

ELECTRICAL & COMPUTER ENGINEERING
UNDERGRADUATE STUDENT
HANDBOOK

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2017-18

ACADEMIC & ADMINISTRATIVE CALENDAR

FALL 2017

September

- 25 Fall Quarter Begins
- 28 Instruction Begins

November

- 10 Veterans Day Holiday
- 23-34 Thanksgiving Holiday

December

- 8 Instruction Ends
- 9-16 Final Exams
- 16 Fall Quarter Ends
- 25-26 Winter Break

WINTER 2018

January

- 1-2 New Year Holiday
- 3 Winter Quarter Begins
- 8 Instruction Begins
- 15 M.L.K., Jr. Holiday

February

- 19 President's Day Holiday

March

- 16 Instruction Ends
- 17-24 Final Exams
- 24 Winter Quarter Ends

SPRING 2018

March

- 28 Spring Quarter Begins
- 30 César Chávez Holiday

April

- 2 Instruction Begins

May

- 2 Memorial Day Observance

June

- 8 Instruction Ends
- 9-15 Final Exams
- 15 Spring Quarter Ends
- 16-17 Commencement Programs

ECE UNDERGRADUATE STUDENT AFFAIRS

MISSION STATEMENT

The mission of ECE Student Affairs is to facilitate ECE faculty, graduate and undergraduate students in understanding and navigating UCSD administrative processes in order to achieve success in their research, educational and professional endeavors, and to prepare students to become engaged and constructive members of a diverse, dynamic and global society.

OBJECTIVES

1. To foster a healthy and cooperative community for ECE faculty, students and staff
2. To motivate and inspire students to be independent, intelligent and innovative engineering professionals
3. To build relationships with alumni and industry partners

STAFF ADVISORS

Myda Prado

Undergraduate Student Affairs Advisor
Jacobs Hall 2702
858-822-0273

Shannon Goodison

Undergraduate Student Affairs Advisor
Jacobs Hall 2701
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ADVISING HOURS

Monday, Tuesday, Thursday, Friday:

9:30 - 11:30 am & 1:30 - 4 pm

Wednesday

1:30- 4 pm

Virtual Advising Center (VAC)

Sign-in on your triton account at: vac.ucsd.edu ECE advising communication is only done via the Virtual Advising Center.

The Virtual Advising Center is open 24 hours a day/7 days a week except on holidays. Post your questions there, and an academic counselor will respond within 24-72 business hours.

Charmaine Samahin-Manns

Student Affairs Director
Jacobs Hall 2700
By appointment only

ELECTRICAL & COMPUTER ENGINEERING

All courses, faculty listings, and curricular and degree requirements described herein are subject to change or deletion without notice. Updates to curricular sections may be found on the Academic Senate website:

<http://senate.ucsd.edu/Curriculum/Updates.htm>.

PROGRAM MISSION STATEMENT

To educate tomorrow's technology leaders.

PROGRAM EDUCATIONAL OBJECTIVES

1. To prepare students for graduate study in engineering or other professional fields.
2. To prepare students to excel in technical careers and apply their knowledge in the professional arena.
3. To prepare students to be leaders in their field, making technical contributions as well as having more general impact on society at large.

PROGRAM OUTCOMES & ASSESSMENT

Program outcomes have been established based on the Program Educational Objectives. Graduates of the ECE Program in Electrical Engineering are expected to have:

1. an understanding of the underlying principles of, and an ability to apply knowledge of mathematics, science, and engineering to electrical engineering problems
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. a knowledge of electrical engineering safety issues
4. an ability to design a system, component, or process to meet desired needs
5.
 - a. an ability to collaborate effectively with others
 - b. an ability to function on multidisciplinary teams
6. an ability to identify, formulate, and solve engineering problems
7. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice, including familiarity with computer programming and information technology
8. an understanding of professional and ethical responsibility
9.
 - a. an ability to communicate effectively in writing
 - b. an ability to communicate effectively in speech
 - c. an ability to communicate effectively with visual means
10. the broad education necessary to understand the impact of engineering solutions in a global and societal context
11. a recognition of the need for, and the ability to engage in, lifelong learning
12. a knowledge of contemporary issues

THE UNDERGRADUATE PROGRAMS

It is imperative that students discuss their curriculum with the appropriate departmental adviser immediately upon entrance to UC San Diego, and at least once a year until graduation.

The Department of Electrical and Computer Engineering offers undergraduate programs leading to the BS in electrical engineering, engineering physics, and computer engineering, and the BA in electrical engineering and society. Each of these programs can be tailored to provide preparation for graduate study or employment in a wide range of fields. The Electrical Engineering Program is accredited by the Accreditation Board for Engineering and Technology (ABET).

The [Electrical Engineering Program](#) has a common lower division and a very flexible structure in the upper division. After the lower-division core (seventy-two units), all students must take seventeen upper-division courses (sixty-eight units) that include a combination of breadth courses, depth courses, technical electives, two professional electives, and one design course.

The [Engineering Physics Program](#) is conducted in cooperation with the Department of Physics. Its structure is very similar to that of electrical engineering except the depth requirement includes seven courses and there are only four electives.

The [Computer Engineering Program](#) is conducted jointly with the Department of Computer Science and Engineering. It has a more prescribed structure. The program encompasses the study of hardware design, data storage, computer architecture, assembly languages, and the design of computers for engineering, information retrieval, and scientific research.

The [BA—Electrical Engineering and Society Program](#) intends to better prepare engineering students in the areas of social sciences and the humanities, as a response to the globalization of engineering and technology. We recognize that “engineering only” training may not be sufficient when students seek alternate career paths besides engineering upon graduation, such as in the law, finance, and public policy sectors.

For information about the program and about academic advising, students are referred to the section on ECE departmental regulations. In order to complete the programs in a timely fashion, students must plan their courses carefully, starting in their freshman year. Students should have sufficient background in high school mathematics so that they can take freshman calculus in the first quarter.

For graduation, each student must also satisfy general-education requirements determined by the student’s college. The six colleges at UC San Diego require widely different numbers of general-education courses. Students should choose their college carefully, considering the special nature of the college and the breadth of education required. They should realize that some colleges require considerably more courses than others. Students wishing to transfer to another college should see their college adviser.

Graduates of community colleges may enter ECE programs in the junior year. However, transfer students should be particularly mindful of the freshman and sophomore course requirements when planning their programs.

These programs have strong components in laboratory experiments and in the use of computers throughout the curricula. In addition, the department is committed to exposing students to the nature of engineering design. This is accomplished throughout the curricula by use of design-oriented homework problems, by exposure to engineering problems in lectures, by courses that emphasize student-initiated projects in both laboratory and computer courses, and finally by senior design-project courses in which teams of students work to solve an engineering design problem, often brought in from industry.

B.S. ELECTRICAL ENGINEERING

Students must complete 180 units for graduation, including the general-education requirements (GER). Note that 140 units (excluding GER) are required. All courses required for the major must be taken for a letter grade and passed with a C- or better.

LOWER DIVISION REQUIREMENTS: 72 UNITS



Mathematics: MATH 18, 20A-B-C-D-E



Physics: PHYS 2A-B-C-D or PHYS 4A-B-C-D-E



Chemistry: CHEM 6A



Programming: ECE 15



Electrical Engineering: ECE 5,25, 30, 35, 45, & 65

ADDITIONAL NOTES

1. Students with AP math credit are strongly advised to take MATH 20B in the fall quarter, leaving room for a GER in the winter quarter.
2. The ECE undergraduate website shows sample course plans. Please refer to the website and consult with the staff advisers in the undergraduate offices in Jacobs Hall 2700.

MATH 20A is a prerequisite for PHYS 2A. Students whose performance on the mathematics placement test permits them to start with MATH 20B or higher may take PHYS 2A in the fall quarter of their freshman year.

UPPER DIVISION REQUIREMENTS: 68 UNITS

Students must select an engineering depth to provide a focus for their studies. Students may choose one of the approved depth sequences listed below, or propose another with the approval of the department. A list of approved technical electives and professional electives can be found in the ECE undergraduate office. Note: In order to fulfill the design requirement, students must complete ECE 111, 190, or 191 with a grade of C- or better. Graduation will not be approved until a written copy of the design project is submitted to the ECE undergraduate office.

Communication Systems

- Breadth Courses: ECE 100, 101, 102, 107, 109
- Depth Courses: ECE 153, 154A-B-C, 158A
- Technical Electives: four upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses
- Design Course: one of ECE 111, 190, or 191

Computer System Design

- Breadth Courses: ECE 100, 101, 102, 103, 109
- Depth Courses: CSE 141, ECE 165 and two of ECE 111, 158A, or CSE 143
- Technical Electives: five upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses

Design Course: one of ECE 111, 190, or 191 (NB: If ECE 111 is selected as a depth course, choose ECE 190 or 191.)

Electronic Circuits and Systems

- Breadth Courses: ECE 100, 101, 102, 103, 107, 109
- Depth Courses: ECE 164, 165, 166
- Technical Electives: five upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses
- Design Course: one of ECE 111, 190, or 191

Electronic Devices and Materials

- Breadth Courses: ECE 100, 101, 102, 103, 107, 109
- Depth Courses: ECE 135A-B, 136L, 183
- Technical Electives: four upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses
- Design Course: one of ECE 111, 190, or 191

Machine Learning and Controls

- Breadth Courses: ECE 100, 101, 107, 109
- Depth Courses: ECE 171A, 174, 175A and one of ECE 171B, 172A, or 175B
- Technical Electives: six upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses
- Design Course: one of ECE 111, 190, or 191

Photonics

- Breadth Courses: ECE 100, 101, 103, 107, 109
- Depth Courses: ECE 181, 182, 183 and either ECE 184 or 185
- Technical Electives: five upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses
- Design Course: one of ECE 111, 190, or 191

Signal and Image Processing

- Breadth Courses: ECE 100, 101, 107, 109
- Depth Courses: ECE 153, 161A-B-C
- Technical Electives: six upper-division engineering, math, or physics courses
- Professional Electives: two upper-division courses
- Design Course: one of ECE 111, 190, or 191

B.S. ENGINEERING PHYSICS

Students must complete 180 units for graduation, including the general-education requirements (GER). Note that 146 units (excluding GER) are required. All courses required for the major must be taken for a letter grade and passed with a C- or better.

LOWER DIVISION REQUIREMENTS: 70 UNITS



Mathematics: MATH 18, 20A-B-C-D-E



Physics: PHYS 2A-B-C-D or PHYS 4A-B-C-D-E



Physics Lab: PHYS 2DL



Chemistry: CHEM 6A



Programming: ECE 15



Electrical Engineering: ECE 25, 30, 35, 45, & 65

ADDITIONAL NOTES

1. Students with AP math credit are strongly advised to take MATH 20B in the fall quarter, leaving room for a GER in the winter quarter.
2. The ECE undergraduate website shows sample course plans. Please refer to the website and consult with the staff advisers in the undergraduate offices in Jacobs Hall 2700.

MATH 20A is a prerequisite for PHYS 2A. Students whose performance on the mathematics placement test permits them to start with MATH 20B or higher may take PHYS 2A in the fall quarter of their freshman year.

UPPER DIVISION REQUIREMENTS: 76 UNITS

Breadth :: 24 units

Courses required of ALL engineering physics majors: ECE 100, 101, 102, 103, 107, & 109

However, because of the scheduling of MATH 110A, PHYS 110A & 130A, they can only be taken in a specific order (please consult the ECE website). For the ECE 109 requirement, credit will not be allowed for ECON 120A, MAE 108, MATH 180A-B, MATH 183, or MATH 186.

Design :: 4 units

NOTE: NOTE: In order to fulfill the design requirement, students must complete one of the following courses with a grade C- or better. Graduation will not be approved until a written copy of the design project is submitted to the ECE undergraduate office.

The engineering physics design requirement can be fulfilled in any of the following 3 ways:

1. ECE 191. Engineering Group Design Project
2. ECE 190. Engineering Design, requires department stamp. Specifications & enrollment forms available in undergrad office.
3. ECE 111: Advanced Digital Design Project OR ECE 118: Computer Interfacing

Electives :: 20 units

2 upper-division engineering, mathematics, or physics courses

3 additional electives which students may use to broaden their professional goals

For additional information, please refer to the section on “*Elective Policy for Electrical Engineering and Engineering Physics Majors.*”

Depth :: 28 units

All BS engineering physics students are required to take PHYS 110A, 130A-B, 140A, MATH 110A, ECE 123 & 166; or ECE 135A & 135B; or ECE 182 & (181 or 183).

ELECTIVE POLICY

for engineering physics majors

TECHNICAL ELECTIVES

Technical electives must be upper-division engineering, math, or physics courses (except for the bioengineering track). At most 1 lower-division course in engineering may be used but it must receive prior approval from the ECE department.

Certain courses listed below are not allowed as electives because of overlap with ECE courses.

Physics

All upper-division physics courses. Students may not receive upper-division elective credit for any lower-division physics courses.

Mathematics

MATH 180A overlaps ECE 109, and therefore will not qualify for elective credit of either type. MATH 183 or MATH 186 will not be allowed as an elective. MATH 163 will only be allowed as a professional elective. All lower-division mathematics is excluded from elective credit of either type.

Bioengineering

The following series of courses will provide “core” preparation in bioengineering and will satisfy up to five courses of the ECE elective requirements:

BILD 1, BILD 2, BE 100, BE 140A-B

The bioengineering department will guarantee admission to these courses for ECE students on a space available basis.

CSE

The following courses are excluded as electives: CSE 3, 4GS, 6GS, 5A, 7, 8A-B, 11, 123A (duplicates ECE 158A), 140, and 140L. CSE 12, 20, & 21 will count toward the three professional electives ONLY.

ECE

Upper-division ECE courses that are not used to satisfy any other requirements.

Mechanical & Aerospace Engineering (MAE)

Credit will not be allowed for MAE 2, 3, 5, 8, 9, 20, 105, 108, 139, 140, 143B, or 170.

Special Studies

Courses 195-199: At most 4 units of 195-199 may be used for elective credit. 197 will count towards the Professional Electives only.

PROFESSIONAL ELECTIVES

Professional electives are acceptable courses taken in one department. Normally these will be upper-division courses in engineering, mathematics, or physics. Students may also choose upper-division courses from other departments provided that they fit into a coherent professional program. In such cases, a lower-division prerequisite may be included in the electives. Courses other than upper-division engineering, mathematics, or physics must be justified in terms of such a program, and must be approved by the ECE department.

Biology and Chemistry

Of the 3 electives intended to allow for the professional diversity, 1 lower-division biology or chemistry course from BILD 1, 2, CHEM 6B-C may be counted for credit in combination with 2 upper-division biology or chemistry courses. Furthermore, this will count only if the student can demonstrate to a faculty adviser that they constitute part of a coherent plan for professional/career development.

Upper-division biology and chemistry courses will count toward the 3 professional electives but not the 3 math/physics/engineering technical electives.

Economics

Suitable electives would include:

ECON 1 and 3 followed by the courses in one of the following tracks:

Macroeconomics: ECON 110A-B

Monetary Economics: ECON 111, and another economics upper-division elective

ECON 1 and 2 followed by 2 courses in one of the following tracks:

Public and Environmental: ECON 118, 130, 131, 132, 133, 137, 145

Labor and Human Resources: ECON 137, 139, 140

NOTE: *ECON 100A can be substituted for ECON 2.*

ECON 1 and 100A followed by 2 courses in one of the following tracks:

Microeconomics: ECON 100B-C

Financial Markets: ECON 120B and 173A

Operations Research: ECON 172A-B (after taking ECE 109 and MATH 20F)

Human Resources: ECON 100B and 136

NOTE: *ECON 120A, and 158-159 will not be allowed as professional electives. If economics is chosen for professional electives, only 1 technical elective is required for engineering physics majors.*

B.S. COMPUTER ENGINEERING

Students wishing to pursue the computer engineering curriculum may do so in either the ECE or CSE department. The set of required courses and allowed electives is the same in both departments; please note that the curriculum requires eighteen upper-division courses. The Computer Engineering Program requires a total of 138 units (not including the general-education requirements). All courses required for the major must be taken for a letter grade and passed with a C- or better.

The Computer Engineering Program offers a strong emphasis on engineering mathematics and other basic engineering science as well as a firm grounding in computer science. Students should have sufficient background in high school mathematics so that they can take freshman calculus in their first quarter. Courses in high school physics and computer programming, although helpful, are not required for admission to the program.

LOWER DIVISION REQUIREMENTS: 68 UNITS



Mathematics: MATH 18, 20A-B-C-D



Physics: PHYS 2A-B-C-D or PHYS 4A-B-C



Electrical Engineering: ECE 35, 45, & 65



Computer Science: CSE 11 or 8B,* 12, 15L, CSE 20 or MATH 15A, CSE 21 or MATH 15B, CSE 30, and CSE 91 (LD CSE Elective)

MATH 20A is a prerequisite for PHYS 2A. Students whose performance on the mathematics placement test permits them to start with MATH 20B or higher may take PHYS 2A in the fall quarter of their freshman year.

**Students without any programming experience are advised to take CSE 8A and CSE 8B, instead of CSE 11. CSE 11 is a faster-paced version of CSE 8A and CSE 8B combined, and requires experience in programming with a compiled language.*

UPPER DIVISION REQUIREMENTS: 68 UNITS

All BS computer engineering students are required to take CSE 100 or MATH 176, CSE 101 or MATH 188, CSE 110, CSE 120, 140, 140L, 141, 141L.

In addition, all BS computer engineering students must fulfill the following upper-division ECE requirements:

ECE 101: Linear Systems.

ECE 109: Engineering Probability and Statistics. This course can be taken in the sophomore year.

ECE 108: Electronic Circuits and Systems. *ECE 108 has been discontinued. Students must replace ECE 108 with an upper division Technical Elective.*

Technical electives: All BS computer engineering students are required to take seven technical electives.

One technical elective must be either ECE 111 or ECE 118.

Of the remaining 6 technical electives, 5 must be ECE or CSE upper-division or graduate courses.

The remaining course can be any computer science and engineering or electrical engineering upper-division or graduate course, or any other course listed under the section titled non-CSE/ECE electives. Other restrictions in the selection of technical electives are also given in the section "[Electives](#)."

NOTES FOR SELECTING & SCHEDULING CLASSES:

(All Courses MUST be taken for a letter grade)

1. First Programming Course: CSE 11 is a faster-paced version of CSE 8A and CSE 8B combined. CSE 8B or CSE 11 must be taken before CSE 12.* Students may self-select which course they wish to take. Students without experience in programming in a compiled language are advised to take CSE 8A and then CSE 8B, instead of CSE 11.
2. CSE 11 and CSE 20/MATH 15A can be taken in the same quarter but is generally discouraged for new freshmen. Please request department approval for enrollment permission at csepeeradviser@eng.ucsd.edu.
3. Students must complete seven technical electives for a total of twenty-eight units. Five of the seven technical electives must be CSE or ECE upper-division courses.

ELECTIVES

The discipline of computer engineering interacts with a number of other disciplines in a mutually beneficial way. These disciplines include mathematics, computer science, and cognitive science. The following is a list of upper-division courses from these and other disciplines that can be applied as technical electives.

A maximum of 4 units of CSE 197 may be used towards technical elective requirements. A maximum of 8 units of CSE 198 and/or 199 may be used towards technical elective requirements. ECE/CSE 195 cannot be used towards course requirements. Undergraduate students must get instructor's permission and departmental stamp to enroll in a graduate course.

Students may not get duplicate credit for equivalent courses. The UC San Diego General Catalog should be consulted for equivalency information and any restrictions placed on the courses. Additional restrictions are noted below. Any deviation from this list must be petitioned

Computer Science with a Specialization in Bioinformatics

Students must petition department for technical elective credit not on approved list.

Mathematics

All upper-division courses except MATH 168A-B, 179A-B, 183, 184A-B, 189A-B, and 195-199. If a student has completed CSE 167, then he or she cannot get elective credit for MATH 155A. Students may receive elective credit for only one of the following courses: CSE 164A, MATH 174, MATH 173, PHYS 105A-B, MAE 107, CENG 100. No credit for any of these courses will be given if MATH 170A-B-C is taken. Students will receive credit for either MATH 166 or CSE 105 (but not both), either MATH 188 or CSE 101 (but not both), and either MATH 176 or CSE 100 (but not both). Credit will be given for only one of the following: ECE 109 or MATH 183 or ECON 120A.

Electrical and Computer Engineering

All ECE upper-division courses except 195-199. Students may not get credit for both CSE 123A and ECE 158A. Credit will be given for only one of the following: ECE 109 or MATH 183 or ECON 120A or MAE 108.

Cognitive Science

Sensation and Perception 101A, Learning, Memory, and Attention 101B, Language 101C, Distributed Cognition 102A, Cognitive Ethnography 102B, Cognitive Engineering 102C, Neuroanatomy and Physiology 107A, Systems Neuroscience 107B, Cognitive Neuroscience 107C, Programming Methods for Cognitive Science 108D, Neural Networks Models of Cognitive I 108E, Advanced Programming Methods for Cognitive Science 108F, Human Computer Interaction 120, Human Computer Interaction Programming 121, Natural and Artificial Symbolic Representational Systems 170, Neural Network Models of Cognition II 181, Representation, Search, and the Web 188.

Students may not get credit for both CSE 150 and Advanced Programming Methods for Cognitive Science 108F or for both CSE 151 and Artificial Intelligence Modeling II 182.

Mechanical and Aerospace Engineering (MAE)

All upper-division MAE courses except MAE 108 & 140 (ONLY Computer Science majors may take MAE 140), and MAE 195-199. Students may receive elective credit for only one of the following courses: CSE 164A, MATH 174, MATH 173, PHYS 105A-B, CENG 100, MAE 107. Students may only get credit for one of the two courses, CSE 167 or MAE 152.

Economics

Microeconomics 100A-B-C, Game Theory 109, Macroeconomics 110A-B-C, Mathematical Economics 113, Econometrics 120A-B-C, Applied Econometrics 121, Decisions Under Uncertainty 171, Introduction to Operations Research 172A-B-C, Economic and Business Forecasting 178.

Credit will be given for only one of the following: ECE 109 or MATH 183 or Econ 120A.

Linguistics

Phonetics 110, Phonology I 111, Phonology II 115, Morphology 120, Syntax I 121, Syntax II 125, Semantics 130, Mathematical Analysis of Languages 160, Computers and Language 163, Computational Linguistics 165, Principles of Discourse and Dialog 169, Psycholinguistics 170, Language and the Brain 172, and Sociolinguistics 175.

Engineering

Principles of Team Engineering 100, Team Engineering Laboratory 100L, Team Engineering 101 (see course description under the Jacobs School of Engineering section).

Students are eligible to receive eight units of technical elective credit for completing a combination of ENG 100A (two units) and ENG 100L (two units). Students must complete one quarter of ENG 100A for two units, and one quarter of ENG 100L for a total of four units. With this combination, students will get credit for one technical elective. To receive credit for two technical electives, students must complete two more quarters of ENG 100L. This credit can be applied to fulfill the technical elective requirements.

Music

Computer Music II 172, Audio Production: Mixing and Editing 173.

Psychology

Introduction to Engineering Psychology 161.

B.A. ELECTRICAL ENGINEERING & SOCIETY

Students must complete 180 units for graduation, including the general-education requirements (GER). Note that 144 units (excluding GER) are required. All courses required for the major must be taken for a letter grade and passed with a C- or better.

LOWER DIVISION REQUIREMENTS: 76 UNITS

Mathematics: MATH 18, 20A-B-C-D-E

24
UNITS

MATH 20A is a prerequisite for PHYS 2A. Students whose performance on the mathematics placement test permits them to start with MATH 20B or higher may take PHYS 2A in the fall quarter of their freshman year.

16
UNITS

Physics: PHYS 2A-B-C-D or PHYS 4A-B-C-D-E

4
UNITS

Programming: ECE 15

4
UNITS

Chemistry: CHEM 6A

20
UNITS

Electrical Engineering: ECE 25, 30, 35, 45, & 65

8
UNITS

Electrical Courses in Social Sciences & Humanities Studies: These can be prerequisite courses for the upper -division depth sequence in social sciences/humanities. For instance, for history studies, this can be 2 history lower-division courses (HILD 2,7,10-12). Historically oriented HUM, MMW, and CAT courses would count as well. At least one lower -division course should have a writing component. For economics studies, this can be 2 lower-division courses (ECON 1, and ECON 4 for the finance track); or one lower-division course (ECON 1) plus one upper-division course for the data analysis track. For political science, the following courses may be utilized: Poli Sci10, Poli Sci11, Poli Sci12, Poli Sci13, Poli Sci30. For sociology studies, students will choose 2 lower-division courses from SOCI 1, 2, and 30, of which 30 is highly recommended.

Other courses in social sciences/humanities will be available after an agreement between ECE and the respective departments/programs are established and approved.

ADDITIONAL NOTES

1. Students with AP math credit are strongly advised to take MATH 20B in the fall quarter, leaving room for a GER in the winter quarter.
2. The ECE undergraduate website shows sample course plans. Please refer to the website and consult with the staff advisers in the undergraduate offices in Jacobs Hall 2906.

UPPER DIVISION REQUIREMENTS: 68 UNITS

Breadth :: 28 units

Courses required of ALL electrical engineering majors: ECE 100, 101, 102, 103, 107, & 109

They are required of all electrical engineering majors and they are an assumed prerequisite for senior-level courses, even if they are not explicitly required. Although the courses are largely independent, ECE 65 is a prerequisite for ECE 100 and 102. Students who delay some of the breadth courses until the spring should be careful to not have delayed their depth sequence.

Design :: 4 units

NOTE: In order to fulfill the design requirement, students must complete one of the following courses with a grade C- or better. When taking this course, the student has the option of having a portion of the project related to his/her social sciences/humanities study. Graduation will not be approved until a written copy of the design project is submitted to the ECE undergraduate office.

The electrical engineering design requirement can be fulfilled in any of the following 3 ways:

1. ECE 191. Engineering Group Design Project
2. ECE 190. Engineering Design, requires department stamp. (Specifications & enrollment forms available in undergrad office.)
3. ECE 111: Advanced Digital Design Project **OR** ECE 118: Computer Interfacing **OR** ECE 155B or 155C: Digital Recording Projects

Electives :: 16 units

4 upper-division engineering, mathematics, or physics courses.

Depth :: 24 units

Students must complete a depth requirement of at least six quarter courses to provide a focus for their studies. Sample depth programs for history and economics students are discussed below. Students may choose this demonstrated sequence or they may propose another with the approval of their faculty co-adviser from the respective social sciences/humanities department.

Concentration in Science and Medicine (8 courses, 32 units)

Students will choose 2 lower-division courses from SOCI 1, 2, and 30, of which 30 is highly recommended; and 6 upper-division courses from the list below.

Lower Division

SOCI 1. Introduction to Sociology SOCI 2.

The Study of Society

SOCI 30. Science, Technology, and Society (highly recommended)

Upper Division

SOCI 113. Sociology of the AIDS Epidemic

SOCI 134A. The Making of Modern Medicine

SOCI 135. Medical Sociology

SOCI 136E. Sociology of Mental Illness: A Historical Approach

SOCI 136F. Sociology of Mental Illness in Contemporary Society

SOCI 138. Genetics and Society

SOCI 149. Sociology of the Environment

General Sociology (8 courses, 32 units)

Students will choose 2 lower-division courses from SOCI 1, 2, and 30, of which 30 is highly recommended; and 6 upper-division courses, including one from EACH of the following 4 concentrations: Science and Medicine

Law and Society

Economy and Society

International Studies

Political Science Studies (6 courses, 24 units)

Policy Analysis

At least 4 courses from

Poli Sci 160AA. Introduction to Policy Analysis

Poli Sci 160AB. Introduction to Policy Analysis

Poli Sci 162. Environmental Policy

Poli Sci 163. Analyzing Politics

Poli Sci 165. Special Topic: Policy Analysis

Poli Sci 168. Policy Assessment

Poli Sci 170A. Introductory Statistics for Political Science and Public Policy and at least 2 courses from

Poli Sci 100H. Race and Ethnicity in American Politics

Poli Sci 102J. Advanced Topics in Urban Politics

Poli Sci 103A. California Government and Politics

Poli Sci 103B. Politics and Policymaking in Los Angeles

Poli Sci 103C. Politics and Policymaking/San Diego

Poli Sci 125A. Communities and the Environment

Poli Sci 126AA. Fundamentals of Political Economy: Modern Capitalism

Poli Sci 142A. United States Foreign Policy

Poli Sci 142J. National Security Strategy

Poli Sci 142M. US Foreign Regional Security

Economic Studies

Track A: Finance (6 courses, 24 units)

Intermediate Microeconomic sequence: Econ 100A-B-C

Finance sequence: Econ 173A-B

One elective course from the following: Econ 104, 105, 109, 113, 119, 120B, 141, 142, 143, 147, 150, 151, 155, 171, 172A

Track B: Data Analysis (7 courses, 28 units, one of them can be taken during lower-division years)

Intermediate Microeconomic sequence: Econ 100A-B-C

Data Analysis sequence: Econ 120B-C

Two elective courses from the following: Econ 104, 105, 109, 119, 121, 125, 150, 151, 152, 155, 173A, 173B, 174, 176, 178

Other upper-division courses for satisfying the depth sequences for other studies in social sciences/humanities will be available after an agreement is established between ECE and the respective department/program in social sciences/humanities.

History Studies (6 courses, 24 units)

At least 4 of these should belong to the specific field the student is pursuing (e.g., History of: East Asia, United States, Europe, Science, etc.).

At least 1 course should be in the field of history of science and technology. At least 1 course should be a colloquium (i.e., a small course, with an emphasis on essay writing).

- HISC 105. History of Environmentalism
- HISC 106. The Scientific Revolution
- HISC 107. The Emergence of Modern Science
- HISC 108. Life Sciences in the Twentieth Century
- HISC 111. The Atomic Bomb and the Atomic Age
- HISC 115. History of Modern Medicine
- HISC 131. Science Technology and Law
- HISC 173/273. Seminar on Darwin and Darwinism
- HILD 2A. United States History
- HILD 7A. Race and Ethnicity in the U.S.
- HILD 10. East Asia: The Great Tradition
- HILD 11. East Asia and the West, 1279-1911
- HILD 12. Twentieth-Century East Asia
- HIUS 140. Economic History of the United States
- HIUS 151. American Legal History since 1865
- HIUS 187. Topics in American Social History
- HIUS 148. The American City in the Twentieth Century
- HIEU 143. European Intellectual History, 1870-1945
- HIGR 222. Historical Scholarship on European History since 1850
- HILA 102. Latin America in the Twentieth Century

Sociology Studies (6 courses, 24 units)

Students may specialize in one of 4 departmental concentrations or complete the general sociology track. Students will choose 8 courses, 2 lower-division and 6 upper-division courses from their choice of concentrations in Science and Medicine, Law and Society, Economy and Society, International Studies, or General Sociology. Note: SOCI 30 is highly recommended for all tracks.

Concentration in International Studies (8 courses, 32 units)

Students will choose 2 lower-division courses from SOCI 1, 2, and 30, of which 30 is highly recommended; and 6 upper-division courses from the list below.

Lower Division

- SOCI 1. Introduction to Sociology
- SOCI 2. The Study of Society
- SOCI 30. Science, Technology, and Society (highly recommended)

Upper Division

- SOCI 130. Population and Society
- SOCI 145. Violence and Society
- SOCI 151. Comparative Race and Ethnic Relations
- SOCI 148. Political Sociology
- SOCI 153. Urban Sociology
- SOCI 157. Religion in Contemporary Society
- SOCI 158. Islam in the Modern World
- SOCI 169. Citizenship, Community, and Culture
- SOCI 176. War and Society
- SOCI 177. International Terrorism
- SOCI 178. The Holocaust
- SOCI 179. Social Change
- SOCI 180. Social Movements and Social Protest
- SOCI 181. Modern Western Society
- SOCI 182. Ethnicity and Indigenous Peoples in Latin America
- SOCI 185. Globalization and Social Development
- SOCI 187. African Societies Through Film
- SOCI 188E. Community and Social Change in Africa
- SOCI 188G. Chinese Society
- SOCI 188F. Modern Jewish Societies and Israeli Society
- SOCI 188D. Latin America: Society and Politics
- SOCI 188J. Change in Modern South Africa
- SOCI 189. Special Topics in Comparative-Historical Sociology

Concentration in Law & Society (8 courses, 32 units)

Students will choose 2 lower-division courses from SOCI 1, 2, and 30, of which 30 is highly recommended; and 6 upper-division courses from the list below.

Lower Division

- SOCI 1. Introduction to Sociology
- SOCI 2. The Study of Society
- SOCI 30. Science, Technology, and Society (highly recommended)

Upper Division

- SOCI 112. Social Psychology
- SOCI 142. Social Deviance
- SOCI 143. Suicide
- SOCI 160E. Law and Culture
- SOCI 140. Sociology of Law
- SOCI 140F. Law and the Workplace
- SOCI 141. Crime and Society
- SOCI 147. Organizations, Society, and Social Justice
- SOCI 159. Special Topics in Social Organizations and Institutions
- SOCI 163. Migration and the Law

Concentration in Economy and Society (8 courses, 32 units)

Students will choose 2 lower-division courses from SOCI 1, 2, and 30, of which 30 is highly recommended; and 6 upper-division courses from the list below.

Lower Division

- SOCI 1. Introduction to Sociology
- SOCI 2. The Study of Society
- SOCI 30. Science, Technology, and Society (highly recommended)

Upper Division

- SOCI 125. Sociology of Immigration
- SOCI 137. Sociology of Food
- SOCI 121. Economy and Society
- SOCI 132. Gender and Work
- SOCI 139. Social Inequality: Class, Race, and Gender
- SOCI 140F. Law and the Workplace
- SOCI 148E. Inequality and Jobs
- SOCI 152. Social Inequality and Public Policy
- SOCI 163. Migration and the Law
- SOCI 167. Science and War
- SOCI 185. Globalization and Social

MINOR CURRICULA

ECE offers three minors in accord with the general university policy that a minor requires five upper-division courses. Students must realize that these upper-division courses have extensive lower-division prerequisites (please consult the ECE undergraduate office). Students should also consult their college provost's office concerning the rules governing minors and programs of concentration.

Electrical Engineering: 20 units chosen from the breadth courses ECE 101, 102, 103, 107, 109.

Engineering Physics: 20 units chosen from the junior year courses PHYS 110A, 130A, MATH 110A, ECE 101, 102, 103, 107, 109.

Computer Engineering: 20 units chosen from the junior year courses ECE 102, CSE 100, 101, 105, 120, 140, 140L, 141, 141L. The department will consider other mixtures of upper-division ECE, CSE, physics, and mathematics courses by petition.

ADMISSIONS, POLICIES, & PROCEDURES

FRESHMAN ELIGIBILITY

Effective fall 2015, admission to all four majors in the Department of Electrical and Computer Engineering is currently restricted as described in the section "Acceptance to Departmental Majors in the Jacobs School of Engineering." Acceptance into a capped engineering major is based on academic excellence demonstrated in high school. Acceptance will be granted to the maximum number of students in each of these capped major programs consistent with maintaining acceptable program quality and in compliance with admissions procedures and criteria approved by the Academic Senate's Educational Policy Committee.

TRANSFER ELIGIBILITY

It is strongly recommended that transfer students complete the following course preparation for engineering majors:

- Calculus I—for Science and Engineering (Math 20A)
- Calculus II—for Science and Engineering (Math 20B)
- Calculus and Analytic Geometry (Math 20C)
- Differential Equations (Math 20D)
- Linear Algebra (Math 18)
- Complete calculus-based physics series with lab experience (Phys 2A-B-C)
- Chemistry 6A (except computer science and computer engineering majors)
- Highest level of introductory "C" computer programming language course offerings at the community college*

*Refer to the UC San Diego General Catalog to select major prerequisite requirement for computer language courses.

Effective fall 2015, admission to all four majors in the Department of Electrical and Computer Engineering is currently restricted as described in the section "[Acceptance to Departmental Majors in the Jacobs School of Engineering](#)." Acceptance into a capped engineering major is based on academic excellence demonstrated in community college or accredited four-year university. Acceptance will be granted to the maximum number of students in each of these capped major programs consistent with maintaining acceptable program quality and in compliance with admissions procedures and criteria approved by the Academic Senate's Educational Policy Committee.

CONTINUING STUDENT ELIGIBILITY

The ECE department may grant admission to continuing undergraduate students who were not admitted to the department as entering students. Admission will be considered for students who have completed the screening courses below demonstrating special aptitude for the ECE curriculum.

Electrical engineering, engineering physics, electrical engineering and society majors:

- Math 20A, 20B, 20C
- Phys 2A-B
- ECE 35, 45, 65

Computer Engineering:

- Math 20A, 20B, 20C
- Phys 2A-B
- ECE 35, 45, 65
- CSE 8A/B or CSE 11

Students may apply in any quarter after they have completed the screening courses. They will be ranked according to grades received from the screening courses taken at UC San Diego. AP credit satisfies the requirement of the screening course but does not get factored into the GPA. All courses will be weighted equally. Applicants will be chosen from this ranking until all open slots in the major are filled. For information on how to change to an ECE major, go to <http://ece.ucsd.edu/undergraduate/capped-major-status>.

ADVISING

Students are encouraged to complete an academic planning form and to discuss their curriculum with the appropriate departmental adviser immediately upon entrance to UC San Diego, and then every year until graduation. This is intended to help students in: a) their choice of depth sequence, b) their choice of electives, c) keeping up with changes in departmental requirements.

IMPORTANT: GRADE REQUIREMENT IN THE MAJOR

COURSES REQUIRED FOR THE MAJOR MUST BE TAKEN FOR A LETTER GRADE. ALL MAJOR COURSES MUST BE COMPLETED WITH A GRADE OF C- OR BETTER. A GPA OF 2.0 IS REQUIRED IN ALL UPPER-DIVISION COURSES IN THE MAJOR, INCLUDING TECHNICAL ELECTIVES. THE GRADE OF D WILL NOT BE CONSIDERED AN ADEQUATE PREREQUISITE FOR ANY ECE COURSE AN

NEW TRANSFER STUDENTS

ENGINEERING & ENGINEERING PHYSICS

The entire curriculum is predicated on the idea of actively involving students in engineering from the time they enter as freshmen. The freshman courses have been carefully crafted to provide an overview of the engineering mindset with its interrelationships among physics, mathematics, problem solving, and computation. All later courses are specifically designed to build on this foundation. All transfer students should understand that the lower-division curriculum is demanding. Transfer students will be required to take all lower-division requirements or their equivalent. Transfer students are advised to consult the ECE website for sample recommended course schedules and for the ECE course requirement guide.

COMPUTER ENGINEERING

Transfer students are advised to consult the ECE website for sample recommended course schedules and for the ECE course requirement guide. Students who do not have any programming experience are encouraged to take the CSE 8A-B sequence instead of CSE 11. Experience has shown that most students who are not familiar with programming and take CSE 11 have to retake the class because the accelerated pace makes it difficult to learn the new material.

Note: Transfer students are encouraged to consult with the ECE undergraduate office for academic planning upon entrance to UC San Diego.

ECE HONORS PROGRAM

The ECE Undergraduate Honors Program is intended to give eligible students the opportunity to work closely with faculty in a project, and to honor the top graduating undergraduate students.

ELIGIBILITY FOR ADMISSION

1. Students with a minimum GPA of 3.5 in the major and 3.25 overall will be eligible to apply. Students may apply at the end of the winter quarter of their junior year and no later than the end of the second week of fall quarter of their senior year. No late applications will be accepted.
2. Students must submit a project proposal (sponsored by an ECE faculty member) to the honors program committee at the time of application.
3. The major GPA will include ALL lower division required for the major and all upper division required for the major that are completed at the time of application (a minimum of 24 units of upper-division course work).

REQUIREMENTS FOR AWARD OF HONORS

1. Completion of all ECE requirements with a minimum GPA of 3.5 in the major based on grades through winter quarter of the senior year.
2. Formal participation (i.e., registration and attendance) in the ECE 290 graduate seminar program in the winter quarter of their senior year.
3. Completion of an 8-unit approved honors project (ECE 193H: Honors Project) and submission of a written report by the first day of spring quarter of the senior year. This project must contain enough design to satisfy the ECE BS four-unit design requirement.
4. The ECE honors committee will review each project final report and certify the projects that have been successfully completed at the honors level.

PROCEDURE FOR APPLICATION

Between the end of the winter quarter of their junior year and the second week of the fall quarter of their senior year, interested students must advise the department of their intention to participate by submitting a proposal for the honors project sponsored by an ECE faculty member. Admission to the honors program will be formally approved by the ECE honors committee based on GPA and the proposal.

UNIT CONSIDERATIONS

Except for the two-unit graduate seminar, this honors program does not increase a participant's total unit requirements. The honors project will satisfy the departmental design requirement and students may use four units of their honors project course as a technical elective.

5-YEAR BS/MS PROGRAM

Undergraduates in the ECE department who have maintained a good academic record in both departmental and overall course work are encouraged to participate in the five-year BS/MS program offered by the department. Participation in the program will permit students to complete the requirements for the MS degree within one year following receipt of the BS degree. Complete details regarding admission to and participation in the program are available from the ECE Undergraduate Affairs office.

ADMISSION TO THE PROGRAM

Students should submit an application for the BS/MS program, including three letters of recommendation, by the program deadline during the spring quarter of their junior year. Applications are available from the ECE Undergraduate Affairs office. No GRE's are required for application to the BS/MS program. A GPA of at least 3.0 both overall and in the major and strong letters of recommendation are required to be considered for program admission.

In the winter quarter of the senior year, applications of students admitted to the program will be forwarded by the department to the UC San Diego Office of Graduate Studies. Each student must submit the regular graduate application fee prior to the application deadline for their application to be processed. Students who have been accepted into the BS/MS program will automatically be admitted for graduate study beginning the following fall provided they maintain an overall GPA through the winter quarter of the senior year of at least 3.0. Upper-division (up to 12 units) or graduate courses taken during the senior year that are not used to satisfy undergraduate course requirements may be counted towards the 48 units required for the MS degree.

CONTINUATION IN THE PROGRAM

Once admitted to the BS/MS program, students must maintain a 3.0 cumulative GPA in all courses through the winter quarter of the senior year and in addition must at all times maintain a 3.0 cumulative GPA in their graduate course work. Students not satisfying these requirements may be re-evaluated for continuation in the program. Admission for graduate study through the BS/MS program will be for the Master of Science degree only. Undergraduate students wishing to continue toward the PhD degree must apply and be evaluated according to the usual procedures and criteria for admission to the PhD program.

5-YEAR BS/MS PROGRAM CONTINUED

CURRICULUM

Students in the five-year BS/MS program must complete the same requirements as those in the regular MS program. Completion of the MS degree requirements within one year following receipt of the BS degree will generally require that students begin graduate course work in their senior year. All requirements for the BS degree should be completed by the end of the senior

(fourth) year, and the BS degree awarded prior to the start of the fifth year. Courses taken in the senior year may be counted toward the BS degree requirements or the MS degree requirements, but not both. Students must have received their BS degree before they will be eligible to enroll as graduate students in the department.

The department offers graduate programs leading to the MS, and PhD degrees in electrical engineering. Students can be admitted into ECE graduate studies through either the MS or PhD programs.

The PhD program is strongly research oriented and is for students whose final degree objective is the PhD. If a student with a BS is admitted to this program, he or she will be expected to complete the requirements for the MS degree (outlined below) before beginning doctoral research. The MS is a technically intensive, research-oriented degree intended as preparation for advanced technical work in the engineering profession, or subsequent pursuit of a PhD.

In addition, the department offers MS and PhD programs in computer engineering jointly with CSE, and a PhD program in applied ocean science jointly with MAE and Scripps Institution of Oceanography.

Admission to an ECE graduate program is in accordance with the general requirements of the UC San Diego graduate division, and requires at least a BS degree in engineering, physical sciences, or mathematics with a minimum upper-division GPA of 3.0. Applicants must provide three letters of recommendation and recent GRE General Test scores. TOEFL or IELTS scores are required from international applicants whose native language is not English. Applicants should be aware that the university does not permit duplication of degrees.

Support: The department makes every effort to provide financial support for PhD students who are making satisfactory progress. Support may take the form of a fellowship, teaching assistantship, research assistantship, or some combination thereof. International students will not be admitted unless there is reasonable assurance that support can be provided for the duration of their PhD program. Students in the MS program may also obtain support through teaching or research assistantships, but this is less certain.

Advising: Students should seek advice on requirements and procedures from the departmental graduate office and/or the departmental website <http://www.ece.ucsd.edu>. All students will be assigned a faculty academic adviser upon admission and are strongly encouraged to discuss their academic program with their adviser immediately upon arrival and subsequently at least once per academic year.

ECE COURSES

For course descriptions not found in the UC San Diego General Catalog, 2014-15, please contact the department for more information.

The department will endeavor to offer the courses as outlined below; however, unforeseen circumstances sometimes require a change of scheduled offerings. Students are strongly advised to check the Schedule of Classes or the department before relying on the schedule below. For the names of the instructors who will teach the course, please refer to the quarterly Schedule of Classes. The departmental website <http://www.ece.ucsd.edu> includes the present best estimate of the schedule of classes for the entire academic year.

LOWER DIVISION

[ECE 5. Introduction to Electrical and Computer Engineering \(4\)](#)

An introduction to electrical and computer engineering. Topics include circuit theory, assembly, and testing, embedded systems programming and debugging, transducer mechanisms and interfacing transducers, signals and systems theory, digital signal processing, and modular design techniques. P/NP grades only. **Prerequisites:** priority enrollment given to engineering majors EC04, EC26, EC27, EC28 and EC37.

[ECE 15. Engineering Computation \(4\)](#)

Students learn the C programming language with an emphasis on high-performance numerical computation. The commonality across programming languages of control structures, data structures, and I/O is also covered. Techniques for using Matlab to graph the results of C computations are developed. **Prerequisites:** a familiarity with basic mathematics such as trigonometry functions and graphing is expected but this course assumes no prior programming knowledge.

[ECE 16. Rapid Hardware and Software Design for Interfacing with the World \(4\)](#)

Students are introduced to embedded systems concepts with structured development of a computer controller based on electromyogram (EMG) signals through four lab assignments through the quarter. Key concepts include: sampling, signal processing, communication, and real-time control. Students will apply their prior knowledge in C (from ECE15) to program microcontrollers and will engage in data analysis using the Python programming language. **Prerequisites:** ECE 15. Priority enrollment given to engineering majors EC04, EC26, EC27, EC28 and EC37.

[ECE 25. Introduction to Digital Design \(4\)](#)

This course emphasizes digital electronics. Principles introduced in lectures are used in laboratory assignments, which also serve to introduce experimental and design methods. Topics include Boolean algebra, combination and sequential logic, gates and their implementation in digital circuits. (Course material and/or program fees may apply.) **Prerequisites:** none.

[ECE 30. Introduction to Computer Engineering \(4\)](#)

The fundamentals of both the hardware and software in a computer system. Topics include: representation of information, computer organization and design, assembly and microprogramming, current technology in logic design. **Prerequisites:** ECE 15 and 25 with grades of C- or better.

[ECE 35. Introduction to Analog Design \(4\)](#)

Fundamental circuit theory concepts, Kirchoff's voltage and current laws, Thevenin's and Norton's theorems, loop and node analysis, time-varying signals, transient first order circuits, steady-state sinusoidal response. Math 20C and Phys 2B must be taken concurrently. Program or material fee may apply. **Prerequisites:** Math 20A-B and Phys 2A.

[ECE 45. Circuits and Systems \(4\)](#)

Steady-state circuit analysis, first and second order systems, Fourier Series and Transforms, time domain analysis, convolution, transient response, Laplace Transform, and filter design. **Prerequisites:** ECE 35.

[ECE 65. Components and Circuits Laboratory \(4\)](#)

Introduction to linear and nonlinear components and circuits. Topics will include: two terminal devices, bipolar and field-effect transistors, and large and small signal analysis of diode and transistor circuits. (Program or material fee may apply.) **Prerequisites:** ECE 35.

[ECE 85. iTunes 101: A Survey of Information Technology \(4\)](#)

Topics include how devices such as iPods and iPhones generate, transmit, receive and process information (music, images, video, etc.), the relationship between technology and issues such as privacy and "net-neutrality," and current topics related to information technology. **Prerequisites:** none.

ECE 87. Freshman Seminar (1)

The Freshman Seminar program is designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman Seminars are offered in all campus departments and undergraduate colleges, and topics vary from quarter to quarter. Enrollment is limited to fifteen to twenty students, with preference given to entering freshmen. **Prerequisites:** none.

ECE 90. Undergraduate Seminar (1)

This seminar class will provide a broad review of current research topics in both electrical engineering and computer engineering. Typical subject areas are signal processing, VLSI design, electronic materials and devices, radio astronomy, communications, and optical computing. **Prerequisites:** none.

UPPER DIVISION

ECE 100. Linear Electronic Systems (4)

Linear active circuit and system design. Topics include frequency response; use of Laplace transforms; design and stability of filters using operational amplifiers. Integrated lab and lecture involves analysis, design, simulation, and testing of circuits and systems. Program or material fee may apply. **Prerequisites:** ECE 45 and ECE 65. ECE 65 may be taken concurrently.

ECE 101. Linear Systems Fundamentals (4)

Complex variables. Singularities and residues. Signal and system analysis in continuous and discrete time. Fourier series and transforms. Laplace and z-transforms. Linear Time Invariant Systems. Impulse response, frequency response, and transfer functions. Poles and zeros. Stability. Convolution. Sampling. Aliasing. **Prerequisites:** ECE 45 with grade of C– or better.

ECE 102. Introduction to Active Circuit Design (4)

Nonlinear active circuits design. Nonlinear device models for diodes, bipolar and field-effect transistors. Linearization of device models and small-signal equivalent circuits. Circuit designs will be simulated by computer and tested in the laboratory. **Prerequisites:** ECE 65 and ECE 100. ECE 100 can be taken concurrently.

ECE 103. Fundamentals of Devices and Materials (4)

Introduction to semiconductor materials and devices. Semiconductor crystal structure, energy bands, doping, carrier statistics, drift and diffusion, p-n junctions, metal-semiconductor junctions. Bipolar junction transistors: current flow, amplification, switching, nonideal behavior. Metal-oxide-semiconductor structures, MOSFETs, device scaling. **Prerequisites:** ECE 65 and Phys 2D or Phys 4D and 4E.

ECE 107. Electromagnetism (4)

Electrostatics and magnetostatics; electrodynamics; Maxwell's equations; plane waves; skin effect. Electromagnetics of transmission lines: reflection and transmission at discontinuities, Smith chart, pulse propagation, dispersion. Rectangular waveguides. Dielectric and magnetic properties of materials. Electromagnetics of circuits. **Prerequisites:** Phys 2A–D or 4A–E and ECE 45 with grades of C– or better.

ECE 109. Engineering Probability and Statistics (4)

Axioms of probability, conditional probability, theorem of total probability, random variables, densities, expected values, characteristic functions, transformation of random variables, central limit theorem. Random number generation, engineering reliability, elements of estimation, random sampling, sampling distributions, tests for hypothesis. Students who completed MAE 108, Math 180A–B, Math 183, Math 186, Econ 120A, or Econ 120AH will not receive credit for ECE 109. **Prerequisites:** Math 20A–B–C, 20D, 20F, with grades of C– or better. ECE 101 recommended.

ECE 111. Advanced Digital Design Project (4)

Advanced topics in digital circuits and systems. Use of computers and design automation tools. Hazard elimination, synchronous/asynchronous FSM synthesis, synchronization and arbitration, pipelining and timing issues. Problem sets and design exercises. A large-scale design project. Simulation and/or rapid prototyping. **Prerequisites:** ECE 25 or CSE 140.

ECE 115. Fast Prototyping (4)

Lab-based course. Students will learn how to prototype a mechatronic solution. Topics include: cheap/accessible materials and parts; suppliers; fast prototyping techniques; useful electronic sketches and system integration shortcuts. Students will learn to materialize their electromechanical ideas and make design decisions to minimize cost, improve functionality/robustness. Labs will culminate towards a fully functional robot prototype for demonstration. **Prerequisites:** ECE 16 or consent of instructor.

ECE 120. Solar System Physics (4)

General introduction to planetary bodies, the overall structure of the solar system, and space plasma physics. Course emphasis will be on the solar atmosphere, how the solar wind is produced, and its interaction with both magnetized and unmagnetized planets (and comets). **Prerequisites:** Phys 2A–C or 4A–D, Math 20A–B, 20C with grades of C– or better.

ECE 121A. Power Systems Analysis and Fundamentals (4)

This course introduces concepts of large-scale power system analysis: electric power generation, distribution, steady-state analysis and economic operation. It provides the fundamentals for advanced courses and engineering practice on electric power systems, smart grid, and electricity economics. The course requires implementing some of the computational techniques in simulation software. **Prerequisites:** ECE 35.

ECE 121B. Energy Conversion (4)

Principles of electro-mechanical energy conversion, balanced three-phase systems, fundamental concepts of magnetic circuits, single-phase transformers, and the steady-state performance of DC and induction machines. Students may not receive credit for both ECE 121B and ECE 121. **Prerequisites:** ECE 121A.

ECE 123. Antenna Systems Engineering (4)

The electromagnetic and systems engineering of radio antennas for terrestrial wireless and satellite communications. Antenna impedance, beam pattern, gain, and polarization. Dipoles, monopoles, paraboloids, phased arrays. Power and noise budgets for communication links. Atmospheric propagation and multipath. **Prerequisites:** ECE 107 with a grade of C- or better.

ECE 125A. Introduction to Power Electronics I (4)

Power generation, system, and electronics. Topics include power semiconductor devices and characteristics, single-phase and three-phase half and full controlled AC-to-DC rectifiers, nonisolated/isolated DC-DC converters, power loss calculation, and thermal considerations, Snubber circuits. **Prerequisites:** ECE 121A.

ECE 125B. Introduction to Power Electronics II (4)

Design and control of DC-DC converters, PWM rectifiers, single-phase and three-phase inverters, power management, and power electronics applications in renewable energy systems, motion control, and lighting. **Prerequisites:** ECE 125A.

ECE 134. Electronic Materials Science of Integrated Circuits (4)

Electronic materials science with emphasis on topics pertinent to microelectronics and VLSI technology. Concept of the course is to use components in integrated circuits to discuss structure, thermodynamics, reaction kinetics, and electrical properties of materials. **Prerequisites:** Phys 2C-D with grades of C- or better.

ECE 135A. Semiconductor Physics (4)

Crystal structure and quantum theory of solids; electronic band structure; review of carrier statistics, drift and diffusion, p-n junctions; nonequilibrium carriers, imrefs, traps, recombination, etc; metal-semiconductor junctions and heterojunctions. **Prerequisites:** ECE 103 with a grade of C- or better.

ECE 135B. Electronic Devices (4)

Structure and operation of bipolar junction transistors, junction field-effect transistors, metal-oxide-semiconductor diodes and transistors. Analysis of dc and ac characteristics. Charge control model of dynamic behavior. **Prerequisites:** ECE 135A with a grade of C- or better.

ECE 136L. Microelectronics Laboratory (4)

Laboratory fabrication of diodes and field effect transistors covering photolithography, oxidation, diffusion, thin film deposition, etching and evaluation of devices. (Course material and/or program fees may apply.) **Prerequisites:** ECE 103.

ECE 138L. Microstructuring Processing Technology Laboratory (4)

A laboratory course covering the concept and practice of microstructuring science and technology in fabricating devices relevant to sensors, lab-chips and related devices. (Course material and/or program fees may apply.) **Prerequisites:** upper-division standing for science and engineering students.

ECE 145AL-BL-CL. Acoustics Laboratory (4-4-4)

Automated laboratory based on H-P GPIB controlled instruments. Software controlled data collection and analysis. Vibrations and waves in strings and bars of electromechanical systems and transducers. Transmissions, reflection, and scattering of sound waves in air and water. Aural and visual detection. **Prerequisites:** ECE 107 with a grade of C- or better or consent of instructor.

ECE 153. Probability and Random Processes for Engineers (4)

Random processes. Stationary processes: correlation, power spectral density. Gaussian processes and linear transformation of Gaussian processes. Point processes. Random noise in linear systems. **Prerequisites:** ECE 109 with a grade of C- or better.

ECE 154A. Communications Systems I (4)

Study of analog modulation systems including AM, SSB, DSB, VSB, FM, and PM. Performance analysis of both coherent and noncoherent receivers, including threshold effects in FM. **Prerequisites:** ECE 101 and 153 with a grade of C- or better.

ECE 154B. Communications Systems II (4)

Design and performance analysis of digital modulation techniques, including probability of error results for PSK, DPSK, and FSK. Introduction to effects of intersymbol interference and fading. Detection and estimation theory, including optimal receiver design and maximum-likelihood parameter estimation. **Prerequisites:** ECE 154A with a grade of C- or better.

ECE 154C. Communications Systems III (4)

Introduction to information theory and coding, including entropy, average mutual information, channel capacity, block codes and convolutional codes. **Prerequisites:** ECE 154B with a grade of C- or better.

ECE 157A. Communications Systems Laboratory I (4)

Experiments in the modulation and demodulation of baseband and passband signals. Statistical characterization of signals and impairments. (Course material and/or program fees may apply.) **Prerequisites:** ECE 154A with a grade of C+ or better.

ECE 157B. Communications Systems Laboratory II (4)

Advanced projects in communication systems. Students will plan and implement design projects in the laboratory, updating progress weekly and making plan/design adjustments based upon feedback. (Course material and/or program fees may apply.) **Prerequisites:** ECE 154A with a grade of C+ or better.

ECE 158A. Data Networks I (4)

Layered network architectures, data link control protocols and multiple-access systems, performance analysis. Flow control; prevention of deadlock and throughput degradation. Routing, centralized and decentralized schemes, static dynamic algorithms. Shortest path and minimum average delay algorithms. Comparisons. **Prerequisites:** ECE 109 with a grade of C- or better.

ECE 158B. Data Networks II (4)

Layered network architectures, data link control protocols and multiple-access systems, performance analysis. Flow control; prevention of deadlock and throughput degradation. Routing, centralized and decentralized schemes, static dynamic algorithms. Shortest path and minimum average delay algorithms. Comparisons. **Prerequisites:** ECE 158A with a grade of C- or better.

ECE 161A. Introduction to Digital Signal Processing (4)

Review of discrete-time systems and signals, Discrete-Time Fourier Transform and its properties, the Fast Fourier Transform, design of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters, implementation of digital filters. **Prerequisites:** ECE 101.

ECE 161B. Digital Signal Processing I (4)

Sampling and quantization of baseband signals; A/D and D/A conversion, quantization noise, oversampling and noise shaping. Sampling of bandpass signals, undersampling downconversion, and Hilbert transforms. Coefficient quantization, roundoff noise, limit cycles and overflow oscillations. Insensitive filter structures, lattice and wave digital filters. Systems will be designed and tested with Matlab, implemented with DSP processors and tested in the laboratory. **Prerequisites:** ECE 161A with a grade of C- or better.

ECE 161C. Applications of Digital Signal Processing (4)

This course discusses several applications of DSP. Topics covered will include: speech analysis and coding; image and video compression and processing. A class project is required, algorithms simulated by Matlab. **Prerequisites:** ECE 161A.

ECE 163. Electronic Circuits and Systems (4)

Analysis and design of analog circuits and systems. Feedback systems with applications to operational amplifier circuits. Stability, sensitivity, bandwidth, compensation. Design of active filters. Switched capacitor circuits. Phase-locked loops. Analog-to-digital and digital-to-analog conversion. (Course material and/or program fees may apply.) **Prerequisites:** ECE 101 and 102 with grades of C- or better.

ECE 164. Analog Integrated Circuit Design (4)

Design of linear and nonlinear analog integrated circuits including operational amplifiers, voltage regulators, drivers, power stages, oscillators, and multipliers. Use of feedback and evaluation of noise performance. Parasitic effects of integrated circuit technology. Laboratory simulation and testing of circuits. **Prerequisites:** ECE 102 with a grade of C- or better. ECE 163 recommended.

ECE 165. Digital Integrated Circuit Design (4)

VLSI digital systems. Circuit characterization, performance estimation, and optimization. Circuits for alternative logic styles and clocking schemes. Subsystems include ALUs, memory, processor arrays, and PLAs. Techniques for gate arrays, standard cell, and custom design. Design and simulation using CAD tools. **Prerequisites:** ECE 102.

ECE 166. Microwave Systems and Circuits (4)

Waves, distributed circuits, and scattering matrix methods. Passive microwave elements. Impedance matching. Detection and frequency conversion using microwave diodes. Design of transistor amplifiers including noise performance. Circuits designs will be simulated by computer and tested in the laboratory. (Course material and/or program fees may apply.) **Prerequisites:** ECE 102 and 107 with grades of C- or better.

ECE 171A. Linear Control System Theory (4)

Stability of continuous- and discrete-time single-input/single-output linear time-invariant control systems emphasizing frequency domain methods. Transient and steady-state behavior. Stability analysis by root locus, Bode, Nyquist, and Nichols plots. Compensator design. **Prerequisites:** ECE 45 or MAE 140.

ECE 171B. Linear Control System Theory (4)

Time-domain, state-variable formulation of the control problem for both discrete-time and continuous-time linear systems. State-space realizations from transfer function system description. Internal and input-output stability, controllability/observability, minimal realizations, and pole-placement by full-state feedback. **Prerequisites:** ECE 171A with a grade of C- or better.

ECE 172A. Introduction to Intelligent Systems: Robotics and Machine Intelligence (4)

This course will introduce basic concepts in machine perception. Topics covered will include edge detection, segmentation, texture analysis, image registration, and compression. **Prerequisites:** ECE 101 with a grade of C- or better. ECE 109 recommended.

ECE 174. Introduction to Linear and Nonlinear Optimization with Applications (4)

The linear least squares problem, including constrained and unconstrained quadratic optimization and the relationship to the geometry of linear transformations. Introduction to nonlinear optimization. Applications to signal processing, system identification, robotics, and circuit design. Recommended preparation: ECE 100. **Prerequisites:** Math 20F or Math 18, ECE 15, and ECE 109 or consent of instructor.

ECE 175A. Elements of Machine Intelligence: Pattern Recognition and Machine Learning (4)

Introduction to pattern recognition and machine learning. Decision functions. Statistical pattern classifiers. Generative vs. discriminant methods for pattern classification. Feature selection. Regression. Unsupervised learning. Clustering. Applications of machine learning. **Prerequisites:** ECE 109 and ECE 174.

ECE 175B. Elements of Machine Intelligence: Probabilistic Reasoning and Graphical Models (4)

Bayes' rule as a probabilistic reasoning engine; graphical models as knowledge encoders; conditional independence and D-Separation; Markov random fields; inference in graphical models; sampling methods and Markov Chain Monte Carlo (MCMC); sequential data and the Viterbi and BCJR algorithms; The Baum-Welsh algorithm for Markov Chain parameter estimation. **Prerequisites:** ECE 175A.

ECE 180. Topics in Electrical and Computer Engineering (4)

Topics of special interest in electrical and computer engineering. Subject matter will not be repeated so it may be taken for credit more than once. **Prerequisites:** consent of instructor; department stamp.

ECE 181. Physical Optics and Fourier Optics (4)

Ray optics, wave optics, beam optics, Fourier optics, and electromagnetic optics. Ray transfer matrix, matrices of cascaded optics, numerical apertures of step and graded index fibers. Fresnel and Fraunhofer diffractions, interference of waves. Gaussian and Bessel beams, the ABCD law for transmissions through arbitrary optical systems. Spatial frequency, impulse response and transfer function of optical systems, Fourier transform and imaging properties of lenses, holography. Wave propagation in various (inhomogeneous, dispersive, anisotropic or nonlinear) media. (Course material and/or program fees may apply.) **Prerequisites:** ECE 103 and 107 with grades of C- or better.

ECE 182. Electromagnetic Optics, Guided-Wave, and Fiber Optics (4)

Polarization optics: crystal optics, birefringence. Guided-wave optics: modes, losses, dispersion, coupling, switching. Fiber optics: step and graded index, single and multimode operation, attenuation, dispersion, fiber optic communications. Resonator optics. (Course material and/or program fees may apply.) **Prerequisites:** ECE 103 and 107 with grades of C- or better.

ECE 183. Optical Electronics (4)

Quantum electronics, interaction of light and matter in atomic systems, semiconductors. Laser amplifiers and laser systems. Photodetection. Electrooptics and acoustooptics, photonic switching. Fiber optic communication systems. Labs: semiconductor lasers, semiconductor photodetectors. (Course material and/or program fees may apply.) **Prerequisites:** ECE 103 and 107 with grades of C- or better.

ECE 184. Optical Information Processing and Holography (4)

(Conjoined with ECE 241AL) Labs: optical holography, photorefractive effect, spatial filtering, computer generated holography. Students enrolled in ECE 184 will receive four units of credit; students enrolled in ECE 241AL will receive two units of credit. (Course material and/or program fees may apply.) **Prerequisites:** ECE 182 with a grade of C- or better.

ECE 185. Lasers and Modulators (4)

(Conjoined with ECE 241BL) Labs: CO₂ laser, HeNe laser, electrooptic modulation, acoustooptic modulation, spatial light modulators. Students enrolled in ECE 185 will receive four units of credit; students enrolled in ECE 241BL will receive two units of credit. (Course material and/or program fees may apply.) **Prerequisites:** ECE 183 with a grade of C- or better.

ECE 187. Introduction to Biomedical Imaging and Sensing (4)

Image processing fundamentals: imaging theory, image processing, pattern recognition; digital radiography, computerized tomography, nuclear medicine imaging, nuclear magnetic resonance imaging, ultrasound imaging, microscopy imaging. **Prerequisites:** Math 20A-B-F, 20C or 21C, 20D or 21D, Phys 2A-D, ECE 101 (may be taken concurrently) with grades of C- or better.

ECE 188. Topics in Electrical and Computer Engineering with Laboratory (4)

Topics of special interest in electrical and computer engineering with laboratory. Subject matter will not be repeated so it may be taken for credit up to three times. **Prerequisites:** upper-division standing.

ECE 190. Engineering Design (4)

Students complete a project comprising at least 50 percent or more engineering design to satisfy the following features: student creativity, open-ended formulation of a problem statement/specifications, consideration of alternative solutions/realistic constraints. Written final report required. **Prerequisites:** students enrolling in this course must have completed all of the breadth courses and one depth course. The department stamp is required to enroll in ECE 190. (Specifications and enrollment forms are available in the undergraduate office.)

ECE 191. Engineering Group Design Project (4)

Groups of students work to design, build, demonstrate, and document an engineering project. All students give weekly progress reports of their tasks and contribute a section to the final project report. **Prerequisites:** completion of all of the breadth courses and one depth course.

ECE 193H. Honors Project (4-8)

An advanced reading or research project performed under the direction of an ECE faculty member. Must contain enough design to satisfy the ECE program's four-unit design requirement. Must be taken for a letter grade. May extend over two quarters with a grade assigned at completion for both quarters. **Prerequisites:** admission to the ECE departmental honors program.

ECE 195. Teaching (2 or 4)

Teaching and tutorial activities associated with courses and seminars. Not more than four units of ECE 195 may be used for satisfying graduation requirements. (P/NP grades only.) **Prerequisites:** consent of the department chair.

ECE 196. Engineering Hands-on Group Project (4)

Groups of students work to build and demonstrate at least three engineering projects at the beginning, intermediate, and advanced levels. The final project consists of either a new project designed by the student team or extension of an existing project. The student teams also prepare a manual as part of their documentation of the final project. (P/NP grades only.) May be taken for credit two times. **Prerequisites:** upper-division standing.

ECE 197. Field Study in Electrical and Computer Engineering (4, 8, 12, or 16)

Directed study and research at laboratories and observatories away from the campus. (P/NP grades only.) **Prerequisites:** consent of instructor and approval of the department.

ECE 198. Directed Group Study (2 or 4)

Topics in electrical and computer engineering whose study involves reading and discussion by a small group of students under direction of a faculty member. (P/NP grades only.) **Prerequisites:** consent of instructor.

ECE 199. Independent Study for Undergraduates (2 or 4)

Independent reading or research by special arrangement with a faculty member. (P/NP grades only.) **Prerequisites:** consent of instructor.

COURSE PLANS & WORKSHEETS

<http://www.ece.ucsd.edu/undergraduate/course-plans-forms>

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IMPORTANT LINKS

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UCSD GENERAL CATALOG	http://www.ucsd.edu/catalog/curric/ECE-ug.html
ECE COURSE OFFERINGS	http://www.ece.ucsd.edu/courses
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ECE FACULTY	http://www.ece.ucsd.edu/people/faculty
IDEA STUDENT CENTER	http://www.jacobsschool.ucsd.edu/idea/
CAREER SERVICES CENTER	http://career.ucsd.edu/
COUNSELING & PSYCHOLOGICAL SERVICES	http://caps.ucsd.edu/#students
STUDENT TRANSFER COURSE INFO SYSTEM	http://www.assist.org/web-assist/welcome.html
STUDY ABROAD	http://icenter.ucsd.edu/studyabroad
FINANCIAL AID OFFICE	http://students.ucsd.edu/finances/financial-aid/index.html

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