Computer Engineering Degree Requirements

Department of Computer and Electrical Engineering and Computer Science
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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.

The Computer and Electrical Engineering and Computer Science Department moved into a new building in Fall 2008. The department administers its own local area network which includes multiple Unix/Linux servers, two software programming labs, a walk-in lab/tutoring center, one advanced workstation lab, an isolated network lab, an AI/visualization lab, a DSP/communications lab, one digital electronics hardware lab, a power systems/electronics lab, and a robotics/control systems lab. There is also a department library/major study room with computers 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/all_abet.pdf.

Requirements for the Bachelor of Science Degree in Computer Engineering

Total Units Required to Graduate		**120 units**
Major Requirements		**95 units**
ECE/CMPS Courses	64	
Cognate Courses	31	
Minor Requirement		**0 units**
General Education Requirements		**24 units**
First-Year Seminar	0*	
LD Area A Foundational Skills	6*	
LD Area B Natural Sciences	0*	
LD Area C Arts and Humanities	6	
LD Area D Social and Behavioral Sciences	3*	
American Institutions	6	
SELF	0**	
Junior Year Diversity Requirement	3	
UD Thematic Areas C and D	0*	
Capstone	0*	
GWAR (Exam) or Class	0**	
Additional Units		**1 unit***

*The following required major courses also meet general education requirements: ECE/ENGR 1618 and 1628 meet First-year Seminar, MATH 2310 or 2510 meets Foundational Skill A4, PHYS 2210 meets LD Area B1/B3, PHIL 3318 meets UD Thematic Area C, and CMPS 4928 meets Capstone. Engineering majors have the following GE modifications: Foundational Skill A3, LD Area B2, 3 units of LD Area D, and UD Thematic Area D.

**The SELF requirement may be met by selecting another General Education course with a SELF overlay or by taking a stand-alone course. The GWAR may be satisfied by taking the GWAR exam, by taking another General Education course with a GWAR overlay, or by taking a stand-alone course. If a student opts to take a stand-alone course for either or both of these requirements, the course(s) will add additional units to that student's general education pathway.
***Additional Units are required to meet the 120 unit requirement for graduation. Any accepted university units may be used to meet this requirement, including stand-alone courses for SELF and GWAR.

SB1440 units required - **58 units***
*Units required for graduation after completion of the Engineering (Computer Engineering focus) model curriculum and lower-division general education at a California community college.

Note: One (1) semester unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Academic Regulation
A grade of C- is the minimal grade acceptable for progression in the CMPS 2010 and 2020 sequence.

Requirements for the Major in Computer Engineering
1. **Lower Division** (20 units):
   ECE/ENGR 1618, 1628, ECE/ENGR/PHYS 2070, CMPS 2010, 2020, 2120
2. **Upper Division** (32 units):
   CMPS 3240, 3600, ECE 3040, 3070, 3200, 3220, 3250, 4910, 4928
3. **Upper Division Elective courses** (12 units):
   Select 12 units of electives from the following:
   Digital Communications and Signal Processing:
   ECE 3230, 4220, 4250, 4260
   Control Systems, Robotics, and Digital Design:
   ECE 3280, 4240, 4570
   Image Processing and Computer Vision:
   ECE 4460, 4470
   Special Topics and Independent Study
   ECE 3770, 3771, 4770, 4771, 4800, 4860, 4870, 4890
   Only a combined total of 4 units of ECE 377x, 477x, 48xx may be used for elective credit.
4. **Required Cognate courses** (31 units):
   MATH 2510 or 2310, MATH 2520 or 2320, MATH 2530, 2610, 3200, PHYS 2210, 2220, PHIL 3318
5. **General Education Courses and Notes:**
   Some of the courses required for the Computer Engineering major also satisfy General Education requirements. Students who complete each of these courses with the appropriate grade will also satisfy the GE requirement, even if they were to change majors:
   • ECE/ENGR 1618 and 1628 satisfy the First-year Seminar requirement.
   • ECE 4928 satisfies the Capstone requirement.
   • PHIL 3318 satisfies UD Thematic Area C and the Computer Engineering Ethics requirement.
   • PHYS 2210 satisfies LD Areas B1.
   • MATH 2510 or 2310 with a grade of C or better satisfies Foundational Skill A4.
   Engineering majors have the following General Education Modifications (GEMs), which means they do not have to take courses to satisfy these GE requirements. These GEMs are specific to the three engineering majors (Computer Engineering, Electrical Engineering and Engineering Sciences). Students who change to another major will not keep the modifications:
   • Foundational Skill A3 is embedded in PHYS 2210, 2220 and ECE/ENGR/PHYS 2070.
   • LD Area B2 is embedded throughout the curriculum.
   • 3 units of LD Area D is met through EAC/ABET outcomes 3c and 3h.
   • UD Thematic Area D is met through EAC/ABET outcomes 3c and 3h.

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

<u>**Computer Science Degree Requirements**</u>

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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 pathways that lead to a B.S. in Computer Science. The traditional Computer Science program follows the guidelines recommended by the Association for Computing Machinery (ACM) and the Accreditation Board for Engineering and Technology (ABET). The Computer Information Systems concentration is intended for training application programmers or for those who wish to apply computer science in another discipline. The Information Security concentration 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 pathways will take different advanced courses of their choice. A Computer Science minor is also offered.

The Computer and Electrical Engineering and Computer Science Department moved into a new building in Fall 2008. The department administers its own local area network which includes multiple Unix/Linux servers, two software programming labs, a walk-in lab/tutoring center, one advanced workstation lab, an isolated network lab, an AI/visualization lab, a DSP/communications lab, one digital electronics hardware lab, a power systems/electronics lab, and a robotics/control systems lab. There is also a departmental library/major study room 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/all_abet.pdf.

Requirements for the Bachelor of Science Degree in Computer Science

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

Total Units Required to Graduate		**120 units**
Major Requirements		**89-90 units**
Major Courses	63	
Cognate Courses	26-27	
Minor Requirement		**0 units**
General Education Requirements		**26-29 units**
First-Year Seminar	2	
LD Area A Foundational Skills	6-9*	
LD Area B Natural Sciences	0*	
LD Area C Arts and Humanities	6	
LD Area D Social and Behavioral Sciences	3*	
American Institutions	6	
SELF	0**	

Junior Year Diversity Requirement	3
UD Thematic Areas C and D	0*
Capstone	1
GWAR (Exam) or Class	0**
Additional Units	**1-5 units***

*The following required major courses also meet general education requirements: MATH 2310 or 2510 meets Foundational Skill A4, PHYS 2210 meets LD Area B1/B3, PHIL 3318 meets UD Thematic Area C, and CMPS 4928 meets Capstone. Students have the option of taking SCI 1409 (Foundational Skill A3) to meet the Math/Science elective requirement of the major, which would reduce Foundational Skills by 3 units if the student opts to take that course for the Math/Science elective. Computer Science majors have the following GE modifications: LD Area B2, 3 units of LD Area D and UD Thematic Area D. See below GE Notes for more details.

**The SELF requirement may be met by selecting another General Education course with a SELF overlay or by taking a stand-alone course. The GWAR may be satisfied by taking the GWAR exam, by taking another General Education course with a GWAR overlay, or by taking a stand-alone course. If a student opts to take a stand-alone course for either or both of these requirements, the course(s) will add additional units to that student's general education pathway.

***Additional Units are required to meet the 120 unit requirement for graduation. Any accepted university units may be used to meet this requirement, including stand-alone courses for SELF and GWAR.

SB1440 units required - **60 units***
*Units required for graduation after completion of the Computer Science transfer model curriculum and lower-division general education at a California community college.

Note: One (1) semester unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Academic Regulation
A grade of C- is the minimal grade acceptable for progression in the CMPS 2010 and 2020 sequence.

Requirements for the Major in Computer Science
1. **Lower Division** (16 units):
   CMPS 2010, 2020, 2120, 2240
2. **Upper Division** (39 units):
   CMPS 3120, 3140, 3240, 3350, 3420, 3500, 3560, 3600, 3620, 3640, 4910, 4928
3. **Upper Division Elective courses** (8 units):
   Select two courses from the following. At least one course must be at the 4000-level:
   Algorithms, Complexity, Theory, and Programming Theory
   CMPS 4500, MATH/CMPS 3300, MATH 3310
   Architecture and Organization
   CMPS 4120, ECE 3200, 4240
   Software Engineering and Visual Computing
   CMPS 3390, 3480, 4350, 4490, ECE 4460, 4470
   Database Systems and Intelligent Systems
   CMPS 4420, 4450, 4560, ECE 4570
   Operating Systems, Networking, and Security
   CMPS 4510, 4620, MATH/CMPS 4300
   Special Topics and Independent Study in Computer Science
   CMPS 3770, 3771, 4770, 4771, 4800, 4860, 4870, 4890
   Only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit.
4. **Required Cognate courses** (26-27 units):
   MATH 2510 or 2310, MATH 2520 or 2320, MATH 3200, PHYS 2210, 2220, PHIL 3318
   One Mathematics or Science elective course (3-4 units) selected from the following: BIOL 1009, 1039, 2010, CHEM 1000, GEOL 2010, MATH 2200, 2530, 2540, 2610, 3500, PHYS 2230, SCI 1409
5. **General Education Courses and Notes:**

Some of the courses required for the Computer Science major also satisfy General Education requirements. Students who complete each of these courses with the appropriate grade will also satisfy the GE requirement, even if they were to change majors:

- CMPS 4928 satisfies the Capstone requirement.
- PHIL 3318 satisfies UD Thematic Area C and the Computer Science Ethics requirement.
- PHYS 2210 satisfies LD Areas B1.
- MATH 2510 or 2310 with a grade of C or better satisfies Foundational Skill A4.
- Students may choose to take SCI 1409 as their Mathematics/Science elective. Completion of SCI 1409 with a grade of C or better satisfies Foundational Skill A3.

Computer Science majors have the following General Education Modifications (GEMs), which means they do not have to take courses to satisfy these GE requirements. These GEMs are specific to the Computer Science major and students who change to another major will not keep the modifications:

- LD Area B2 is embedded throughout the curriculum.
- 3 units of LD Area D is met through CAC/ABET outcomes 3c and 3g.
- UD Thematic Area D is met through CAC/ABET outcomes 3c and 3g.

Requirements for the Bachelor of Science in Computer Science with a Concentration in Computer Information Systems

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

Total Units Required to Graduate	**120 units**
Major Requirements	**82-85 units**
Major Courses	58
Elective Courses or Minor	12+
Cognate Courses	12-15
Minor Requirement	**0 units+**
General Education Requirements	**32 units**
First-Year Seminar	2
LD Area A Foundational Skills	9*
LD Area B Natural Sciences	3*
LD Area C Arts and Humanities	6
LD Area D Social and Behavioral Sciences	3*
American Institutions	6
SELF	0**
Junior Year Diversity Requirement	3
UD Thematic Areas C and D	0*
Capstone	0*
GWAR (Exam) or Class	0**
Additional Units	**3-6 units***

+Students can opt to take either a discipline-based minor or Computer Information System electives to satisfy the 12 unit elective requirement. If a minor is chosen, it must be a discipline-based minor and cannot be a general education thematic minor.

*The following required major courses also meet general education requirements: MATH 1040 or 1050 or 1209 or 2200 meets Foundational Skill A4, PHIL 3318 meets UD Thematic Area C, and CMPS 4928 meets Capstone. Computer Science majors have the following GE modifications: LD Area B2, 3 units of LD Area D and UD Thematic Area D.

**The SELF requirement may be met by selecting another General Education course with a SELF overlay or by taking a stand-alone course. The GWAR may be satisfied by taking the GWAR exam, by taking another General Education course with a GWAR overlay, or by taking a stand-alone course. If a student opts to take a stand-alone course for either or both of these requirements, the course(s) will add additional units to that student's general education pathway.

***Additional Units are required to meet the 120 unit requirement for graduation. Any accepted university units may be used to meet this requirement, including stand-alone courses for SELF and GWAR.

Note: One (1) semester unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Academic Regulation
A grade of C- is the minimal grade acceptable for progression in the CMPS 2010 and 2020 sequence.

Requirements for the Major in Computer Science with a Computer Information Systems Concentration
1. **Lower Division** (15 units):
   CMPS 2010, 2020, 2120, 2680
2. **Upper Division** (39 units):
   CMPS 3120, 3350, 3390, 3420, 3500, 3560, 3600, 3620, 3640, 3680, 4910, 4928
3. **Elective courses or Discipline-based Minor** (12 units):
   Select 12 units of electives from the following or complete a discipline-based minor+:
   ENGR 2350, 2360; CMPS 2240, 2650, 2770, 2771, or any other 3000-level or 4000-level CMPS course.
   Only a combined total of 4 units of CMPS 277x, 377x, 477x, and 48xx courses may be used for elective credit.
   Students may substitute courses from other departments relevant to this concentration, such as ECE, MATH or PHYS, for elective courses with permission of their department advisor.
   +Only a discipline-based minor can be used in lieu of the 12 elective units. A thematic general education minor will not count for this requirement.
4. **Advanced Elective course** (4 units):
   CMPS 4350 or 4420 or 4450 or 4490 or 4500 or 4510 or 4560 or 4620
5. **Required Cognate courses** (12-15 units):
   MATH 1209 or 2200; either MATH 1040 or both MATH 1050 and 1060; PHIL 3318
   Higher level mathematics courses (Calculus I or higher) may be used for either of (or both of) the mathematics requirements.
6. **General Education Courses and Notes:**
   Some of the courses required for the Computer Science major also satisfy General Education requirements. Students who complete each of these courses with the appropriate grade will also satisfy the GE requirement, even if they were to change majors:
   - CMPS 4928 satisfies the Capstone requirement.
   - PHIL 3318 satisfies UD Thematic Area C and the Computer Science Ethics requirement.
   - MATH 1040, 1050, 1209, 2200, or Calculus I with a grade of C or better satisfies Foundational Skill A4.
   Computer Science majors have the following General Education Modifications (GEMs), which means they do not have to take courses to satisfy these GE requirements. These GEMs are specific to the Computer Science major and students who change to another major will not keep the modifications:
   - LD Area B2 is embedded throughout the curriculum.
   - 3 units of LD Area D is met through CAC/ABET outcomes 3c and 3g.
   - UD Thematic Area D is met through CAC/ABET outcomes 3c and 3g.

Requirements for the Bachelor of Science Degree in Computer Science with a concentration in Information Security

C. Information Security Concentration
This concentration 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		**120 units**
Major Requirements		**87-88 units**
Major Courses	60	
General Cognate Courses	15	
GINS Cognate Courses	12-13	
Minor Requirement		**0 units**
General Education Requirements		**32 units**
First-Year Seminar	2	

LD Area A Foundational Skills	9*
LD Area B Natural Sciences	3*
LD Area C Arts and Humanities	6
LD Area D Social and Behavioral Sciences	3*
American Institutions	6
SELF	0**
Junior Year Diversity Requirement	3
UD Thematic Areas C and D	0*
Capstone	0*
GWAR (Exam) or Class	0**

Additional Units   **0-1 units*****

*The following required major courses also meet general education requirements: MATH 2310 or MATH 2510 meets Foundational Skill A4, PHIL 3318 meets UD Thematic Area C, and CMPS 4928 meets Capstone. Computer Science majors have the following GE modifications: LD Area B2, 3 units of LD Area D and UD Thematic Area D.

**The SELF requirement may be met by selecting another General Education course with a SELF overlay or by taking a stand-alone course. The GWAR may be satisfied by taking the GWAR exam, by taking another General Education course with a GWAR overlay, or by taking a stand-alone course. If a student opts to take a stand-alone course for either or both of these requirements, the course(s) will add additional units to that student's general education pathway.

***Additional Units are required to meet the 120 unit requirement for graduation. Any accepted university units may be used to meet this requirement, including stand-alone courses for SELF and GWAR.

Note: One (1) semester unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Academic Regulation
A grade of C- is the minimal grade acceptable for progression in the CMPS 2010 and 2020 sequence.

Requirements for the Major in Computer Science with an Information Security Concentration
1. **Lower Division** (16 units):
   CMPS 2010, 2020, 2120, 2240
2. **Upper Division** (32 units):
   CMPS 3120, 3140, 3350, 3420, 3500, 3600, 3620, 3640, 4910, 4928
3. **Information Security elective courses** (12 units):
   Select three courses from the following. At least one course must be at the 4000-level:
   CMPS 2650, 3650, 4450, 4510, 4620, MATH/CMPS 4300
4. **Required General Cognate courses** (15 units):
   MATH 2510 or 2310, MATH 2520 or 2320, MATH 3200, PHIL 3318
5. **Global Intelligence and National Security (GINS) required Cognate courses** (12-13 units):
   One GINS Analytical Tools course (3-4 units) selected from the following:
   CRJU 3500, ECON/MIS 3200, GEOL 4050, MIS 4100, SOC 4018
   If a Geographical Information Systems (GIS) Tools course is not available, CMPS 3480, ECE 4460 or ECE 4470 may be substituted for ECON/MIS 3200 or GEOL 4050.
   9 units of GINS upper division focus area courses selected from:
   CHIN 1010, 1020, CRJU 4340, HIST 3150, 3310, 3410, 3420, 3490, 4510, PLSI 3040, 3320, 3330, 3340, 3350, 3380, 3610, 3620, 3630, SOC 4028
   Other GINS focus area or strategic language courses may be used with the consent of a program advisor.
6. **General Education Course and Notes:**
   Some of the courses required for the Computer Science major also satisfy General Education requirements. Students who complete each of these courses with the appropriate grade will also satisfy the GE requirement, even if they were to change majors:
   - CMPS 4928 satisfies the Capstone requirement.
   - PHIL 3318 satisfies UD Thematic Area C and the Computer Science Ethics requirement.
   - MATH 2510 or 2310 with a grade of C or better satisfies Foundational Skill A4.
   Computer Science majors have the following General Education Modifications (GEMs), which means they do not have to take courses to satisfy these GE requirements. These GEMs are specific to the Computer Science major and students who change to another major will not keep the modifications:

- LD Area B2 is embedded throughout the curriculum.
- 3 units of LD Area D is met through CAC/ABET outcomes 3c and 3g.
- UD Thematic Area D is met through CAC/ABET outcomes 3c and 3g.

Requirements for a Minor in Computer Science
A Minor in Computer Science will require the student to take a total of at least 16 units of 2000-level or higher course work as well as satisfy the additional requirements:
a. CMPS 2020 (which requires CMPS 2010 or the equivalent with a grade of C- or better).
b. One course chosen from the following: CMPS 2120, 2240, 2650, or 2680. MATH 3000 may be substituted for CMPS 2120.
c. At least 8 units of upper division course work in computer science (normally two courses) chosen with the help of a computer science advisor. MATH 3300 may be substituted for one computer science course.

Electrical Engineering Degree Requirements

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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.

The Computer and Electrical Engineering and Computer Science Department moved into a new building in Fall 2008. The department administers its own local area network which includes multiple Unix/Linux servers, two software programming labs, a walk-in lab/tutoring center, one advanced workstation lab, an isolated network lab, an AI/visualization lab, a DSP/communications lab, one digital electronics hardware lab, a power systems/electronics lab, and a robotics/control systems lab. There is also a department library/major study room with computers 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/all_abet.pdf.

Requirements for the Bachelor of Science Degree in Electrical Engineering

Total Units Required to Graduate		**120 units**
Major Requirements		**90 units**
CMPS/ECE Courses	56	
Cognate Courses	34	
Minor Requirement		**0 units**
General Education Requirements		**24 units**
First-Year Seminar	0*	
LD Area A Foundational Skills	6*	
LD Area B Natural Sciences	0*	
LD Area C Arts and Humanities	6	
LD Area D Social and Behavioral Sciences	3*	
American Institutions	6	
SELF	0**	
Junior Year Diversity Requirement	3	
UD Thematic Areas C and D	0*	
Capstone	0*	
GWAR (Exam) or Class	0**	
Additional Units		**6 units***

*The following required major courses also meet general education requirements: ECE/ENGR 1618 and 1628 meet First-year Seminar, MATH 2310 or 2510 meets Foundational Skill A4, PHYS 2210 meets LD Area B1/B3, PHIL

3318 meets UD Thematic Area C, and CMPS 4928 meets Capstone. Engineering majors have the following GE modifications: Foundational Skill A3, LD Area B2, 3 units of LD Area D, and UD Thematic Area D.

**The SELF requirement can be met by selecting another General Education course with a SELF overlay or by taking a stand-alone course. The GWAR may be satisfied by taking the GWAR exam, by taking another General Education course with a GWAR overlay, or by taking a stand-alone course. If a student opts to take a stand-alone course for either or both of these requirements, the course(s) will add additional units to that student's general education pathway.

***Additional Units are required to meet the 120 unit requirement for graduation. Any accepted university units may be used to meet this requirement, including stand-alone courses for SELF and GWAR.

SB1440 units required - 58 units*

*Units required for graduation after completion of the Engineering (Electrical Engineering focus) model curriculum and lower-division general education at a California community college.

Note: One (1) semester 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 Electrical Engineering
1. **Lower Division** (12 units):
   ECE/ENGR 1618, 1628, ENGR/ECE/PHYS 2070, CMPS 2010
2. **Upper Division** (32 units):
   ECE 3040, 3070, 3200, 3230, 3320, 3370, 3340, 4910, 4928
3. **Upper Division Elective courses** (12 units):
   Select 12 units of elective courses from the following. At least one course must be at the 4000-level:
   Digital Design and Embedded Systems
   ECE 3220, 3250, 4240
   Digital Communication and Digital Signal Processing
   ECE 4220, 4250, 4260
   Control Systems and Robotics
   ECE 3280, 4570
   Power Systems and Power Electronics
   ECE 3380, 4330, 4370
   Image Processing and Computer Vision
   ECE 4460, 4470
   Special Topics and Independent Study
   ECE 3770, 3771, 4770, 4771, 4800, 4860, 4870, 4890
   Only a combined total of 4 units of ECE 377x, 477x, 48xx may be used for elective credit.
4. **Required Cognate courses** (36 units):
   MATH 2510 or 2310, MATH 2520 or 2320, MATH 2530, 2610, 3200, CHEM 1000, PHYS 2210, 2220, PHIL 3318
5. **General Education Courses and Notes:**
   Some of the courses required for the Electrical Engineering major also satisfy General Education requirements. Students who complete each of these courses with the appropriate grade will also satisfy the GE requirement, even if they were to change majors:
   - ECE/ENGR 1618 and 1628 satisfy the First-year Seminar requirement.
   - ECE 4928 satisfies the Capstone requirement.
   - PHIL 3318 satisfies UD Thematic Area C and the Electrical Engineering Ethics requirement.
   - PHYS 2210 satisfies LD Areas B1 and B3.
   - MATH 2510 or 2310 with a grade of C or better satisfies Foundational Skill A4.

   Engineering majors have the following General Education Modifications (GEMs), which means they do not have to take courses to satisfy these GE requirements. These GEMs are specific to the three engineering majors (Computer Engineering, Electrical Engineering and Engineering Sciences). Students who change to another major will not keep the modifications:
   - Foundational Skill A3 is embedded in PHYS 2210, 2220 and ECE/ENGR/PHYS 2070.
   - LD Area B2 is embedded throughout the curriculum.
   - 3 units of LD Area D is met through EAC/ABET outcomes 3c and 3h.

- UD Thematic Area D is met through EAC/ABET outcomes 3c and 3h.

Computer Science Course Descriptions

Lower Division

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

CMPS 1200 Basic Computer Skills (3)
This course covers computer skills essential to success at a university. Specific applications include the Microsoft Office suite of tools: Word, Excel, PowerPoint and Access. The course material is based on Windows 7 and Microsoft Office 2010. Each week lecture meets for 150 minutes. Prerequisite: None.

CMPS 2010 Programming I: Programming Fundamentals (4)
Introduces the fundamentals of procedural programming and object-oriented programming. Topics include: data types, control structures, functions, arrays, I/O, pointers and dynamic memory allocation, and features of object-oriented programming. 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 150 minutes and lab meets for 150 minutes. Prerequisite: (1) MATH 0030; or (2) other satisfaction of the Entry Level Mathematics requirement.

CMPS 2020 Programming II: Data Structures and Algorithms (4)
Builds on the foundation provided by CMPS 2010 to introduce the fundamental concepts of data structures and algorithms that proceed from 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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2010 with C- or better.

CMPS 2120 Discrete Structures (4)
Discrete structures and applications in computer science. Provides an introduction to proof techniques, propositional and predicate logic, functions, relations, sets, big-oh notation, counting techniques, summations, recursive definitions, recurrence relations, discrete probability and simple circuit logic. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2010 with a grade of C- or better and MATH 1040 or 1050 or higher.

CMPS 2240 Computer Architecture I: Assembly Language Programming (4)
Introduction to computer architecture and assembly language programming. Covers number systems and data representation, CISC and RISC instruction set architectures, internal organization of a computer, and basics of logic design. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2010 with a grade of C- or better.

CMPS 2650 Linux Environment and Administration (4)
This course covers common Linux commands, shell scripting, regular expressions, tools and the applications used in a Linux programming environment. The tools to be introduced include make utility, a debugger, advanced text editing and text processing (vi, sed, tr). These basic skills are extended to cover the knowledge and skills critical to administering a multi-user, networked Linux system. Administrative 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 150 minutes and lab meets for 150 minutes. Prerequisite: None.

CMPS 2680 Web Programming I (3)
An introduction to webpage layout and design with HTML and CSS and client-side web programming with Javascript. Students will design and create a webpage using technologies covered in the course. Each week lecture meets for 150 minutes. Prerequisite: None.

CMPS 2770 Special Topics (1-3)
A study of programming languages not offered otherwise. Prerequisite: CMPS 2010 with a grade of C- or better or permission of the instructor.

CMPS 2771 Special Topics Laboratory (1)
Optional laboratory for the study of programming languages not offered otherwise. Each week lab meets for 150 minutes. Co-requisite: CMPS 2770. Prerequisite: CMPS 2010 with a grade of C- or better or permission of the instructor.

Upper Division

CMPS 3120 Algorithm Analysis (3)
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 100 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better and 2120.

CMPS 3140 Theory of Computation (3)
An introduction to computability theory to include finite automata, push-down automata, formal grammars, Turing machines, decidability, intractability and NP-completeness. Each week lecture meets for 100 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3120.

CMPS 3240 Computer Architecture II: Organization (4)
This course focuses on the design of the CPU and computer system at a functional level. Topics include CPU instruction sets and functional units, control unit design, interrupt handling and DMA, I/O support, memory hierarchy, virtual memory, buses and bus timing, and an introduction to instruction level parallelism, multithreading, and multiprocessing. Hardware security issues will also be discussed. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2240 or ECE 3200.

MATH/CMPS 3300 Numerical Analysis (4)
Topics include: computer representation of numbers and round-off errors, algorithms and stability, numerical solutions to nonlinear equations in one variable, direct and iterative methods for solving linear systems of equations, interpolation and polynomial approximation, numerical differentiation and integration, and initial value problems for ordinary differential equations. A computer algebra system (CAS) will be used to program numerical algorithms and identify their limitations. The CAS will also be used on homework and exam problems. Each week lecture meets for 200 minutes. Prerequisites: (1) C- or better in MATH 2020, 2320, or 2520, and (2) C- or better in MATH 2610 or CMPS 2010.

CMPS 3350 Software Engineering (4)
This course is a general introduction to Software Engineering. The course will cover the specification, development, management, and evolution of complex software systems. Students will learn 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 will form groups and choose a software project early in the course, then apply methodologies learned in the course to complete their project. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 3390 Client, Server, Internet and Hand-held Device Programming (4)
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 invocation) 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 phones or tablets) will be discussed and applied in student projects. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 3420 Database Systems (4)
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 150 minutes and lab meets for 150 minutes. Prerequisites: CMPS 2020 with a grade of C- or better and CMPS 2120.

CMPS 3480 Computer Graphics (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 3500 Programming Languages (3)
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. Features of OOP, thread, synchronization and concurrency, functional function will be discussed. Each week lecture meets for 100 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 3560 Artificial Intelligence (3)
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 100 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better and CMPS 2120.

CMPS 3600 Operating Systems (4)
A study of the introductory concepts in operating systems: historical development of batch, multi-programmed, and interactive systems; virtual memory, 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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 3620 Computer Networks (4)
A study of the theory of computer networking focusing on the TCP/IP Internet protocols and covering the five layers: physical, data link, network, transport, and application. Communication on wired, wireless, and cellular networks will be covered. The course will introduce secure communication and its incorporation into different layers of the model. As part of the laboratory component, students will learn systems programming as it relates to interprocess communication over sockets, I/O handling, process and thread control, and the development of client/server programs. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 3640 Distributed and Parallel Computation (3)
Introduction to core topics in distributed and parallel computation. System models, parallel vs. distributed systems, communication, locality, concurrency, non-determinism, fault tolerance, distributed algorithms, and parallel programming. Each week lecture meets for 100 minutes and lab meets for 150 minutes. Prerequisites: CMPS 3600 and 3620.

CMPS 3650 Digital Forensics (4)
Investigative techniques, evidence handling procedures, forensics tools, digital crime reconstruction, incident response, ethics, and legal guidelines within the context of digital information and computer compromises. Hands-on case studies cover a range of hardware and software platforms and teach students how to gather evidence, analyze evidence, and reconstruct incidents. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Co-requisite or prerequisite: CMPS 2010 with a grade of C- or better or CMPS 2650.

CMPS 3680 Web Programming II (3)
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. Each week lecture meets for 100

minutes and lab meets for 150 minutes. Prerequisites: CMPS 2010 with a grade of C- or better and CMPS 2680 or instructor approval.

CMPS 3770 Special Topics (1-3)
This course will be used to supplement other courses with additional work at the intermediate level. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: CMPS 2020 with a grade of C- or better or permission of instructor.

CMPS 3771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at the intermediate level. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Co-requisite: CMPS 3770. Prerequisite: CMPS 2020 with a grade of C- or better or permission of the instructor.

CMPS 4210 Advanced Computer Architecture (4)
Foundations of parallelism in computer architecture. This course concentrates on the quantitative principles of computer architecture, instruction set and addressing design, instruction-level parallelism (ILP), compiler considerations for parallelism, cache and memory design, multiprocessor (including multi-core processors) and thread-level parallelism (TLP). A constant theme is how the hardware can achieve greater efficiency by exploiting various types of parallelism. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3240.

MATH/CMPS 4300 Applied Cryptography (4)
An introduction to cryptography, history and its present day use. Topics include: symmetric ciphers, hash functions, public-key encryption, data integrity, digital signatures, key establishment, key management, prime generation, integer factorization, discrete logarithms, pseudo-random number generation, and computational complexity. Each week lecture meets for 200 minutes. Prerequisites: (1) C- or better in MATH 2020, 2320, or 2520, and (2) C- or better in MATH 3000 or CMPS 2120.

CMPS 4350 Advanced Software Engineering (4)
Continuation of the introductory software engineering course. 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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3350.

CMPS 4420 Advanced Database Systems (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3420.

CMPS 4450 Data Mining and Visualization (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3120.

ECE/CMPS 4460 Image Processing (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3040.

ECE/CMPS 4470 Computer Vision (4)
Imaging formation, early vision processing, boundary detection, region growing, two-dimensional and three-dimensional object representation and recognition techniques. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: MATH 2320 or 2520 and (CMPS 3120 or ECE 3040).

CMPS 4490 Game Design (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2020 with a grade of C- or better.

CMPS 4500 Compiler Design (4)
An introduction to compiler design and construction. Coverage includes lexical, syntactic, and semantic analysis, top-down and bottom-up parsing, code generation, and error detection. Theoretical topics include finite and push-down automata. Students will implement a compiler front-end. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3500 or permission of the instructor.

CMPS 4510 Vulnerability Analysis (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 2240 and CMPS 3500.

CMPS 4560 Advanced Artificial Intelligence (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: CMPS 3560.

CMPS 4620 Network and Computer Security (4)
Fundamentals of network and computer security and information assurance. Topics covered include basic cryptography, authentication, access control, formal security policies, assurance and verification, trusted OS design, and network attacks. Methods to provide better security at both the system and network level will be presented, particularly with respects to risk analysis, cost-benefit analysis, and psychological acceptability. Ethics and legal issues related to security research will also be discussed. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: CMPS 2020 with a grade of C- or better and either CMPS 3620 or 3650.

CMPS 4770 Special Topics (1-3)
This course will often be used to supplement other courses with additional work at a more advanced level. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: CMPS 2020 with a grade of C- or better or permission of instructor.

CMPS 4771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at a more advanced level. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Co-requisite: CMPS 4770. Prerequisite: CMPS 2020 with a grade of C- or better or permission of the instructor.

CMPS 4800 Undergraduate Research (1-4)
Independent study into a research topic under the supervision of a faculty member. Students will establish the research goals and objectives with their faculty supervisor. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

CMPS 4860 Internship in Computer Science (1-4)
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 the number of credit units offered. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

CMPS 4870 Cooperative Education (1-4)
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 the number of credit units offered. Course is repeatable, but only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

CMPS 4890 Experiential Prior Learning (1-4)
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 2020 and have the approval of the department. Only a combined total of 4 units of CMPS 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: CMPS 2020 with a grade of C- or better and permission of the instructor.

CMPS 4910 Senior Project I (2)
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: At least 12 units of 3000- or 4000-level CMPS coursework.

CMPS 4928 Senior Project II (2)
This is the completion phase of the project. Students will present a project report to the entire class, explaining the nature of the work, the finished product, and its relationship to the field. Students will demonstrate proficiency in critical thinking, information literacy, written communication, and quantitative reasoning in their written project report. Additionally, students will demonstrate an understanding of their academic pursuits by reflecting on their studies of the arts, humanities, natural sciences, behavioral sciences, and social sciences. Prerequisite: CMPS 4910 and completion of at least 90 units. Prerequisite or Co-requisite: Completion of or concurrent enrollment in all GE course requirements for computer science majors. (GE Capstone)

CMPS 4960 Leadership in Computer Science (1-2)
Leadership in computer science related activities that meet campus and/or community needs. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements, but can be used as additional university units. Prerequisite: Permission of the instructor.

CMPS 4970 Service Learning in Computer Science (1-2)
Service learning in computer science related activities that meet campus and/or community needs. Students will design and/or implement a service learning project in consultation with their faculty supervisor and, if applicable, community partners. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements, but can be used as additional university units. Prerequisite: Permission of the instructor.

CMPS 4980 Teaching in Computer Science (1-2)
Experience supporting teaching activities in department courses, providing tutoring in the department tutoring center, leading problem solving sessions, and/or supporting other instructional activities in the department. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements, but can be used as additional university units. Prerequisite: Permission of the instructor.

Electrical and Computer Engineering Course Descriptions

Lower Division

ENGR/ECE 1618 Introduction to Engineering I (2)
This course will provide an introduction to the practice of engineering and the various areas within the engineering disciplines. Students will be informed of engineering curricula and career opportunities within the various engineering disciplines. This course will also introduce students to important topics for academic success, both at the major level and at the university level. 100 minutes lecture. (GE FYS)

ENGR/ECE 1628 Introduction to Engineering II (2)
This course builds on the foundational skills in engineering design and practices developed in ENGR/ECE 1618. Students will design, build, test, and present engineering projects designed to solve specified problems within given constraints. Additionally, the impact of engineering from a global, social, economic, and environmental perspective is presented through case studies. 100 minutes lecture/discussion. Prerequisite: ENGR/ECE 1618. (GE FYS)

ENGR/ECE/PHYS 2070 Electric Circuits (4)
An introduction to the analysis of electrical circuits. Use of analytical techniques based on the application of circuit laws and network theorems. Analysis of DC and AC circuits containing resistors, capacitors, inductors, dependent sources and/or switches. Natural and forced responses of first and second order RLC circuits; the use of phasors; AC power calculations; power transfer; and energy concepts. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: PHYS 2220 with a grade of C- or better, or permission of the instructor.

ECE 2600 High-speed Rail (4)
The course gives an overview of the high-speed rail (HSR) technology crossing electrical transmission and traction drive control systems, power supply technology, signal and communication systems, mechanical and civil engineering, and transportation scheduling, and provides an opportunity to learn a variety of software packages regarding the aerodynamics impact on a high speed train, operating the high speed train and designing the train interior layout, and the passage service system. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 1040 or 1060 and basic computer skills.

ECE 2770 Special Topics in Engineering (1-3)
This course will be used to supplement regularly scheduled courses with additional material at the beginning level.

ECE 2771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at the beginning level. Co-requisite: ECE 2770.

Upper Division

ECE 3040 Signals and Systems (4)
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 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 and ENGR/ECE/PHYS 2070.

ECE 3070 Analog Circuits (4)
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 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 and ENGR/ECE/PHYS 2070.

ECE 3200 Digital Circuits (4)
Introduce combinational logic and sequential logic designs, and microprocessors. Cover digital concepts, number systems, operations, and codes, logic gates, Boolean algebra and logic simplification, combinational logic and its functions, flip-flops and related devices, counters, shift registers, memory and storage, concepts of microprocessors,

assembly language, computers, and buses. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070.

ECE 3220 Digital Design with VHDL (4)

Introduces logic system design using a hardware description language (VHDL). Covers the VHDL language in depth and explains how to use it to describe complex combinational and sequential logic circuits. Include a weekly lab where students will get hands-on experience implementing digital systems on Field Programmable Gate Arrays. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070 and ECE 3200.

ECE 3230 Digital Communications (4)

This course focuses on the representation of signals and noise, Gaussian processes, correlation functions and power spectra, linear systems and random processes, performance analysis and design of coherent and noncoherent communication systems, phase-shift-keying, frequency-shift-keying, and M-ary communication systems, optimum receivers and signal space concepts, information and its measure, source encoding, channel capacity, and error correcting coding. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520, ENGR/ECE/PHYS 2070, ECE 3040.

ECE 3250 Embedded Systems (4)

Introduce embedded systems. Cover embedded concepts, NI sbRIO embedded system devices, LabVIEW RT and FPGA modules, combinational and sequential logic circuits design, finite state machines, memory and storage, sensor and motor interface. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ECE 3070 and 3200.

ECE 3280 Instrumentation, Control, and Data Acquisition (4)

Introduction to LabVIEW and NI Elvis board. Students learn how to use NI virtual instruments, such as function generators, oscilloscopes, etc., design a variety of projects on analog and digital inputs, outputs, and signal generations, and use both simulation and hardware test-beds to verify their projects and performance. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ECE 3200 or consent of the instructor.

ECE 3320 Fields and Waves (4)

This course focuses on the fundamentals of electromagnetics. Students are expected to acquire expertise in vector analysis, electrostatic and magnetic fields, Maxwell's equations, plane waves, reflection, attenuation, and impedance. Knowledge of circuit theory, Matlab, differential equations, and calculus are required to successfully complete the course. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 and ENGR/ECE/PHYS 2070.

ECE 3340 Control Systems (4)

Introduce control system analysis and design. Cover control system modeling, time response, reduction of multiple systems, stability analysis, steady-state errors, root locus technique, PID controller, and fuzzy controller. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3040.

ECE 3370 Power Systems Fundamentals (4)

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 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070 and ECE 3040.

ECE 3380 Power Electronics and Electrical Drives (4)

The course is an introduction to switched-mode power converters, electromechanical energy conversion systems, and electric drives. 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 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3070, 3320, 3370.

ECE 3770 Special Topics in Engineering (1-3)
This course will be used to supplement regularly scheduled courses with additional material at the intermediate level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements.

ECE 3771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at the intermediate level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Co-requisite: ECE 3770.

ECE 4220 Digital Signal Processing (4)
This course provides an 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. Overviews of modern DSP applications such as modems, speech processing, audio and video compression and expansion, and cellular protocols. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520, ENGR/ECE/PHYS 2070, ECE 3040.

ECE 4240 Microprocessor System Design (4)
Introduce microprocessor architecture and organization. Cover bus architectures, types and buffering techniques, Memory and I/O subsystems, organization, timing and interfacing, Peripheral controllers and programming. Design a microprocessor system. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ENGR/ECE/PHYS 2070 and ECE 3200.

ECE 4250 Wireless Communications (4)
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 are presented. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520, ENGR/ECE/PHYS 2070, ECE 3040.

ECE 4260 Wireless Networks (4)
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 communications. 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 150 minutes and lab meets for 150 minutes. Prerequisite: MATH 2320 or 2520.

ECE 4330 Mechatronics (4)
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 150 minutes and lab meets for 150 minutes. Prerequisites: CMPS 2020 with a grade of C- or better, ECE 3070, and 3200.

ECE 4370 Power Systems Analysis (4)
This course follows the discussions from the first course in power systems. This course focuses on power flow, symmetrical components, faulted system analysis, and protection schemes. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3370.

CMPS/ECE 4460 Image Processing (4)
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 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3040.

CMPS/ECE 4470 Computer Vision (4)
Imaging formation, early vision processing, boundary detection, region growing, two-dimensional and three-dimensional object representation and recognition techniques. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: MATH 2320 or 2520 and (CMPS 3120 or ECE 3040).

ECE 4570 Robotics (4)
Introduce robotic systems. Cover Mindstorms NXT, motion control, target steering and trajectory planning, obstacle avoidance, line tracking, and multiple sensor fusion. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070 and ECE 3040.

ECE 4770 Special Topics in Engineering (1-3)
This course will often be used to supplement other courses with additional work at a more advanced level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at a more advanced level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Co-requisite: ECE 4770. Prerequisite: Permission of the instructor.

ECE 4800 Undergraduate Research (1-4)
Independent study into a research topic under the supervision of a faculty member. Students will establish the research goals and objectives with their faculty supervisor. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4860 Internship (1-4)
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 the number of credit units offered. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4870 Cooperative Education (1-4)
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 semesters. Offered on a credit, no-credit basis only. The department will determine the number of credit units offered. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4890 Experiential Prior Learning (1-4)
Majors in Computer and Electrical Engineering with significant prior experience in computers and/or electronics 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 2010 and have the approval of the department. Only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: CMPS 2010 with a grade of C- or better and permission of the instructor

ECE 4910 Senior Project I (2)
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: At least 12 units of 3000- or 4000- level ECE and CMPS courses.

ECE 4928 Senior Project II (2)
This is the completion phase of the project. Students will present a project report to the entire class, explaining the nature of the work, the finished product, and its relationship to the field. Students will demonstrate proficiency in critical thinking, information literacy, written communication, and quantitative reasoning in their written project report. Additionally, students will demonstrate an understanding of their academic pursuits by reflecting on their studies of the arts, humanities, natural sciences, behavioral sciences, and social sciences. Prerequisite: ECE 4910 and completion of at least 90 units. Prerequisite or Co-requisite: Completion of or concurrent enrollment in all GE course requirements for engineering majors. (GE Capstone)

ECE 4960 Leadership in Engineering (1-2)
Leadership in computer and electrical engineering related activities that meet campus and/or community needs. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements, but can be used as additional university units. Prerequisite: Permission of the instructor.

ECE 4970 Service Learning in Engineering (1-2)
Service learning in computer and electrical engineering related activities that meet campus and/or community needs. Students will design and/or implement a service learning project in consultation with their faculty supervisor and, if applicable, community partners. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements, but can be used as additional university units. Prerequisite: Permission of the instructor.

ECE 4980 Teaching in Engineering (1-2)
Experience supporting teaching activities in department courses, providing tutoring in the department tutoring center, leading problem solving sessions, and/or supporting other instructional activities in the department. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements, but can be used as additional university units. Prerequisite: Permission of the instructor.