UNOFFICIAL GUIDE TO ENGINEERING SCIENCES

SOCIETY OF ENGINEERING SCIENCES

2019-2020

Contents

Introduction

Welcome to Cal! We, the students of the College of Engineering, would like to congratulate you on your admission to one of the finest engineering institutions in the world. You are now a member of a very elite group of students who make up Cal's Engineering Science Program.

As former freshmen and junior transfers, we understand the feelings of confusion and the overwhelming amount of information you may be experiencing as you enter UC Berkeley Engineering. It is a monumental task to sort through all of the new information and determine the path you will take here at Berkeley. You have to take the initiative to find out about classes and chart your own course. Within a couple of years, you will be making many important decisions that will undoubtedly affect your future. Drawing on our past experiences in Engineering Science and other related engineering disciplines, we hope that we will be able to give you a hand in making informed decisions and to help you avoid the pitfalls of the college system.

The Unofficial Guide to Engineering Sciences contains information concerning classes, majors, graduate schools, jobs, careers, and campus resources. We hope that this will become a valuable resource to you whenever you have any questions about the engineering program. This guide does not replace your faculty adviser, ESS adviser, or any of your peers. However, we hope that the booklet will help answer most of your questions about your new major. We also recommend you read the sections on other Engineering Science majors as well – many students find the different perspectives helpful, and sometimes switch their focus as a result! Either way, we hope it will help you formulate your own path here at Berkeley. Welcome to the Cal Engineering family! Good luck and GO BEARS!

Energy Engineering

Energy Engineering (EnE) offers an interdisciplinary look at the challenges around the quickly-changing energy landscape. Energy Engineering majors take the same strong quantitative base that other Berkeley engineers take, including physics, linear algebra, single and multivariable calculus, as well as chemistry. It is currently a small major, but every year since its creation in 2012, the major has increased rapidly, some years even doubling in size.

To start off, E93 (Energy Engineering Seminar) is a great opportunity to learn about energy-related topics. It is a guest speaker seminar targeted at beginners that brings in various people who work in the field of Energy Engineering to give presentations about the main ideas in Energy Engineering.

In addition to these core quantitative classes, a huge variety of other perspectives shed light on the energy issue. Required classes come from departments all over the College of Engineering, as well as outside it. The required Civil Engineering classes generally take a bird's-eye view, focusing on fluid and energy flows at large scales, as well as the associated chemical reactions. From Mechanical Engineering, EnE pulls in a more rigorous mathematical approach to the physical and energetic interactions between and within systems. Electrical Engineering classes seem to split the difference, with EE 137 A + B (Electric Power Systems) taking a high-level view of power systems and EE 134 (Photovoltaics) taking a detail-oriented view of semiconductors. Statistics, sustainability and economics courses also inform the study of energy. Each of these categories pulls a class from a set of possible classes listed on the degree worksheet. For example Stat 134, IEOR 172, or Math 55 can be used for the statistics requirement. Each brings a different perspective to the intersection of statistics and energy. All of these skills come together in a senior capstone project E 194, which allows students to synthesize and apply the knowledge they have gained to a current problem in energy engineering.

Given the breadth of the Energy Industry, the Energy Engineering curriculum allows for students to choose from a multitude of classes and forge their own path here at Cal. This allows students to obtain an understanding of the industry as a whole while also giving them the opportunity to specialize in their given field of interest. Certain classes are offered during only Fall or only Spring, so early planning is beneficial. If you are having trouble deciding what classes to take, SES and the Engineering Science department have created a few potential schedules to help guide you! :)

Student groups are very important in determining what you want to do with your major, as well as for meeting people with similar interests. (For example, try SES!) Berkeley Energy & Resources Collaborative (BERCU) attracts a variety of majors and puts on some really cool events, occasionally fueled by free pizza. Engineering project clubs such as Human Powered Vehicle and CalSol are also great ways to hone skills and meet people. Also take a look at Engineers for a Sustainable World, a club dedicated to hands-on sustainability projects. It's very popular both for Energy Engineers and your peers in Environmental Engineering Science!

EnE's interdisciplinary nature allows the pursuit of a variety of different career paths including graduate school, mechanical engineering, solar photovoltaics at either the system level or the semiconductor level, and more. The Career Center sends out newsletters about research or internship opportunities, and signing up for BOTH engineering and environmental newsletters will allow you to see a large range of possibilities. (For more information, see career.berkeley.edu/MailList/MailList.) In addition, SES and the College of Engineering are great resources for whatever career path you are on.

Examples of relevant challenges include improving energy efficiency in buildings, transportation, and industrial sectors; reducing emissions of carbon dioxide and other environmental impacts associated with fuel combustion in power plants and engines; designing and managing smart energy grids; developing non-fossil energy systems including wind, solar, geothermal, and nuclear power; and developing and improving production, storage, and distribution infrastructure needed for electric vehicles, hydrogen fuel cells, and biofuels.

Final Note: Many EnEs recommend taking Thermodynamics early (to account for scheduling), and to avoid taking both CE 107 and ERG 100 (the content is quite similar). For a list of FAQs about the major and other information, visit engineeringscience.berkeley.edu/energy-engineering.

Engineering Mathematics & Statistics

This major is a combination of math and engineering. Due to the breadth of this program, it is especially suited for those who plan to enter graduate school. If you are unsure of engineering but still love math and science, Engineering Mathematics & Statistics (EMS) is still for you. Additional engineering or science deficiencies for graduate work that you may have can be made up early in graduate school, and your broad background can offer some creative sparks for research. If it turns out that engineering is not right for you, you still will have important knowledge of it that can help you in other fields. This is an excellent program for additional math coursework and a stepping-stone to graduate work in math or science education. Alternatively, you may develop a pre-actuarial plan with technical courses in math, statistics, operations research, and engineering economics, and with social science courses in economics, business, and law.

It is important to emphasize that lower division math classes are very different from upper division classes. Upper division classes are more theoretical and have little emphasis on computation. For additional guidance, you may want to contact the mathematics department. The department office is located in 970 Evans. Also, the Mathematics Undergraduate Student Association (MUSA) can be very helpful. They may be contacted by e-mailing `musa@math.berkeley.edu`.

You can find many potential clusters of engineering courses that will give you some concentration. One way is to look at the courses required or recommended for other engineering majors and their various options. The College of Engineering Undergraduate Guide (`coe.berkeley.edu/guide`) is a good source to look at classes required for other majors. Of all the engineering departments, the Industrial Engineering and Operations Research (IEOR) department is closest to EMS. Look at the IEOR 160 series.

Your upper division math/stat classes require Math 128A (a class in numerical analysis for which prior exposure to a high level programming language is recommended), Math 110 (linear algebra, a course very similar to Math 54), Stat 134 or IEOR 172, 3 electives in math or statistics from an approved list, and, most importantly, one of the following two-course sequences:

1. Math 104, Introduction to Analysis, and Math 105, Second Course in Analysis.
2. Math 104 and Math 185, Introduction to Complex Analysis.

Note that Math 104 is a rite of passage where you basically prove calculus. However, be aware that it is NOT an easy course. To quote the Math Department's Undergraduate Announcement, "students are advised that this [Math 104] is a very difficult course, and is best taken following another upper division mathematics course." Typically, Math 110 and Math 128A are considered to be easier upper division courses.

Broadly speaking, Math 105 covers further topics in analysis and gives an introduction to the beautiful subject of integration theory, which is taught in the introductory graduate

analysis course. On the other hand, in Math 185 you will see the application of analysis techniques to functions of complex variables. Complex analysis finds many engineering applications, ranging from signal processing to fluid mechanics and quantum mechanics. If you are interested in these applications, you should take Math 185. If you plan on pursuing graduate studies in mathematics, you should take both!

If you are more interested in applied mathematics more than pure math, then the math electives that may be of interest are:

- 123 Ordinary Differential Equations
- 126 Partial Differential Equations
- 128B 2nd Course in Numerical Analysis (may not count as an upper-division technical elective)
- 170 Mathematical Methods for Optimization

The four basic core courses for the math major in L&S are Math 104, 185, 110, and 113 (Abstract Algebra). Thus, if you are really interested in math, you should choose 113 as an elective. L&S math majors also need to take one course from each of two of the following subject areas: Computing (which you automatically satisfy because of Math 128A); Geometry (Math 140, 141, 142); Logic and Foundations (Math 125A, 135). These courses are possibilities for the three-course elective. If you are interested in statistics, then you should consider completing the full Stat 134-135 sequence to have a more complete background in Probability (Stat 134) and Statistics (Stat 135), even though there are statistics courses satisfying the elective requirement which require only 134. Just for reference, L&S statistics majors are recommended to take Math 104, 105, 113, 126, 128A, and 185. If you can, give the honors sections a try when you take Math 104, 185, 110, and 113, especially 104. These are rigorous and difficult sections, but they are worth the work if you really love and appreciate the beauty of mathematics.

Although it is not required, you may want to take Math 55 (or CS 70) on discrete mathematics. This class introduces proof methods and techniques, and it helps you adjust to upper division math classes, which tend to be far more theoretical than lower division classes. Discrete mathematics also places a lot of emphasis on structures (such as sets, graphs, relations) and less on computation, so it exposes students to sides of math they haven't seen before. You get a chance to write clear, concise proofs, and get a "flavor" of upper division mathematics. (This counts as a lower-division elective!)

Within computer science, the 150 series are computer architecture courses; the 160 series, software; the 170 series, computer theory; and the 180 series, computer applications. Also, check out the 120 series in the Electrical Engineering department, which includes signal processing, communication, and random processes, which are all subjects which go hand in hand with the mathematical background and engineering focus of the major.

The requirement for a computer science minor is CS 61ABC, CS 70, and three upper division courses in computer science. Unfortunately, only one upper division CS course can

overlap for the CS minor, but at least you can have the equivalent of a CS minor, which is still something for the resume. Another feasible minor is chemical engineering provided completion of either the Chem 1 or Chem 4 series.

If you are interested in the physics side of applied mathematics, you may also want to consider concentrating on physics courses such as fluid dynamics or quantum mechanics. Of course, talk with your faculty adviser when planning your technical electives. Also consider talking to some of your Engineering Science neighbors over in Engineering Physics.

Because any two EMS students can potentially have drastically different programs, it is very important that you glean as much as you can out of your faculty adviser and talk to people in the many fields in which you are interested. Ask your faculty adviser and your professors for people that can give you more information. If they refer you to another professor, do not be afraid to go to their office hours even though you are not in their class.

Engineering Physics

"Scientists investigate that which already is; Engineers create that which has never been" - Albert Einstein. Umm, why not do both!?

As an Engineering Physics (EP) major, you can pick from a range of foci – an engineering mindset with a strong understanding of physics. You might be interested in semiconductors, but you will probably know more solid-state physics than most electrical engineers. You might be interested in building machines, but you will probably know more advanced methods in mechanics than most mechanical engineers. Engineering Physics starts you off with more of a first-principles approach! If you're curious about the foundations of technology, these extra physics classes help quench that thirst.

Chief among the attractions of Engineering Physics is the ability to take diverse classes. Go wild! Still, it helps to emphasize a particular area of study. Choose your curriculum according to your interests.

Lower Division: Many students use the AP credits to pass out of Math 1A/1B. Once you finished Math 1A/1B/53, you can choose between Math 54 and Physics 89. Both courses teach you the skills needed for upper-division courses, but Physics 89 is more physics-oriented because the applications to physics are emphasized. Math 54 is more general and gives you a better mathematical intuition of linear algebra and differential equations. For chemistry, many students use the AP credits to pass out, but if you are particularly interested in chemistry or chemical engineering, consider taking Chem 4A even you already got credit for Chem 1A. This class is required for students in the College of Chemistry and gives you are more solid understanding of chemistry principles.

For the programming requirement, if you want to gain general coding experience, we would recommend CS 61A. In this class, you will learn Python, Scheme, and develop good coding practices. If you want to gain coding experience for engineering, we would recommend Engineering 7. This class is required for most engineering majors such as Mechanical Engineering, and you will learn MATLAB with high-performance numerical computation and visualization. The last option is Physics 77. This class is designed for Physics students in L&S who want to gain some relative coding experiences; it is less challenging than CS 61A and Engineering 7. But if you decide to take Physics 77, we would recommend you also to take Physics 88, a 2-unit useful class that teaches you data science with applications to physics.

For the lower division electives, you need to take three courses from the list: Astro 7A, Astro 7B, Chem 1B or Chem 4B, Chem 3A/3AL, CS 70, MSE 45 (45L are recommended), EE 16A, EE16B, Bio 1A/1AL, Bio 1B.

Here are some of the path students took according to their interests:

- Astrophysics: Astro 7A + Astro 7B + One Lower-division technical elective

- Biology: Bio 1A + Bio 1B + One Lower-division technical elective
- Chemistry: Chem 4B, Chem 3A/3AL + One Lower-division technical elective
- Electrical Engineering: EE 16A, EE 16B, CS 70
- Mechanical Engineering: ME C85, EE 16A, EE 16B
- Material Engineering: MSE 45/45L, EE 16A, EE 16B

Many of the courses listed above are important prerequisites for upper division classes, and some are only offered in either fall or spring. Check the Berkeley Academic guide and be sure to plan ahead!

For Physics requirements, we strongly encourage taking the Physics 5 series. The Physics 5 series is designed for Physics majors, and the added rigor and challenge will help you adjust to upper-division physics and mathematics courses more quickly. Most Physics majors take the 5 series, so that is where you can meet the students that will be in your upper-division physics classes. The specialized lab courses for Physics 5 series help you to build a stronger understanding of the experimental side of physics, which will help you to succeed in the upper-division lab classes. On the other hand, Physics 7 series is less challenging, so if you have a heavy course plan, Physics 7 series can also be a good option.

Upper Division: You will notice that your upper division requirements allow you to choose either an engineering course or the equivalent physics course for a broad range of subjects. If your goal is physics graduate school, it is recommended that you take Physics 105 (Mechanics), 112 (Thermodynamics), 137A/B (Quantum Mechanics), and 110A/B (Electrodynamics) in order to be prepared for graduate studies. This isn't a strict requirement, but all of these topics are incredibly important for the Physics GRE, a test that's critical for grad school applications. On the other hand, if your goal is to enter a specific industry (say, for instance, robotics), then choose engineering courses related to your future career path. Or, you can take both!

For the lab courses, Physics 111A is most useful for basic engineering and physics research – it equips you to understand experimental technique and instrumentation, which is ubiquitous. Physics professors highly value this course on your resume if you are pursuing undergraduate research. EE 143 is also very useful (and is recommended by Professor Attwood), especially if you are interested in semiconductors and fabrication techniques. The specific skills developed in this class can make you highly desirable to employers in these fields, as well as open up opportunities for research in the electrical engineering department. NE 104 is designed for students who are interested in nuclear radiation and helps students build a stronger understanding of the application of atomic physics. All of these classes can help you to be a great undergraduate researcher, so don't hesitate to take them earlier on if you think it might interest you.

For math, you have a choice between the 121 series and 104/185. In general, students are split on which ones to take. We'll try and distill the pros and cons here. The 104/185 sequence can be difficult and time-consuming; however, they more adequately prepare

you for graduate school in theoretical physics. Many students appreciate the logical clarity of Math 104 and that it demystifies "rigorous" math. Math 185 (Complex Analysis) provides you a strong mathematical background, teaching theorems that underpin many core principles of quantum mechanics, E&M, and signal processing. This is a difficult class, but it will pay off if you intend to go more into theory. If you want to know how to apply advanced math in engineering and physics, that is where the 121 series comes in. It prepares you for math you will see in upper-division physics courses (special functions, solving different differential equations, and Fourier series). The 121 series is about as time-consuming as 104/185, but sacrifices some curricular cohesion to avoid excessive rigor. The 121 series is sometimes described as a jumbled math toolbox, whereas 104/185 is sometimes attributed as a series where you struggle to prove obvious facts like y = x has a slope of 1. If you are struggling to decide, ask your friends that have already taken them! Engineering physics majors tend to have strong opinions on this topic.

Generally, the engineering courses tend to hone your numerical-spatial problem-solving skills, while physics courses will demand critical thinking with more equations and almost no numbers. Here are some key notes for upper-division classes:

- ME 104 and ME 106 have MEC85 and Engineering 7 as prerequisites.
- EE 117 and EE 118 have EE 16A and EE16B as prerequisites.
- Physics 141A has Physics 137A/B as prerequisites.
- Engineering 40 counts as an upper-division class for the thermodynamics requirement.
- NE 104 has NE 101 as a prerequisite.
- Students planning to pursue graduate school in physics are advised to complete Physics 111B (for 3 units) to satisfy the laboratory requirement.
- The 15 units of upper division engineering and 14 units of upper-division physics include the ones directly listed as requirements. Essentially this means you have to balance your physics and engineering workloads.
- At least 40 units of approved upper division technical subjects (mathematics, statistics, science, and engineering). These 40 units DO include all required upper division technical course work taken for the major.

Have questions or need help for classes? Ask the major representative from SES or the faculty advisor! Remember to consult with your faculty adviser often, and talk about potential plans for future semesters. Your advisers are on your side – make sure to take advantage of the guidance they can provide!

Environmental Engineering Science

Introduction: The Environmental Engineering Science (EES) major is a rigorous interdisciplinary program pairing engineering fundamentals with courses in the environmental and natural sciences. Although environmental engineering options may be found in the chemical, civil, mechanical, and material science engineering departments, the EES curriculum provides a broader foundation in the sciences. At the same time, it allows students to focus their study on environmental issues more than any other program option in the College of Engineering. As a student in this program, you will have many chances to direct your own curriculum. Thus, it is important that you plan ahead and research course prerequisites, units, and availability.

EES vs. CEE with Environmental Emphasis: Many lower division students with a strong interest in environmental engineering have trouble choosing between the EES track and the Civil Engineering with an environmental emphasis.

- For starters, your diploma will say B.S. Environmental Engineering Science or B.S. Civil and Environmental Engineering, depending on your decision.
- Civil Engineering requires a few more courses not environmental in nature (to be expected), including Civil Engineering Materials (CE 60), Mechanics of Structures (CE 130), and Engineering Data Analysis (CE 93). A Civil Engineering student is also required to take both a design elective as well as four core courses, not all of which are related to environmental engineering.
- In contrast, the EES program requires more breadth and applications to the earth sciences, architecture, or chemistry (depending on your choices; see Advanced Science Sequence section). For example, EPS 108 (Field Geology; includes field trips every week), EPS 50 (The Planet Earth), and Architecture 140 (Energy and the Environment) will count toward your major. Thermodynamics, hydrology, math, stats, and computing are also required in EES.
- Both majors require a number of upper division technical electives (EES with 12 units, CE with 15 units).
  - CE requires that these electives exist within the College of Engineering or Chemical Engineering, while EES electives may encompass technical courses in or out of engineering.
  - CE electives may be any combination of classes (so long as they are engineering-related), while EES has what are known as Clusters. There are five Cluster categories (Air Pollution and Climate Change, Biotechnology, Ecosystems and Ecological Engineering, Environmental Fluid Mechanics, Geoengineering, and Water Quality), each representing a unique aspect of environmental engineering. You can choose courses from any of the cluster categories to fulfill the required 12 units. Look out for classes with prerequisites (e.g., in Electrical Engineering, Mechanical Engineering, MCB) not often taken by EES students.

- Unlike the Civil Engineering major, the EES program does not yield an ABET-accredited engineering degree. However, the flexibility of the EES program allows each student to specialize in what they are most interested in, while a Civil Engineering degree covers the breadth of civil engineering practice with some emphasis on environmental engineering.
- Visit the Engineering Guide for the full requirements:
  - `engineering.berkeley.edu/academics/undergraduate-guide`

Lower Division Basic Science Electives: One key decision occurs during your sophomore year when you can choose three basic science electives from this list: Physics 7C, Bio 1A/1AL, 1B, Chem 1B, 3A, 3B, and EPS 50. Those who have taken AP, IB, or A-Level exams in Biology should check to see if they can pass out of Bio 1A/1AL and Bio 1B (link at `admission.universityofcalifornia.edu/counselors/exam-credit`). For those possibly considering grad school, many programs, such as in the earth sciences, recommend or require one full year of chemistry, so Chem 1B may be a wise choice. The Chemistry 3 series is relevant to many aspects of environmental engineering, such as toxicology, biofuels, and soil chemistry. EPS 50 is helpful for Geoengineering. Those more physics-minded (for example, those interested in the Atmospheric Science Advanced Science Sequence) might find Physics 7C useful.

Clusters: Build cluster/sequences carefully. Make sure you have the necessary knowledge to get the job you want. Explore different possibilities. Remember that you can't knock out series and cluster course requirements with one class. Not all classes are offered every semester! Also, there are many classes not listed in the requirements that you can get approved into a cluster or sequence! Consult your faculty adviser for more information.

Advanced Science Sequence: In accordance with the program's goal of a broad science background, students are required to take at least 8 units from any of the following sequences: Atmospheric/Climate Science, Biochemistry/Microbiology, Ecosystems/Soils, Geology/Geodynamics, Organic Chemistry, or Physical Chemistry. For more information, consult the EES requirements.

Fluid Mechanics Elective: CE 100 is the most commonly taken fluid mechanics course by EES students. Unlike ME 106 and ChemE 150A (the other two options), CE 100 discusses open channel flow applicable to streams and rivers, an important aspect of environmental engineering. In addition, those considering the other two classes should look up and consider the respective prerequisites.

Thermodynamics Elective: ME 40 is the standard and likely the easiest option. Those with an eye toward chemistry should certainly consider ChemE 141 and E 115, the other two choices. Note that the Civil Engineering graduate program likes to see E 115 completed (since it is upper division).

Hydrology Elective: CE 103 covers the hydrological cycle, floods, runoff analysis, and watershed modeling, while CE 115 involves a significant amount of chemistry and covers

topics such as pH, alkalinity, acid/base speciation, metal chemistry in aqueous systems, and redox chemistry.

Upper Division Math/Stats/Computing Elective: Lastly, you will be required to select an advanced mathematics course in your junior year. Perhaps the most practical are the two statistics options. In particular, Stat 133 (Computational Statistics) is very practical and teaches R (a programming language), but the class is in high demand. Some, including Math 128A and E 177, emphasize programming (using MATLAB). Others are pure math classes, including Math 104, 110, 126, and 185. Students are advised to read further on individual class descriptions to determine which is best for them.

Other Recommendations: Many EES students highly recommend Professor Nazaroff's CE 111 (Environmental Engineering) and CE 107 (Climate Change Mitigation). Taking a class that has a big semester project (group or individual) can be a great experience (and really boost your rsum). Try classes outside your major or go for a minor (or double major)!

Minors and Double Majors: It can be fairly easy to minor in a related field or double major. In particular, look at Architecture, Earth & Planetary Science (EPS), Forestry, Molecular Environmental Biology (MEB), Sustainable Environmental Design (SED), and the College of Environmental Design (CED). You might find a graduate program is right for you in an outside department! For example, some EES graduates are completing a master's program in EPS.

Last Words: Talk to professors, but don't limit yourself to talking to professors just in the major. There are people in Architecture, EPS, Forestry, MEB, and Sustainable Design EVERYWHERE that can have interests similar to you and have opportunities for you. The Engineering Student Services (ESS) and departmental advisers are really friendly and accessible. Be sure to consult frequently with your faculty adviser, departmental adviser, AND the ESS office in 230 Bechtel for detailed information about courses/degree requirements.

Academic Resources

Center for Achieving Engineering Excellence: Counseling, tutoring, and workshops in math and science for College of Engineering students.
227 Bechtel Engineering Center, coe.berkeley.edu/caee

Counseling: We have a staff psychologist with office hours in Bechtel. If you feel like you're under a lot of stress or would like to talk in a confidential setting, contact Christine Zhou of University Health Services (UHS) at christinez@uhs.berkeley.edu or (510) 643-7850.

Eta Kappa Nu: Peer tutoring by EECS honors society students in lower division engineering prerequisites and upper division EECS classes. 290 Cory Hall 10 AM – 4 PM during the week.
hkn.eecs.berkeley.edu/tutor

Student Learning Center: Tutoring in first year math, science, composition, and social science. Also provides study skills workshops.
140 Cesar Chavez Center, slc.berkeley.edu

Tau Beta Pi (TBP): Test bank, course surveys/syllabi, mock interview opportunities, and a general helpdesk.
tbp.berkeley.edu/student-resources

Society of Engineering Sciences (SES): We have a Google Drive folder with various notes, textbooks, and academic resources. In addition, older members are valuable resources to help you decide on courses, get tips on various classes/professors, and learn about career/postgraduate opportunities.

In addition to the above resources, tutoring and academic assistance is available at all of the Residence Halls at the Academic Services Center.

Computing & Scheduling Resources

Internet access and email are integral to your educational experience. Most courses have web sites for class information, and professors often use email to communicate with their students. It is highly recommended that you obtain your own computer. But if this is not possible, don't worry, there are plenty of options.

On campus, there are several facilities (including libraries) with computers and printers that are available free of charge. Some libraries (including Moffitt) have computers for short-term checkout. If you are enrolled in an EECS class, you will also have access to the Cory and Soda workstations, including 200 pages of free printing per semester.

Open Computing Facility (OCF) accounts are available to all students free of charge. The lab (located in the MLK student union) offers a limited amount of free printing, web hosting, and other services. See more at `ocf.berkeley.edu`. (Fun fact: OCF hosts our website.)

Software can be downloaded from `software.berkeley.edu` for academic and personal use. This includes Adobe Creative Cloud Suite (including Illustrator and Photoshop), Microsoft Office 365 (including Word 2016), Windows 10, Mathematica, and MATLAB. If you're working with data, be sure to check out computing tools at the Berkeley Institute for Data Science (`bids.berkeley.edu`) and the D-Lab (`dlab.berkeley.edu`).

Scheduling is always a nightmare, but there are important resources to help you out. Most important are CalCentral (`calcentral.berkeley.edu`), which assists you with all of your scheduling needs; and NinjaCourses (`ninjacourses.com`), which has course ratings submitted by other students so you can easily compare professors from the student perspective. UC Berkeley stopped updating this site, but the reviews of professors are still helpful. Some people also use (`ratemyprofessors.com`) to find opinions on classes and lecturers, but be careful, since most people who post on that site are heavily biased either for or against the professors. `classes.berkeley.edu` is also a good resource that can help with scheduling. An unofficial but very useful site that tracks enrollment numbers and waitlist statistics is `berkeleytime.com` Remember that you can always talk to your peers (including SES members), your ESS Adviser, your Departmental Adviser, or your Faculty Adviser for in-depth information about courses, research, internships, and other academic planning.

Other Resources

College of Engineering

- Changing College: coe.berkeley.edu/coc
- Changing Major: engineering.berkeley.edu/academics/majors-minors/change-major
- Degree Requirements: engineering.berkeley.edu/student-services/degree-requirements
- Humanities Requirements: coe.berkeley.edu/hss

Decals (Student-Taught Classes): www.decal.org

Engineering Guide: engineering.berkeley.edu/academics/undergraduate-guide

Engineering Organizations and Competition Teams: engineering.berkeley.edu/student-life/teams-and-organizations

Freshman and Sophomore Seminars: Get a unique, small-group class experience with a faculty and other new students. fss.berkeley.edu

Rose Hills Research Funding for Undergraduates: surf.berkeley.edu

Study Abroad: studyabroad.berkeley.edu

Undergraduate Conference Travel Grant Info: iis.berkeley.edu/content/undergraduate-conference-travel-grant

Your Berkeley Portal: calcentral.berkeley.edu

Tip: Use Facebook with your @berkeley.edu address and you'll find Facebook groups for Berkeley organizations and majors. Join a few FB groups and pages related to your major and interests (e.g. Mechanical Engineering, BERC, Applied Mathematics, Computer Science) to stay updated and ask other questions! **We're at fb.com/berkeleyses and fb.com/groups/berkeleyses**.

Advising

When seeking answers to questions regarding courses or your degree, here is a list of some important resources. For more information, see coe.berkeley.edu/advising.

ESS (Engineering Student Services) Advising

Your ESS Adviser is located in 230 Bechtel (Engineering Student Services office) and is available via appointment or drop-in advising. Have a quick question? Drop-in advising is on Wednesday from 9 AM – 11:30 AM and 1 PM – 3:30 PM. For a specific time allotted exclusively to you, you are strongly encouraged to make an appointment with your ESS Adviser. Appointments are 20 minutes and you must chek-in within 5 minutes of your appointment time to avoid having to reschedule. Appointments are not on Berkeley Time ("Berkeley Time: = 10 minutes after the official start time) – they start at the appointed time. To schedule an appointment with your adviser, go to: engineering.berkeley.edu/student-services.

Your ESS adviser will suggest a reasonable curriculum for you to follow while Cal. This is the adviser you will want to talk to concerning requirements for your major. They also answer such questions regarding Humanities/Social Sciences (HSS) requirements, changing of majors, transfer/AP/IB credit, and engineering-related paperwork. If you are unsure of your major (or if you would like to add a major), ESS advisers are the ones to meet with.

For further questions, feel free to call or email Engineering Student Services, (510) 642-7594, or email your ESS Adviser directly. Your assigned ESS Adviser is listed by major:

Engineering Math and Statistics (EMS), Energy Engineering (EnE) and Environmental Engineering Science (ESS) Olivia Chan (oychan@berkeley.edu).

Engineering Physics (EP): Bryan Jones (bkjones@berkeley.edu).

Engineering Undeclared (EU) Joey Wong (joeywong@berkeley.edu).

Departmental Advising

Engineering Science's departmental advisers answer registration questions, describe courses, interpret departmental policy, and make referrals to resources on campus. They are incredible people to get to know and work with. They are dedicated to supporting you both as an Engineering Science student and as a human.

All students should see Felicia Bautista for departmental advising. Her office is in 750

Davis Hall and she has drop-in advising during: Mondays, Tuesday, Thursdays, and Fridays from 9 AM - Noon and 1 - 4 PM. All other times are by appointment only.

Faculty Advising

In addition to your ESS Adviser, every Engineering Science student is assigned to one member of the faculty in their given field of study. The Engineering Science Department assigns your faculty adviser, and you will be notified of the name of your adviser shortly after your arrival at UC Berkeley. If you develop a good relationship with your faculty adviser, they can be an invaluable resource, providing insightful, experience-based knowledge to help guide you through your years at Cal. This is the adviser you approach with specific questions regarding courses and instructors. They have a better understanding of which courses are best and most pertinent to your studies and can also provide detailed descriptions of classes. They will also approve your schedule when enrollment begins (at our Pizza with Professors event every semester) and make sure that you are meeting all of your academic requirements while maintaining good academic standing in your department.

In addition, your faculty adviser can be a friend in your department who can recommend you for research and job opportunities, as well as serving as a good source of reference for graduate school. Your faculty adviser is usually available during his or her office hours, and sometimes by appointment.

Energy Engineering

Ana Claudia Arias/508 Cory Hall/`acarias@eecs.berkeley.edu`

Scott Moura/625 Davis Hall/`smoura@berkeley.edu`

Tarek Zohdi/6117 Etcheverry Hall/`zohdi@me.berkeley.edu`

Alexandra von Meier/406E Cory Hall/`vonmeier@berkeley.edu`

Engineering Math and Statistics

Ilan Adler/4183 Etcheverry Hall/`adler@ieor.berkeley.edu`

James Casey/6125 Etcheverry Hall/`jcasey@me.berkeley.edu`

Engineering Physics

David Attwood/567 Cory Hall/`attwood@eecs.berkeley.edu`

Junqiao Wu/322 Hearst Memorial Mining Building/wuj@berkeley.edu

Environmental Engineering Science

Kara Nelson/663 Davis Hall/karanelson@berkeley.edu

Other Advising

The College of Engineering runs a **Peer Adviser** program to assist ESS advising. The advisers are engineering upperclassmen and can help you find the right forms, answer quick questions, or chat about life. They are located in 230 Bechtel. More information at this link:

engineering.berkeley.edu/student-services/advising/peer-advising

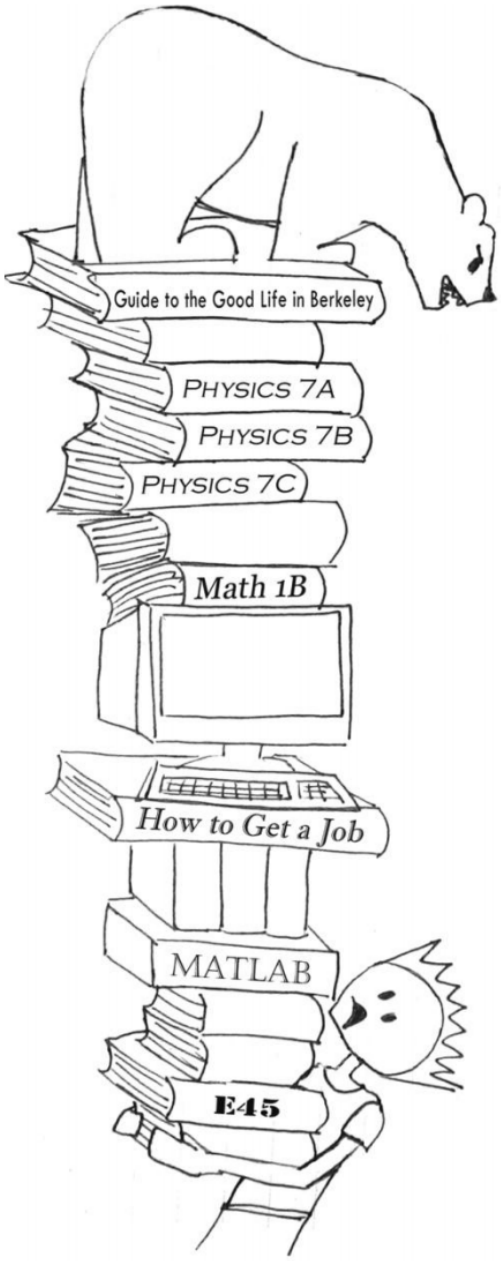
The **Center for Access to Engineering Excellence (CAEE)** in 227 Bechtel Hall has two professional staff advisers and a learning support specialist available for all engineering undergraduates. There are new student programs, tutoring for introductory classes, and workshops throughout the school year. More information at this link:

bit.ly/2boCY3j

Often, the most reliable information and opinions come from your peers. We encourage you to **get involved in clubs** like SES so that you can network with upperclassmen and seek their advice. Additionally, clubs are generally a great source of academic resources, including academic advising sessions and peer-counseling.

If you have questions for your Engineering Science peers, we have a Piazza page! Piazza is a platform many college classes use to allow peers and instructors to ask, answer, and discuss questions. Create a Piazza account (with your Berkeley email) and enroll using the following link: piazza.com/berkeley/other/engsci101

Engineering 98



Engineering 98 is brought to you by

E98 Surviving Berkeley Engineering and Tau Beta Pi The Engineering Honor Society

Got questions?

What classes should I take, and with which professors?
How do I get a summer internship?
How can I study more effectively?
What's the right major for me?
Is it possible to have a life AND be an engineer?
What are some good places to eat around here?
How do I succeed as an engineer at Berkeley?

E 98 has answers.

Engineering 98 is a student-run class, designed specifically for new engineers by those who have been through it all.

This 1-unit P/NP DeCal covers:

- Study strategies and academic resources
- Interview tips and résumé development
- Tele-BEARS, professor, and course advice
- Internship and research information
- Student life and the best places to eat!

For more information:
visit: http://e98.berkeley.edu
e-mail: e98coords@gmail.com

Engineering 98/198: Spring Edition

On top of the E98 course offered in the Fall to help students get oriented, the Engineering Science (ES) department offers a seminar course in the Spring that can be very valuable to ES students unsure about how to navigate Berkeley's world of research.

ENGIN 98/198 is a seminar series in which you will learn about the research that's taking place right here at Cal by engineering faculty. Guest speakers will discuss their current research and how you can develop your interests into opportunities. Professor Arias, a faculty advisor for the Engineering Science department, is the organizer for this course, and she makes sure to pull speakers from a broad range of fields. This course is offered Pass/No Pass for 1 credit. 90% attendance is required for a Pass, but there are no other requirements. Engineering Science students have found it very helpful for learning about all of the different fields where our skills can be applied.

Lunch will be provided.

Keep an eye out for it when you sign up for classes in the Spring!

Graduate School

How to Find a School

Start by meeting with your professor and/or faculty adviser during office hours to talk about suitable schools and graduate programs aligned with your interests. Ask your professors or faculty adviser about which programs have good reputations in your particular field. If you are interested in research, you should also browse the lab pages associated with different university labs – every school has its own specialty!

Many programs in the sciences (e.g. Physics, Chemistry, Biology) typically want Ph.D. students, while engineering programs tend to offer more MS degrees. If you are not sure whether you would want to pursue research, you should actively look for research internships in the summers leading up to your senior year! Amassing experience in different labs and work situations is a great way to build a convincing application and to meet professors who would be willing to write you a letter of recommendation!

During the summer before your senior year, compile a list of schools (and for Ph.D's, a list of professors at each school whose work you are interested in). Email the graduate schools for information about the application process and email professors letting them know you are interested in their school. If you plan to enter graduate school in the fall, application deadlines usually range from December to February.

Letters of Recommendation

Most graduate school applications require at least three letters of recommendation. Students usually get letters of recommendations from professors, graduate students, or employers. Graduate schools are not only looking at your academic ability, but also at your ability to interact and work with other people. If you have worked for any professors or have had an internship in industry, make sure you ask your professor or supervisor to write you a letter of recommendation. As much as possible, you want your professor to be able to list *specific* details about you, your performance, and why they think you are a good student – so make sure to keep your advisor and employers updated about what you do!

Graduate Record Examinations (GRE)

The GRE is a standardized test, the scores of which are accepted by most graduate schools across the US and also in many other countries as one of the criteria for consideration for admissions to graduate programs. Among the graduate programs that accept your scores in the GRE, engineering programs are the most lucrative. A combination of high scores

in GRE, engineering degrees, and lots of hard work is the key to a successful career in the field of engineering!

Although most graduate schools have worked out various criteria for selecting the applicants who can be granted admissions, your performance in the GRE is one criterion that will be considered by most graduate schools. The weight given to your GRE scores may vary from school to school, but it is a well-known fact that competitive or good GRE scores will definitely tilt the scales in your favor if you are being compared with other applicants. It's not necessarily true the great GRE scores guarantee admission to a great graduate school, but doing poorly can significantly hurt your chances. While considering your scores in GRE, engineering colleges or graduate schools offering majors in engineering pay more emphasis on your Quantitative Reasoning score, which is the math score. Although your scores in the other two GRE sections are also important, you should aim for scoring very high in the Quantitative Reasoning test section of the GRE if you wish to graduate with a major in engineering subjects.

Career & Internships

How to Get a Research Job

If you are interested in doing research within an engineering science group, you should talk to faculty advisers and talk to the professors directly. If you would like to work in another department, such as Mechanical Engineering, EECS, Molecular Cell Biology, or Chemical Engineering, browse the department website's list of professors and what they are currently working on. From this list you can email a professor to make an appointment. Many professors do not respond unless it's clear that you are interested in their research specifically, so make those details clear in your email.

Prepare yourself when meeting the professor. Look professional and act interested. Ask questions to demonstrate that you have some knowledge of the professor's research. Have a résumé and a copy of your transcript ready. Consider beforehand whether or not you want to be paid (very often lab budgets don't initially allow for this) and how much time you want to put in. If the first interview doesn't work out, don't be discouraged. Just try again! The most important part of the process is starting. Once you start and get some contacts, eventually you will get a research job.

If emailing professors isn't working out, try emailing their grad students or post-docs. The response rate is generally higher because graduate students have more time to meet with people. If you end up working in the lab, you will primarily interact with graduate students, so they're naturally more invested in you. Also, try looking at URO (Undergraduate Research Opportunities Program) through the College of Engineering or URAP (Undergraduate Research Apprenticeship Program) through the College of Letters and Sciences.

If You're Not Going to Graduate School

The majors in Engineering Science are geared towards graduate studies. Thus, most of the curriculum focuses on the theoretical aspects of the various disciplines, leaving out some of the more practical engineering courses. This may put you at a disadvantage when competing for an industrial position against a mechanical or chemical engineer, who has a stronger practical-industrial background. On the other hand, holders of a Ph.D. degree usually take research and development positions. Nevertheless, there is no reason to despair. If your purpose and desire is to get a position in industry (and start earning good money in the process) with just a bachelor's degree, then these humble pointers might be of some help:

1. Decide your field; try to take as many related engineering courses as possible. This might seem painful to do since this may imply giving up your "easy" electives for

some "hardcore" engineering ones, but the payoff will be landing a good job once your weaknesses have become your strengths.

2. Get an engineering-related job before graduating. This is a must since this is what employers look for when they hire someone. Anything will work, i.e., part-time, full-time, paid, or volunteer.

3. Remember that experience is what counts. For job listings and references, go to the Career Center located at 2440 Bancroft Way. If it is too hard for you to work during the semester, try to get a summer job or take a semester off and get a CO-OP. Taking a CO-OP or an internship is the best way to get a permanent job.

   Always have your résumé ready. This is crucial. The handbook available at the Career Center has very valuable résumé advice and examples. You may even want to enroll in one of the many résumé-writing classes offered on campus.

4. Apply for internships! An internship is an effective way to connect your academic experience with the professional work arena. It allows you to gain valuable exposure to the workplace, provides the opportunity for skill development, and gives you a competitive edge in the job search.

Engineering Science programs are not ABET accredited, so consider taking the Fundamentals of Engineering (FE) exam before graduation!

Getting Started

Visit `career.berkeley.edu/Internships/Internships.stm`.

- Internship Listings
- Frequently Asked Questions
- Meet with a Counselor
- Externships – Short term "job shadowing" opportunities
- Campus Opportunities – Campus-affiliated internships and experiential opportunities

Libraries & Department Offices

Bioscience and Natural Resources Library (2101 VLSB)	(510) 642-2531
Chemistry Library (100 Hildebrand Hall)	(510) 642-3753
Kresge Engineering Library (110 Bechtel)	(510) 642-3339
Main Stacks, Doe	(510) 643-4331
Math/Stat Library (100 Evans Hall)	(510) 642-3381
Physics/Astronomy Library (351 Le Conte Hall)	(510) 642-3122

College of Engineering, Dean's Office
320 McLaughlin Hall
(510) 642-5771

Engineering Student Services
230 Bechtel Engineering Center
(510) 642-7594
ess@coe.berkeley.edu

Society of Engineering Sciences

The professional and social club of Engineering Science – meet others in your major!

Mission Statement

The Society of Engineering Sciences is dedicated to enhancing the lives of students within the Engineering Science department at University of California, Berkeley. The Society provides a node for Engineering Science majors to meet, interact with professors and faculty advisers, find research opportunities, and explore common goals. We support the diverse interests and needs related to the interdiscipline of Engineering Science and its scholars.

Founded in 1980, the Society of Engineering Sciences is comprised of students with interests in Energy Engineering, Engineering Math and Statistics, Engineering Physics, and Environmental Engineering Science. The primary purpose of this society is to give representation to and advance the interests of the Engineering Sciences. Additionally, SES seeks to provide resources, support, and activities to Engineering Undeclared students and to represent their interests in the college. Due to our multidisciplinary nature, all majors are welcome.

SES provides the opportunity for interaction of students with common interests. While SES represents a huge diversity of fields, it also serves to unite a group of largely interdisciplinary majors, which face unique goals and issues. Overall, SES is an extremely flexible and personal organization whose main goal is to continually adapt and serve the wide variety of member interests.

Anyone interested in becoming more involved is encouraged to contact one of the officers below. Please visit our website at ses.berkeley.edu. SES is an Engineering Student Council sponsored organization.

2019-2020 SES Officers

President	Anthony Vogliano
Vice President	T.G. Roberts
Secretary-Treasurer	Daniel Frise
Energy Engineering Representative	Brittany Wais
Engineering Mathematics & Statistics Representative	Eric Jankowski
Engineering Physics Representative	Difan Wen
Environmental Engineering Science Representative	Derek Morimoto