Society of
Engineering
Sciences

Unofficial Guide to Engineering Sciences

2009 – 2010

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, we understand the feelings of confusion and the overwhelming amount of information you may be experiencing as you enter your college experience. 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 the couple of years, you will be making some 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 Science* contains information concerning classes, majors, graduate schools, jobs, careers, and campus resources. We hope that this will become a first resource to you whenever you have any questions about the engineering program. This guide does not replace your faculty advisor, student affairs advisor, or any of your peer advisors. However, we hope that the booklet will help answer most of your questions about your new major. Perhaps it will help you formulate your own path here at Berkeley. Welcome to the Cal Engineering family! Good luck and GO BEARS!

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Society of Engineering Sciences

Founded in 1980, the Society of Engineering Sciences is comprised of students with interests in Computational Engineering Science, 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 any of the officers (pg 39). Please visit our website at http://www.coe.berkeley.edu/ses/. SES is an Engineers' Joint Council sponsored organization.

Advising Introduction

When seeking answers to questions regarding courses or your degree, here is a list of some important resources.

Student Affairs Advisor

Your student affairs advisor is located in 230 Bechtel and is available for advising Monday through Friday 9:00 a.m. – 12:00 p.m. and 1:00 p.m. – 3:30 p.m. Currently drop-in advising is available Wednesdays only. For a specific time allotted exclusively to you, you are strongly encouraged to make an appointment with your advisor, thereby avoiding any excess waiting during the drop-in period. It is a good idea to check your specific advisor's schedule by contacting the office since they sometimes change. http://coe.berkeley.edu/students/ current-undergraduates/ advising/student-affairs-advising.html

Your advisor will suggest a reasonable curriculum for you to follow at Cal. This is the advisor you want to talk to concerning requirements for your major. They also answer such questions regarding breadth requirements, changing of majors and transfer and AP credit or engineering-related paperwork.

For further questions, feel free to call the Student Affairs Office in the College of Engineering in 20 Bechtel. 642-7594

Faculty Advisor

In addition to a student affairs advisor, every engineering student is assigned to one member of the faculty in his/her given field of study. The Student Affairs Office assigns your faculty advisor, and you will be notified of the name of your advisor shortly after your arrival at UC Berkeley. If a good relationship is developed with your faculty advisor, he or she can be an invaluable resource, providing insightful, experience-based knowledge to help guide you through your years at Cal. This is the advisor 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 and make sure that you are meeting all of your academic requirements while maintaining good academic standing in your department.

In addition, your faculty advisor 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 advisor is usually available during his or her office hours, and sometimes by appointment.

Engineering Science Office

The Engineering Science Student Liaison, Ms. Patricia M. Berumen, is also available to meet with you to offer encouragement and support. In addition, she is the primary liaison between you and the faculty/Student Affairs office. The Engineering Science office is located in 230 Bechtel Engineering Center, and its hours are 8:00 a.m. – 12:00 p.m. and 1:00 p.m. – 5:00 p.m..

For further questions, feel free to e-mail Ms. Berumen (patbcoe@berkeley.edu) or to contact her by telephone (642 – 8790).

Other students

Often the most reliable information and opinions come from your peers. We encourage you to get involved in societies like SES so that you can meet many fellow engineers who have already experienced the curricula at Cal and who will be willing to answer your questions. Societies like SES hold advising and peer-counseling to provide as many resources to the student as possible.

230 Bechtel Engineering Center

We already talked about the advisors, but the Student Affairs office has numerous publications regarding your major and classes, such as the *College of Engineering Announcement, Undergraduate Information for Advisors and Students*, and the *Humanities and Social Science Requirement*. The advisors also have information on tutoring services and careers.

Engineering Student / Alumni Mentorship Program

This program pairs up current Berkeley students with alumni who have already established their career goals. It is a valuable service that allows students to sharpen their academic focus and begin career planning. For more information, go to:

http://alumni.berkeley.edu/Students/Mentorship/main.asp

Academic Resources

Student Learning Center – Tutoring in first year math, science, composition, and social science. Also provides study skills workshops. 140 Cesar Chavez Center. For further information see the web site. http://slc.berkeley.edu/

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. http://www-hkn.eecs.berkeley.edu/student/tutoring.shtml

Charles Tunstall Multicultural Engineering Program (MEP) – Counseling, tutoring, and workshops in math and science for minority students. 230 Bechtel Engineering Center, 642-7594

Workshops for Women in Engineering – Workshops in math, chemistry, and physics for freshmen and sophomore women. 312 McLaughlin Hall, 643-6443.

OCF (Open Computing Facility) – OCF accounts are available to all students free of charge. The lab computers are equipped with Windows 2000 and Office 2000; they are also loaded with UNIX for the more daring user. http://www.ocf.berkeley.edu

Society of Engineering Sciences (SES) – Copies of this guide, chance to meet other engineering science majors. 220 Bechtel, http://www.coe.berkeley.edu/ses/

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

E98: Surviving Berkeley Engineering

Engineering 98 is the freshman introductory class for Berkeley engineering students. Designed and taught entirely by senior engineering students, this course teaches you in one semester what would normally take you an entire college career to stumble upon. In addition to letting you in on the secret study locations or best humanities classes, this course will help you discover more about your major and career path. We strongly recommend you enroll in this class and gain valuable knowledge in a fun, sociable, and casual environment.

It helps students adjust academically, offering career planning advice, and encouraging students to find their niche here at Cal. E98 is student run and student taught class. It is approximately 10 weeks, P/NP, and one hour a week, so it's not too big a drain on your time. Activities include designing a four year plan, making a resume, finding out about research, and much more. You'll get to meet a great group of very enthusiastic and personable mentors who will help you adjust smoothly to Berkeley's College of Engineering. This course has received outstanding reviews from previous students.

For more information, visit:

e98.berkeley.edu
www.decal.org/e98

Engineering Math & Statistics

This major is a combination of math and engineering. Because of the breadth of this program, it is especially suited for those who plan to enter graduate school soon after obtaining the bachelors degree. If you are unsure of engineering but still love ***math*** and science, Engineering Math and 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 education and a stepping-stone to graduate work in math or science education. You may also develop a pre-actuarial curriculum with technical courses in math, statistics, operations research, and engineering economics and with social science course in economics, business and law. Your broad background could enable you to show your students numerous fields that rely on math, creating more interesting and challenging curricula. 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 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. In the College of Engineering Announcement 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 math and stat. 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 101 or 134, 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 (Integration), Second Course in Analysis.
2) Math 104 and 185, Introduction to Complex Analysis.

Note that Math 104 is a very highly recommended course where you basically prove calculus. However, be aware that Math 104 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."

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 Intro to Partial Differential Equations
128B 2nd course in Numerical Analysis
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 might want to 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 Math 134-135 sequence to have a more complete background in Probability (Math 134) and Statistics (Math 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 74, a transition to upper division mathematics. This class teaches you how to write clear concise proofs, and it helps you adjust to upper division math classes, which tend to be far more theoretical than lower division classes. You should consider taking Math 74 concurrently with Math 53 or 54.

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.

The requirement for a computer science minor is CS 61ABC, Math 55, and three upper division courses in computer science (not electrical engineering). Unfortunately, the CS minor is not conferred for upper division CS courses used to satisfy a major, 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. 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 advisor and talk to people in the many fields in which you are interested. Ask your faculty advisor 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 his/her office hours even though you are not in his/her class.

Engineering Physics

Chief among the attractions of Engineering Physics is the ability to take diverse classes. Go wild! But it helps to emphasize a particular area of study, whether it be the Physics side or the Engineering side. Choose your curriculum according to your interests. For example, if you are thinking about going to graduate school for Physics, taking a programming class might not be immediately relevant.

Read the fine print in the *General Catalog* and know what the prerequisites are for a class. That way, you can take your requirements before taking upper-division classes. Since some classes are offered in only the Fall or Spring semester, missing a prerequisite can become a hassle. Key survey classes that are important prerequisites for many interesting upper division classes are E36, E45, and EE40.

Some of the required classes have a list of recommended – but not strictly required – classes. Ask the professor if the prerequisite is actually necessary. Also, many students agree that unless you're going to emphasize math or chemistry, you will be best off if you use Advanced Placement credit for any math and chemistry classes you can. This should help guard against redundancy and give you more time for the really interesting and important upper division classes. It could also help make your semester unit loads more bearable. We strongly encourage taking the Physics 7 Honors sequence. The added rigor and challenge will help you adjust to upper-division Physics and Mathematics courses more easily.

Because you will have to make choices between engineering and physics courses, it might be helpful to have some student descriptions of classes in addition to the *General Catalog*. Remember the engineering courses tend to hone your numerical-spatial problem solving skills while physics courses will demand critical thinking with almost no numbers.

Remember to consult with your faculty advisor often, and inform your advisor about your plans for graduate studies.

Environmental Engineering Science

The environmental engineering science 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 engineering science 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. The department of civil engineering is a close competitor, offering an environmental emphasis. Many lower division students with a strong interest in environmental engineering have trouble choosing between the engineering science track and the civil engineering emphasis. The differences in the two programs are subtle, but numerous. During the freshman and sophomore years, civil engineering requires courses in engineering geology, civil engineering materials, and computer-aided design, none of which are required for the environmental engineering science curriculum. A civil engineering student is also required to take four core courses in their junior year, of which no more than two are related to environmental engineering. Finally the civil program requires a design elective, which is not included in the engineering science curriculum. On the other hand, environmental engineering science students must take a semester of general biology, a year of upper division math or statistics, and an upper division science sequence. Unlike the civil engineering emphasis, the engineering science program does not yield an accredited engineering degree. However, the flexibility of the engineering science 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.

As a student in this program, you will have many chances to direct your own curriculum. It is important that you plan ahead and find out which courses have prerequisites that must be satisfied prior to taking them. One key decision occurs during your sophomore year when you can choose two basic science electives from this list: Physics 7C, Biology 1A, Chemistry 3A, Chemistry 3B, and EPS 50. Physics 7C focuses on relativity, optics, and quantum theory, and provides little knowledge which you will find useful in future courses. Biology 1A should be taken if you are considering an ecology or microbiology cluster in your senior year. You may also find Chemistry 3B and 3A (Organic Chemistry). Chemistry 3 series is relevant to many aspects of environmental engineering and would probably be a good choice for one of your two courses in the sequence. EPS 50 is helpful for the Geotechnical Engineering cluster. These are all fun courses and most environmental engineers who have taken them enjoyed the experience. Your first taste of environmental engineering will be in the beginning of your junior year.

You will find yourself with even more choices in your junior year. Most environmental engineers choose CE100 as their fluid mechanics course. Unlike ME106 and ChemE150A (the other two options), CE100 discusses open channel flow applicable to streams and rivers, an important aspect of environmental engineering. Note that the course curriculum does not convey the fact that ME106 requires ME104, and ChemE 150A requires ChemE140. The choice between CE130 and ME104 is somewhat arbitrary, as you will probably not find yourself using the information learned in either of these classes in your future studies. CE130 focuses on stresses and internal forces in beams, whereas ME104 mirrors much of the material taught in Physics 7A. It does, however, go into much greater depth. For thermodynamics, ChemE141 and E115 are the choices most relevant to your studies. ME105, while interesting, focuses on thermodynamics in engines and power plants. ME105B with a biological focus on thermodynamics can be a good alternative. Lastly, you will be required to select an advanced mathematics sequence in your junior year. All of these math courses are potentially valuable depending on your interests. The 121 series covers material generally required of graduate engineering and upper division physics students and hence they are quite challenging. Perhaps of most interest is the statistics option. While Statistics 101 is highly theoretical, 102 teaches skills which are valuable to most environmental engineers. The most important influence you have in choosing your curriculum occurs during your senior year when you choose your cluster courses. The *College of Engineering Announcement* outlines the choices, but it is equally possible to create your own or mix courses in the suggested clusters.

With adequate planning, it is very easy to get a minor in chemical engineering. Simply choose ChemE140, and then take thermodynamics (141) and fluid mechanics (150A) through the

Chemical Engineering department. Finally, choose the “Process Engineering” cluster in your senior year and you will have completed the minor. For the minor to be awarded, you must submit a notification of completion to 420 Latimer Hall.

Chemistry minors require one year of organic chemistry, one year of physical chemistry, and two additional upper division chemistry courses. Taking Chemistry 3A, instead of 1B, and then Chemistry 3B as a lower division science elective can satisfy the organic chemistry requirement. Physical chemistry (Chem120A-120B) may be taken as your upper division science sequence. With these four classes out of the way, you will be two courses away from a minor in Chemistry. See the College of Chemistry or the *General Catalog* for more information.

NOTE: Be sure to consult frequently with your faculty advisor AND the Student Affairs Office in 308 McLaughlin for detailed information about courses/degree requirements.

Computational Engineering Science

(This is not the same as computer science!)

The availability of affordable and increasingly more powerful desktop computers has forever changed how complex engineering and science projects are executed. By combining analytical and computational modeling with experimental observations, real-world problems become tractable. The academic program is designed to foster interdisciplinary skills required for modeling, simulating and solving complex problems in science and engineering.

Students will first receive a broad base in natural sciences and in mathematical analysis and will subsequently apply this knowledge to modeling, simulation and visualization of a variety of complex systems. Students in the program will advance beyond the traditional analysis of simplified models, will attack computationally those problems that are analytically intractable, and will work on projects that may involve several disciplines.

The Program has four components:

1) Building a broad base in the sciences, with biology, chemistry and physics courses
2) Developing skills in analytical and computational modeling through theoretical and applied courses in mathematics and computer science.
3) Building depth with engineering or science minors or clusters.
4) Applying computational and analytical tools to engineering or applied science projects.

Industry, government and academia have increasing demands for graduates capable of solving complex interdisciplinary engineering and science problems. Graduates of the program will be well prepared for employment in engineering companies and national laboratories and will also be excellent candidates for graduate programs in engineering and applied science.

Student Comments on Classes

Lower Division

Chemistry 3 series: Organic Chemistry: Do your homework, even though you don't have to turn it in. If you want to, you can learn a lot in this class, even though it is not as thorough as the 112 series. You will be competing with pre-meds, but people will be nicer if you tell them you are in engineering and not in L&S. Take good notes and go to class, and you will come out with a good knowledge of organic chemistry that can be applied to many other classes, including MCB classes for BioE and Environmental Engineering Science majors.

Math (H)53: (Honors) Multivariable Calculus: This class is required for all engineers. It is an introduction to vector calculus and ideas of double and triple integrals. These ideas are directly related to topics in Physics 7B. The honors course is a good course; like 53, but more in depth and an emphasis on tougher problems.

Math (H)54: (Honors) Linear Algebra and Differential Equations: This math class is required for all engineers. It covers basic matrix manipulations, vectors, and differential equations. The books for this class are poorly written so it would help to go to lecture and section. The honors course is a good course; like 54, but more in depth and emphasis on tougher problems.

Math 55: Discrete Mathematics: The topics covered in this class include logic, mathematical induction sets, elementary number theory and statistics. Some find this class boring and it is not recommended unless required. CS 70 covers similar topics but is aimed at computer science majors.

CE11: Principles of Environmental Engineering Science: If you are an environmental engineering major, take this class as early as you can. It provides an introduction to environmental concepts such as material balances and teaches other quantitative tools to assess problems. You also get to go on field trips to power plants, wastewater treatment facilities, and other exciting places.

E7: Intro to Computer Programming for Scientists and Engineers: Programming in MATLAB. This course assumes no prior programming experience and provides programming skills which are not only essential for later programming you will likely learn, but also come in handy for other classes. While there are a few matrix operations and differential equations involved, many students do well without having taken linear algebra and differential equations (Math 54). The computer labs provided can get crowded so you may want to obtain a copy of MATLAB software for your laptop.

E36: Engineering Mechanics I: This class focuses on rigid bodies in equilibrium. You can take it right after Physics 7A since you'll have gotten an introduction to the subject. Even though this class is only two units, you must do problem sets every week. Make sure to keep up with those.

EE40: Introduction to Circuits: This course is a prerequisite for all other upper division EECS classes. The course is problem solving intensive with the intent to develop a strong intuition and insight into the basics of circuit theory. The final project is to build a light sensing alarm. You can also participate in an end-of-the-semester robot competition. The laboratory class is recommended for hands on experience with oscilloscopes, digital multimeters and other electronic instrumentation and circuit components. Some introduction to microfabrication is also provided.

E45: Properties of Materials: This is a really cool class on materials science. Learn why some materials act the way they do, why steel makes a good sword and why glass is clear. The lab is pretty interesting (where else would you get to play with liquid nitrogen?), and the quantity of useful information learned that can be applied to future studies is amazing. If you have a curious mind as to why things work, this class will answer a lot of your questions.

Physics 7 Series: General Physics: Covers a variety of physics concepts that form the foundation for later engineering courses. 7A (Mechanics) and 7B (Thermodynamics, Electricity & Magnetism) are required for all engineering students. Physics 7C covers optics, relativity, and quantum mechanics. You may use an AP Physics course to replace 7A. The Physics H7 series is the honors version.

Physics H7 Series: Honors General Physics: Excellent courses for students with solid calculus backgrounds. Places physics on solid mathematical foundation, and emphasizes challenging problems and theory over simple application and "plug and chug" problems. This series is highly recommended for anyone seriously interested in learning physics. The textbooks for H7A and H7B are excellent, and instructors are above average. Motivation is a must.

Upper Division

Civil and Environmental Engineering

CEE108: Air Pollutant Emissions and Controls: This is an excellent overview of air pollution problems and control methods. The six criteria of air pollutants are discussed in great detail. There is also a strong focus on mobile source emissions and methods of regulating vehicle emissions. Professor Harley is outstanding!

CEE109: Indoor Air Quality: The only undergraduate course on indoor air quality taught in the country! Study indoor emission sources, methods of quantifying human exposure to indoor air pollutants, and applications of statistical properties to environmental engineering. The semester project is a challenging and rewarding experience. This is a very practical course for people considering careers in air quality engineering or related fields.

CEE111: Environmental Engineering: Get introduced to the various aspects of environmental engineering. This is a prerequisite for most other environmental engineering courses so try to take it early. There are challenging problem sets and tough exams lie ahead. But if you take this right after CE11, you should do just fine.

CEE100: Elementary Fluid Mechanics: A great fluid mechanics option for environmental engineers. Learn about fluids through several examples relating to the environment. This is the only introductory fluids course that covers open channel flow. The laboratory portion has a flexible time schedule. Basically, you watch the TA's demo and then do the experiment at your convenience. Just be sure you turn in the lab report on time.

CEE130: Mechanics of Materials I: This class builds on some of the principles taught in E36, but it is much more complex. There are lots of formulas and you need to be able to visualize some stuff in 3-D. The focus is on internal forces in beams.

CEE 173: Groundwater and Seepage: This class is interesting if you are planning to focus in geotechnical engineering. There is a strong emphasis on the understanding of Darcy's Law. You study steady state as well as transient models of groundwater flow, with a light emphasis on contaminant transport. The laboratory portion requires you to learn how to use MODFLOW, a computerized groundwater flow simulation. But overall, it's not that bad.

Chemical Engineering

ChemE150A: Fluid Mechanics: Learn how to calculate the types of flow in a tube, and in the mean time learn how and why a tornado works the way it does. Use conservation of mass, momentum and energy to produce powerful engineering tools like the Continuity Equation and the Navier-Stokes Equation. A little dry at times, but real world applications abound. It is very important to DO your homework, as with some professors, homework can be half of the class grade.

Engineering

E115: Engineering Thermodynamics: This is a general introduction to Thermodynamics for all engineers. It includes a basic treatment of ideal and non-ideal gases, as well as flows, multiphase materials in chemical reactions, and mixtures. Since this class is intended for Nuclear Engineering and Materials Science, it is more general than ChemE 141 or MechE 105, which deal with specific applications in their respective fields. Highly recommended for a broad coverage of Thermodynamics! Physics 112 may be substituted in some curricula.

E117: Methods of Engineering Analysis: Teaches you common mathematical methods used in engineering. Topics include Power Series, the Legendre & Bessel equations, Laplace Transforms, Fourier Series, and 1st/2nd Order Partial Differential Equations. While the big brother to this course is at the graduate level, the undergraduate course is rather formulaic. The professor and the GSI give plenty of step-by-step examples. Take this class if you want to defeat that pesky differential equation that appears in one of your other engineering classes.

E170: Intro to Modeling and Simulation: This is a course in the Computational Engineering Science program and part of one advanced math option in Environmental Engineering Science. The course teaches the use of models and simulations on real life situations. The highlight of this course is a group simulation project. The course assumes a good grasp on MATLAB so E7 is a must. Math 53 and 54 are also strongly recommended. There are some basic physics involved but anyone who has taken Physics 7AB will be sufficiently prepared.

Electrical Engineering

EE100: Electronic Techniques for Engineering: This is the equivalent of EE40 for non-EECS majors. For example, Bioengineers, Chemical Engineers, etc. may take 100 instead of 40. It goes less in-depth in the study of circuits. Nonetheless, if it is a requirement but you have no interest in circuits, take EE100. If you are interested in learning more about circuits, EE40 will also satisfy your requirement. Physics 7B is a prerequisite.

EE117: Electromagnetic Fields and Waves: Another applications sequence, the assumption here is that you already understand electrostatics and magnetostatics up to Maxwell's equations as given in Physics 7B. Therefore, only a review of these topics is given, highlighting important points necessary for the development of electromagnetic field theory. The focus of the course then is on Maxwell's equations and their consequences and applications. You will be introduced to Poisson and Laplace's equations as well as their application to practical problems. You will also be introduced to the wave equation, its solution, properties and applications. Topics covered are the propagation of waves in conductors and dielectrics, and phenomena such as the skin effect. Physics 110A may be substituted in most curricula.

EE120: Signals & Systems: This course will teach you how to analyze signals. Take the prerequisites for this class seriously, because it is all math! Topics covered in this class include Fourier Series/Transform, Laplace Transforms, Modulation, and Discrete Time Fourier Transforms. The homework for this class is usually lengthy. This course definitely builds character!

EE123: Digital Signal Processing: This class is an extension of EECS 120. This class, like its prerequisite, is extremely challenging. All the material is theoretical and very little time is given to application. Labs use a program to simulate discrete time signal processing.

EE143: Microfabrication Technology: A thorough introduction to microfabrication techniques and uses. Covers the fabrication of devices like MOSFETs and MEMS, design rules, modeling and analysis of various fabrication processes, and a brief look at future developments. The lab is quite interesting. 3 hours a week to process a silicon wafer over a semester, but the two end-of-semester write-ups are around 30-40 pages. Thin film technology is applicable to many fields (the class is about half graduate students from EECS, ME, ChemE, and possibly physics), but the theory is not exciting like quantum mechanics, it's mostly modeling.

Mathematics

Math 110: Linear Algebra: Linear Algebra is one area of mathematics that has found its way in many, many application fields, from quantum mechanics to theoretical computer science. A highly recommended course for anyone, especially those who want to test the water of upper division math courses but finds Math 104 a bit intimidating.

Math 126: Partial Differential Equations (PDE): The class covers the solution to basic solution and wave equations and also a little of non-linear PDE, utilizing Fourier series, concepts of convergence, basic properties of harmonic equations, Green's function, and multivariable calculus. This is one of the more application-oriented courses for math majors that many students in physics and applied sciences take it.

Math 104 and 185: The former deals with real analysis (real as in real variables) while the later deals with complex analysis (complex as in real and imaginary variables). These courses are quite theoretical, having as their major focus many proofs of the pertinent mathematical theorems. By the end of these courses you will understand why the Riemann integral exists and how to prove Cauchy's integral theorem. If you like rigor, depth and proofs, this is the class for you. For Math 104, even though this is a hard course (especially the honors section, though it's definitely worth the work), try taking it as early as possible while you are still taking some lower division course, in order to balance the workload. Maybe you want to take Math 104 with a humanities course you are taking P/NP.

Math 121AB: Mathematical Tools for the Physical Sciences: Almost the same material that is covered by Math 104 and Math 185 is covered by these two classes, but in a somewhat different order and perspective. These are “problem solving classes” that will give you the necessary tools to work on almost all your physics courses. While theoretical questions are of secondary order, they are by no means easy classes. Here you will get working knowledge of complex analysis, Fourier analysis, finite and infinite dimensional space algebra, operational math, and partial differential equations with applications to classical mechanics, electricity and magnetism, and quantum mechanics.

Molecular and Cellular Biology

MCB 100: Intro to Biochemistry: This is a difficult class, but you will learn a lot. The class covers cycles, including Kreb’s Cycle, Calvin Cycle, oxidative phosphorylation, glycolysis, etc. It also covers DNA basics and lipid, sugar and protein structure. This is a generally a "weeder" class for pre-meds, so keep up with your studying.

MCB 102: Survey of Biochemistry: This course covers the same material as MCB 100 but in less depth (that’s not saying it’s EASY). The majority of the students in the class are MCB or pre-med, so it is extremely competitive. Make sure to keep up with the reading, especially in the second part of the course that deals with memorizing the different biochemical cycles. Take for the love of the subject, not for an easy A.

MCB 160: Introduction to Neurobiology: Interesting class that gives a broad overview of the nervous system works on the macro (vision) and micro (neurons) levels. Class is not too difficult.

MCB 150: Immunology: Great class, and possible to receive a good grade as well. Learn about all the immensely cool stuff the immune system can do. Read the latest immunology papers on cancer and AIDS research. Don’t miss this class. If you can fit it in, you will learn something new and cool every lecture.

Mechanical Engineering

ME104: Engineering Mechanics II: Here you will learn Newtonian and Eulerian Mechanics up to two dimensions. This is a more rigorous extension of Physics 7A. You will study the theory and work out lots of problems. Typical problems here are projectile motion, kinematics and kinetics of different mechanisms, elastic and inelastic collision and some rotational problems (two-dimensional). Conservation of linear and angular momentum is also covered.

ME105: Thermodynamics: A mechanical engineering approach to thermodynamics, using engines, cycles, humidity, etc as applications of the basic laws of thermodynamics. This class focuses on practical applications, with a glossing over of some theory and chemical terminology.

ME106: Fluid Mechanics: This is another of the typical introductory engineering classes. The degree of difficulty of this course depends heavily on the instructor, ranging from very theoretical to very practical. In context, the lecture is based on the theoretical aspects of fluid mechanics, for which you will need good background knowledge of vector analysis (Math 54). On the other hand, the homework sets, exams, and sample problems are very practical and applied for that you only need the skills acquired up through Math 53. The applications range from determining hydrostatic pressures in submerged vessels, pipe and pump selection and design, the effects of drag, and energy balance in a fluid system. This is a down to earth class that can be very fun. Almost all problems are 2-D. For this class you need a very good understanding of the conservation principles of energy, mass and momentum. ME104 is a must, but you can take this course without ME105 and do well.

ME 185: Intro to Continuum Mechanics: This is a very theoretical course. Nevertheless, this course can prepare you for the art of solving real (and difficult) problems. You will study general continuous media (both solids and fluids.) Looking at the three dimensional properties of continuous media makes this class more difficult. This requires the use of tensors, which are an indispensable tool in mechanics and physics. This is an ideal class to take after Physics 105. The concepts learned in this course are directly applicable to ME106, ME102A and CE130. This is a magnificent, elegant course for which the mechanical engineering department is recognized through-out the campus.

Physics

Physics 105: Analytic Mechanics: This course is on classical mechanics. It is assumed that the student knows sufficient Newtonian mechanics so that only a very superficial review of it is given. Instead the focus is in Lagrangian mechanics (this is a method dealing with energies instead of forces), which simplifies problems that are otherwise impossible with Newton's methods. Here you will learn about oscillatory motion, central force motion (planetary motion), rotation in three dimensions, coupled oscillators, and an introduction to solid and fluid mechanics in three dimensions. You can survive the mathematical techniques in this class with just Math 53, but it is highly recommended that you take upper-division Math (either 121A or 104) prior to or concurrently with this. This course is your first foot into quantum mechanics.

Physics 110AB: Electromagnetism and Optics: This is a tough sequence. In both the 110 sequence and in EE117, you'll be expected to remember material from the 7 series, but this material will be rederived more rigorously in the 110 series. You'll probably start with a quick review of vector analysis followed by an in-depth survey of electrostatics, magnetostatics, electrodynamics culminating with the Maxwell's equations. The second course starts off with a review of Maxwell's equations and continues on with the wave equation, wave guides, radiation and special relativity. Comparing this sequence with the EE117 series, one would say that they are the same in content except for the topic of relativity. But there are significant differences. This sequence is somewhat theoretical and highly mathematical. People say that this is the mathematical "boot camp" for physics majors. The emphasis is on solving boundary value problems and using proper boundary conditions. Here, a must is Math 53 and 54.

Physics 111: Modern Physics: This is a laboratory class made up of two components: Basic Semiconductor Components (BSC) and Classical Experiments. For one semester, you will take the BSC section covering the subjects of electrical circuit analysis (in a lab section!). In Classical Experiments, you will do really fun experiments that will make you a believer of physical theory. You will reproduce some of the famous experiments like Millikan's oil drop experiment, Rutherford scattering, Fabry-Perot interferometry, as well as some other more modern experiments. What is more important, you will learn very valuable and precious laboratory techniques.

Physics 112: Intro to Statistical and Thermal Physics: This is a theoretical course with a great number of applications. Generally, it covers thermal physics and statistical mechanics. Topics include statistical methods in physics, relations between energy and temperature, Boltzmann distribution, ideal gas, quantum gases. Applications are: cosmology, superconductivity, superfluidity, blackbody radiation, Fermi gases, boson condensates, semiconductors, phase transformations, heat engines and many more. You will actually do problems on all these fields. This is a unique course where knowing the theory really pays off in the applications. This course is a stepping-stone into solid-state physics. Math 53 will do fine. Physics 137A would be good also, but it is not entirely necessary. In fact, a good choice would be to take this course concurrently with Physics 137A.

Physics 137AB: Quantum Mechanics: Interesting material, but horribly tedious problems. The math (i.e. integrals) is extremely long, which is why this is also an elective for Applied Mathematics majors. The first course covers the time-independent Schrödinger Equation in one and three dimensions (with basic potentials), angular momentum, scattering, and the hydrogen atom. Upper-division mathematics (especially linear algebra) is recommended but not necessary. This course is do-able with just Math 53 and 54.

Physics 142: Introduction to Plasma Physics: This course is a good general theory of plasma physics. The class discusses plasmas from the microscopic, to the macroscopic, and magnetohydrodynamics. It covers the essential plasma parameters, and it develops techniques for using approximation methods. The focus of the class is processes such as diffusion, wave generation and interactions with electric and magnetic fields. Unlike other Physics classes, this one involves numerical computation rather than dealing with concepts and general solutions. A firm grounding in classical physics (Physics 105 & 110) and dimensional analysis (ME106) will be useful. This class is great for those interested in understanding plasmas for general knowledge, as well as for those looking to explore experimental physics rather than theoretical development.

Tips About Math Courses

Other useful math classes, though not required, include:
Math 128A (5 units) Numerical Analysis (Math 54 prerequisite)
Statistics 134 (3 units) Concepts of Probability (Math 1B prerequisite)

Note that Math 110 is very helpful for Physics 137A. Statistics 101 and Statistics 102 are relevant for Physics 112. Math 128A is hard and time consuming, but it is useful. You'll also get some computer experience, especially in problem simulation.

Sometimes it's enlightening to observe how your physics and engineering professors perform their math and how they think about a certain problem or concept. Their math notation or technique is often slightly less rigorous than your math professor's. This could help you relate abstract mathematics to physical concepts you can visualize.

For more course reviews, visit: tbp.berkeley.edu

Computing Resources

One of the first questions you may ask yourself on deciding to come to Cal is "Do I need a computer?" Having access to a personal computer is very useful, although not a necessity. If you have a computer, or the means to purchase a computer, it is highly recommended that you do so. But if this is not possible, don't worry, there are plenty of options. On campus, there are several computer labs and facilities that are available free of charge to be used as a resource for the student. These facilities come equipped with both Macintosh and PC computers with World Wide Web and email capabilities, as well as printers. There are several locations of these computer labs on campus with varying hours. For all the locations and times, check *Resource: A Reference Guide for New Berkeley Students* that you will receive during your orientation. In addition, if you are enrolled in an EECS class then you will have access to the workstation in Cory and Soda Halls. The World Wide Web and email are of major importance for education and becoming integrated into the classroom. Most courses have web sites for class information, and professors and graduate student instructors find email the most convenient way to communicate with their students. Therefore, it is of utmost importance that you use the computer facility for web access as well as establishing your own UC Berkeley email account.

To establish and email account you will need your CalNet ID and password.

Go to https://calmail.berkeley.edu:10100/cgi-bin/eligibility.pl and follow the onscreen instructions.

Software can also be downloaded from http://software-central.berkeley.edu/

Or software can be purchased from The Scholar's Workstation http://www.tsw.berkeley.edu.

Those living in the campus housing can consult their Resident Computer Consultant (RCC) who will be more than willing to help you get started. Those in the dorms benefit from the in-room ethernet connection, making web and email use quick and simple.

Jobs, Careers and Graduate School

Graduate and Medical School

How to Find a School

To find a description of universities and their graduate programs, you may want at Peterson's Guide to Graduate Schools. Another useful resource is *The Gourman Report*, which is a compilation of "top 25" lists of graduate schools for many specific programs, including bioengineering and environmental engineering. Also, ask your professors or faculty advisor about which programs have good reputations in the particular field which you are interested in. Once you get a tentative list of schools you could go to the Career and Graduate School Services on 2111 Bancroft Way (2nd floor) and look at their catalogs. During the summer before your senior year, call or email the graduate schools for applications and a description of their graduate program. Most schools will first send you a catalog and an application later. If you plan to enter graduate school in the fall, application deadlines usually range from December to February.

Graduate schools have either a bioengineering or a biomedical engineering graduate program depending on how closely associated the program is to its medical school. Most programs are for a Ph.D. degree and to a lesser extent the MS degree. Some schools also have MD/Ph.D. programs for the biomedical sciences/engineering that may also be worth looking into.

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.

A useful resource is the Letter of Evaluation Service that was established as a convenience for UC Berkeley students and alumni who wish to maintain a file of letters of evaluation to support applications to graduate or professional schools. Since its clients solely fund this service, a fee of $30.00 is charged, which includes 5 free "kits" for the letter writers. This service duplicates the letters and sends them off to wherever you want, thus lifting the burden on the letter writer. Their office is located at the Career and Graduate School Services. If you use the Letter of Evaluation Service, be sure to request recommendation letters well in advance of the application deadlines. The entire process of getting a letter written, having it delivered to CGSS, and finally sent out to graduate schools takes about one month.

Graduate Record Examinations

Nearly all the graduate programs for engineering require you to take the GRE General Test. Some engineering programs, such as mechanical engineering, will also require you to take the GRE Engineering Subject Test (there are 17 different subject tests). Most physics graduate schools require the Physics GRE Test, in addition to the General Test. The General Test is a multiple choice examination similar to the SAT, designed to measure verbal, quantitative, and analytical skills that you have developed in the course of your academic career. It may be taken on computer or with paper and pencil. The computer test has four sections: verbal (30 minutes), quantitative (45 minutes), analytical (60 minutes), and experimental. There are seven sections on the paper and pencil test: 2 verbal, 2 quantitative, 2 analytical, 1 experimental, each taking 30 minutes. The verbal and quantitative sections are similar to the SAT in format as well as difficulty. The analytical section measures your ability to make rational assessments about unfamiliar, fictitious relationships and to think through arguments logically. A key difference between the GRE and SAT is that the GRE does not penalize you for incorrect answers. The paper and pencil GRE Examinations are offered in October, December, February, April, and June, with an application deadline about one month before the exam date. The computer test is given throughout the year on weekdays and weekends. You must call in advance for an appointment. Consult a GRE preparation guide for more information and practice exams.

Medical School

For bioengineering and environmental engineering majors, it is easy to change to premed since the course requirements parallel each other. However with an engineering science degree, you still have the option to apply for medical school. In order to apply, you must take the MCAT approximately 12-18 months before your expected entrance to medical school. The MCAT is comprised of four sections: Verbal Reasoning (VR), Physical Science (PS), Biological Sciences (BS), and the Writing Sample (WS). For each of the first three parts (VR, PS, BS), a separate score is reported with the maximum score being 15. An average score for people who are admitted to medical school is a little above 10. For further information on requirements of 123 medical schools and brief descriptions of each, consult *Medical School Admission Requirements* by the Association of American Medical Colleges. This book and many other helpful handouts (including the MCAT registration packet) can be found at Career and Graduate School Services on 2111 Bancroft Way (2nd floor).

Careers

How to Get a Research Job

If you are interested in doing research within an engineering science group, you should talk to faculty advisors 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, obtain the departmental announcement which contains a detailed listing of professors and what they are currently working on. From this list you can call or email the professor to make an appointment. 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 resume 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. 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/medical 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 Bachelors degree, then these humble pointers might be of some help:

1) Decide what you like and/or want; try to take as many “related” engineering courses as possible. This might seem something painful to do since this may imply giving up your “easy” electives for some “hard-core” engineering ones, but the payoff will be landing a good job, since now 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 and Graduate School Services Center, located in the Banway building at 2111 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. For information contact the Engineering Cooperative Education Program located in 209 McLaughlin Hall, phone 642-6385. Always have your resume ready. This is crucial. “Don’t leave home without it.” The handbook available at the Career Center has very valuable resume advice and examples. You may even want to enroll in one of the many resume-writing classes offered on campus.

Libraries and Department Offices

Libraries

Bioscience and Natural Resources Library - 2101 VLSB, 642-2531

Kresge Engineering Library - 110 Bechtel, 642-3339

Math/Stat Library - 100 Evans Hall, 642-3381

Chemistry Library – 100 Hildebrand Hall, 642-3753

Physics-Astronomy Library – 351 Le Conte Hall, 642-3122

Main Stacks - Doe, 643-4331

Department Offices

College of Engineering, Office of the Dean - 320 McLaughlin Hall, 642-5771

College of Engineering, Student Affairs (Engineering Undergraduate Office)
308 McLaughlin Hall, 642-7594

Biochemistry & Molecular Biology - 121 Koshland Hall, 643-9072

Bioengineering – 459 Evans, 642-8991

Cell & Development Biology - 299 Life Sciences Addition, 642-2396

Chemical Engineering - 201 Gilman Hall, 642-2291

Chemistry - 419 Latimer hall, 642-5882

Civil Engineering - 760 Davis Hall, 642-3261

Computer Science (L&S) - 387 Soda Hall, 642-1042

Electrical Engineering & Computer Science - 231 Cory Hall, 642-3214

Engineering Sciences - 230 Bechtel Engineering Center, 642-8790

Genetics - 121 Koshland Hall, 643-9072

Industrial Engineering and Operations Research - 4135 Etcheverry, 642-5484

Immunology - 299 Life Sciences Addition, 643-9446

Integrative Biology - 3060 VLSB, 642-3281

Material Science and Mineral Engineering – 210 HMMB, 642-3801

Mathematics - 970 Evans Hall, 642-6550

Mechanical Engineering - 6187 Etcheverry Hall, 642-4094

Molecular and Cell Biology - 2083 VLSB, 643-8895

Neurobiology - 299 Life Sciences Addition, 642-3935

Physics - 366 LeConte Hall, 642-7166

Engineering Societies

•American Society of Civil Engineers (ASCE)
http://calasce.org/

•American Society of Mechanical Engineers (ASME)
http://ocf.berkeley.edu/~asme/

•Bioengineering Association of Students (BEAST)
http://www.ocf.berkeley.edu/~beast/

•Black Engineering and Science Students (BESSA)
http://bessa.berkeley.edu/

•Black Graduates in Engineering & Science Students Association (BGESS)
http://bgess.berkeley.edu/

•California Engineer Magazine
http://caleng.berkeley.edu/

•Chi Epsilon (XE), Civil Engineering Honor Society
http://www.ce.berkeley.edu/~xe/

•Computer Science Undergraduate Association (CSUA)
http://www.csua.berkeley.edu/

•Eta Kappa Nu (HKN)
http://hkn.eecs.berkeley.edu/

•Engineering in Medicine and Biology Society (EMBS)
http://www-inst.eecs.berkeley.edu/~embs/

•Engineering Joint Council (EJC)
http://ejc.berkeley.edu/

•Hispanic Engineers & Scientists (HES)
http://www.berkeleyhes.org/

•Institute for Operations Research and the Management Sciences (INFORMS)
http://www.ieor.berkeley.edu/~informs/

•Institute of Industrial Engineers (IIE)
http://queue.ieor.berkeley.edu/~iie/

•Open Computing Facility (OCF)
http://ocf.berkeley.edu/

•Society of Engineering Sciences (SES)
http://www.coe.berkeley.edu/ses/

•Society of Naval Architects and Marine Engineers (CalSNAME)
http://www2.decf.berkeley.edu/~calsname/

•Society of Women Engineers
http://swe.coe.berkeley.edu/

•Tau Beta Pi Society
http://tbp.berkeley.edu

•Women in Computer Science and Engineering (WICSE)
http://www-inst.eecs.berkeley.edu/~wicse/

Engineering Science Faculty Advisors

Engineering Mathematics and Statistics

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6125 Etcheverry Hall
2-2863
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Engineering Physics

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Conclusion

We hope that the *Unofficial Guide to Engineering Science* has been a helpful resource in helping to answer your questions about Engineering Science and alleviate any worries you may have. If we have not answered all your questions, feel free to stop by one of our events and ask questions of our officers. That is what they are there for! In addition, don't be afraid to e-mail us. One of our officers will promptly answer your question or direct you to the correct campus resource. Remember that there is no such thing as a *stupid* question. Whether or not you choose to remain a part of the Engineering Science program, we wish you the best of luck in your future endeavors.

We're always looking for a few motivated people…
If you're interested in joining our officer team or you have…
Comments? Questions? Gripes?
E-mail **n3rdkw@berkeley.edu**

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Thanks for reading!

The Fine Print:
Information contained in the Unofficial Guide to Engineering Science is believed to be correct. However, SES is not responsible for any errors contained within this document. Always double check with the appropriate advisors prior to making any final decisions regarding the course of your major.

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