed under the Computer Engineering Degree Program and carry the ECE prefix.

Note: Several of the courses required for Computer Engineering are listed under the Computer Science Program. Additionally, all Computer Engineering and Electrical Engineering courses descriptions are listed under the Computer Engineering Degree Program and carry the ECE prefix.

Lower Division

ECE 160 Introduction to Engineering (3)
This course will provide an introduction to the practice of engineering by reviewing its history and current state. Students are informed about various areas within the discipline of engineering, e.g. chemical, agricultural, and electrical. Finally the impact of engineering from a global, social, and political perspective is presented through a number of case studies.

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

Upper Division

ECE 304 Signals and Systems I (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 234 or consent of the instructor.

ECE 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 234 or consent of the instructor.

ECE 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.

ECE 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.

ECE 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: ECE 320 or CMPS 320.

ECE 325 Properties of Materials (5)
Fundamental electrical, optical, and magnetic properties of materials, elementary quantum mechanics, crystal structure, energy bands, metals and semiconductors. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: ECE 307 and PHYS 223.

ECE 330 Signals and Systems II (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 or 234 and ENGR 207 or PHYS 207.

ECE 332 Fields and Waves (5)
Vector analysis, electrostatic and magnetic fields, Maxwell's equations, plane waves. Reflection, attenuation, and impedance. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: MATH 204 or 234 and PHYS 223.

ECE 336 Electrical Machinery (5)
This course is an introduction to the analysis and design of electromechanical energy conversion systems, magnetic circuit theory, general transformer and machinery theory, DC and AC motors and generators. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: ECE 304 and 307.

ECE 337 Fundamentals of Power Systems (5)
This course is an introductory subject in the field of electric power systems. Electric power systems have become increasingly important as a way of transmitting and transforming energy in industrial, military and transportation uses. The course covers basic elements of power system, three-phase circuit analysis, transformers, transmission line configuration, the per unit system and power flow. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: ENGR 207 or PHYS 207 and ECE 304 or consent of the instructor.

ECE 377 Special Topics in Computer and Electrical Engineering (1-5)
This course will be used to supplement regularly scheduled courses with additional material at the intermediate level.

ECE 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 ECE 320 or CMPS 320.

ECE 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 or 233, and ECE 320 or CMPS 320.

ECE 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: ECE 320 or CMPS 320.

ECE 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 ECE 320 or CMPS 320.

ECE 425 Wireless Communications (5)
In this course analytical characterizations of mobile communications channels are developed. The main techniques for mitigating the mobile communication channel effects such as Equalization, Diversity, etc. are examined. Multiple access techniques used in wireless communications, such as FDMA as well as digital TDMA and CDMA techniques that allow multiple users to share a given spectrum is examined. Students will learn how to design a cellular system for a given coverage area, and how to carry out the performance analysis of the designed system. They will also know how to increase the capacity (number of users accommodated) in a cellular system. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: ECE 304 and 330 or consent of the instructor.

ECE 426 Wireless Networks (5)
This course focuses on wireless data communications including wireless Internet. The students acquire knowledge into the current and future state-of-the-art of technology in the field of wireless communication. Another goal of the course is to ensure student(s) can explain the impact of commercial, political, and regulatory factors on the design of wireless systems. The course will treat current relevant technologies, and the exact content may change from year to year. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: ECE 304 or consent of the instructor.

ECE 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 or 233 and CMPS 223 with a grade of C- or higher.

ECE 433 Mechatronics (5)
Intelligent electro-mechanical systems. Topics include electronics (A/D, D/A converters, op-amps, filters, power devices), software program design (event-driven programming, state machine-based design), DC and stepper motors, basic sensing and basic mechanical design. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: ECE 307, 320, and CMPS 223.

ECE 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: ECE 304, 306, 330, and MATH 340.

ECE 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 ECE 304.

ECE 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 with a grade of C- or higher and ECE 304.

ECE 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.

ECE 464 Power Electronics and Semiconductors (5)
The course is an introduction to switched-mode power converters. It provides a basic knowledge of circuitry for the control and conversion of electrical power with high efficiency. These converters can change and regulate the voltage, current, or power; dc-dc converters, ac-dc rectifiers, dc-ac inverters, and ac-ac cycloconverters are in common use. Applications include electronic power supplies, aerospace and vehicular hybrid power systems, and renewable energy systems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: ECE 304 and 307.

ECE 477 Special Topics in Computer and Electrical Engineering (1-5)
This course will often be used to supplement other courses with additional work at a more advanced level. Prerequisite: Permission of the instructor

ECE 489 Experiential Prior Learning (1-5)
Majors in Computer and Electrical Engineering with significant prior experience in computers may have some of their experience count for academic credit toward their degree. In order to be considered for experiential learning credit the student must have completed CMPS 224 and have the approval of the department.

ECE 490A Senior Project I (3)
After consultation with the faculty supervisor and investigation of relevant literature, the student(s) shall prepare a substantial project with significance in the designated area. The timeline, teamwork responsibilities, milestones, and presentation(s) will be scheduled. Prerequisite: Upper-division standing.

ECE 490B Senior Project II (3)
This is the completion phase of the project. The student(s) will present a project report to the entire class, explaining the nature of the work, the finished product, and its relationship to the field. Prerequisite: Upper-division standing and ECE 490A.

Academic Regulation
A grade of C- is the minimal grade acceptable for progression in the CMPS 221, 222, and 223 sequence.

Lower Division

The Department of Computer Science offers courses on topics of current interest to the community from time to time. Call the Computer Science office, (661) 654-3082, to express interest or inquire concerning offerings.

CMPS 120 Computer Skills and Concepts I (5)
Instruction and tutoring in basic computer skills. An overview of computer terminology, hardware and software. Included: storage devices, input/output devices, the internet, operating systems, word processing, spreadsheets, presentation software, creating web pages and simple databases. Meets for 250 minutes. Prerequisites: None.

CMPS 150 Introduction to Unix (1)
Basic Unix commands and programming utilities will be introduced. Students will learn how to use email, a text editor, and manage files and directories. This course is designed for students who have no experience with Unix. Computer Science majors are encouraged to take CMPS 215 in place of this course, if possible.

CMPS/MATH 206 Advanced Engineering Mathematics (5)
Introduction to ordinary differential equations, Fourier Series and Integral, other transforms, and partial differential equations; applications to computer hardware, such as the resonance, wave equation, transmission line equation, and filtering. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: MATH 203.

CMPS 211 Internet Programming and Web Design (5)
Introduction to internet programming using HTML and JavaScript or other scripting language. The course is intended for students with no programming experience. Students will learn the concepts of structured programming and control structures. They will become familiar with HTML interfaces by designing interactive web sites. This course may be used as an elective in the CIS track. Prerequisite: None.

CMPS 215 Unix Programming Environment (3)
This course covers common Unix commands, shell scripting, regular expressions, tools and the applications used in a Unix programming environment. The tools to be introduced include make utility, a debugger, advanced text editing and text processing (vi, sed, tr). Each week lecture meets for 100 minutes and lab meets for 150 minutes. Prerequisite: None.

CMPS 216 Unix System Administration (3)
This course covers the knowledge and skills critical to administering a multi-user, networked Unix system. The course assumes a basic knowledge of Unix commands and an editor (vi or Emacs). Topics include: kernel and network configuration, managing daemons, devices, and critical processes, controlling startup and shutdown events, account management, installing software, security issues, shell scripting. Many concepts will be demonstrated during hands-on labs. Each week lecture meets for 100 minutes and lab meets for 150 minutes. Prerequisite: CMPS 215.

CMPS 221 Programming Fundamentals (5)
Introduces the fundamentals of procedural programming. Topics include: data types, control structures, functions, arrays, and standard and file I/O. The mechanics of compiling, linking, running, debugging and testing within a particular programming environment are covered. Ethical issues and a historical perspective of programming within the context of computer science as a discipline are given. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: MATH 85 or satisfaction of Entry Level Mathematics (ELM).

CMPS 222 Object-Oriented Programming (5)
Builds on foundation provided by CMPS 221 to introduce the concepts of object-oriented programming. The course focuses on the definition and use of classes and the fundamentals of object-oriented design. Other topics include: an overview of programming language principles, basic searching and sorting techniques, and an introduction to software engineering issues. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 221 with C- or higher.

CMPS 223 Data Structures and Algorithms (5)
Builds on the foundation provided by CMPS 221 to introduce the fundamental concepts of data structures and algorithms that proceed from them within the framework of object-oriented programming technology. Topics include: recursion, fundamental data structures (including lists, stacks, queues, hash tables, trees and graphs) and basics of algorithmic analysis. Necessary components of object-oriented programming method will be introduced. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 221 with C- or higher.

CMPS 224 Assembly Language Programming (5)
Introduction to machine architecture and program structure; code, data, and stack segments; programming with an assembly language. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 221.

CMPS 270 Introduction to CAD in Engineering (3)
Use of computer-aided design software, such as AutoCAD, in engineering. CAD concepts including drawing setups, commands and system variables, layers and object properties, 2-dimensional entity creation, coordinate systems, creating objects, drawing with precision, plotting, and editing methods are applied to a variety of engineering applications. Two hours lecture/discussion and three hours laboratory per week.

CMPS 271 Intermediate CAD in Engineering (3)
Intermediate topics in computer-aided design using AutoCAD. Introduction to 3-dimensional drawing and modeling with engineering applications, adding text to drawings, creating dimensions, using blocks and external references, managing content with Autocad Design Center, creating a layout to plot, plotting your drawings, working with raster images, creating compound documents with OLE, and using other file formats. Two hours lecture/discussion and three hours laboratory per week. Prerequisite: CMPS 270

CMPS 277 Topics in Programming Languages (1-5)
A study of programming languages not offered otherwise. Prerequisite: Knowledge of a high-level programming language or permission of the instructor.

CMPS 280 X-Windows (3)
This course is an introduction to the use of an X-Windowing environment. The course is designed more for the end user than for X11 programmers. Its goal is to familiarize the applications user with the standard X11 productivity tools as well as explain the underlying principles, configuration questions, and security considerations involved in working or administering an X-Workstation with Internet access. Each week lecture meets for 100 minutes and lab meets for 150 minutes.

CMPS 281 Problem Solving in Compute Science (1)
This workshop is designed for students in the Louis Stokes alliance for Minority Participation Program (LSAMP), but is open to other students as well. It covers topics from CMPS 221. Typically students work during the meeting on problems related to their class, being helped by a facilitator.

CMPS 295 Discrete Structures (5)
Discrete structures and applications in computer science. Proofs, with a focus on induction. Introduction to propositional and predicate logic, functions, relations and sets, algorithm analysis, counting techniques, recursion and solution or recurrence relations, graph theory and trees. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 221 with a grade of C- or higher and MATH 190 or 191 or higher.

Upper Division

CMPS 305 Numerical Analysis (5)
Number representation and basic concepts of error; numerical solutions of nonlinear equations and systems of equations; interpolation and extrapolation; numerical differentiation and integration; numerical solution of ordinary differential equations; approximation by spline functions. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 221 and MATH 203 or permission of instructor. Cross-listed with MATH 305: Numerical Analysis.

CMPS 311 Server Scripting Languages (5)
Languages, principles and techniques fundamental to web application development on the server side. The latest languages and technologies are addressed, to include ASP, PHP, Perl, Python. Prerequisites: CMPS 221 and 211 or instructor approval.

CMPS 312 Algorithm Analysis and Design (5)
Algorithm analysis, asymptotic notation, hashing, hash tables, scatter tables, and AVL and B-trees, brute-force and greedy algorithms, divide-and-conquer algorithms, dynamic programming, randomized algorithms, graphs and graph algorithms, and distributed algorithms. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 295 or 300 and 223.

CMPS 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.

CMPS 321 Computer Architecture (5)
This course follows the Digital Logic Design course and focuses on the design of the CPU and computer system at the architectural (or functional) level: CPU instruction sets and functional units, data types, control unit design, interrupt handling and DMA, I/O support, memory hierarchy, virtual memory, and buses and bus timing. In contrast, the Digital logic Design course is primarily concerned with implementation; that is, the combinatorial and sequential circuits which are the building blocks of the functional units. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 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: CMPS 320.

CMPS 335 Software Engineering (5)
A general introduction to Software Engineering. Deals with the specification, development, management, and evolution of complex software systems. Shows how to cost-effectively apply the methods and theory from Computer Science to solve difficult problems. The course presents a broad perspective on software and system engineering and surveys a wide spectrum of tools and techniques. Students are required to complete a project as part of a small software engineering team. Students may choose system projects involving software and hardware integration. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 340 Introduction to Digital Forensics (5)
Investigative techniques, evidence handling procedures, forensics tools, digital crime reconstruction, and legal guidelines. Case studies cover a range of hardware and software platforms. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: None (CMPS 215 or a good working knowledge of Unix is recommended).

CMPS 342 Database Systems (5)
Basic issues in data modeling, database application software design and implementation. File organizations, relational model, relational database management systems, and query languages are addressed in detail. Two-tier architecture, three-tier architecture and development tools are covered. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 295.

CMPS 350 Programming Languages (5)
An examination of underlying concepts in high level programming languages and techniques for the implementation of a representative sample of such languages with regard to considerations such as typing, block structure, scope, recursion, procedures invocation, context, binding, and modularity. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 356 Artificial Intelligence (5)
This course is intended to teach the fundamentals of artificial intelligence which include topics such as expert systems, artificial neural networks, fuzzy logic, inductive learning and evolutionary algorithms. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 312 or consent of instructor.

CMPS 360 Operating Systems (5)
A study of the introductory concepts in operating systems: historical development of batch, multiprogrammed, and interactive systems; file, memory, device, process, and thread management; interrupt and trap handlers, abstraction layer, message passing; kernel tasks and kernel design issues; signals and interprocess communication; synchronization, concurrency, and deadlock problems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 371 Computer Graphics (5)
Introduction to computer graphics hardware, animation, two-dimensional transformations, basic concepts of computer graphics, theory and implementation. Use of graphics API's such as DirectX or OpenGL. Developing 2D graphics applications software. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 376 Computer Networks (5)
A study of computer networks focusing on the TCP/IP Internet protocols and covering in detail the four layers: physical, data link, network, and transport. This course includes a laboratory in which students will cover important network utilities, debugging tools, process and thread control as it relates to network programming, and the coding of programs which do interprocess communication over sockets. The typical Internet client program which accesses a TCP network server daemon will be covered in detail. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 377 Special Topics in Computer Science (3-5)
This course will be used to supplement other courses with additional work at the intermediate level. Prerequisite: Permission of instructor.

CMPS 394 Client, Server, Internet and Hand-held Device Programming (5)
This course will use Java's features and libraries to explore client-side, server-side, and internet programming. The concepts of multi-threading, synchronization, and network programming (socket and remote-method onvocation) will be introduced and used to develop internet client-server programs such as chat room, on-line help, file transfer, etc. The concepts of graphic user interfaces (GUIs) and hand-held devices (such as Android phone or tablets) will be discussed and applied in student projects. Meets for 200 minutes of lecture and 150 minutes of lab. Prerequisites: Completion of CMPS 222 and 223 with a C- or higher.

CMPS 410 Theory of Language Translation (5)
A study of techniques relevant to the theory of language translation including finite state machines, formal languages, grammars, lexical and syntactic analysis. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 350.

CMPS 411 Theory of Automata (5)
A study of algorithms as they relate to nonlinear data structures and external files. Time and space analysis of several popular algorithms, and a discussion of NP-hard and NP-complete problems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS 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 320.

CMPS 421 Advanced Computer Architecture (5)
Continuation of CMPS 321 including speed-up arithmetic algorithms, vector and parallel processing, organization of memory for high performance processors, and a comparative study of supercomputer architectures. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 321.

CMPS 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 CMPS 320.

CMPS 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.

CMPS 435 Advanced Software Engineering (5)
Continuation of study of the software lifecycle. Methods and tools for the implementation, integration, testing and maintenance of large, complex software systems. Program development and test environments. Group laboratory project. Technical presentation methods and practice. Ethical and societal issues in software engineering. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 335.

CMPS 442 Advanced Database Systems (5)
A wide range of topics such as query processing and optimization, object-oriented database systems, distributed database systems, database warehousing and data mining will be discussed. The course will also be used to introduce emerging issues related to database systems. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 342.

CMPS 445 Data Mining and Visualization (5)
Knowledge discovery in and visualization of large datasets, including data warehouses and text-based information systems. Topics covered include data mining concepts, information retrieval, analysis methods, storage systems, visualization, implementation and applications. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 312

CMPS/ECE 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 ECE 304.

CMPS 450 Compiler Construction (5)
An introduction to the construction of compilers, including lexical and syntactic analysis, code generation, and error detection. This course includes a 2 1/2 hours per week laboratory in which students will implement a compiler for a given programming language. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 350.

CMPS 451 Vulnerability Analysis (5)
Identification and quantification of security weaknesses in programs, systems and networks. Topics include professional ethics, static binary analysis, dynamic binary analysis, anti-analysis techniques, risk assessment, penetration testing, vulnerability classification and mitigation techniques. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 350

CMPS 456 Advanced Artificial Intelligence (5)
Continuation of CMPS 356. This course is intended to teach about advances in artificial intelligence. It includes advanced topics on artificial neural networks such as distributed and synergistic neural network models, hybrid artificial intelligence techniques such as neuro-fuzzy models, advanced machine learning techniques and meta-heuristic evolutionary algorithms. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 356.

CMPS 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.

CMPS 460 Advanced Operating Systems (5)
Continuation of CMPS 360. Various topics in popular operating systems. Real-time and distributed operating systems will be addressed. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 360.

CMPS 465 Advanced System Analysis and Design (5)
Design and construction of sizeable software products. Technical management of software development teams. Software development process models, software design, documentation, quality assurance during development, software unit and integration testing, CASE tools, development environments, test tools, configuration management. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 335.

CMPS 471 Advanced Computer Graphics (5)
Continuation of CMPS 371. 3D graphics transformations, multi-resolution model building and rendering. Advanced computer graphics concepts-theory and implementation. Advanced animation techniques in a 3D environment. This course includes a laboratory. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 371.

CMPS 472 AI Agents in Virtual Environments (5)
Continuation of CMPS 471. This course is about creating and interacting with intelligent three-dimensional virtual environments. Topics covered will include hierarchical architecture of three-dimensional virtual environments, and a framework of incorporating intelligent agents within the virtual environment. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 371.

CMPS 473 Computer Game Design (5)
The course will cover fundamental concepts behind designing a game engine. The concepts, theories, and programming aspects of physics engine, graphics engine, and control engine will be covered. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisite: CMPS 223.

CMPS/MATH 475 Applied Cryptography (5)
An introduction to cryptography, history and its present day use. Topics include symmetric cyphers, hash functions, public-key encryption, data integrity, digital signatures, key establishment, key management. Related topics include prime generation, integer factorization, discrete logarithms, pseudo-random number generation and computational complexity. Prerequisite: CMPS 221, and one of CMPS 295 or MATH 300

CMPS 476 Advanced Computer Networks and Computer Security (5)
Continuation of CMPS 376. Various advanced topics in computer networks and computer security will be addressed. Each week lecture meets for 200 minutes and lab meets for 150 minutes. Prerequisites: CMPS 376

CMPS 477 Special Topics in Computer Science (1-5)
This course will often be used to supplement other courses with additional work at a more advanced level. Prerequisite: Permission of instructor.

CMPS 489 Experiential Prior Learning (1-5)
Majors in Computer Science with significant prior experience in computers may have some of their experience count for academic credit toward their degree. In order to be considered for experiential learning credit the student must have completed CMPS 223 and have the approval of the department.

CMPS 490A Senior Project (3)
After consultation with the faculty supervisor and investigation of relevant literature, the student(s) shall prepare a substantial project with significance in the designated area. The timeline, teamwork responsibilities, milestones, and presentation(s) will be scheduled. Prerequisites: Upper-division standing.

CMPS 490B Senior Project (3)
This is the completion phase of the project. The student(s) will present a project report to the entire class, explaining the nature of the work, the finished product, and its relationship to the field. Prerequisite: Upper-division standing and CMPS 490A.

CMPS 496 Internship in Computer Science (1-5)
Internships may be arranged by the department with various agencies, businesses, or industries. The assignments and coordination of work projects with conferences and reading, as well as course credits, evaluation, and grading are the responsibility of the faculty liaison (or course instructor), working with the field supervisor. Offered on a credit, no-credit basis only. The department will determine credits and application of credit.

CMPS 497 Cooperative Education (5)
The Cooperative Education program offers a sponsored learning experience in a work setting, integrated with a field analysis seminar. The field experience is contracted by the Cooperative Education office on an individual basis, subject to approval by the department. The field experience, including the seminar and reading assignments, is supervised by the cooperative education coordinator and the faculty liaison (or course instructor), working with the field supervisor. Students are expected to enroll in the course for at least two quarters. The determination of course credits, evaluation, and grading are the responsibility of the departmental faculty. Offered on a credit, no-credit basis only. The department will determine application of credit.