Eta Kappa Nu, the ECE Honors Society, proudly presents

Doctor Everitt's Neighborhood

Issue #4, Fall 2012

An Independent Guide to ECE at Illinois
Dear Readers,

I’m proud to present the 4th issue of Dr. Everitt’s Neighborhood (DEN) to the ECE community. We’ve been hard at work this past year to make this issue as great as it can be; as a result, this issue contains more than 40 new course reviews written by fellow ECE students. Over the past year, we’ve greatly expanded our course review portfolio with many new course reviews about both fundamental classes and technical electives. I’d like to thank all of the students who have contributed to DEN, for helping to make this possible. It’s been amazing to see DEN evolve so much in the span of one year.

For those who aren’t familiar, DEN is an independent guide to ECE at Illinois – a guide written by students, for students. Inspired by MIT’s “Underground Guide to Course VI”, the first edition of DEN was published in Spring 2009 by HKN’s Director of Student Services, Chris Li. Since then, DEN has taken on a life of its own, with numerous students helping to keep DEN strong.

One of the biggest changes we’ve made this past year was moving the DEN website onto the Engineering School’s wiki. The wiki system has proven invaluable, making it easier than ever to contribute to DEN; if you want to contribute, it is now as easy as surfing to our wiki space and logging in. I’d like to thank Suraj Malhotra, the outgoing IEEE President, for this brilliant idea. Our wiki can be reached online at bit.ly/DENHKN.

I’d also like to thank all the wonderful people in the HKN Alpha Chapter for all their hard work and support. Without them, none of this would have been possible.

If you are interested in contributing, either hop on our wiki or send me an email at goldste6@illinois.edu. I’m looking forward to another amazing year as Editor of DEN, and would love to have all the help I can get.

I hope you find this latest issue of DEN helpful and informative. Thanks for reading!

Sincerely,

David Goldstein
Editor-in-Chief, Dr. Everitt’s Neighborhood
Special Thanks to Our Contributors

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Graduate ECE Courses

ECE 515 - Control System Theory & Design
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Should I take X with Y?

This page is dedicated to advising students about different course combinations.

Should I take ECE 110 with ECE 190?

Coming in as a freshman in ECE, some students consider taking ECE 110 and ECE 190 in the same semester. These are the first two introductory courses in the ECE curriculum. Obtaining a solid foundation of the material covered in these classes is critical to your future success in later ECE courses. It is not advised that the average student take these two courses at the same time, though a few take them together successfully. Although not very difficult, ECE 110 quickly jumps into simple circuit analysis and circuit elements and it can be overwhelming if you never saw circuit analysis in high school. ECE 190 is more homework-intensive than ECE 110 - the majority of the homework for the class comes in the form of 5 Machine Problems (programming assignments). ECE 190 starts by going over digital logic, which is covered in the second half of the semester in ECE 110. If you take these together, your workload can get a little heavy once the ECE 190 MPs begin, especially if you are a incoming freshman with no prior knowledge of circuits or programming. Although it is not recommended for the average student, a few strong students that have prior knowledge in these areas can do well taking these classes together. If you are interested in taking ECE 110 and ECE 190 together, talk with your adviser first.

The ECE Department also has a page describing its philosophy on taking ECE 110 and ECE 190 at the same time.

Should I take ECE 190 with ECE 210?

Taking ECE 190 and ECE 210 can work very well for students who preformed well in ECE 110. Students who take ECE 210 immediately after taking 110 will have an advantage over students who waited a semester to take ECE 210, because almost the whole first third of 210 is a review of ECE 110. This first third is mostly DC circuit analysis, Thévenin and Norton circuits, DC power, and some other material with RC and LC circuits at the end. As many people know, ECE 190 will take a bit more work than 210 because of its MPs. Although it is a decent amount of work to take these courses concurrently, it is probably a good idea if you are a strong student and did well in ECE 110. This way you can get a jump ahead in your path to graduation and EE can begin to take upper level classes after ECE 210 is completed. There is almost no topical overlap between ECE210 and ECE190, as ECE210 is fundamentally a math class whereas ECE190 is primarily a programming class.

Should I take ECE 210 with ECE 290?

If you are thinking about doing this, the answer is that you probably should. By the time you get to both classes you should be pretty well prepared, having taken ECE 110 and ECE 190. Both classes are a fair amount of homework (with 290 typically taking quite a bit more time than 210), and both typically have problem sets due weekly. The combined workload may be a little tough, but if you try to spread out your earlier ECE classes, you'll just end up having to take all your technical electives in your last year or two, which will easily be worse. If you've already exhausted most of the basic math and physics requirements for ECE, there really is no reason to put 210 and 290 off. ECE 290 is the gateway to upper level CompE courses, and ECE 210 is a prerequisite for almost all EE courses, so postponing taking either class is only going to limit what you can choose as tech electives later. Many students, especially Sophomores, try this combination, and usually are pretty successful with it.

What to Expect:

Both classes have a little bit of associated lab work, but the 210 labs are fairly short and typically are 2-3 hours of work each; 210 has a total of 5 labs, which start about a month into the semester and are every other week; 290 has a total of 7 lab assignments, which you do on your own time, and are due roughly every 1.5-2 weeks and each one typically takes a little more time than the last, but typically take around 3 hours. Homework for 210 doesn't take too long if you understand the concepts; 290 homework can take a considerable more time. In total, the combined homework should probably take somewhere in the 12-18 hours a week range. Considering the two classes should be about half your course load, this is not unreasonable.

Should I take ECE 385 with ECE 391?

Several daring students have tried taking ECE 385 and ECE 391 in the same semester. The combination of the two is very difficult, since 385 is a time-intensive lab course, and 391 involves several intensive MPs. Students who can handle the workload of this combination do well, but taking any other time-consuming classes at the same time is strongly discouraged, since between 385 and 391 exceptional students can expect an average of 30 hours of lab work a week (including documentation for 385). Both courses have open-ended final projects, so if you want to put extra effort and time into these, you'll probably have to choose whether to focus your effort on 385's final project (which can be whatever digital circuit you want, subject to TA approval) and 391's MP3, which is a group MP in which students get to design their own Unix-like Operating System. Both projects can be really cool, so if you would like to go all-out on both, you probably want to take these classes in different semesters.
Engineering Core

This section contains information about the core Math, Chemistry, and Physics courses that all engineering majors are required to take.
CHEM 102 & 103 - General Chemistry I + Lab

Instructors:

A variety of professors, both new and old, teach CHEM 102. Some of the more experienced professors include Tom Hummel and Christine Yerkes, who have both taught CHEM 102 and other introductory chemistry courses for several years. CHEM 103 is taught by lab TA’s that vary from semester to semester.

Prerequisites:

If you do not have much chemistry background, it is often recommended to take CHEM 101 before taking CHEM 102 (incoming freshmen are given a placement test before summer registration to determine where they should start). The hardest math that you will do in this course is basic algebra, so calculus knowledge is not needed.

If you have a strong chemistry background, but for some reason do not have AP or equivalent credit, then you will want to consider taking the proficiency exam at the beginning of the semester. If you are really dedicated you may even be able to self-study the material over break and do the same thing. If you test out of CHEM 102 you are not required to take CHEM 103.

When to Take It:

You will probably want to take this class as soon as possible to keep your academic options open. Although CHEM 102/103 has little relevance to most of ECE, it is a fundamental course if you want to take technical electives related to bioengineering later on.

Class Content:

CHEM 102 starts off with the absolute basics, significant figures and finding the right number of sig figs for simple calculations. It then moves on to writing simple reactions, balancing equations, and going over some of the naming conventions for compounds. From there, a wide variety of topics are covered, including the properties of gases and applications of the ideal gas law, the inner workings of the atom (electron orbitals, electron spin, emission spectra, etc), writing Lewis dot structures/VSEPR model, equilibrium in relation to chemical reactions, acid/base reactions, and redox reactions. All of the major topics have corresponding labs in CHEM 103.

Work:

Depending on what section of CHEM 102 you’re in you may have either written or online homework or some combination of each. Generally the homework consists mostly of straightforward calculations and a couple of conceptual problems. You’ll likely be spending an hour or two on the homework per week. There are discussion quizzes roughly every two weeks that strongly relate to the homework that you do.

There are three hour exams throughout the semester. There is a book of old hour exams sold in the Illini Union Bookstore that is very helpful when preparing for the types of questions that are on the exam. You may even be able to find old exams online on the old course websites.

The CHEM 103 labs meet every two weeks and there are six labs in total. There are online pre-labs/post-labs and “interactive video labs” (IVL’s) that you will need to do. The pre-labs and post-labs are usually rehashes of calculations you did in the 102 homework, and the IVL’s can be completed in a short amount of time. You will also have a lab workbook that you will need to set up appropriately before coming to lab. Many of the labs will not require the full amount of time given.

Life After:

CHEM 102/103 is a good foundation for any student to have to grasp the fundamental workings of our physical world, which is why it is required or all students in the college of engineering. For many students, though, CHEM 102/103 will be the first and last chemistry course that they will take at UIUC. Most of what is covered in CHEM 102/103 has little direct relation to the things studied in ECE, although the behavior of gases/chemical equilibrium will come up in PHYS 213, and some of the quantum concepts introduced will be revisited later in PHYS 214 and lightly touched upon in a process based class like ECE 444. However, it is expected of you by the ECE professors that you have this basic chemistry background. For those interested in the bioengineering subdiscipline, or perhaps even those pursuing a bioengineering minor, the follow-up courses CHEM 104/105 and CHEM 232 are essential.
PHYS 212 - University Physics, Electricity and Magnetism

Instructors:

Instructors vary every semester. Prof. Douglas Beck has been teaching this course for years and he is very well experienced. Other instructors include Gary Gladding and Naomi Makins in recent semesters.

Prerequisites:

The official prerequisites are PHYS 211 and credit or concurrent registration in MATH 241.

When to Take It:

Students should take this class after MATH 221 and PHYS 211, which will mostly likely be either their second or third semester. Although PHYS 211 and 212 talk about different topics, the concepts in both of them are analogous, such as potential energy, vector sum of forces, etc; students are also expected to have a working knowledge of basic kinematics / dynamics, covered in PHYS 211. Thus, a solid understanding of PHYS 211 material could absolutely make it easier to understand the concepts in 212.

Strong math skills will also help a lot because they can greatly help students understand the derivation of formulas. On the course website it says concurrent enrollment in MATH 241 is required. Calc 3 is greatly helpful in the derivation of formulas in E&M, but in this course they try to keep the math relatively simple, so it is not necessary to have experience in Calc 3 for this course - the Calc 3-style integrals are kept simple enough that a conceptual understanding of the physics is enough to be able to compute them. Taking the courses concurrently may be helpful, since students will get an understanding of what some of the complex Calc 3 integrals mean in Phys 212.

It is recommended to take this class sooner rather than later because it teaches the fundamentals necessary for further Electrical Engineering classes; it is a prerequisite for ECE 210 and thus should be taken before taking any of upper-level Electrical Engineering courses, since most have 210 as their prerequisite (either directly or indirectly). Taking ECE 110 beforehand or concurrently will make the circuit analysis portion of this class significantly easier, since techniques and skills learned in ECE 110 are a great aid to quickly solving circuit problems for this class; when taken concurrently, many beneficial circuit analysis techniques will be taught in ECE 110 before they can be utilized in PHYS 212.

Class Content:

The class begins by introducing Coulomb's Law, the equation for electrical forces between point charges; from there, the concept of the electric field is introduced in the context of non-moving charge distributions; Gauss's law relating electric flux to charge is introduced and used as a way to compute the fields for simple charge distributions. This discussion of electrostatics ends with the introduction of electric potential energy, voltage, and capacitance. From here, the class moves into basic electric circuits, covering current, Kirchhoff's rules, basic circuits of resistors and voltage sources and simple RC circuits. The class then dives into a discussion of magnetostatics, beginning with the Lorentz force, the Biot-Savart Law, and Ampere's law. After this short introduction to magnetism, the course begins exploring the relationship between electric and magnetic forces with Faraday's Law, which leads into a discussion of self-inductance and then a discussion of inductors in simple circuits, such as RL, LC, and RLC circuits; it is here that AC circuits and phasor analysis is finally introduced. After this, the course finally lays out Maxwell's laws and derivates from them the wave equation, thus showing mathematically that electromagnetic waves can exist. From here the course moves into optics, talking about polarization, and then moving to a simple ray model of light to analyze reflection, refraction, lenses, and mirrors.

Work:

This course is organized like PHYS 211, with online prelectures as well as biweekly 50-minute lectures, weekly labs and weekly discussions. The course uses smartPhysics, and all homeworks, checkpoints and prelectures are online. The prelectures are short video tutorials that students are required to watch before coming to lecture, which introduce the material that will be discussed in lecture; students also must complete a short quiz (the "CheckPoint") before coming to lecture, which serves to check understanding - these are graded only for completion. The lectures then are used to go over problems related to the material in the prelectures and should help students understand the material from the prelectures; iClickers are used in lectures to take attendance as well as to help the instructors figure out what concepts students are having trouble with. Lectures also include some cool demonstrations. The online homework is usually a bit harder than the exams. All the exams are multiple choice, which usually makes them a bit easier since a solution yielding an answer that isn't a choice generally indicates mistaken reasoning or computation errors. There are 3 tests throughout the semester, as well as a cumulative final.

In the lab you are going to get a deep understanding of the concepts covered in lectures. There are prelabs due at the beginning of each lab, which basically acts as a review of concepts that are going to be covered in that lab. Labs are usually done in groups of 4, and groups have 2 hours to complete the experiments and answer all the questions related to the lab; by the end of the lab time, students should be ready to turn in their labs - no extra lab report is required. In the discussion section, students form discussion groups (generally 4 people) and work through the discussion problems together. At the end of each discussion, there will be a short quiz that tests the topics in that discussion. Overall, there are many components to this course; all parts combined, the workload is a bit over 10 hours per week.

Life After:

The topics covered in PHYS 212 are useful in lots of ECE classes; Electricity and Magnetism is continued in ECE 329, with the wave nature of electrical signals considered for transmission lines; linear circuits are discussed thoroughly in ECE 210, building off KCL, KVL, and explaining phasors; optics return in PHYS 214, but with light analyzed while considering wave-particle duality. It is generally recommended to take ECE 210 and PHYS 214 after Phys 212 because not only they are closely related, but also they are both the prerequisites for higher-level ECE courses.
PHYS 214 - University Physics, Quantum Physics

Instructors:

Prof. Kwiat teaches this course often; he is a great guy. He is one of those professors that students will remember after they graduate. The lab and discussion sections are taught by a myriad of different TAs, all of them graduate students.

Prerequisites:

Phys 212 (and indirectly Math 241) are the prerequisites for this course. The concepts learned in Phys 212 that carry over are mostly wave behavior related. Understanding solutions to differential equations (linear, 2nd order) will benefit understanding of the course, though students can get by without taking a differential equations class such as Math 286 beforehand (or concurrently).

When To Take It:

Phys 214 is taken either as a freshman or a sophomore, although there are rare cases where people have put it off until senior year. The latter case is highly not recommended, though, since the concepts taught in the course will be extensively used in upper level ECE courses. Phys 214 is most often taken (and recommended to be taken) in the same semester as Phys 213, since they are both 8-week courses (Phys 214 is taken in the first 8 weeks, and 213 is taken in the last 8 weeks of a semester). Some may find it a bit intense though, since 214 and 213 are both full physics courses condensed into 8 weeks - each is like having a 4 credit hour course that only lasts half of the semester. Occasionally students take the classes in different semesters, but this isn't very common.

Class Content:

Phys 214 begins by introducing waves and wave behavior mathematically and demonstrates how phenomena such as diffraction and interference come about. These topics will be reviewed in more intricate detail in the courses ECE 329 and ECE 350 (Fields and Waves I/II). Wave-particle duality is introduced, which leads into quantum mechanics concepts such as the Uncertainty Principle. Schroedinger's Equation is solved for both the infinite and finite potential well, which should be an easy concept to grasp when Math 286 (Intro to Differential Eq.) is taken concurrently with this course. Schroedinger's Eq. will be used to show how quantum tunneling occurs, and then a shallow exploration of 3D potentials (particle in a box was 1D) and the hydrogen atom will ensue. How quantum numbers m, n, l, and s (from CHEM102) arise as a result of the quantum nature of matter and energy is covered last.

Work:

Like its cousins in the University Physics sequence, Phys 214 has lectures, discussions and labs. There are 3 hour-long lectures a week, a two-hour weekly discussion, and a lab which meets 4 times through the 8 weeks. Grading for the class breaks down into the following:

- Lecture attendance points - taken via 3 or 4 i-clicker questions every lecture.
- Discussion quizzes - once a week, at the end of discussion. They are not the largest part of the grade, but still important to getting an A. Working the discussion problems during discussion time is recommended. All members of a discussion table receive a different version of the quiz.
- Prelab report - simple and easy to complete. Make sure to complete this before coming into lab.
- Lab report - depending on the lab, these can take a while to complete. Summarize and format the data and results you found in lab.
- Weekly smartPhysics Homework - These can take a long time depending on how well students understand the concepts. They focus mostly on quantitative questions, calculator and pencil/paper recommended.
- Exams - one midterm and one final. These make up the bulk of the grade. Studying for these exams is absolutely necessary. Sometimes they will actually photograph the exam room, so don't cheat.

Overall, Phys 214 has many components to it, but a lot of it is busy work. This class is about average in terms of the amount of time it takes, with much of the time spent on it during scheduled class time, such as labs and discussions.

Life After:

Both EEs and CompEs will see the concepts in Phys 214 in their core and advanced courses. While not explicitly discussed, concepts from this course are used in the study of semiconductor devices and students are expected to have knowledge of this material for ECE 340). Students who find this information interesting should consider taking upper level quantum courses such as Phys 485 or Phys 486 and Phys 487. Those looking for a more device oriented course may want to take ECE 485 (Prereq Phys 485).
MATH 221 - Calculus I

Instructors:

Instructors change every semester. In recent semesters, it has been taught by Prof. Mortensen, Cunningham and Rosenblatt.

Prerequisites:

This course is for those who have a little calculus background. Those who do not have any experience in calculus should take Math 220 instead, which covers all the topics in MATH 221 plus some high school algebra at a slower pace. A minimum score of 70% on the ALEKS Math exam is required for placement into either of these two courses.

When to Take It:

If you do not already have AP credit for this class, you should take it during your first semester. This class is best taken as soon as possible because it is a prerequisite course for almost all core classes - in particular, it is a prerequisite for Math 231 and Phys 211, which in turn are prerequisites for further courses in Math, Physics, and ECE.

Class Content:

The class starts by introducing the concept of limits and continuity. Afterwards, it moves on to teaching differentiation and various differentiation rules (product rule, chain rule, etc.). Various applications of differentiation, such as finding extrema and curvature of graphs, and finding velocity and acceleration are covered. After covering differential calculus, the course moves on to integration and integration techniques - definite and indefinite integration are covered, as are their relation via the fundamental theorem of calculus. The course ends with applications of integration such as finding areas between curves and volumes of objects resulting from rotations of curves.

Work:

The exact amount of work depends on the instructor. Usually, this class has weekly homework; some instructors use WebAssign, a web-based homework system. This class also has a twice-a-week discussion session, in which a TA goes over the material (and sometimes cover new material); the discussion sections often include quizzes. The amount of time that a student spends on this course will depend on their background. For those with strong backgrounds, it doesn’t take a long time to finish these tasks. Students should generally expect to spend at least 5 hours per week outside of class. Usually, this class has three one-hour exams held at regular intervals during the semester, as well as a cumulative final. Some professors allow students to use a notecard during the exams.

Life After:

This course prepares students for Calculus II (Math 231), which continues the ideas of Calculus I by teaching how to integrate more complicated functions, among other things. The material from Calculus I is fundamental to many ECE, Math, and Physics classes that ECE majors must take.
MATH 231 - Calculus II

Instructors:

The instructors of the course vary from semester to semester. In Spring 2012, the course is taught by Prof. Robert DeVille, Prof. Jared Bronski, Prof. Kevin Ford and Prof. Bertrand Guillou.

Prerequisites:

The officially listed prerequisite for this class is Math 220 or Math 221. Students who have taken AP Calculus AB and scored a 4 or 5 and students who have scored a 3 in AP Calculus BC with AB subscore 4 or 5 will be able to earn Math 220 (5 hours) credits and take this class their first semester; students who have taken AP Calculus BC and scored a 4 or 5 will be awarded the credit for Math 220 & Math 231 (8 hours), and thus will be able to skip this class and take MATH 241 (Calculus III). However, since understanding the material covered in Calculus II is very important to being successful in Engineering, students who have scored a 4 in AP Calculus BC are highly recommended to discuss with adviser whether to accept the Math 231 AP credit or take the course.

When to Take It:

Since the only requirement for this class is Math 221 or Math 220, ECE students generally take this class in their freshmen year, either in the first semester, for those who have earned the credits for Calculus I through AP, or in the second semester after taking Calculus I. This class is a prerequisite of Math 241 & Math 286, and thus a prerequisite for most ECE classes; therefore, students should take Math 231 as soon as possible.

Please note that it is truly necessary to meet the requirements and have a firm understand of the Calculus I materials before taking this class.

Class Content:

The class is the second course in calculus and analytic geometry, and it deals with techniques of integration, conic sections, polar coordinates, and infinite series, in other words, the materials from Chapter 7 to Chapter 11 (excluding Chapter 9) in the textbook: “Calculus: Early Transcendentals”.

Continuing the study of Calculus from Calculus I, the class starts with techniques of integration, including integration by parts, manipulating trigonometric integral using trig identities, and trigonometric substitution. Most of the time in this class, however, is spent on series. Students will learn the concept of series, sequences, convergence, and learn about alternating series, power series, Taylor series, and the like.

The rest of the classes are spent on arc length, curves and polar coordinate. Depending on the lecturer's preference, these topics may be covered throughout the semester or at the very end.

Work:

The workload of this class varies, depending on the preference of the instructor. Some professors think enough amount of homework are crucial to students' understanding, while others emphasize on discussion sections and quizzes. Generally the homework each week should take about 2-4 hours to complete.

The class generally has 3 midterms. Some students feel that MATH 231 is somewhat harder than MATH 241, as many students have a hard time understanding the concept of Taylor series. Implementing the techniques of integration also takes some work and memorization. The good thing is that there are a dozen TAs to help you.

Note that this course offers merit workshop, which is a 2-hour discussion section option. See the link below:

http://merit.illinois.edu/students_courses.html

Life After:

Completing this class gives students the skill to tackle many mathematical problems. The techniques of integration will be used again and again in later math classes such as Math 286 (Intro to Differential Equations Plus). The knowledge of series will be useful in ECE 313 (Probability with Engineering Applications) when discussing discrete random variables.

Course-wise, most students will choose to take Math 241 immediately afterwards.
MATH 241 - Calculus III

Instructors:

Professors for Math 241 vary from semester to semester. Spring 2012 saw Professors Frankland, Murphy, and Tolman teaching the course, even though none of them had previously taught it.

Prerequisites:

Technically Math 231 is a prerequisite for Math 241. Much of the material from Calculus 2, however, is never mentioned in Vector Calculus: Math 231 although it is extremely important to be comfortable with techniques for integration, sequences and series never show up in this course. Any previous experience with vectors or basic matrix operations (primarily computing determinants) will help you in this class, but the early course material covers all of these topics.

When to Take It:

Math 241 is the next logical step following Math 231 and prior to Differential Equations. Most ECE majors take this course either second semester of Freshman year or first semester of Sophomore year, though those with AP credit for Calculus BC may take it during their first semester. Concurrent enrollment in Physics 212 may prove helpful as the formulas in Physics 212 often utilize concepts from Calculus 3, helping to demonstrate what the topics taught in Math 241 really mean and how they can be applied to real problems.

Class Content:

Math 241 typically breaks down into three tests that cover three sections of the textbook (7th Edition of Early Transcendentals as of Fall 2012).

1. The first section of Calculus 3 covers an introduction to vectors and operations on vectors, including the dot product, cross product, and applications of these operations to find geometric quantities. Part of this section will also cover functions of multiple variables, reparametrization of equations, and what the graphs of vector functions and functions of three dimensions look like. Includes chapters 12-13 in the text book.
2. The second section is the meat of the course where students learn to manipulate vector functions and functions of multiple variables. Topics include partial derivatives, directional derivatives, finding extrema of functions of several variables, and multiple integrals. Although many of these topics are natural extensions of Calculus 1, there are still topics that may cause hangups. Multiple integrals are vital to the remainder of this course. Includes chapters 14 and part of 15.
3. Many consider the final third of this course the most difficult part. It begins with multiple integrals in alternate coordinate systems (Cylindrical and Spherical) and change of variables in multiple integrals to finish up Chapter 15. Chapter 16 begins easily with vector fields and line integrals, but get very abstract and difficult with divergence, curl, and surface integrals. Green's Theorem, Stokes' Theorem, and Divergence Theorem are the culmination of everything in the course.

Work:

Many instructors assign homework in this course via WebAssign, others opt to give written homework. Most sections of the class also require students to attend a discussion section twice a week which is taught by a TA, in which students are usually asked to work together on several problems; sometimes short quizzes are given in discussions, which may be as simple as working through one of the recent homework problems. Students in this class should be prepared to read the text book and work through many examples.

Typically the course has three midterms, each covering one of the portions of the course described above, and a cumulative final.

Life After:

Immediately after Calculus 3, most students take a class in differential equations (either Math 286, Math 285, or Math 441). The material learned in Calculus 3 also shows up in Electricity and Magnetism classes such as Phys 212 and ECE 329.
MATH 286 - Introduction to Differential Equations Plus

Instructors:

Various professors teach Math 286. They usually change semester by semester but all instructors generally do or have done research in the topics covered by Math 286. This means that most of the professors who teach Differential Equations Plus will generally know their material very, very well so never be afraid to ask questions. Generally the classes that are most quickly registered are for the Mathematica sections. The class is taught mostly in a lab setting using Mathematica. However the normal lecture / discussion sections are just as good, even though the exams may be a bit tougher.

Prerequisites:

It is definitely required that Calculus I and II be taken before Diff Eq. Mostly because a lot of the class will involve plenty of topics covered in calculus and professor will mostly assume that the calculus topics have been covered. Taking Calculus II before taking Differential Equations is a must since a lot of the integration techniques will be covered. Taking Calculus III before Math 286 is generally better in order to get more practice with harder integrals and to get a firm grasp on a lot of the graphing techniques covered. Officially, Calculus III is a prerequisite for the class, but very little learned in Calc III is useful, since functions of multiple variables are rarely covered. Another suggested class to take before Math 286 is Math 415, Applied Linear Algebra. The most difficult part of Math 286 is definitely Diagonalization, Eigenvectors and Eigenvalues and Math 415 introduces these concepts fairly well. However, knowledge of Linear Algebra, as taught in Math 415, is not assumed.

When to Take It:

The class is offered every semester and it should be taken either before or at the same time as ECE 210. Math 286 and ECE 210 share a lot of related topics, although they cover them during different times of the semester. ECE 210 generally assumes that its students have already seen some differential equations, but it does not rely on Math 286. However, taking Math 286 before ECE 210 would be good since the topics covered in Math 286 will be reviewed in ECE 210 so taking it before means more practice. Taking them concurrently would also work since ECE 210 and Math 286 complement one another and so material covered in one class will help the material covered in the other. Math 286 does touch on some concepts covered in Physics 211, Physics 212 and Physics 214, however the content presented will only be a brief discussion so it is not essential that Physics 211, 212 or Physics 214 be taken before Math 286.

Class Content:

The class will mostly cover Ordinary Differential Equations (ODE's) and will cover a little bit of Partial Differential Equations (PDEs), as well as Fourier Series. It also covers Eigenvectors and Eigenvalues, which is the main thing that sets it apart from Math 285. The beginning of the course will be introducing first-order ordinary differential equations and the methods to solve them, both theoretically and numerically; first-order linear ODEs are solved as a particularly important case. It will also give examples and applications of first order differential equations. Then the course will cover higher order linear ODEs, again outlining methods to solve them theoretically and numerically while presenting applications. The first midterm will generally be about first order differential equations and the early part of higher order linear ordinary differential equations. After the midterm, the class will cover systems of ordinary differential equations, matrix algebra, diagonalization, eigenvectors and eigenvalues. The second midterm will focus on these topics. After the second midterm, the class will introduce Fourier series and partial differential equations, boundary value problems, the wave equation, the heat equation, and Sturm-Liouville problems. The Mathematica sections may cover the material in a different order.

The systems that are shown as applications are also reviewed concepts seen in Physics 211, Physics 212 and Physics 214, even though Differential Equations are not listed as official prerequisites to any of these physics classes. Topics like the Schrodinger equation, LRC/RLC circuits and Electromagnetic waves will be briefly covered. The class content also significantly differs between the Mathematica sections and the lecture / discussion sections. In the Mathematica sections, the concepts are taught in such a way to explore the equations and their properties while the lecture / discussion sections generally provide a more theoretical basis.

Work:

Expect to put in a fair amount of effort in this class. The weekly homework will generally take from 2-5 hours to complete, and the examples in lecture and in the book will definitely help. The quizzes and exams are fair and will generally cover material discussed in class; however, sometimes the professors will expect the students to apply what they learned to a new concept. So expect to work a little extra when studying for exams and quizzes. The Mathematica sections provide exams and quizzes which are less difficult, however the weekly homework is a lot more involved and takes more time to do. Also the Mathematica sections require the use of Mathematica in order to do the homework and will involve a bit of coding in Mathematica. Ordinary Differential equations are difficult only at first but once the algorithms to solve them have been grasped they become really standard and easy. The beginning of ODE's will seem hard due to a lot of integration but after a point everything will just reduce to being solved through algebra. The hardest part of the class is definitely Eigenvectors and Eigenvalues and solving systems using them. This part of Math 286 is where most students should expect to really work hard and keep up with the coursework. However once Eigenvectors and Eigenvalues have been covered the class becomes a lot better. Lastly PDEs and Fourier Series are not as difficult as Eigenvectors and Eigenvalues but they are still challenging. However the class mostly outlines algorithms on solving them and just like ODEs, once the algorithms have been grasped they are not too bad. Fourier Series becomes significantly easier if taking Math 286 and ECE 210 together since both classes will complement each other here and it is like taking a class a getting an extra review. Overall Math 286 will be a bit difficult so expect to work but it is not a killer class at all. Grasping the material may take a little time and effort but the pacing of the class and its difficulty are not too crazy.

Life After:
Math 286 is a corequisite for ECE 210, and a lot of concepts covered in this class will be reviewed in plenty of core EE classes. This class will definitely prepare, or introduce its students to a lot of the EE classes involved with circuits and signals. People who enjoy a lot of the core mathematical concepts covered in Calculus and Linear Algebra will definitely enjoy this class since a lot of the concepts introduced reduce solving differential equations to Algebra and Calculus. Similarly students who are proficient at solving systems using predefined algorithms will also enjoy Math 286 since a lot of the class is about applications of mathematical algorithms to solve differential equations. Lastly people who enjoy doing a lot of "sneaky" and elegant methods of solving mathematical equations will definitely enjoy Math 286 since a lot of very difficult equations and systems will often be shown to be ridiculously easy given some elegant way of looking at the problem. Classes to consider are: Math 416 - Abstract Linear Algebra, Math 442 - Intro to Partial Differential Equations, and ECE 310 - Digital Signal Processing
RHET 105 - Principles of Composition

Instructors:

This class is usually taught by graduate students from the department of English. The instructors vary every semester.

Prerequisites:

There are no prerequisites for RHET 105. Note that if you achieve 32-36 for your ACT English score, you'll have earned the 4 hours of credit for RHET 105 and fulfilled the composition I requirement. If you have scored 4 or 5 on AP English Language & Composition or AP English Literature & Composition, you'll also have earned the credit for RHET 105 and exemption from Composition I requirement.

When to Take It:

Since this course is counted as Freshman Composition I course, most students take it in their freshman year.

Class Content:

Rhetoric 105 is designed to develop students' academic writing skills through writing practice, particularly with writing analytic and argumentative essays based on primary and secondary sources. Emphasis will be on invention, organization, drafting, and revising. Students will be organized into small groups to discuss the given topics and brainstorm ideas. Some of the classes will be used to review each others' draft papers, since peer reviewing is an important process in academic writing.

The current textbooks used are Writer's Help and Writing@U of I, both in e-book form. Writing@U of I features U of I professors from different fields talking about their experiences on writing academic journals. Writer's Help shows the students the standard formats for academic writings and guidelines for referencing secondary sources.

Work:

The class generally last 90 minutes, and there are two classes every week. Depending on the instructor's preference, you might write 3-6 essays throughout the semester. You'll start with essays about 2 pages long and gradually work your way up to 4-5 pages. Sometimes your essay might have to be a continuation of the previous essays you wrote. There's usually a final presentation which you collaborate with some of your fellow classmates. This means there's no "final exam" for this class.

There's also be short in-class writings every now and then, as one of course goals is to guarantee 7500 words of writing throughout the semester.

Life After:

After this class, you should be able to academic papers in MLA format, which should be proven helpful if you would like to get into research later. If this class piques your interest in creative writing, the English Department has some classes you might be interested take to fulfill general education requirements.

This class is a prerequisite for most classes that satisfies the Advanced Composition requirement. Electrical Engineers get Advanced Comp credit from ECE 445 (Senior Design) or ECE 499 (Senior Thesis).
ECE Core

This section encompasses all ECE courses which are explicitly required for both ECE students.
ECE 110 - Introduction to Electrical and Computer Engineering

Instructors:

This course is directed by Professor Brunet and Professor Franke; most recently, it was taught by Professor Brunet, Professor Frizzell and Professor Haken. Professor Loui has also taught this class in the past. A separate professor directs the labs, Professor Patricia Franke, but most lab sections are taught by teaching assistants (TAs).

Prerequisites:

Credit or concurrent registration in MATH 220 or MATH 221 is listed as a prerequisite for this course. The class rarely touches on calculus, but it is helpful to understand concepts such as the average value of a function and to be comfortable doing simple math quickly. The class works well with prior credit or concurrent registration in PHYS 212 because ECE 110 applies the basic physics of electricity and circuits.

When to Take It:

Most ECE students take ECE 110 as freshmen, or immediately when they transfer to Illinois, although there are some cases in which ECE 110 will be taken sophomore year. This will happen if a student did not come in with many AP credits or if the student decided to wait to take ECE 110. Those who already have a solid foundation in math and physics from high school, who are eager to jump into engineering, should take it their first semester. Students often find it better to take the class first semester because the class opens doors to the next level of ECE classes. A large portion of the class is GE students during spring semesters. Students are often concerned about taking ECE 110 with ECE 190 in the same semester. For a discussion on taking both classes at once, please see the ECE 190 course review.

Class Content:

ECE 110 introduces students to various subfields in ECE. The course consists of a lecture and a lab. ECE 110 distinguishes ECE Illinois from other universities' programs because it brings freshman into ECE laboratories during their first weeks on campus. Students immediately gain hands-on experience with electronic components like logic gates. Throughout the semester, students design circuits that control a small car, making it follow a path using sensors and TTL gates alone... no remote controls! Students experience the excitement of building real-world applications with ECE theory. The class focuses equally on electrical engineering and on computer engineering. The physical foundation of electronics is developed early in ECE 110, including extensive use of Kirchhoff's Current and Voltage Laws. Students study various electrical components including resistors, diodes, capacitors, current sources, voltage sources, and transistors. From there, students learn about the application of transistors to digital computers. This includes learning about multiplexers, flip-flops, registers, counters, and sequential circuits. The semester ends with the study of encoding, encryption, and compression. All topics are extensively described in the lecture notes, lectures, Lon Capa notes, and lecture transparencies. In contrast to many later ECE classes, ECE 110 covers a wide variety of topics, which makes the course more challenging for some students. The lab experiments line up well with lecture content, allowing students to combine knowledge from both lab and lecture.

Work:

All assigned lecture homework is provided and interactively graded by an online system called Lon Capa. Each week, students work on several graded online homework assignments. An interactive grader is used on Lon Capa which tells users whether their answer is correct, accepting a corrected answer afterward if available. Students attend a three hour lab session once a week. A significant portion of the course grade comes from exams. There are three midterm exams and a final exam. Exams can be mastered by diligently completing online assignments and lecture notes problems on paper without notes. There is also a research activity project that begins fairly early in the semester. This project is usually done in groups of four and consists of writing a paper about research in a sub-field of ECE, and reviewing papers from other groups; normally, each group member contributes 1-2 pages. Overall, ECE 110 requires a good amount of time to finish the assigned work per weekly. The lab accounts for 40% of students' grades for the class.

Life After:

ECE 110 is the first ECE class students take, and helps students determine whether ECE is right for them. Many of the ideas introduced here will be explained in great depth in higher level courses. It is normal for students to be frustrated at some point during ECE 110, but any student who finds some part of ECE 110 fascinating will be prepared for the challenge ahead. The next level of ECE classes includes ECE 190 (Computing Systems), ECE 210 (Analog Signal Processing), and ECE 290 (Introduction to Computer Engineering). Any of these classes can be taken next, though ECE 190 precedes ECE 290.
ECE 190 - Introduction to Computing Systems

Instructors:

This course is taught by various CompE professors. Professor Steve Lumetta has taught this course multiple times; most recently, it was taught by Professor Yih-Chun Hu. Professor Sanjay Patel is an author of the textbook for this course. They all have a lot of experience teaching this course. The textbook, Introduction to Computing Systems by Patt and Patel has been the textbook for the course for over five years and all instructors follow the format of the book very closely. Thus, the approach to the course and its format is consistent among different instructors.

Prerequisites:

ECE 110 is listed as a prerequisite. ECE 190 is a programming intensive class and any background in programming will make this class easier to understand, making it worthwhile to have a feel for programming before the class. The programming language used in ECE 190 is C, a high-level programming language widely used in the CompE curriculum. Getting familiar with the first 2-3 chapters of the textbook before the class is also useful as those chapters are meant as review.

When to Take It:

In rare cases, exceptional freshmen with a background in computing-related topics (familiarity with bits, logic, algorithms, programming syntax) may be able to take ECE 110 and 190 together in the same semester. For such students, it is the practice of the ECE department to send a 'friendly warning' that explains the course load and gives statistics on past students who take the two classes concurrently. However, students who are not yet accustomed to the workload necessary to complete successfully the core math and science courses should not take ECE 110 and 190 together, regardless of previous programming experience. For students interested in CompE, it is ideal to take this course in the freshman year because the class is a good window into the curriculum. EE majors often take this class their third semester with ECE 210.

Class Content:

The class gives an introduction to the many layers of computing. While the course starts with a theme about the applications of programming in C, the main course content gradually moves from the lower level with bits, logic units, and state machines to the higher level with machine language, assembly language, and ultimately C. The class teaches problem solving methods and good practices in code implementation and debugging techniques, all of which are valuable concepts to learn and practice early. Assembly language, the LC3 ISA, and C programming are all concepts used in higher CompE classes like ECE 290, ECE 391, and ECE 411.

Work:

As mentioned before, the textbook is followed closely, making it important to keep on track with the reading for assignments and exams. The class has written exercises for the first month which involve extensive problems which are mostly from the first few chapters of the textbook. The class introduces the concept of Machine Problems (MPs), which are programming assignments to be electronically turned in. There are 5 assignments as follows: The first is a simple problem to be implemented in C. The second MP is done in machine language. The third is done in assembly language using the LC3 instruction set. The last two MPs are in C. Each MP is divided into 2 checkpoints, meaning that one checkpoint is due every week after the first month. The MPs take 10-20 hours a week, which varies with the difficulty of the checkpoint. There are three exams in the class and a cumulative final. IExam each exam may have a written portion focusing on theory and/or a programming portion that requires students to code and correctly solve a given problem, just like an MP. The programming portion is done on a computer and is the majority of the exam, in time allotted and in score weighting. Partial credit is sometimes available for the programming parts but is fairly hard to earn, which is one of the main reasons why the exam averages are fairly low. Each exam is followed by a regrading process which requires students to correct the mistakes and submit the requests. Overall, ECE 190 requires a fairly large weekly time commitment in relation to other ECE courses. Past students said they have spent between 4.6 and 17.2 hours per week on this course.

Life After:

The class is an overview of the CompE classes to follow and is an essential introduction to programming before venturing into other classes that cover data structures, systems programming, network programming, the DSP lab and system organization classes. Most students go on to take ECE 290, the digital logic class, in the following semester or two; the basic computer architecture concepts carry over, as well as basic knowledge about assembly language programming. CS 225 (Data Structures) is also a common next step, as it is a required course for CompEs and the gateway to all upper-level CS classes.
ECE 210 - Analog Signal Processing

Instructors:

This course is currently directed by Prof. Kudeki. Instructors vary from semester to semester. However, Professors Trick, Kudeki, Franke, O’Brien, and other professors from the areas of signal processing, control systems, and communications have made repeat appearances.

Prerequisites:

ECE 110, PHYS 212, and credit or concurrent registration in MATH 285 or MATH 286 are listed as the prerequisites of this course; EE or CompE majors would pick MATH 286 because it is a requirement. Relevant topics from ECE 110 and PHYS 212 include basic circuit analysis and lab work involving breadboards, oscilloscopes, and function generators. Although MATH 285/286 can be taken concurrently with ECE 210, it is strongly recommended to take it before taking this course. Paying extra attention on topics like first order solution, Fourier series, Fourier transforms, and Laplace transforms will come in handy in ECE 210. An ability to understand topics in MATH 285/286 will be beneficial towards the latter half of the course when dealing with topics such as phasors, time-invariant systems, and Fourier and Laplace transforms approach to circuits.

When to Take It:

Students who know they are interested in EE should take ECE 210 as soon as possible since it is the prerequisite for many required and elective EE courses such as ECE 313, 329, 410, 430, and so forth. To some extent ECE 210 is more like a standard initial EE course. ECE 210 is about basic circuit and analog signal processing, covering only a small portion of the broad field of EE, but the course develops one’s intellectual maturity applicable in other areas of EE. It is strongly recommended for EE majors to take this course at latest by the second semester of sophomore year to graduate in time in four years.

Debate exists among students regarding whether or not to take ECE 210 simultaneously with ECE 290 as per the flow chart posted on the ECE website --the combination of which is described colloquially as “ECE 500” among students to describe the alleged difficulty of said combination. Written weekly homework assignments from both classes are due on Wednesdays. Whether or not one should take the course concurrently with ECE 290 varies on the individual’s academic progress. However, a student who has performed well above average in ECE 110 and ECE 190 and has completed the physics requirements (213 and 214) should have no issue taking “ECE 500” in the same semester. Generally, students taking “ECE 500” along with both Physics 213 and 214 may find the combined workload more strenuous. Although ECE 500 might sound stressful to sophomores or freshmen, it is one way to train oneself to prepare for the heavier workload in coming semesters. Taking ECE 500 will develop your ability to effectively manage your time and cope with more assignments. In short, ECE 500 exposes you to what it is like to take multiple ECE courses later in your career.

Class Content:

ECE 210 will be, for most students, the first real synthesis of electrical engineering and mathematics. The first quarter of the course comprises a review of basic circuit analysis. Being able to apply and understand topics such as source-transformation, Thevenin/Norton equivalent circuits, and transient analysis is quite important. Students will learn that many analog circuits can be treated as a linear system. At this point, the course becomes increasingly mathematical when first-order differential equations, phasor analysis, Fourier series, and Fourier and Laplace transforms are introduced (in the order mentioned). There will be GE students taking this course as ECE 211 which only covers up to the part before the Fourier transform. EE majors will find many future uses of Fourier transforms, and should master their understanding of the topic. To complement the material covered in lecture, lab work involves the development of an AM radio receiver. In each lab, students construct and analyze a component of the receiver using oscilloscopes and function generators. Students are expected to complete a total of five lab assignments within the time given though extra hours are available. An additional honors section led by upperclassmen is also available to students who want to get to know the basic use of MATLAB and Python for signal processing purposes. Usually completion of three to four assignments will give you honors credit.

Work:

The work in this class comes primarily from written homework assignments and the 5 lab assignments. The homework assignments are due weekly. Homework problems are assigned from the textbook and do not require a significant investment of time typically, as each chapter contains many examples that are comparable to homework problems. Making an effort to fully understand the concepts behind every problem will shorten the amount of time required to prepare for exams.

Each lab assignment consists of 1-3 pre-lab questions and questions to be answered during the lab session that will be due within a week. Aside from verifying results/responses or completing incomplete lab work, there is no additional work involved for the lab. The lab work for ECE 210 is actually less than the lab work for ECE 110’s final project. Nonetheless, students curious about the practical usage of the mathematical approaches in ECE 210 will find a great example in the lab, which features real-world electronics applications. The mathematical concepts also become clear as well when students put the right effort into their labs.

Exams reflect material covered in homework, but will more often than not contain 1-2 tricky problems that test the student’s ability to apply concepts to somewhat unfamiliar situations. Practicing with the past exams and having a strong conceptual understanding will help one perform well on exams, as will reading the textbook. Overall, ECE 210 requires a normal or average weekly time commitment in relation to other ECE courses. Past students said they have spent between 4.5 and 7.9 hours per week on this course.

Life After:
The follow up required courses, ECE 313 and ECE 329, as well as virtually all technical electives under the EE curriculum build on the mathematic principles and practice introduced in ECE 210. Students should develop a better idea of their academic interests after taking this course. Generally, students who dislike this class as a whole do not intend to pursue EE as a major. Be aware though that ECE 210 is only the tip of the iceberg of EE, not liking this course does not necessarily mean not liking EE. Students who especially find the signal processing portion of ECE 210 interesting should consider taking ECE 310 (Digital Signal Processing) and ECE 420 (Digital Signal Processing Lab) in the following semester, which takes frequency-domain analysis in a new realm. ECE 330 (Power Circuits and Electromechanics) builds on the power-related topics in 210 such as circuit equivalents, resonance, and phasors.
ECE 290 - Introduction to Computer Engineering

Instructors:

This course’s director Professor Brown has retired recently but still taught the course. This course is often split between two professors. The current instructors are Professor Kindratenko and Brown. Other professors who have taught ECE 290 include Profs. Hutchinson and Loui.

Prerequisites:

ECE 110 is listed as a prerequisite, whereas ECE 190 is listed as a pre- or co-requisite.

When to Take It:

Experience in ECE 110 is a must. Students who enjoyed the logic design for digital circuits or Boolean algebra will enjoy this course as it introduces more advanced designs. Exposure to ECE 190 either before or during the semester in which 290 is taken is also essential. Advisors and the ECE 290 course website recommend against taking ECE 190 and 290 during the same semester. However, some above-average students who took ECE 190 and 290 at the same time in the past suggest that taking the two courses together is a logical choice as far as material covered goes. Many of the topics in ECE 190 dealing with logic gates and sequential and combinational circuits are covered in ECE 290 at an accelerated pace. The LC-3 assembly code (developed by Prof. Sanjay Patel featuring simple instruction sets) is covered in both courses (but in greater depth in 290). CompE majors are recommended to take this course latest by sophomore second semester to ensure a four year graduation.

Class Content:

ECE 290 takes a bottom-up approach. That is, each topic in the course is a synthesis of previous topics. Students begin at the gate level and then learn techniques in Boolean algebra. Afterwards, combinatorial circuits are covered and form a logical transition into discussion of counters, registers, and memory. The material culminates on the next level of abstraction, the LC-3 assembly language and its implementation. Towards the end of the course, ethics also become a focal point as students evaluate a case study.

Work:

For much of the course, students will have three weekly assignments: (1) a written assignment in the form of a problem set, (2) online homework on Mallard, and (3) a weekly lab that is completed through the EWS workstations. Students who enjoy design-oriented work will enjoy these assignments. For the most part, timely completion of these assignments requires a thorough understanding of the material before beginning these assignments. Although completion of these assignments can sometimes be time consuming, help is readily available through online discussions on Compass and resources written by Prof. Brown on Mallard. Beware that the workload of this course is somewhat heavy, requiring a larger time commitment than an average ECE course. It helps to work with other students on assignments and manage time well. Past students said they have spent between 7.2 and 16.3 hours per week on this course.

Life After:

Despite it being demanding, students generally learn a lot about the essentials of computer engineering in ECE 290. There are two follow-on courses in the curriculum. ECE 385 is a lab course that puts the principles learned in ECE 290 into practice. ECE 391 is a lecture and lab course that teaches a more complex assembly language (x86), and drifts toward the software side of computer engineering. Neither class is a prerequisite for the other, but it is wise to take ECE 385 before ECE 391. ECE 385 will introduce you to the difficulty and time commitment of an open format ECE lab. In an open format lab, you can spend tons of time on lab work in addition to your regularly scheduled weekly time slot. Students who do well in ECE 290 are recommended to take ECE 385 right after ECE 290. It can be considered as a lab course designed for ECE 290. Designs for the ECE 385 course will require a solid understanding in ECE 290 material. ECE 391 is also an open lab format and the difficulty and time commitment is greater than ECE 385. Like ECE 210, 290 is a course in which students develop a good sense of whether they are interested in electrical or computer engineering.
ECE 313 - Probability with Engineering Applications

Instructors:

Prof. Sarwate is the course director and teaches ECE 313 most frequently. Other instructors usually in the areas of communications, systems, or signal processing have also taught this course in the past, such as Profs. Singer, Bresler, Meyn, Hajek, and Milenkovic.

Prerequisites:

Although the material covered in ECE 210 is not directly related to ECE 313, it is listed as the official prerequisite; this is because students are expected to have the same level of mathematical maturity as is required for ECE 210. Distributions over multiple random variables are introduced in the second half of the course, making it crucial to know integration over high-dimensional surfaces, covered in MATH 241. Other mathematical tools include geometric and Taylor series; your poker instincts should also help you succeed.

When to Take It:

Since MATH 241 is the only topical prerequisite, you can take ECE 313 immediately afterwards. If your interests lie in communications, control systems, and signal processing, you should take ECE 313 early---surely no later than fall semester of your junior year. The course time table suggests that this course be taken at the junior level, but students fulfilling the official and topical prerequisites should take the class earlier. STAT 410 (which has STAT 400 as a prerequisite) can be substituted for ECE 313. A minority of students opt to take STAT 410 if they are not interested in probability theory and applications within engineering, which in general can be more rigorous than statistics. Note that the ECE 313 pathway and STAT 400 and STAT 410 pathway are not equivalent in terms of course syllabi, as STAT 400 and STAT 410 mostly teach about statistics, and relatively little about probability as it is needed for advanced ECE courses in the areas of communications and signal processing. For students seeking a Mathematics minor, the STAT 400/410 combination is particularly useful as it can be counted towards both ECE and Mathematics requirements.

Class Content:

The first half focuses on discrete random variables (binomial, geometric, Poisson) and introduces the principles of expected value, mean, variance, likelihood, and conditional probability. Examples in lecture and problems in the homework involving topics such as communications networks and industrial/manufacturing situations make up the application aspect of the course. The second half of the course deals with continuous and multiple random variables. In this portion of the course, students are introduced to the continuous distribution function and the probability density function, hypothesis testing, jointly Gaussian random variables, correlation, and expectation and variance of multiple random variables. Many students find the first half of the course easy and the second half extremely challenging. This is because the first half focuses on logic, but the second half emphasizes algebra skills. Nonetheless, ECE 313 does not merely exercise your prior mathematical calculation skills, since you must choose and justify a distribution to use for a problem.

Work:

The work consists of a total of 13-14 weekly problem sets, two midterm exams, and a final (which is usually worth 45% of the final grade). The assignments usually contain problems that are intended to be neither too challenging nor too trivial for students who are up to speed with the material. These problems are a mixture of simple calculation, application to real-world situations, and derivations of relations that may save time and work in the future. Old websites are archived, along with solutions to previous homework and exams. Please resort to this useful resource only if you are really stuck on a problem; the strategy of copying solutions does not work as well for midterms as finals. The exams will appear trivial compared with the homework problems. Past students have said they have spent between 4 and 13 hours per week for the course.

Life After:

Probability theory forms the basis of communications, control systems, and areas of other fields within electrical and computer engineering. Not surprisingly, ECE 313 is a prerequisite for upper level technical electives in many of these areas, such as ECE 361, 438, 459, 418, etc. For students seeking to broaden their intellectual (and possibly career) horizons, probability theory is applicable to modeling in many areas such as finance and economics. If you wish to pursue graduate studies in the aforementioned disciplines, you should consider MATH 347 (Fundamentals of Math), MATH 415/416 (Linear Algebra), and MATH 444/447 (Real Analysis).
ECE 329 - Fields and Waves I

Instructors:

The course is directed by Professor Kudeki. Past lecturers have included Profs. Oelze, Kim, Waldrop, Peck, and Goddard. Apart from electromagnetics, lecturers tend to have backgrounds in related fields including biomedical imaging/instrumentation, remote sensing, and solid-state electronics.

Prerequisites:

ECE 205 or ECE 210 is listed as the official prerequisite to the course. Since a fundamental understanding of electromagnetic waves and their applications, Coulomb forces, Gauss’s laws and Maxwell equations is crucial, it is generally advisable to review PHYS 212 before taking this course. Circuit fundamentals from ECE 205 or 210 are applied towards the end of ECE 329 when studying transmission lines. Familiarity with phasors, basic differential equations, and vector calculus is helpful for mathematical expressions such as Maxwell’s equations and potential functions. Students are also expected to be comfortable with elementary geometry and calculus – two very useful tools for studying plane waves.

When to Take It:

Officially, ECE 205 or 210 are listed as prerequisites. Exceptional students who have excelled in math and physics may find it feasible to take ECE 210 and 329 concurrently, because there are a few topical overlaps between the two courses, such as the concept of phasors. For most students, however, taking ECE 210 helps them get accustomed to the mathematical rigor involved in electrical engineering. ECE 205 is a course on circuits for students not in electrical and computer engineering and is considerably less math intensive than ECE 210. As the first 300 level course, ECE 329 appears intimidating; however, it is no more rigorous than ECE 210.

Class Content:

The first part of the course is a survey of electrostatics and Maxwell’s equations, which are relevant to electromagnetic fields in both differential and integral forms. They form the backbone of this course; knowing them from the beginning is advantageous as some later concepts are formulated within the same framework. Students then learn about potential functions, electromagnetic wave behavior in material media such as conductors, dielectrics, and magnetic materials. The course emphasizes plane wave transmissions and their phasor forms; it is advisable to pay close attention to their mathematical derivations. Towards the end of the course, students learn about transmission lines and using Smith charts to determine reflection coefficients and input impedances.

Work:

There are 14 weekly homework sets with roughly six problems. These problems are generally not too difficult and tend not to contain calculations, but rather derivations of expressions. Past exams have been known to contain at least two problems from homework; study then carefully and make optimal use of resources such as the text, online notes, and practice problems. These assignments are not time consuming for students who try to link mathematics and concepts from physics. Exams are also based on the fundamental concepts and contain both conceptual challenges as well as straightforward calculations. Overall, ECE 329 requires an average weekly time commitment in relation to other ECE. Past students said they have spent between 3 and 10 hours per week on this course.

Life After:

Wave and field behavior is relevant to topics ranging from theory to application in areas such as wireless communications, optics, GPS, and modeling of interconnects in circuits. ECE 329 provides a better direction of their intellectual and professional interests in ECE. Knowing electromagnetics is beneficial in the solidstate electronics area. Simulation of electromagnetics in various media is a major research undertaking. The follow-on elective, ECE 350 Fields and Waves II, takes a broader and more in-depth survey of lines, fields, waves and their behavior in transmission lines and antennas, building on ECE 329 concepts. It is advisable to take 350 immediately after 329. As of Spring 2011, ECE 329 and ECE 342 are the prerequisites for ECE 453: Wireless Communication Systems. ECE 437: Sensors and Instrumentation also lists ECE 329 as a prerequisite.
ECE 340 - Solid State Electronic Devices

Instructors:

Prof. Leburton is the course director. Professors that have taught ECE 340 in the past include Prof. Pop, Liu, Gilbert, Carney, Fang, Mohamed and Tucker, to name a few. Most professors who teach this course specialize in device physics or nanoelectronics.

Prerequisites:

Officially PHYS 214 is listed as a prerequisite, while ECE 329 is listed as a pre-/co-requisite. ECE 340 involves many physics concepts such as diffusion and particle distribution, so having completed PHYS 213 is almost as important as PHYS 214. In fact, several PHYS 213 lectures cover semiconductor physics at a basic level. The first part of ECE 340 will involve various topics from PHYS 214 such as the concept of discrete energy levels, and a brief discussion of Schrödinger’s Equation and its consequences in semiconductors. Relevant topics from ECE 329 include Maxwell's equations in material media and carrier mobility. They apply in ECE 340 to topics such as p-n junctions and carrier flow, but should be covered early enough in the semester if taken concurrently with ECE 340. Overall, these courses are most helpful in developing an intuition for what is happening at the physics level inside electronic devices.

When to Take It:

Taking this course in accordance with the stated prerequisites and co-requisites is especially important for ECE 340, due to its emphasis on conceptual understanding. Because of the overlap with physics concepts, it is best to take this as soon as possible after the prerequisites. This course is a gateway to many other courses in electrical engineering such as electronic circuits and IC fabrication, and in physics. It is beneficial for students considering careers in anything to do with physical and quantum electronics and circuits to take ECE 340 as early as possible.

Class Content:

Much of the theory discussed in ECE 340 can be traced back to discoveries made in ECE at Illinois. The material in ECE 340 is cumulative in a very clear-cut manner; new topics build on previous topics continuously in the course. In the beginning, students are introduced to semiconductor physics with crystal lattice structures, doping, energy band diagrams, and carrier drift and diffusion. These topics form the theory and math needed to cover the next section of p-n junctions and diodes. P-n diodes are then used in understanding the physics behind bipolar junction transistors and finally metal-oxide transistors, the last topic covered. Recent changes to the course have emphasized theory and concepts over equations and rigorous math. Therefore this course is similar to physics courses in that it is essential to have an understanding of the concepts and not just the equations. In fact, part of the conceptual understanding involves recognizing when various approximations can be made that simplify analysis and calculations. This includes the effects of heavy doping or ignoring the effects of recombination of carriers.

Work:

Homework assignments are assigned each week and usually consist of three or four problems that may involve drawing band diagrams, derivations, calculations, conceptual explanations, or using an online semiconductor simulation applet. It is important to keep up with the material and attend class because several unannounced quizzes are offered throughout the semester. Many of the homework and exam problems are very similar to those in the textbook. Therefore, it is advisable to do work beyond the homework in order to prepare for exams. There are often several different sets of lecture slides and online texts on the course website that are helpful if the student needs a slightly different explanation of some difficult material.

Life After:

Not surprisingly, ECE 340 is the prerequisite to many courses in the area of solid-state electronics, including ECE 441 (Physics and Modeling of Semiconductor Devices), ECE 444 (Theory and Fabrication of Integrated Circuits), and ECE 482 (Digital IC Design). Taking ECE 342/343 (Electronic Circuits) either before, concurrently, or after ECE 340 provides a good overview of electronic circuits at both the device and circuit levels.
ECE 385 - Digital Systems Laboratory

Instructors:

For many years, Prof. Janak Patel taught the lecture section. In fall 2009, Prof. Rakesh Kumar taught the lecture section. In any case, you will interact more with TAs for the duration of the class, which is mostly laboratory work.

Prerequisites:

You must take ECE 290 before ECE 385. The wiring skills learned in ECE 110 labs are also extremely useful. An understanding of the concepts presented in ECE 290 is essential to completing the labs in this course. Being able to recall memory, counter, state diagram, and LC-3 concepts is crucial to doing well in this course.

When to Take It:

Many students take ECE 385 in first semester of their junior year. It is strongly recommended to take this course as soon as the student has finished ECE 290 so that the material from ECE 290 will still be fresh. Although some EE students take ECE 385 in their last semester because it is the last required CompE course for EE majors, this is not recommended for students doing well in ECE 290. Not taking this class will not affect EE curriculum severely.

Class Content:

The purpose of the course is to get experience constructing circuits, instead of only working with theoretical design. Each week is a new lab and, unlike other lab courses, much of the work designing and constructing the lab is done outside of class. The lab time itself is usually used for demonstration of your work or debugging if something goes wrong. The first half of the semester, you will use ICs and wires to build your circuits on a breadboard. The 7th lab switches to VHDL design to be implemented on an FPGA. VHDL is a unique language in the code you write is compiled into instructions that the FPGA uses to rewire its hardware—you aren’t writing code that is executed on set hardware, you are writing code that creates hardware to perform a function. It is like a virtual simulation of hardware on a computer. It is a good language to know for interviews as VHDL can be used to simulate complicated circuits, so employers value your exposure to the language. The class as a whole is good to take as it introduces you to some of the difficulties encountered in actually building circuits, as opposed to simply making a theoretical design. Some people also refer to this course as a debugging course, since you learn almost as much about debugging as you do about circuit design.

Work:

Don’t be fooled by the fact that ECE 385 is a 2 hour class. The class requires extensive work each week completing the labs, often taking 10 to 20 hours. Overall, ECE 385 requires much larger weekly time commitment than an average ECE course. Past students said they have spent between 15.3 and 20.7 hours per week on this course. It is extremely helpful to know a lab partner whom you can work with before registering for the class. There are ten labs total and a final project. Not only does the designing and wiring have to be completed outside of class, but students should also debug before demonstrating their lab. Additionally, the labs require reports which will take several hours to complete. Sometimes it helps to ask a TA about grading criteria. You will spend more time on the labs as the semester progresses and the difficulty of the labs increases. You will get several weeks to work on the final project; make sure you start early in case you run into difficulties. It is possible to take this class with other work intensive classes, but you will have a heavy semester. This is a challenging course, but finishing it will be rewarding.

Life After:

Computer engineers thrilled by this course should take ECE 391 right away, which is a prerequisite for ECE 411, the next course using VHDL. VHDL is in a family of Hardware Description Languages (HDLs) including Verilog, SystemVerilog, and SystemC. HDLs are similar to programming languages in that once you’ve learned one, the similarities of concepts between HDLs overwhelm the differences of syntax. Learning VHDL in 385 prepares you well to use any HDL in the workplace. There is a huge job market for working with FPGAs. Additionally, the concepts learned in this class are applicable to ASICs and processors. The “Life After” section for ECE 411 elaborates on career opportunities.
ECE & CS Technical Electives

This section contains course reviews for ECE and CS courses which can be used for technical elective credit. Some of these classes are required for some students, depending on their major.
CS 173 - Discrete Structures

Instructors:

Professor Margaret Fleck and Professor Viraj Kumar usually teach CS 173 however there may be some different professors in different semesters. Both Professors are great at discussing the material and Professor Fleck provides informative notes from the lectures. Her class notes are definitely a contending substitute for the textbook and are great review material for this class. She makes her notes available on the website for anyone so getting the class notes is easy as well. Both professors are also great at carefully explaining confusing material during their office hours. They usually take extra care to ensure that all questions are answered and the material is learned.

Prerequisites:

CS 173’s few prerequisites is that its students have seen some code beforehand and have been in coding classes. Most of the official prerequisites are definitely a must since coding is a dire requirement for this course. Students who get credit for any of CS 101, CS 125, or INFO 103 should be fine to take this class. All ECE majors who have also taken ECE 190 will be more than prepared for the course. Though the course website indicates that Math 220/221 and Math 231 requirements, they are not strict. It is very rarely the case that students find calculus concepts in this class. Most of the concepts covered will be in the discrete domain and it is not necessary to have an in-depth understanding of calculus, especially Calculus II.

When to Take It:

Discrete Structures officially a prerequisite for CS 225, which is the gateway to most, if not all CS courses. However, some students do well by taking CS 173 and CS 225 together. There is a lot of overlap between the two classes. However it is still recommended that CS 173 be taken before CS 225. As such, take Discrete Structures as early as possible, especially for Computer Engineering majors. Most higher level CS courses will definitely cover discrete math concepts so the topics introduced in CS 173 will be reviewed again and again. Furthermore a lot of the computer engineering concepts are also introduced in this class and so it will complement a lot of early computer engineering classes, like ECE 190 and 290. Though it is possible to do well even when taking discrete structures concurrently with a coding class, like ECE 190 or CS 125, it is highly recommended to take the coding class before taking CS 173. An exposure to coding will greatly help the understanding of discrete math and taking them concurrently will most likely just be a bigger burden to try and grasp the concepts faster.

Class Content:

The topics covered in CS 173 will introduce number theory concepts, mathematical proofs, especially inductive proofs, set theory, graph theory, recursive relations, trees, counting, common algorithms, and big O analysis. The beginning of the course is first a review of math concepts and basic boolean logic, then the class covers proofs and number theory. After number theory the class covers sets, relations and functions and the first midterm will be about this time. After the midterm the class will cover graph theory and induction which will lead to recursive functions and unrolling. The class then goes into trees and big O analysis and about this time will be the second midterm. The last topics covered will be algorithms, sets of sets, counting and planar graphs. All of the concepts introduced in CS 173 will definitely be seen in higher level CS and ECE courses. Set theory, graph theory, recursive relations, algorithms, proofs and trees will all be seen again in CS 225. Counting is a major part of ECE 313 and PHYS 213. ECE 190 and 290 will also cover a small amount of algorithms, trees, state diagrams and counting. Most importantly, though CS 173 will introduce the fundamentals, a lot of higher level classes will work from these concepts so the content seen in CS 173 will be very persistent in a lot of the core ECE/CS classes.

Work:

The class structure was changed as of the Spring 2012 semester to include three exams, weekly homework assignments, and a brief Moodle quiz corresponding to each lecture (due shortly after the lecture it corresponds to). Of the three exams there are two midterms and a final. Discrete Structures is a very straightforward class but it is very easy to fall behind at the end of the semester. Furthermore, the homework sets are definitely difficult and it is helpful to work in groups when doing homework or studying. The homework will generally take about 4-6 hours to complete each week, but there is a lot of help available. The quizzes and exams are fair and are mostly easier than the homework. There are still some challenging questions here and there, but the exams and quizzes are usually a lot more straightforward. Reading the class notes will be more than enough to keep up with the class. Some parts, like trees and relations may seem really straightforward but students should always just try and keep up with the class since there are some concepts are the very, very difficult, like graph theory, sets of sets, functions, and counting. There is also a textbook available for the class and it is very helpful in explaining the concepts but is not specifically required to do well in the course. Professor Fleck's notes are more than enough to keep up with the class. Overall, Discrete Structures covers a lot of material but is given at a very good pace with a lot of support from the staff. Students should just try and keep up with the material and everything should be fine.

Life After:

CS 173 is the gateway to all higher level CS and ECE tech-electives. Content seen in CS 173 will be reviewed again and again for most ECE/CS tech-electives. CS 225 (Data Structures) can be taken afterwards, if not taken concurrently. For students who enjoy CS theory, consider CS 373 (Theory of Computation) and CS 473 (Fundamental Algorithms), which both build on the fundamentals introduced in CS 173.
CS 225 - Data Structures

Instructors:

Cinda Heeren has been teaching this course for a several years now. She is a very capable instructor who is also very friendly to students. She also tries to keep class interesting, sometimes involving the class in activities not normally seen in traditional "lectures." In general, her explanations are clear and thorough. She always uploads her lecture slides to the course website, and these generally are good enough to make the textbook unnecessary.

Prerequisites:

Officially, one of either ECE 190 or CS 125 and one of either CS 173 or MATH 213 (Discrete Math). Since ECE 190 teaches C while CS 125 teaches Java, during the early part of the course the ECE students need to pick up the concept of “classes” while the CS students need to learn how to use pointers. It seems like the students coming from ECE 190 have a slightly easier time, but after a couple of weeks everyone is pretty much on the same page. Although officially it says CS 173 or MATH 213 is required, not having taken either of those two courses doesn't put a student at much of a disadvantage. The only important skill from those classes that's needed in CS 225 is the ability to see induction and do inductive proofs. This can be learned fairly easily with a little bit of effort. If a student is taking Discrete Math at the same time as CS 225, then induction would have already been covered by the time CS 225 may need it.

When to Take It:

For EE students using this class as one of the 3 out of 5 courses, it doesn't really matter when CS 225 is taken. However, for CompE students, this class is much more important as it is the gateway to many upper level ECE and CS courses. CS 225 should be taken soon after taking ECE 190, and as mentioned earlier, it can be taken after or in conjunction with Discrete Math. With the emphasis placed on using software for a variety of work in ECE, this is a fundamental course and will benefit EEs seeking to strengthen their programming skills. Another reason to take this class early is so the student will have an advantage if applying for internships related to software development.

Class Content:

For students interested in pursuing any kind of software development in their careers, the material covered in CS 225 will be extremely important and useful. The class introduces students to many types of data structures such as lists, stacks, queues, and trees, as well as searching and sorting techniques. These are all fundamental concepts that interviewers will test time and time again. Students will learn the inner workings of how to implement these data structures in code as well as learn to analyze its performance using principles from discrete math - namely, big-O analysis.

Work:

Students who enjoy programming will love CS 225. The majority of the workload for the class is contained in the form of usually 7 MPs. 2-3 weeks are given for each MP. Many of the MPs are really cool, such as compressing an image using a quadtree or building a random maze and then solving it. Students who start early and work at a steady pace will find doing the MPs to be pretty fun. There is also a lab section for this course, and in recent semesters the lab assignments have been mandatory. Usually the labs focus on practicing new concepts. Labs are graded but solutions are provided too. Overall, this course requires a fairly larger weekly time commitment in relation to other courses in the ECE curriculum. The class also has 2 midterms and a final - the midterms tend to focus more on understanding and writing code, while the final has a bit less code and focuses a bit more on big-O performance of the algorithms you've learned in class.

Life After:

As mentioned earlier, CS 225 is a prerequisite to many higher level ECE and CS courses. Many course options that are cross-listed between CS and ECE such as ECE 448 (Artificial Intelligence) open after taking this class. In addition to this academic aspect, there's a real-world benefit as well. Students looking towards software development as a possible career will find that the concepts learned from this class will help greatly in competing for internships in this field.
CS 373 - Theory of Computation

Instructors:
This course has been taught by various professors, but is often taught by Professors Lavalle and Parthasarathy.

Prerequisites:
Officially, CS 173 (or Math 213) and CS 225 are prerequisites.

When to Take It:
This class is commonly taken by Juniors and a few advanced Sophomores. CS 173 (or Math 213) is a must before taking CS 373, since CS 373 builds everything on discrete math concepts that are taught in these classes. Much of the course is spend showing how certain things are computable, so many times the course goes over some simple algorithms; thus, topics from CS 225 such as breadth-first search and depth-first search are expected to have already been learned and, on a few occasions, big-O analysis is used. Students with a strong background in mathematical proofs will have a much easier time in this class, although experience beyond CS 173/Math 213 is not strictly required.

Class Content:
The course begins with a detailed discussion of Finite Automata - both deterministic (DFA) and nondeterministic (NFA). These essentially correspond to what can be computed in constant memory. Regular expressions are also discussed, and eventually it is shown that regular expressions exactly describe the languages accepted by finite automata, and that both DFAs and NFAs can compute the same languages. At the end of this discussion, several algorithms for deciding questions about DFAs and regular languages are discussed.

After this initial discussion of regular languages, the class dives into Turing Machines, which are supposed to be a theoretical model for algorithms. The halting problem is discussed; a lot of time is then devoted to learning reductions, via which various languages are proven undecidable or unrecognizable.

Context-Free Grammars are also introduced (sometimes before Turing Machines), which capture the idea of nesting different constructs. Chomsky Normal form is constructed, leading to the result that the membership problem for Context-Free Languages is decidable; then the CYK algorithm for quickly testing membership is described. A few algorithms for CFGs are discussed. Lastly, the class begins to talk about basic complexity theory, getting as far as explaining the meaning of the famous P versus NP problem.

Work:
This class is very proof-oriented, with much of the lectures focused on discussing various properties of different computation models. The work for this class is primarily located in the homework assignments; the amount of homework may vary significantly from semester to semester; Typical assignments take anywhere from 3-7+ hours; this past semester, there were a total of 6 homework assignments. The class has two midterms and a final. Students not used to mathematical proofs will probably have to spend some time studying to understand the material; collaboration on the homework assignments is occasionally allowed, so it may be beneficial to take this class with a friend.

Life After:
Students interested in learning more about algorithms and complexity theory should consider CS 473 (Fundamental Algorithms). The discussion of regular and context-free languages makes 373 a good introduction to issues of parsing and lexing programming languages, which is important for CS 421 (Compilers and Programming Languages). A variety of other upper-level CS classes list CS 373 as a prerequisite, such as CS 476 (Program Verification), and CS 477 (Formal Software Development Methods). Students who have taken CS 373, CS 225, and ECE 391 will have the necessary prerequisites to take almost any 400-level CS class.
CS 418 - Interactive Computer Graphics

Instructors:
John Hart has been teaching this course for a while now. He has been working in the field of Computer Graphics for a long time, and he's a really great teacher.

Prerequisites:
The official prerequisites are CS 225, one of MATH 225 or MATH 415, and MATH 241. If you know enough about matrix theory and basic matrix math/manipulations, you can probably get away with not taking MATH 225 or MATH 415. This course assumes knowledge of C/C++ programming, vector calculus, and some matrix theory.

When to Take It:
Most people that take it do so during their junior or senior year, but this course can be taken as soon as you complete the prerequisites. CS 418 is typically offered every semester. It's a good technical elective to round out a solid course load, without adding too much extra work.

Class Content:
CS 418 offers a hands-on introduction to computer graphics. Students will learn about Graphical Processing Units (GPUs) and how to program them for graphical applications. The standard language used is C/C++ with the OpenGL library, but ambitious students are allowed to explore other technologies, languages, and libraries (like WebGL) for their MPs. The course material also covers essential topics in computer graphics like color theory, perspective/viewing, transformational geometry, the graphics pipeline, lighting techniques, textures and environment mapping, parametric surfaces, vertex and fragment shaders, physical simulation, and animation.

Work:
This class has 4 different MPs, each designed to demonstrate mastery of the topics described above. Students get a few weeks to do each MP, which is usually plenty of time to finish. The best part is that when students finish each MP, they end up with a really nice graphic that would be great as part of a portfolio to show off to future employers. The class also has a 2-3 written exams over the course of the semester, which test overall understanding of the topics and techniques discussed in class. For an MP-based technical elective, this course is not overly time consuming.

Life After:
Students who are interested in continuing in computer graphics after this course, it is recommended that you take CS 419 (Production Computer Graphics), which builds upon the knowledge learned in CS 418. Students interested in learning more about programming graphics cards may be interested in ECE 408, which teaches CUDA, a language which enables general-purpose parallel computations on graphics cards.
CS 419 - Production Computer Graphics

Instructors:

The class is taught by Professor David Forsyth, who is a well known figure in the field of computer vision.

Prerequisites:

The official prerequisite for the course is CS 418, which should be taken prior to taking this class. As with CS 418, it is important to know the basics of Linear Algebra (matrix and vector math); it is also recommended to have a good general understanding of calculus and statistics.

When to Take It:

The class is usually offered only in the spring semester. It is recommended to plan ahead and take CS 418 sometime before taking this. Since this class is the most advanced graphics class offered at the undergraduate level, it is recommended to take this class during the junior or senior year of the undergraduate curriculum.

Class Content:

The topics covered in CS 419 are very different from those covered in CS 418. Whereas CS 418 focuses more on real-time rendering using OpenGL, CS 419 covers topics such as ray tracing, texture synthesis, image analogies, hole filling, 3D reconstruction from multiple images, modeling, and animation. A lot of emphasis is put on ray tracing and related techniques which requires students to understand the concept of integration and statistical sampling. However, students are not required work out any explicit mathematical solutions. Later topics are rather brief overviews of many different areas of graphics research. These topics are largely based on published graphics papers, so this class helps if you are planning to go into computer graphics for graduate school.

Work:

The class does not usually have a midterm exam, but it does have a final. There are 6 MP's throughout the semester. The MP's can all be done in groups except for the first one. The first three MP's require you to build a ray tracer which outputs an image of a scene, and add features to the ray tracer you have built. The fourth MP requires you to pick one of three graphics papers covered in the class and implement a working program using the algorithm presented in the paper. The fifth MP is not really an MP since you just need to use an existing software to insert a virtual object into a video. In the final MP, you also get a choice between 5 different topics covered in the later parts of the class. The MP's are not too bad if you have decent programming experiences and have understood the lectures, but it can get somewhat time consuming to debug due to the time it takes to render your images. Even though you can use any language to implement your MP, it is recommended to use a language with fast execution time (like C++), because more time may be spent waiting for your image to render rather than you writing code.

Life After:

This class is geared towards people who are serious about getting a career in a field related to computer graphics. It teaches you more advanced topics in graphics in case you wanted to go to graduate school or work as a graphics engineer.
CS 425 (ECE 428) - Distributed Systems

Instructors:
This course has been taught by a variety of CS and ECE professors. Recently, it has been taught by Professors Vaidya and Borisov.

Prerequisites:
Officially, the prerequisite is one of ECE 391 or CS 241.

When to Take It:
This class requires strong programming skills and a good understanding of asynchrony in programs; exceptional students may find it possible to take it at the same time as ECE 391 or CS 241. This class is offered every semester.

Class Content:
CS 425 is an overview of Distributed algorithms and Distributed Systems concepts. The class starts off with a discussion of different system models which will be used throughout the semester - namely, synchronous and asynchronous networks. After this, the class covers failure detection, timing and ordering issues (in the context of multicast), and continues to discuss the impossibility of consensus in an asynchronous system if even 1 process might crash. From here, many different topics are covered, such as distributed hash tables, distributed mutual exclusion algorithms, leader election, concurrency control (transactions), byzantine fault tolerance, replication, distributed shared memory, and various approaches to consistency, partition resilience, and availability, to name several; some major themes throughout the course are Fault Tolerance and scaleability (peer-to-peer designs). If time remains, other topics may be covered.

Work:
The lectures tend to move pretty fast and cover a lot of material. The class has a single midterm and a final; as such, it is necessary to review a good deal before both tests. The class also has several homeworks and 2 or 3 MPs. The homeworks are not given very often, and often will necessitate a bit of review, but otherwise are not too hard. The MPs is where a good portion of the work for the class comes in. MPs are done in groups of 2, so finding a good partner is a great asset. The MPs usually take about a month, and are on topics such as reliable, causally-ordered multicast and distributed hash tables. The MPs require a bit of socket programming and some understanding of the basic OS utilities such as how processes work and how to use system calls (especially fork()). The overall workload for the class varies based on whether there is currently an MP - the workload is pretty light when there is no MP going on, but MPs take a serious amount of time. Unlike earlier classes such as CS 225 and ECE 190, MPs require careful planning and cannot be implemented in a few nights.

Life After:
Students who enjoy this class may want to consider CS 438 (Networking). This course prepares students to design distributed systems such as peer-to-peer networks or cloud-style services, so this class is great preparation for working on internet or cloud applications.
CS 426 - Compiler Construction

Instructors:

CS 426 is usually taught by Vikram Adve. It is generally only taught in Fall, so plan your schedules accordingly.

Prerequisites:

For Illinois undergrads, CS 421 (Programming Languages and Compilers) is listed as a prerequisite. It is a fairly strict requirement: the professor will assume students have lexing and parsing mastered before the course starts. He goes over both very briefly as a refresher, but students will definitely need to learn it on their own if they haven't taken CS 421. For graduate students coming from other universities, ideally students should have taken at least one PL/compiler course. The class is practically oriented, so if the previous course was theoretical most of the material will be new.

When to Take It:

As previously mentioned, this class is best taken after CS 421, so students should be familiar with compilers and the basic steps a program takes from source to binary. It helps, but is not essential, to be familiar with standard CS concepts like DAGs, graph traversal algorithms, etc. The course project is in C++, so students should be comfortable with the language and with pointers in order to save yourself a lot of headache during the multiple MPs.

Class Content:

The overall structure of the class closely follows the flow of a modern compiler. Adve first starts with lexing and parsing, which involves reading in source code and converting it to a tree format (AST). He then moves on to IR generation, which takes a good chunk of the class. The final segment of the class is about optimization, register allocation, and instruction scheduling. Below is a list of topics (not necessarily in-order, as Adve likes to jump around):

- Intermediate Representations: Ways of representing code from possibly multiple source languages that make it easy to do optimizations.
- Runtime Environments: Techniques for interpreting programs
- Intermediate Code Generation: Ways of generating intermediate code from source code
- Optimization Basics: How to optimize code to run faster or use less memory
- Dataflow Analysis: How to analyze code to determine how to optimize it
- Global Optimizations: More advanced techniques to optimize code to run faster or use less memory
- Register Allocation: Algorithms for mapping IR variables to registers
- Instruction Scheduling: Converting IR to machine (assembly) code

In general, you will be taking what you learn in lecture and using it when doing the MPs. Paying close attention in lecture can make your life much easier, since parts of the MPs are often done outright in lecture.

Work:

Most of the work in the class will be in doing the Machine Problems, which take students through the process of writing a compiler frontend. Students are given 2-3 weeks for each machine problem. The first MP involves writing a lexer and parser for Cool, a simple object-oriented language. Two sub-MPs will have students convert the AST to LLVM compiler Intermediate Representation. The third MP will have students implement some of these optimizations in your compiler. Each of these MPs is pretty in-depth - little code other than class definitions is given to students. Each takes about 10-20 hours.

There are also two Homeworks, which mostly revolve around stuff in class that's not covered by MPs. Each takes around 5 hours.

There's also a midterm and a final. Students can optionally take this class for 4 units and do a project involving a additional optimizations for their compiler.

Life After:

CS 426 is a good intro compilers class that teaches students in detail how compilers are actually implemented. The natural next step is to take CS 526, the graduate version which has a more focus on research. Students in CS 426 also learn LLVM IR and a bit about the LLVM code base in the class, which will make the learning curve if they want to do an LLVM-related project much easier.
CS 438 - Communication Networks

Instructors:

In recent semesters, this class has been taught by Robin Kravets and Constantine Polychronopoulos. It has also been previously taught by Steve Lumetta and Philip Godfrey.

Prerequisites:

The official prerequisites are: CS 241 or ECE 391, and one of ECE 313, MATH 461, and MATH 463.

When to Take It:

Most students who take this class do so as Juniors or Seniors; it is offered every semester. Taking ECE 391 or CS 241 beforehand is a good idea because the class discusses a lot of algorithms that involve some element of parallelism, some of which are typically implemented at the OS level; moreover, the class is taught in C, so having the extra C programming experience from ECE 391 or CS 241 is helpful. The other prerequisite - a probability class - is also helpful, but all that is really necessary is a good understanding of simple probabilities and a willingness to self-study some of the more complicated probability concepts, such as Markov processes, and exponential and poisson random variables; students who take one of the probability classes concurrently will learn most of the necessary probability material before it is needed. Some small bits of the material in this class are review from ECE 110, ECE 210 and ECE 290, such as error detecting and correcting codes and Nyquist's theorem.

Class Content:

This class covers a lot of material. Essentially, the class is programming-centric view of networks that covers the 7-layer OSI model, starting at the bottom layer and moving up. The class begins with the Physical layer, briefly talking about encoding information onto signals and modulation; moving on to the data-link layer, framing and error detecting and correcting codes (such as parity bits, Hamming codes and CRCs). At this point, the class begins discussing of shared media, covering various approaches to media access control protocols, with aloha, ethernet, wireless, and FDDI's token-ring protocols as examples. Next, bridged networks and switched networks are discussed. The class then dives into routing protocols - specifically, the distance vector and link-state methods. Finally reaching the core of the network layer, the course dives into internetworking, talking about IPv4, IPv6, IP address assignment, CIDR, subnetting, and NATs. Border Gateway Protocol is discussed, as well as DNS. After this discussion of how the internet works, the class moves on to the transport layer, discussing how to implement reliable, in-order end-to-end protocols, with TCP as the prototypical example; the class also discusses congestion control and congestion avoidance, and the various solutions attempted by different TCP implementations. At the end of the semester, the class briefly discusses quality of service, performance analysis, and network security.

Work:

The workload for this class may vary depending on the professor; when taught by Robin Kravets in Spring 2012, this class had a very substantial workload for a technical elective. The class has both homework assignments and MPs. In recent semesters, there have been 4 homeworks - approximately one a month. Each assignment is fairly long, covering a lot of material and often taking 10+ hours each to complete, mainly because of the length. Additionally, there are typically a few MPs in this class; in Spring 2012, there were 3 MPs: the first MP was implementing a simple Google Talk client, leveraging existing libraries; the second MP was the most complicated, in which students had to implement their own distributed routing protocol which ran in a simulated network. The third and final MP required reliably transferring a file, which essentially involved implementing a TCP-like protocol. The second and third MPs are typically done in pairs, but for the second MP each student had to write their own routing protocol, and only shared code for the network simulation.

The class has a midterm and a final. The difficulty of the exams will depend on the instructor, but given the sheer amount of material covered, it is easy to spend a lot of time studying for the exams, especially for the final. The book for the class covers everything found in lecture and more, but it is advisable to use lecture slides & past homework for review since the book is not a quick read.

Life After:

Students who enjoy this class might also like CS 425 (Distributed Systems), which discusses applications that can be built on top of networks. For those interested in Wireless Networks, ECE 439 (CS 439) is the logical next step. Additionally, one could choose to continue studying networking at the graduate level, with classes such as CS 538 (Advanced Computer Networks), CS 525 (Advanced Distributed Systems), and ECE 567 (Communication Network Analysis). Students interested in security should consider CS 460 (Security Laboratory), CS 461 (Computer Security I) and CS 463 (Computer Security II).
CS 450 (ECE 491, MATH 450, CSE 401) - Numerical Analysis

Instructors:

Professor Michael Heath is the course director and wrote the textbook for this course. Other professors who teach this course are Luke Olson and Anil Hirani.

Prerequisites:

The listed prerequisites are: CS 101 or CS 125; CS 357 or MATH 415, and MATH 285. It is really a good idea to have taken these courses or their equivalents (such as ECE 190 instead of CS 125, Math 286 instead of Math 285, etc.) beforehand, especially MATH 415. The material in CS 450 builds upon many of foundational concepts in these prerequisite courses, so students would be at a significant disadvantage if they didn't come in with the proper background. This is one of the few ECE/CS courses that will revisit every MATH 415 concept in some way, shape, or form. If a student doesn't have the required background but still wants to take a similar class, CS 357 provides a much gentler introduction to a portion of the material covered in this class and doesn't require students to be familiar with linear algebra and differential equations.

When to Take It:

CS 450 is a popular course for both advanced undergrads and beginning grad students and is offered every semester. There really isn't any other undergrad course that follows on to CS 450, so an undergrad who wants to take this class can take this class whenever it works best. However, this class opens up some research opportunities, so an undergrad interested in the area should take CS 450 earlier to give themselves the opportunity. Likewise, CS 450 is a great foundational course for grad students, so depending on a students specialization, they may want to take it sooner than later.

Class Content:

Numerical Analysis is about using computers to solve mathematical problems that come up in all fields of science and engineering. Students will learn about many of the foundational algorithms along with their theoretical underpinnings. This class builds on itself the entire semester: it starts off with a brief introduction to floating-point arithmetic and the challenges it poses. Next it moves into numerical linear algebra: looking at solutions to linear systems, linear least-squares, and eigenvalue problems. Next, it covers nonlinear systems and nonlinear optimization. After that it moves on to interpolation (filling in the gaps in data sequences), after which it tackles numerical quadrature - numerically evaluating derivatives and integrals. Finally, the class looks at differential equations, covering initial value problems, boundary value problems, and partial differential equations. CS 450 is an introductory survey, so it covers a lot of material at a basic level, giving students a solid background to go wherever they want in scientific computing. This class has a lively pace and rarely gets boring, so it is a very enjoyable course, especially for students who are interested in an area of ECE that requires any kind of numerical computation (signal processing, controls, communications, robotics, numerical circuit analysis, etc).

Work:

CS 450 has 7 homeworks that are assigned approximately every-other week. Each of these homeworks will have a handful of problems, and most of the problems involve the implementation and analysis of algorithms and concepts presented in class (either in Matlab or Python, depending on the instructor). The homeworks can require some thought, but they will not take too much of one's time. The class has two exams (an in-class midterm and a final), along with about 8 ten-minute quizzes that are given at the end of each chapter. All exams and quizzes are multiple choice and test a students conceptual and mechanical understanding of the ideas presented in class. They do not require a lot of messy math (that's what we have computers for, and why people take this class). In general, the homeworks will not be a huge burden, but students will spend a good amount of time reviewing material from lectures.

Life After:

As mentioned before, there are really no undergraduate courses that directly follow CS 450. However, grad students and interested undergrads who want to dive further into numerics can take one of CS 554: Parallel Numerical Algorithms, CS 555: Numerical Methods for PDEs, CS 556: Iterative and Multigrid Methods, or CS 558: Topics in Numerical Analysis. Most students who take CS 450 will probably not take these advanced courses, but many will be involved in jobs or research that uses scientific computing in some fashion - anything from simulating rockets at NASA to designing algorithms for high-speed trading on Wall Street.
CS 465 - Principles of User Interface Design, Implementation and Evaluation

Instructors:

The course is taught by Professor Bailey.

Prerequisites:

CS 225 is the official prerequisite for the course. However, the class is also open to non-ECE/CS majors as well. A general understanding of programming and the willingness to learn the required technology for your project is what is really required.

When to Take It:

Take this course when you feel the need to understand how user interface design works. This need generally arises when you are working on a project that involves a user-oriented application. The course is offered every fall.

Class Content:

The class covers an overview of user interface design, starting from how people conceive things to evaluating your designs. The course begins by teaching students how to use various procedures in order to evaluate how people perform an action and use the observation to guide their designs. Then, the course moves on to low fidelity prototypes where students rapidly iterate their interfaces in order to get the best design. Afterwards, students evaluate their design using various heuristics. The course also covers miscellaneous topics that are closely linked to user interface design such as topography or color schemes. Although this course is officially a CS course, the emphasis on design makes the lecture more like a lecture in a humanities class.

Work:

There are three homework assignments and one final project in the course. The homework assignments involve interviewing other people for their feedback, so you need to plan ahead. However, the professor gives students about 2-3 weeks to complete these assignments. The project is a semester-long group project where students get developing an application with a user interface, either on their own or with another student. The project is closely tied to the course content with various checkpoints related to the material covered in lecture. The workload is not too bad (3-4 hours per homework/checkpoint) until the functional prototype checkpoint where students have to implement their applications. As a developer, students may need to spend more than 20 hours, depending on the complexity of their chosen project.

There is one midterm and one final exam for the course. The exams are based on the assigned readings and lectures. The style of the exams are more like general education courses with definitions and short answer questions (almost no equations).

Life After:

The class gives students a good understanding of how user interfaces are designed; students are trained to understands how applications are designed from beginning to end. Unfortunately, there are no other user interface design courses.
CS 473 - Algorithms

Instructors:

This course is taught by many of the algorithms faculty in the computer science department. Some of the past teachers have been Jeff Erickson, Chandra Chekuri, & Sariel Har-Peled.

Prerequisites:

The listed prerequisite is CS 373. However, CS 473 has very little topical dependence on CS 373. The main thing gained by taking CS 373 beforehand is that a student comes in with more mathematical maturity and has a better mental capacity to understand the material. This is why it is highly recommended for undergrads to take CS 373 before attempting this class. Grad students should not have too much of a problem if they haven’t taken CS 373. The classes that are definitely needed beforehand are CS 173 and CS 225. Without the material presented in these classes, a student would be completely lost.

When to Take It:

CS 473 is a required course for all Computer Science majors, so it is offered every semester and there is always good attendance. There really isn’t any follow-up course at the undergraduate level, so there is no real need to take CS 473 right away. CS 473 is also popular with ECE grad students, and when they take it will greatly depend on what kind of research they are pursuing.

Class Content:

CS 473 is a survey of common algorithms used in all fields of computing and covers a wide range of different topics. After finishing this course, students will have a good understanding of many core problems in computer science, and how to solve them algorithmically. Students will also come out with the ability to solve new algorithmic problems by exploiting patterns to come up with efficient computational solutions. CS 473 also gives puzzle-lovers an opportunity to flex their creative muscles because much of the work requires a good dose of "thinking outside the box." More than one student has started calling CS 473 by the name "Advanced Puzzles," which is certainly a term of endearment.

The course starts right where CS 225 left off, the first portion is devoted to graph algorithms, covering DFS, BFS, shortest path problems, and many of their applications. The next big topic is recursion, and CS 473 explores two main types of recursive algorithms. First, is "Divide & Conquer" where a big problem can be broken up into small independent problems, and next is "Dynamic Programming" where a big problem can still be broken into smaller problems, but they are all dependent on each other. The class then moves on to a brief introduction of Greedy Algorithms and Randomized Algorithms. Following that, the class spends quite a bit of time on Network Flow and many related problems such as Bipartite Matching. The final leg of the class looks at classes of "Hard" problems that are not known to have any sort of efficient algorithm. These problems live in different complexity classes such as NP-hard and NP-complete, and students learn the structure of each of these classes and how to prove if new problems are indeed a part of one of these complexity classes. The class might also touch briefly on other topics such as Linear Programming and Approximation Algorithms.

CS 473 is fairly broad and doesn’t cater to any one applied area in ECE or CS, so anyone who will work with computer algorithms in the future will benefit from this class. Furthermore, any student looking to pursue an advanced degree in a computing field will greatly benefit from this course because CS 473 covers classic problems and algorithms come up over and over again in the world of computing.

Work:

CS 473 comes with a heavy workload, so it is recommended for a student to take this class when they have a decent amount of time to give to it. This class has weekly homeworks, which can be done and submitted in groups of up to three. Each homework has three problems that usually involve designing an algorithm to solve a novel problem or doing a related mathematical proof. These problems are tricky and take quite a bit of thought, but they are very doable for any student who stays current on the course material. In addition, there is a weekly quiz on Moodle that is designed to reinforce more of the "nut and bolt" concepts presented in the class, while the written homeworks tend to focus on applying the material. The class has two midterms and a final, and the exams make up the bulk of the course grade. One additional benefit of the CS 473 homeworks is that students start to develop a more mature mathematical writing style. Most students entering CS 473 have not had to write too many proofs or explanations of mathematical processes, and the class gives them an opportunity to hone their skills.

Life After:

CS 473 isn’t really a prerequisite for any other undergraduate course, but many of the presented topics come up in graduate courses and computer research. Students who really enjoyed CS 473 might consider taking CS 573, the graduate version where some of the same material is covered, but in much more depth. Other courses of interest are CS 598CC Approximation Algorithms, & CS 579 Computational Complexity. Students who enjoyed the the graph theory presented in this course may want to take MATH 412 (Graph Theory) if they want to deal with graph theory in a more traditional sense.
ECE 310 - Digital Signal Processing I

Instructors:

Directed by Prof. Singer, this course is usually taught by recognized veterans in the digital signal processing (DSP) field such as Profs. Bresler, Jones, Liang, Ahuja, Singer, Smaragdis, and Do. Sometimes the semester will be split between two different lecturers.

Prerequisites:

The official prerequisite is ECE 210 analog signal processing. Many of the topics in the last third of ECE 210 (LTI Systems, stability, Fourier and Laplace transforms, frequency response and block diagrams) will be found again in ECE 310—in the digital domain. Knowing Fourier transforms is crucial to this course. Students not yet exposed to MATLAB may want to learn a little about it on their own. This course will have a very fast pace right from the beginning. Since DSP is applied mathematics by nature, having taken courses such as Math 415 will put you at an advantage. Be prepared for heavy math requirements in this course.

When to Take It:

If you want to work in DSP, Communications, or control systems, you should take ECE 310 immediately after 210 because it is a gateway course (in content and as a prerequisite) to other courses in the communications/systems/signals area. It is recommended to take this course right after ECE 210 if you want to be involved in fields associated with signal processing. This is one of the 3 out of 5 choices for EE majors. A lot of EE applications are associated with this course’s material. Even for students who are not planning on specializing in signal processing, this course can still be useful. It is also highly recommended that you take the new Matlab supplement, ECE 311, in conjunction with ECE310. Though it is not required, 311 will give a more realistic view on how one might apply DSP to a real system using computational software. It also helps to reinforce the concepts covered in lecture.

Class Content:

As the title suggests, you will see everything in ECE 210 once again—but in digital form. Replace every integral you saw in ECE 210 with a summation and you have digital signal processing, sort of. In the first part of the course, students take an idealized look to the digital frequency domain and the discrete time Fourier transform, which is ultimately a special case of the Z-transform. Many of the characteristics of systems covered in ECE 210 such as linearity, causality, and stability along with operations such as convolution surface once again—only this time with respect to the digital domain. Analog to digital and digital to analog converters, along with considerations of aliasing are also discussed. Each of these topics forms a building block to digital filter design, in which students participate towards the end of the course. At this point, practical considerations are introduced regarding finite impulse response (FIR) and infinite impulse response (IIR) filter design methods and the advantages and disadvantages of each. Upsampling and downsampling are also covered. The course covers the FFT (fast Fourier transform), which has many applications. ECE 310 wraps up with discussions of application and other methods that can reduce the computational cost of filter implementation.

Work:

The workload in ECE 310 comprises about 14 weekly problem sets, quizzes (there are six of these), and a final. The problem sets cover a wide spectrum and contain a variety of types of problems: computations, derivations, coding in MATLAB, and conceptual explanations. Although there is not really any new mathematics introduced in ECE 310, computations in these problem sets and quizzes can be complex and sometimes demand some time and thought. On that note, successful and timely completion of homework assignments generally suggests readiness for quizzes. The quizzes and the final exam are the only major factors in determining students’ grades. On some semesters, there will be three midterm exams instead of quizzes. By investing time each week into understanding the concepts and the homework, students can be successful in this class. The final exam is comprehensive.

Life After:

ECE 420 Embedded DSP Lab gives students hands-on experience with design related problems. ECE 417 (Multimedia Signal Processing), ECE 418 (Image and Video Processing), and ECE 480 (MRI) give students a glimpse into other applications of DSP. Although there aren’t any undergraduate speech processing courses, several efforts have been made in the past with special topics (ECE 398, 498, etc.). Other relevant and related courses include ECE 361 Digital Communications, ECE 459 Communication Systems, ECE 486 Control Systems, and ECE 403 (Audio Engineering). You should also consider MATH 415 or 416 (Linear Algebra), MATH 444 or 447 (Real Analysis), or ECE 493 (Advanced Engineering Math) if you wish to pursue DSP at the graduate level. A new class on global satellite navigation, ECE 456, was recently introduced and makes use of concepts developed in ECE 310.
ECE 311 - Digital Signal Processing Lab

Instructors:

This class was first introduced in Summer 2011. The professor who taught that class at the time was Prof. Chandra Radhakrishnan. However, the instructors for this class seem to change every semester. Currently, Prof. Liang and Prof. Bresler are teaching this course in Fall 2011, and Prof. Do and Prof. Smaragdis taught the course in Spring 2012.

Prerequisites:

The prerequisite for this class is ECE 310 (Digital Signal Processing I). It can be taken concurrently with ECE 310. Knowledge on Digital Signal Processing is necessary to take this class.

When to Take It:

ECE 311 and ECE 310 were used to one course called ECE 410 not long ago. It is highly recommended that you take this class concurrently with ECE 310. This class is the perfect complement to ECE 310. It helps you further understand the concepts in ECE310 such as DFT, z-transform or filter design. ECE310 is offered every semester. You can also take this class in the spring (ECE310 is offered in the spring as well). This is not too hard a class, so you can take this class to accommodate a challenging schedule.

Class Content:

This class is designed to be the complement to ECE310. The work for this class is primarily in MATLAB (and Microsoft Office). This class focuses on helping students understand concepts from ECE310. Instead of working with pencil and paper on problems like in ECE310, students have a chance to work out the problems using MATLAB to plot and understand DTFT, CTFT, DFT, and the like; calculation, the magnitude/phase response of a discrete system, the sampling process, the unit step response, impulse response, effects of quantization, and the z-transform are also covered. The lab teaches students how to use different methods to design different types of filters. You'll have a chance to actually understand how the magnitudes and phases of the designed filters look like, instead of just looking at the derived equations. Note that this class is designed to use MATLAB particularly in DSP, so they only give you a short introduction on basic syntaxes and functions of MATLAB. It will be very helpful if you are already familiar with MATLAB before you take ECE 311, but it will not put you in a big disadvantage if you are not. Each lab session usually runs in small size, around 10 people. It's very convenient to ask TA questions.

Work:

The work required for this class is usually 7-8 bi-weekly labs and one final lab. There's no pre-lab assignment for these labs. The final take-home lab tests you on all the concepts covered in the previous labs, and is due in 24 or 48 hours. The nice thing about this lab class is that you do not have to write extensive lab reports. According to one of the professors who has taught the course, students should spend about 4 to 5 hours to understand the concepts and work on every lab. If you spend more than that amount of time, you should stop by an office hour to get help. It is expected that you are able to complete the lab assignment during the lab sessions, but you may work outside of the lab session if you wish.

Life After:

This lab trains you extensively on MATLAB, so it would be a plus if you take classes that use MATLAB after this class, such as ECE486 (Control Systems) or ECE420 (Embedded DSP Lab).
ECE 330 - Power Circuits and Electromechanics

Instructors:

Professor Pete Sauer has been teaching ECE 330 for many years now. He is one of the most senior professors and an expert in the Power & Energy Systems area. Other professors such as Prof Overbye and Prof Garcia have taught the course in the past alongside Prof Sauer. Usually, ECE 330 will have two sections, the morning section is taught by Professor and afternoon one is taught by TA. Other instructors include Professor Pilawa, a recent addition to the power group at UIUC, and a handful of guest lecturers.

Prerequisites:

The only prerequisite is ECE 210, which is a fairly easy course. Make sure you are good with circuit and linear systems, circuit analysis and elements because they form the basis to the course. After a short review of basic circuit elements along with real, reactive and complex power, you learn concepts of magnetic circuits and electromechanical systems. These will form the basis for understanding more advanced concepts such as induction, synchronous and single-phase machines.

In addition, knowledge about phasors and complex numbers is heavily used in this course. This course contains some knowledge which is taught in ECE 329. However, taking it without ECE 329 is totally fine because ECE 330 focuses more on real applications rather than on pure magnetic theory in ECE 329. MATH 415 is recommended because it will be useful for linear system stability analysis, but it is not required.

When to take it:

Take this course to satisfy the 3 out of 5 criteria, or if you have an interest in power systems stability, inductive motors, and generator design. The best time to take this course is after taking ECE 210, which is usually the first/second semester of the second year.

Class Content:

This class has a lot to do with circuits. The class is roughly divided into four topics. Solving basic circuits using nodal analysis, loop equations and Kirchhoff’s laws constitutes the first quarter of the course. The second quarter comprises of three phase power circuits. Concepts such as Star/Wye and Delta three phase connections, line impedances, phasors and source and load connections are taught. The third quarter forms the basis to the magnetic circuits, mutual inductance and transformers. Key concepts such as flux linkages, polarity markings in mutually coupled coils,induction dot, ideal transformers, equivalent circuits for transformers with linear core and open and short circuit tests for a transformer are taught at this point of time. System stability analysis and system state related knowledge would be covered in third quarter. The last part of the course covers synchronous, induction and dc machines. Differences between motors and generators and synchronous and asynchronous systems are covered.

Work:

The workload for this course is not too heavy. The homework is really crucial as most of the homework problems usually end up on the quizzes. Each quiz typically has one to two problems and it is around 10 minutes, which should be manageable if the homework is done properly. In addition, some critical homework problems will be taught before the quiz begin. Make sure you have a clear idea about each homework problem in order to get a better understand in later class. There will be two midterms. For these midterms one can go through the past exams and solutions. Past exams since Fall 1999 are uploaded on the 330 website. These are a great help when preparing for both quizzes as well as midterms. For the final, it is highly recommended to go through every existing past exam deliberately.

Life After:

ECE 330 opens the door to the power and energy area. You should take this course if you are interested in motor design, grid system and transformer design. You can take up ECE 464 (Power Electronics, Prerequisite ECE 342) and ECE 469 (Power Electronics Lab, Prerequisite ECE 343) in order to have further knowledge on power device such as power electronic switching devices, dc-ac converter. You could also take up ECE 476 (Power System Analysis) if you have an interest in power systems stability analysis. Both of these courses are offered in the fall semester only. During the spring semester, ECE 431 (Electric Machinery) is another course you can take. ECE 431 is closely connected to ECE 330 and the lab of this course usually has heavy workload. ECE 432 is another course which can be taken if you are interested in advanced electric machinery. The only deal is that this course is offered once every two years. ECE 333 (Green Electric Energy) is another great course that is offered every semester. If you are interested in alternate energy such as wind turbines and photo-voltaic cells, you should consider ECE 333. You could also take up Solar Decathlon, which is a two semesters course which satisfies your senior design criteria as well. Finally, if you wish to specialize in the controls area, you should also take up ECE 486 (Control Systems); this will course will help you in power electronic design and lead the way to advanced grid system control.
ECE 333 - Green Electric Energy

Instructors:

The ECE department started this course in Fall 2009. Professor Alejandro Dominguez-Garcia and Professor Overbye alternate teaching this course each semester. Usually, ECE 333 has two sections. The morning lecture is given by the Professor, while the instructor of the other section varies with semester, but is usually a TA.

Prerequisites:

ECE 210 is the only official prerequisite; it is necessary to understand phasors and diodes beforehand. Basic circuit analysis is required. In addition, ECE 340 and ECE 313 may be helpful for understanding some concepts, but they are not strictly necessary for this class.

When to take it:

This course counts as an ECE technical elective, and it will be a good survey if you intend to apply for a job related to renewable energy. If you are interested in power and energy, especially wind and solar power, you should take it soon after ECE 210. This course works very well when taken with ECE 330, as the classes cover related material.

Class Content:

The order the course goes in changes each semester; generally, though, it starts with an introduction of the US power grid and renewable resource utilization in recent years in North America and around the world. Three phase power and the basics of transmission lines is covered. The class then talks about photovoltaic concepts, such as partial shading and various approximate models of photovoltaics. In addition to discussing circuit analysis, ECE 333 also applies statistics to discuss the economics of green energy development and integration of renewable energy. During this process, factors that affect efficiency of solar panels such as shading and isolation and estimation of the profit of operating wind power plants are taught. There is also some power electronics content, such as buck-boost converters and ripple control methods for maximum power point tracking. Additionally, the class spends a good deal of time on wind energy, discussing wind turbine components and operation of wind turbine farms. Various wind power models will be introduced. This portion of the class is more related to ECE 313, and much time will be spent calculating average power, analyzing wind speed data, and calculating average wind speed for different situations. Professor Overbye emphasizes the power grid and power flow when he teaches the class.

Work:

The workload for this course is not too heavy. The homework comes from the textbook, and most of the homework problems usually end up on the quizzes. Each quiz typically has one to two problems, and is given in around 10 minutes at the end of class each week. The quizzes should be manageable for students who understand the homework. Lectures vary from “introduction” lectures, which present the big picture view, to “technical” lectures, which explain the homework and problems that are similar to those on exams. There will be two midterms. Past exams are usually posted one week before the midterm. Going over lecture notes will be helpful. There are usually some questions which only test conceptual understanding and do not require calculations, in addition to traditional problems involving number crunching.

Life After:

Students who are interested in motor design, grid system and transformer design should consider taking ECE 330 if they have not already taken it. These two courses are related in several ways (3 phase power, state space notation), and many students take them at the same time.

Students who are interested in power circuit design can take ECE 464 (Power Electronics, Prerequisite ECE 342) and ECE 469 (Power Electronics Lab, Prerequisite ECE 343) to learn more about power devices such as power electronic switching devices and dc-ac converters; many of the circuit models taught in ECE 333 will be again studied in ECE 464 in more depth. Students who want to have some applied experience in green energy can participate in Solar Decathlon; it is a two semester course which also satisfies senior design criteria as well. In this project, students design a “Green house” with a team that competes in a design competition every two years. Students interested in controls should consider taking ECE 486 (Control Systems); this course will help in power electronic design and lead the way to more-advanced grid system control. In addition, ECE 431 (Electric Machinery) is another course you can take in the power energy area; it is only taught in the spring. ECE 431 is closely connected to ECE 330 has a fairly time-consuming lab component.
ECE 342&343 - Electronic Circuits & Electronic Circuits Laboratory

Instructors:

This course is taught by couple different professors who are well-known in the field of electronic circuits. In recent semesters, Professors Rosenbaum, Shanbhag, Chiu and Schutt-Aine have taught the class.

Prerequisites:

The official prerequisite is ECE 210. Many tools are carried over from ECE 210 to do the circuit analysis in this class, especially for AC small signals analysis.

When to Take It:

342/343 is offered every semester, and fulfills an electrical engineer’s 3/5 curriculum requirement. It is also the gateway to a number of different circuits-related courses. This is a fundamental course for just about any area of electrical engineering since just about anything that an electrical engineer could possibly care about is made possible by circuits. This is also a good course to take early if you are interested in internships in hardware positions.

Class Content:

This course is a basic overview of all the common circuits that electrical engineers will commonly come across. The range of circuits covered in the class includes anything from a rectifier to a CMOS amplifier. Most of the course involves applications of BJTs and MOSFETs. Much of the course deals with the characterization of circuits using models such as the small signal and high-frequency model. Towards the end of the class, most of these concepts come together when analyzing different types of amplifiers. In the process, you will learn about how certain approximations can ultimately make the physics from 340 turn into electronic devices. This course is important for anyone interested in how modern electronics works, and comes with a medium-to-light work load. You need to understand the equations that model these circuits, but the work is more conceptually difficult than computationally difficult.

ECE 343 is a closed lab, meaning that you should be able to complete labs within allotted periods. In the lab, will work with fundamental circuits such as an AC power supply and a CMOS amplifier. There are four major projects that are broken into typically three to four phases. Usually, the initial phases involve simulation via PSPICE and the later phases involve implementing designs on breadboards. There is no open-ended work (i.e. a final project) in the lab course. At the conclusion of each project, you write a lab report that often includes your simulation and actual results.

Work:

The course load for 342 is not too demanding. Homework can be decently challenging, but does not take too much of one’s time. The first test is mostly review from previous classes, and is generally easier than the later tests. As for 343, the work load is fairly light. There are four lab reports spaced fairly evenly throughout the semester. Be careful though when the deadline for a lab report is near, as the lab report could take up a substantial amount of time to complete. The labs are pretty simple overall and merely reaffirm the concepts learned in 342.

Life After:

Students who have taken and enjoyed ECE 342/343 are open to wide range of choices from the different subspecialties of ECE. For this reason, it is wise and feasible to take this course early on. Follow-on courses such include, ECE 453 – Wireless Communications Circuits, ECE 482 – Digital IC Design (typically offered only in the fall) and ECE 483 – Analog IC Design (typically offered only in the spring) and ECE 464 – Power Electronics.
In fall 2009, Prof. Cangallaris and Prof. Kudeki taught this course. Both sections follow the same syllabus and have the same homework. Prof. Cangallaris is the course coordinator and Prof. Kudeki wrote the notes for the class. An additional text written by Rao is included as supplementary material, and it is an excellent reference text with challenging example problems. The textbook is not strictly required, as none of the homework or lecture notes are taken directly from the book by Rao.

Prerequisites:

The only formal prerequisite for the course is ECE 329, but the course requires mastery over integral calculus as well. If you liked ECE 329, then you’ll probably like this course. Make sure you understand concepts such as transmission line theory, wave interaction with dielectric media and Maxwell equations (plus boundary equations), as these core concepts are built upon in ECE 350. The new course focuses on antennas and electromagnetic (EM) wave propagation and wave interactions, so ECE 350 will feel like an extension of ECE 329.

When to take it:

Take this course to satisfy 3 out of 5 credit or if you have an avid interest in antennas, wireless communication, or electromagnetic fields. The best time to take this course is directly after taking ECE 329. Take this class as early as possible, as it is truly a fundamental course in EM.

Class Content:

The current course content has been entirely reworked by Prof. Kudeki and Prof. Cangallaris, among others. The course beings with a review of Maxwell’s equations, basic mathematics, field potentials, wave equations and a discussion of gauges. The core material of the course is then divided into a couple major topics. The first major topic is the idea of a Hertzian dipole and radiating antennas. You will learn how to formulate and approximate complex antenna radiation equations using the Hertzian dipole. You will also discuss the ideas of radiated power, resistance and gain. The discussion of the simplified antenna nicely transitions into the topic of wave interference, where you will explore beam patterns of antenna arrays. You will explore the ideas of near and far field radiation and you will learn how and when to make approximations regarding plane waves and their propagation patterns. A discussion of the Rayleigh distance is also covered in this section. The following section covers a new topic, reflected and transmitted waves. You will learn about reflectors, the Doppler effect and total intern reflection. You will also review TE and TM wave polarizations. You will follow up these topics with the ideas of wave propagation in dispersive media, and you will gain some insight into real world problems with wireless communication networks. The penultimate topic is the concept of waveguides. You will discuss guided modes, 1D, 2D, 3D cavity waveguides, dielectric waveguides, and their respective resonant modes. You will conclude the semester by coming full circle, and studying antenna reception. These concepts all contribute to the big picture of learning how EM waves are transmitted and received in communication networks.

Work:

The class consists of weekly homework that is a good reflection of the exams. The homework is challenging, but it will cover the absolute essentials and “common knowledge” that all must have in an introductory EM course. To solve the homework problems, you will need to understand the intuitive concepts and then apply their mathematical groundwork. Some of the problems are very difficult to understand conceptually, so I would suggest starting early so you can attend office hours. Reading the notes is absolutely essential and they directly compliment the lectures. There are some interactive java applets available online that help to develop and intuitive understanding of the materials.

Life After:

For those of you who want more than a sample of these topics, you can specialize in wireless communications or electromagnetic waves or photonics. If you found the section on antennas interesting, take the follow up course ECE 454 (Antennas) to further your understanding. If you would rather learn about designing radio systems to send and receive information, you can take ECE 453 (Wireless Communication Systems). If you need a lab, you can take ECE 451 (Advanced Microwave Measurements). In this course you will learn how to take high frequency measurements. On the other hand, if you're looking for ECE 329 part 3 then take ECE 452 (Electromagnetic fields). This course builds off of ECE 329 and ECE350 by covering Maxwells equations and waveguides, but takes it one step further by introducing optical modulation schemes and coupled waveguides. Taking ECE 452 directly sets you up to take ECE 520, which is basically ECE 329 part 4 (it never ends…). Otherwise, if you like lasers, take ECE 455 (Optical Electronics) and learn how optical lasers work. There are also a number of specialized courses, such as ECE 447 (active microwave circuit design), ECE 458 (applications of radio wave propagation), and ECE 457 (microwave devices and circuits).
ECE 361 – Fundamentals of Digital Communications

Instructors:

This course is directed by Prof. Visawanth. It is the results of modifications over the years to what was ECE 461 and ECE 398PV. Profs Sarwate, Visawanth, Todd Coleman, Veeravalli and Srikant have taught this course in some shape or form in recent memory.

Prerequisites:

ECE 210 and ECE 313 are listed as the prerequisites. It is especially important to have a good background and/or interest in probability. Probability theory forms a sizeable bulk of this course—you will need to be able to work with continuous and (to a lesser extent) discrete random variables throughout this course. It will be helpful if you have taken ECE 310 because one of the main topics, inter-symbol interference, involves more or less a linear time-invariant channel in discrete time. If you have any exposure to linear algebra, you will have an advantage because the field of digital communications involves a lot of linear algebra.

When to Take It:

ECE 361 is usually offered only in the spring semester. If you are interested in communications, you should take this course after completing ECE 313.

Class Content:

ECE 361 deals primarily with theory—that is, modeling of a communication system, which consists of the transmitter, channel, and receiver. Throughout the course you will consider how communication systems achieve constraints on energy efficiency, rate, and accuracy. You will use what you learned in ECE 313 to examine the efficiency and accuracy of various methods of communication of bits across a channel. A recurring theme in the course is how to construct a sufficient statistic at the receiver by processing the received bits in order to ultimately reconstruct the original sequence. In the first part of the course, you will learn about communication across a wire line channel and about the implications of using schemes such as repetition coding, pulse position modulation, and sequential communication. In the second half of the course, students deal with wireless channels, in which effects from electromagnetic fields such as Doppler shift and mobility affect the modeling of the channel. In this portion of the course you will gain insight on modern techniques in communications that companies such as Qualcomm use.

Work:

The workload in this course is comparable to that of ECE 329. Each week students are assigned a problem set consisting of up to about 4 problems. Typically these problems will ask you to apply something learned in lecture to derive or prove an interesting relationship.

Life After:

The communications area electives are only usually offered once a year, with ECE 459 (Communications Systems) in the fall only and ECE 463 (Digital Communications Lab) in the spring only. Since this is a course that deals primarily with theory, there are numerous options for you if you are interested in applied aspects of communications. ECE 361 is a pre/co-requisite to ECE 463, which is a LabVIEW-based lab course in digital communications. In ECE 453 (Wireless Communications Systems), you work with radio frequency (RF) circuitry to build hardware components in communications systems. ECE 459 (Communications Systems) is a theory course that deals primarily with analog communications and modulation techniques, but with a few topical overlaps with ECE 361. In ECE 438 (Communication Networks) and ECE 439 (Wireless Networks), you explore network architectures between computers (ECE 438 and 439 are cross-listed with the CS department). Students who wish to pursue digital communications at the graduate level should also consider MATH 415/416 (courses in linear algebra), MATH 444/447 (courses in real analysis), and/or ECE 493 (Advanced Engineering Math).
ECE 380 - Biomedical Imaging

Instructors:

Stephen Boppart is a UIUC grad, with his PhD from MIT and MD from Harvard. He is Head of Biophotonics Imaging Laboratory at Beckman, and he is leading the way to discover new ways to detect cancer earlier. Beyond his many accomplishments, he is an incredibly personable and accessible professor.

Prerequisites:

Math 285/286 is the only prerequisite for this course, and the equations that are used are reviewed during lecture. A little bit of MATLAB experience is helpful, and an understanding of signal processing is advantageous but not necessary.

When to Take It:

This is a great tech elective to take early. It has fewer prerequisites than most, and since it covers several different modalities, you can get a clear idea of whether biomedical imaging suits you. Taking it early leaves time for taking more advanced courses in specific modalities and pursuing undergraduate research in the field. It is offered every semester.

Class Content:

The course is fascinating because it covers several different modalities: X-Ray, Computed Tomography, Ultrasound, Magnetic Resonance, Optical Imaging, and Nuclear Imaging. The course introduces how humans visualize and perceive images, as well as brief coverage of physiology; these concepts are applied to creating more effective images. A unique part of the course is that the material learned in class is applied to "emergencies" that come up in class; Professor Boppart puts an image on the screen and asks the class to help radiology find the problem, which is either a technical or medical issue.

Work:

The course has two 80-minute lectures each week, and a weekly assignment that can take 2-5 hours. The exams are straight-forward and relevant to the material.

Life After:

This class prepares you for courses that are more specific to each modality. Generally, ECE 310 - Digital Signal Processing and ECE 311 Digital Signal Processing Lab are useful if you enjoyed the course as a whole. Other useful courses are an ultrasound course offered (ECE 472), an MRI course (ECE 480), as well as more courses in optics and bioengineering. The research an ECE major can do in this field is diverse and advanced, as UIUC houses many of the leaders in the biomedical imaging.
ECE 391 - Computer Systems Engineering

Instructors:

This class is taught by many professors. Prof. Matt Frank is known for being down to earth, in touch with students’ experience in the lab, and his willingness to meet with students to discuss anything. Prof. Steve Lumetta is known for his good presentation of material, and his high expectations. Profs. Kalbarczyk and Borisov also teach this course.

Prerequisites:

You really do need ECE 290 before you take ECE 391. Your understanding of LC3 assembly and processor architecture will be crucial in transitioning to x86 assembly.

When to Take It:

Many students take ECE 391 first semester senior year, just in time to serve as a pre-req for ECE 411, which they take their last semester. If you are a consistently good student, you will benefit from taking this class earlier. This is an outstanding class to discuss in interviews if you want an internship or career in low-level programming. It is a requirement for CompEs, and a good class for any EE interested in a software career.

Class Content:

This course is all about bridging the gap between hardware and software. Students begin by learning x86 assembly. x86 is similar to the LC3 in many ways, but is more complex; while the LC3 is just a textbook example, x86 is an industry standard. Students learn how processors organize and access RAM, and how processors keep track of and switch between multiple programs running at once. Students learn about how computers handle inputs like key-strokes and moving the mouse, and how programs use an operating system’s system calls to execute commands in the processor. The final goal is a thorough understanding of how operating systems work, using Linux as an example.

Work:

This course is lab based (open lab), and has a substantial work load. Try to avoid taking other heavy labs at the same time. There are three MPs. Each MP has a pre-lab. Pre-labs are a small time commitment, and can be completed in groups. Do pre-labs diligently, since they cover the materials you need to understand for the MPs. The MPs themselves are the bulk of the work, but rest assured there are no post-lab reports. The first two MPs are individual; the third MP is in a group of three or four. In the first MP, students write several routines in x86 assembly. In the second MP, students write hardware device drivers for a hand-held controller, for an already-written computer game. They also modify the given code to expand the VGA graphics capabilities and enable multi-threads. In the third MP, students write their very own basic version of Linux, starting from almost nothing. All MPs are done in an emulator, but for your own satisfaction, it is possible to load your own operating system onto your actual computer. The last MP is extremely challenging, but even more rewarding.

Life After:

If you liked this class more than ECE 290 and ECE 385, you are probably on track for a software career. If you liked ECE 385 better, you are probably on track for a hardware career, and should hurry up to take ECE 411, so you can talk about it in your interviews. The combination of ECE 391 and ECE 411 leads to the deep understanding of hardware, software, and their interactions, which defines a quality computer engineer. ECE 391 trains students to be good coders. You can use this course to help you into any software job. Specifically, it is good preparation for low level programming jobs, such as operating systems and device drivers for PCs, smart phones, or any handheld electronic gadget. Any company that makes processors, ASICs, or FPGAs, needs software written for their specific hardware. Other low level programming classes you would likely enjoy are ECE 428 (Distributed Systems), ECE 435 and 438 (Communication Networks and Lab), and almost any 400 level CS class.
ECE 395 - Advanced Digital Systems Laboratory

Instructors:

This class is usually taught by Professor Haken, who is known for his invention the Continuum Fingerboard. His research is in computer music, so he is really great at embedded systems, DSP, programming and more! As a mentor, he is pretty awesome. He has experience in academia and in industry. He was a consultant before he was a professor so he has a lot of cool stories about Intel, Motorola, and even some companies from the biomedical industry. He is a really cool guy.

Prerequisites:

ECE 385 is officially the only prerequisite, but many students motivated to pursue their own projects take ECE 395 without credit in ECE 385.

When to Take It:

Most students take this as a junior or senior. Exceptional sophomores can do well in this class too. Students who are fast and self sustaining learners, have experience with embedded systems (other than Arduinos), and have a good network of contacts that have knowledge in other fields, may be able to be successful in this class before taking ECE 385.

Class Content:

This is a class where you get to make anything you want... within reason. Keep in mind that you have to use a micro controller/FPGA/Computer because it is a Digital Systems Lab, but let your imagination run wild.

These are some projects people have done in the past:

- Automatic Foosball Table (You can play foosball against a computer)
- Hydraulic Hexapod (six legged robot)
- Graphics Cards (from scratch)
- Tesla Coils
- iPad-Controlled Power Wheels (The small electric cars that toddlers can drive)
- Robots of all kinds (Arms, Hands, Battle bots, etc)

Work:

The workload varies, depending on what you choose to make. This is one of the most open classes in the entire college. You basically need to spend enough time to get things done.

Life After:

This class prepares you for actual work and ECE445 (senior design). You get to work on a long term project with a deadline and you need to do whatever you can to meet that deadline and finish this. Students can really learn a lot in this class.
ECE 402 - Electronic Music Synthesis

Instructors:

This class is taught exclusively by Professor Haken, inventor of the Continuum Fingerboard. Prof. Haken is fairly laid back. He wants you to enjoy the class and appreciate computer music, and students always do. He enjoys teaching the class, presents material in a very understandable way, and often reminds students that anyone who put forth a decent amount of effort will get an A or B.

Prerequisites:

The University states prerequisites for this class, but most are not actually necessary. If you have any musical background at all (i.e. took piano lessons when you were 7, or played trumpet for a year in 5th grade), you do not need MUS 103. You just need a basic understanding of music. You should take ECE 290 first. ECE 310 is absolutely unnecessary, as long as you won’t get too upset about having difficulty with a small percentage of the material.

When to Take It:

This course is only offered in the Fall. It is a good class to take as an early tech elective, right after taking ECE 290.

Class Content:

This course is a great technical elective. It is extremely interesting and not an overwhelming workload. The course is mostly conceptual. There is some math, but it is not a primary part of the course. Throughout the class, you learn the history of electronic music. You learn about how the ear hears, and how you can create sounds and music using sine waves as building blocks.

Work:

Homework consists of reading one article a week, two to ten pages, and writing a page of answers to qualitative questions, which all in all, takes about three hours, once a week. You also spend two hours per week in the lab with a partner, working with music synthesis software. The lab won’t show up on your schedule; you sign up for a time during the first week of class. There are no lab write-ups, and no time required beyond the two hours spent in lab. Labs are fun, informative, and not tough. You spend the last four weeks of class on an open ended final project. Again, it’s neat, but not overwhelming.

Life After:

Students who enjoy ECE 402 will likely also enjoy ECE 403, Audio Engineering. The job market for computer music engineers is primarily in the film industry, and is not overwhelmingly expansive. Professor Haken has introduced students to internships with Lucasfilm in the past.
ECE 411 - Computer Organization and Design

Instructors:

This class is taught every semester by various professors, including Rakesh Kumar and Steve Lumetta. Professor Kumar is known for taking student suggestions and concerns seriously. Professor Lumetta is known for clear presentation of material and high expectations.

Prerequisites:

You really do need ECE 391 before you take this class.

When to Take It:

ECE 411 is commonly known as the Computer Engineering Senior Design class. Most students take this class as a senior. If you can take it second semester junior year, or first semester senior year, you will be able to talk about it while you interview for full-time jobs. Interviewers will drool over you in awe when you talk about this class.

Class Content:

This course is a requirement for CompEs, and any EE specializing in Computer Engineering should take it. The class teaches topics similar to ECE 290, but far more advanced. In 290, you learn how to make a processor work. In ECE 411, you learn how to make a processor fast, by adding optimizations. You learn about pipelining, a method of dividing an instruction into multiple steps. You learn about speculation, which means guessing what the processor will do next, so you can do it early, which leaves you a few steps ahead if you guessed right. You also learn about cache design, the topic of adding a tiny bit of fast memory, and using it wisely, to reduce the wait time for accessing memory.

Work:

This class is difficult and time consuming, and is primarily lab based. Required time commitment is similar to ECE 391. Typically there is no homework; all work is lab related. During the labs, which you do on your own time in the EWS labs, you design the LC3b processor in VHDL, similar to ECE 385, but with many new features. Design is done in Mentor HDL Designer, a software CAD tool, and no FPGAs are involved. In the first lab, you implement only part of the LC3b instruction set. In the second lab, you complete the instruction set. After that, you add a memory system (cache) to your processor. The first several labs are all individual. The final project is done in a group of two or three. In the final project, you implement all the features from previous labs, and add an entire new field of complexity, called pipelining. You will spend at least ten hours a week in lab, and many, many more during the last few weeks of the final project. You should avoid taking any other difficult lab classes at the same time, and should try to take a light course load.

Life After:

Students who enjoy the lab portion will probably enjoy ECE 412, an embedded systems lab class which mixes concepts from ECE 391 and ECE 411, dabbling in both hardware development on an FPGA and software development for a processor on that FPGA. Students who enjoy ECE 411 might pursue careers in computer architecture with Intel, AMD, or NVIDIA. They may also go into other fields of digital design, such as ASICs and FPGAs. There are lots of ASIC and FPGA jobs in the defense industry, with companies like Lockheed Martin, Northrop Grumman, and Raytheon.
ECE 412 – Microcomputer Laboratory

Instructors:

This class has been taught by Professor Deming Chen recently. There is usually one TA who manages the lab portion of the class. Professor Chen is known for catering lecture to students’ interests.

Prerequisites:

You really do need ECE 385. You are expected to be familiar with, but not yet an expert at, VHDL. You can’t just pick up VHDL because you know C or Java, because it’s not a software language, it’s a hardware language. ECE 391 (or CS 232) is helpful because there are a few spots in the class where you will dive into the nitty-gritty of Linux. If you have a fair amount of Linux experience, you might consider taking this class without ECE 391. There are no required books, but if you decide to get a book, consider “RTL Hardware Design using VHDL” by Pong P. Chu. It explains how VHDL code affects the resulting hardware, rather than just listing syntax rules as some other popular books do.

When to Take It:

Students typically take this class their senior year, simply because of the prerequisites. It is a challenging class, but an ambitious junior who has succeeded in ECE 391 or ECE 411 would do well. ECE 411 is not a prerequisite, but if you are going to take both, take ECE 411 first. Students are strongly advised to take only one of ECE 391, ECE 411, or ECE 412 per semester, as all three of these classes are substantially time consuming labs. If you loved ECE 391 and ECE 411, this class is for you.

Class Content:

This course teaches how software interacts with hardware, with an emphasis on hardware design. There is a lecture component to the class, which teaches high level concepts, but the class is almost entirely dedicated to the lab. Field Programmable Gate Arrays (FPGAs) are similar to processors in that they are made of transistors in silicon and run much faster than software, but are different in that they are flexible and their transistors can be rewired to perform any hardware task you design into them. It’s like having a basket of AND gates, OR gates, XOR gates, inverters, and flip-flops, and being able to connect them all any way you want, by writing VHDL code and downloading it to the FPGA. This class gives you practical, hands on experience designing hardware specifically for FPGAs, and software to complement it.

Work:

This course is lab based (open lab), and has a substantial work load. Try to avoid taking other heavy labs at the same time. There are four MPs, all of which revolve around an FPGA development board. The first MP is individual; the remaining MPs are in teams of two. The first MP is a refresher of VHDL and ECE 385, focused on connecting a keyboard to the FPGA. In the second MP, you design hardware for the FPGA that performs calculations on numbers sent from a processor, and feeds the results back into the processor, the foundation of “hardware acceleration.” You also write a Linux device driver and a C program to drive your piece of hardware. In the third MP you design hardware to take video input from a camera, convert it from the camera’s format to a displayable format, and display the video on a VGA monitor. The fourth MP is an open ended project.

Life After:

If you are fortunate enough to take this class in time for interviews, you will be highly sought after for digital hardware design jobs and embedded systems jobs. You would also be well prepared for a software job in low level device drivers, like the one written in MP2. FPGA design is growing while Integrated Circuit (IC) design is shrinking, because in many cases FPGAs are becoming cheaper to work with. While the class is taught with FPGAs, the concepts are applicable to embedded systems in ICs as well. If you enjoy hardware design, consider ECE 411 and ECE 462. If you stay for grad school, ECE 511 and ECE 512 are the follow-on courses. The defense industry employs a lot of FPGA engineers, including Boeing, Lockheed Martin, Northrop Grumman, and Raytheon. An enormous number of small and mid-size companies employ FPGA engineers, since IC design is too expensive for small quantities.
ECE 420 - Embedded DSP Laboratory

Instructors:

This class is usually taught by Prof. Douglas Jones. Other professors in the area of DSP, such as Profs Bresler, Allen, and Hasegawa-Johnson have taught this course in the past.

Prerequisites:

The only prerequisite listed for the class is ECE 310. While ECE 310 is the only class that is absolutely essential, experience with assembly programming, C programming and MATLAB is a major plus. Students who have previously taken ECE 391 definitely have an advantage, but the exposure to assembly programming through ECE 190 is sufficient before taking this class.

When to Take It:

This class is usually offered every semester. Taking this class within a couple of semesters of taking ECE 310 is a good idea, as solid understanding of the material in ECE 310 makes this class a lot easier. Each week's prelab and quiz typically involves questions from DSP theory. It might also be enjoyable to take this class after taking other electives in related areas such as imaging and communications so that you can do something cool for your final project.

Class Content:

This is a very enjoyable and rewarding lab for undergraduates. The class can be challenging, but the skills taught are very applicable. The focus is on implementing most of what is taught in ECE 310, so you deal with practical issues of DSP implementation such as quantization error, memory usage, floating point precision. You code in TI (Texas Instruments) Assembly code, C, and some minor work in MATLAB for this class—the assembly and C code are used to program the DSP chip, whereas MATLAB is mainly used for simulation before programming the DSP. The structured labs, which are available online on Connexions, walk you through implementing various DSP schemes, and the final project gives you the freedom to explore a project of personal interest under the guidance of the professor and TAs.

Work:

This is an open lab, meaning you will need to complete lab assignments at the DSP lab outside of class hours. The work required for this class is 5 required weekly labs, each of which includes a pre-lab assignment and a demonstration of the assignment. The pre-labs often deal with something from ECE 310. These weekly labs cover essentials such as implementation of FIR and IIR filters, FFTs, and up and down sampling. You will also be given an oral quiz on the weekly lab assignments. After the 5 labs, you work on the final project. For the final project, you will present a project proposal, a helper lab assignment, a design review presentation, and a demonstration of the final project.

The nice part about ECE 420 is that the weekly labs do not require you to spend time writing up reports, but instead require you to spend the time understanding the theory and practical considerations. The final projects in this class are usually substantial, and are very rewarding once completed. Some examples of past final projects include a guitar effects mixer, number-recognizing processors, and a modem. The average student can expect to devote between 6 to 10 hours per week on this class outside class hours.

Life After:

If you enjoy ECE 420, classes to check out include ECE 417/418, ECE 486, and ECE 463. ECE 417/418 are classes that teach further signal processing theory and have associated lab work. ECE 486, the control systems lab, and ECE 463, the digital communications lab, are related electives. Students also may find the oral aspects of the course (quizzes and presentations) are integral for preparation for the workplace and beyond.
ECE 425 - Intro to VLSI System Design

Course Description

Instructors:

Martin Wong is the instructor for this course.

Prerequisites:

ECE 385 and ECE 411 are listed as the official prerequisites. The course begins with basic digital design concepts and how circuits are implemented in practice. A good knowledge of ECE 290 and 385 are needed for this. Some knowledge or internship experience in digital circuit design is helpful in understanding cell placement and routing techniques discussed in the later part of the course. However, ECE 411 is not absolutely necessary to do well in this course. ECE 411 does not cover these concepts, so if you did well in 290 and 385 then you should not be at a significant disadvantage.

When to Take It:

The course is only offered in the fall, so you should take it as soon as you finish the prerequisites. If you are considering a career in IC or processor design, this course will greatly help you understand layout challenges and algorithms. The course is complemented by ECE 482 (Digital IC Design). ECE 425 focuses on a higher level of design and cell placement, while 482 focuses on a lower level such as gate delays and transistor level design. There is some overlap in content, especially with layout techniques and software tools. Therefore students taking both courses will have a significant advantage in both courses, especially using Cadence design software to do custom layouts.

Class Content:

The course begins with a review of ECE 385 concepts, such as finite state machines and flip flops. It then covers transistor level implementations of common logic circuits. Layout design rules and best practices are discussed, with MPs giving students a chance to learn the impact of these rules. The second half of the course covers VLSI chip placement and routing techniques. Much of IC design is focused on minimizing area, and the course provides a history of the algorithms done to do so. Important VLSI concepts such as routing, cell placement, and partitioning are also discussed. The benefits and drawbacks of each algorithm are highlighted. Much of the discussion focuses on the high-level algorithms used by software tools to place transistors and logic gates.

Work:

The majority of the course is spent on the machine problems. There are three MPs. In the first one students build a standard cell library of basic gates such as AND, OR, NOT. The second MP is the most involved by far. It requires around 5-10 hours a week consistently for about a month. It is the design of an old AMD microprocessor datapath. The cell library from MP1 is used to create the schematic of the design. You then test and debug your design, trying to reduce the number of transistors as much as possible. Then the design is laid out by hand to match the schematic. The third MP introduces students to the automated design flow. A gate-level schematic is generated from Verilog RTL code and a layout is generated from that. The third MP requires much less time than the second.

There are only two midterms in the course (no final!). They focus on the five or six homework assignments given throughout the course. A student will do well on exams if they have a good knowledge of the homework concepts. The exams and homework do not require a significant time commitment.

Life After:

This class is absolutely necessary if you plan on doing digital circuit design or processor design. Because interconnect delays are now larger than gate delays, VLSI knowledge is more important than ever. The MPs introduce you to the design flow and use the exact Cadence software that is used in industry. You will have a huge advantage in interviews if you have experience using these tools. Also knowing how transistors are placed in a layout is helpful for anyone doing digital or processor design, no matter what stage of the design flow you work on.

The course is a prerequisite to a graduate level VLSI course, ECE 582 Physical VLSI Design. It provides a more advanced look at the concepts introduced in 425.
ECE 437 – Sensors and Instrumentation

Instructors:

This class is usually taught by Prof. Makela. Prof. Bernhard has also previously taught this course. The professors have done a great job of making the class an in-depth and useful introduction to electrical sensors and instrumentation. Prof. Makela explains the course material very well and keeps students engaged in his class. The online website has many useful resources for a better understanding and completing the laboratory work.

Prerequisites:

The only prerequisite listed for the class is ECE 329. One of the main technical elements in this course is the use of LabVIEW. In this course, LabVIEW is mainly used for sensor data acquisition and processing. Having prior LabVIEW knowledge would give you an advantage in completing the course lab assignments, but the instructor does not expect students to have prior LabVIEW knowledge.

When to Take It:

This class is usually offered every other semester, usually in the fall. ECE 437 is a three credit hour ECE lab course. This course sets the stage for applications in project courses like ECE 445 (Senior Design) and ECE 395 (Advanced Digital Projects Laboratory), since most projects involve taking in data from the real world.

Class Content:

ECE 437 has an enjoyable and rewarding lab for all ECE majors. A unique part of this course is the large amount of guest lecturers who speak during the weekly lectures. The last third of the semester usually has 4-5 professors from different concentrations and majors discussing how they implement sensor systems in their line of work. Through these guest lectures, students get to see real-world applications for the sensors and instrumentation being studied in class. Early in the semester students even get to voice their interests on which sensors they learn about from guest lecturers. The sensors covered in this course include temperature sensors, capacitive proximity sensors, inductive proximity sensors, ultrasonic sensors, accelerometers, optical sensors, and rotary encoders. In the weekly lab sessions, students learn about the sensors, data acquisition and processing of the sensor data using LabVIEW, wireless sensor networks, and the limitations of sensors. Overall, the class has a fair mixture of theory and application.

Work:

There are 9 required weekly labs, each of which includes a short pre-lab assignment and a long post-lab report. The pre-lab assignments are essential to being prepared for the lab sessions. The post-lab reports usually take about 4-5 hours to complete, but are not conceptually difficult to complete. Lab sessions are always very interesting and engaging. One of the lab sessions involves visiting the anechoic chamber in Everitt Lab. There are 2 exams in this lab course, a midterm and a final exam. The content of the exams include sensor theory and real-world applications and scenarios. After the 9 weekly labs, there is a final sensor system project. Students are given real-world scenarios that require a sensor system to be designed for it. This project is a written proposal of the sensor design. The proposal requires using knowledge about sensors learned in the course and knowledge gained from outside research. The proposal is not too lengthy, but it does require looking up sensor data sheets and documentation to justify sensor design choices. The average student can expect to devote 5-7 hours per week on this class outside class hours.

Life After:

If you enjoy ECE 437, you may find useful applications of your sensors knowledge in ECE 445, required for electrical engineers, or ECE 395, an independent project course in computer engineering. Nonetheless, the course is invaluable for any engineer since it is commonly required to manipulate available tools to obtain useful real world data, and much of this data is collected with electrical sensor systems.
ECE 441 - Physics and Modeling of Semiconductor Devices

Instructors:

This course is usually taught by Professor Leburton, the course director. However, every few years Professor Rosenbaum lectures for the course instead.

Prerequisites:

ECE 340 - Solid State Electronic Devices is the listed prerequisite for this course. While some of the material from ECE 340 is reviewed in the first few weeks of this course, it is very important that students have a strong understanding of the topics introduced in ECE 340.

When to Take It:

Students that are interested in taking ECE 441 should consider taking it anytime after they finish ECE 340. For most students, this means sometime during Junior or Senior year. However, this course is only offered during the Spring semester and even then there is only one lecture time. Students who want to take this class should plan accordingly.

Class Content:

ECE 441 acts as a continuation of ECE 340. Because of this, the first few lectures consist mostly of reviewing these concepts. However, students should note that this time around there is a larger emphasis on deriving and understanding the results that were presented in ECE 340. Following this, the course starts to work through PN junctions, BJTs, and MOSFETs (again). As stated previously, while some of the material presented for each of these devices may be review, a deeper understanding is expected. ECE 441 addresses many secondary effects that are ignored or overlooked in ECE 340. For instance, when discussing PN junctions, much more time is spent looking at breakdown effects and the engineering consequences of them. Overall, students should find that ECE 441 is basically a more in-depth view of ECE 340 with a focus on modern devices and solutions.

Work:

Students are expected to turn in weekly homework assignments during lecture; the homeworks generally consist of a combination of problems from the text and questions written by the professor. Also, there are two simulation assignments where students are expected to use TCAD and tools hosted on nanoHUB to answer a short additional problem set. Weekly homework sets are generally released slightly more than a week before their due date, while the simulation assignments are generally given about two weeks ahead of time. The remainder of the grade comes from a single in-class midterm and a final exam. Students are generally given a basic formula sheet and may be allowed to bring a page of notes and/or the text, but exactly what is allowed varies each semester.

Life After:

Those interested in semiconductors should also consider taking ECE 444, ECE 481, and/or ECE 488. While none of these courses require students to take ECE 441, they all focus on similar subject matter. ECE 444 focuses on the fabrication of semiconductor devices, while 488 focuses strictly on compound semiconductors and ECE 481 introduces a wide variety of topic in nanotechnology. Students looking for courses that build off what they learned in ECE 441 should look into graduate courses such as ECE 535, ECE 565, and ECE 585.
ECE 444 - Theory and Fabrication of Integrated Circuits

Instructors:

The lecture part of this course is taught by various professors, including Joseph Lyding, Xiuling Li and James Coleman. You will learn well from any of these professors, who are rising stars or established veterans in the area of solid-state electronics. Generally, lecture sections are not interchangeable. Each professor covers slightly different material based on his or her expertise, and gives their own exams on their own schedule. The lab part of the course is overseen by Dane Sievers, but run on a daily basis by TAs.

Prerequisites:

Taking ECE 340 before ECE 444 is highly recommended.

When to Take It:

Most people take this class shortly before graduating since it always fills up quickly and is difficult to get into. If you want to take this class, register the minute your registration window opens. Our university is famous for the lab portion of this class. It is a unique opportunity not available to undergraduates at any other university in the country. Alumni rave about this class and it is an opportunity you should make every effort to capitalize on. If you enjoyed ECE 340 and intend to pursue a career in semiconductors, you absolutely must take this course.

Class Content:

This lecture portion of this course explains how devices like transistors, capacitors, and gates are built into silicon chips used in computers, called integrated circuits. Students begin by learning about how silicon wafers are formed. Students then learn about doping regions of silicon by using masks, photolithography, etching, and furnaces. Students also learn how different devices are connected with miniscule wires. In addition to learning the basic techniques used in lab, students learn more advanced techniques which are too expensive for the lab portion of this course, but are used commonly in industry. The course is primarily qualitative, with a few brief, heavily math based portions. Students who were overwhelmed by the intense math of ECE 340, but were fascinated by the underlying concepts, will enjoy and succeed in ECE 444.

In the lab portion of this course, you make an integrated circuit, in the famous clean room in the basement of Everitt, starting with a bare silicon wafer. You perform oxidation, photolithography, etching, doping, and metallization in several steps to produce capacitors, diodes, BJTs, and MOSFETs. Producing one wafer full of these devices takes about ten weeks. Testing the devices takes the remainder of the semester. Yes, your devices will actually work at the end of the semester!

Work:

Homework is assigned in class, averaging a few written problems each week. The homework is outstanding for both solidifying the material learned in class and preparing for the exams. Homework is a moderately small time commitment. The lab is closed form, meaning you only work 3 hours a week, during your scheduled time. For the first three quarters of the lab, time commitments are minimal. There are a few quick prelabs at the beginning of the semester. Halfway through the semester there is a moderately time consuming lab report, intended to familiarize you with software used in class. Toward the end of the class there are two substantial, time intensive lab reports. Although tedious, these lab reports bring most students to an epiphany of understanding of integrated circuits. All of the abstract concepts learned in ECE 340 become real, and you finally understand.

Life After:

Taking ECE 444 opens up doors to research opportunities, graduate school, and jobs. The ECE 444 website lists hundreds of semiconductor companies that will fight to hire students who have taken ECE 444. Students who love ECE 444 could enjoy working at a company with an integrated circuit fabrication facility (a “fab”). A big keyword for job searches is “process technology”. This career path can also open up opportunities for travel to China and Taiwan, where a huge portion of the world’s integrated circuits are manufactured. Anyone interested in moving to Taiwan should consider TSMC and UMC, Taiwan’s semiconductor powerhouses. Major US companies are AMD, IBM, and Intel. The course is also helpful for circuit designers, helping them understand the physical aspects of the devices they design on CAD systems.
ECE 445 - Senior Design

Professor's Perspective

by Prof. P. Scott Carney, ECE 445 Course Director

ECE 445 is the capstone project course for EE majors. Most EEs take it, although one may instead take Senior Thesis (ECE 497/499) or Cube Sat (ENG 491), both two-semester classes. Recently we recognized that the workload in the class had grown well beyond the two hours of credit given. As of Fall 2011, the course counts for four hours of credit. The class involves quite a bit of technical writing and so now it also counts as an Advanced Composition class.

Engineers perform a sort of magic. We leverage the great intellectual achievements of the basic sciences and mathematics and turn them into the stuff of the modern world. For most of their undergraduate career, our students spend their time mastering the science and the math necessary to be engineers. In Senior Design they harness the power of the engineering process: that layer on top of the basic science that enables the management of highly complicated designs to produce reliable solutions to difficult problems from start to finish. Good engineering process unleashes the engineer's creativity by providing a system to track, test and incorporate ideas freeing the engineer to focus on inventing solutions to the most intellectually challenging parts of the problem. In ECE 445, we provide the structure for students to produce amazing results. The students provide the content and the creativity.

Students in ECE 445 choose or propose their own projects. Each semester there are projects proposed by mentors from within the department, from other departments on campus, from community members and from industry partners. Many students take the opportunity to follow their own dreams and carry out a project or solve a problem that they bring to the class themselves.

This semester we have students working with Boeing, Rolls Royce, Walmart, and a start-up incubator based in Chile. A few projects are helping to develop a pacing system for the Uni-High swim team. Other projects are developing engineering solutions for wildlife tracking and monitoring for UIUC researchers. Then there are student-proposed projects like the Braille e-book reader, the robotic sidewalk salt dispenser, or a device to help friends find each other in a crowd.

I am happy to discuss project ideas with students not yet enrolled. I hope students will spend their whole undergrad tenure looking forward to 445 and the chance to do an incredible project.

Much more information may be found here http://courses.engr.illinois.edu/ece445/
ECE 452 - Electromagnetic Fields and Electro-Optics

Instructors:

Professor Shun Lien Chuang teaches this class, and he is an excellent teacher. Not only does he explain the material very clearly and from the most fundamental level (Maxwell’s Equations), but he provides motivation by showing why you’re going to need to know the material in the future and how you’re going to use it. He literally wrote the book on the class subject. The book is very up-to-date and authoritative, which is why it's also used at many other prestigious universities. Most graduate students in semiconductor lasers have a copy of this book and study it extensively before taking their qualifying exam, to make sure they’re solid on the fundamentals.

Prerequisites:

ECE 350 is the only formal prerequisite. In that sense, this course can be understood as ECE 329 part 3. Professor Chuang builds the course off of Maxwell’s Equations. You will have to memorize them for this class. Background in electromagnetics and optics will be beneficial in this class, although not necessarily essential. Some basic matrix algebra (matrix operations, eigenvalues and eigenvectors) is useful as well in understanding the derivations of higher concepts.

When to Take It:

If you enjoyed the plane wave reflections and wave guide theory portions of 350, this class is for you. If you want to master the electromagnetic foundations of the optical regime (e.g., for fiber optics), this class is for you. It is usually offered only in the fall.

Class Content:

The class begins with a review of Maxwell’s equations. From here the course dives into polarization and reflection/transmission at dielectric boundaries. Prof. Chuang emphasizes the k-vector throughout the course, which allows a solid conceptual understanding. You will be able to derive the reflection/transmission coefficients, Brewster’s angle and critical angle from basic principles after the first third of the class. The second third focuses on wave propagation in anisotropic media, materials that have a directionally dependent index of refraction. These are important for applications such as polarizers and quarter wave plates, which are explained in detail. Prof. Chuang also covers waveguides, focusing primarily on dielectric and metal waveguides for semiconductor lasers, and on optical fibers. Finally, the last third of the course culminates in coupled wave guide theory and wave propagation in electro-optic crystals. Electro-optic effects in crystal structures are derived, and light modulation using both longitudinal and transverse amplitude modulators are covered. While the last third class is more device-specific, the first two thirds have extremely good material that will help in many disciplines.

Work:

The class workload is rather demanding. Homework is assigned every week, without fail (12 HW's total), each with 4-8 problems, and a mixture of solving problems and proving relationships derived in class. Expect to spend 6-8 hours per week on reading and homework. That said, the homework questions and tests are very doable. When Professor Chuang gives you a question on a homework or exam, you can have confidence in your ability to answer it based on the material presented in his book and lectures (I couldn't imagine taking this course without the textbook). A study partner should get you through most roadblocks, and the TA will be necessary once in a while. If you’ve read the book, attended the lectures, and can do the homework, the exams should not be a problem. Prof. Chuang is a reasonable grader, but take caution before trying to argue for a higher exam score.

Life After:

Much of the material in this class involves solving Maxwell's equations in semiconductors and on semiconductor substrates. If optics and photonics sound interesting to you, ECE 455 (Optical Electronics) might be a good class to take. EM wave propagation is important to wireless communications as well, and there are many related courses in the 450 series of the ECE curriculum that cover everything from antennas to other modulation schemes to propagation in the atmosphere. Since the course has a heavy emphases on fiber communications, somebody looking to work in that field should take this class. This is a good class to take before (or with) ECE 520 (Electromagnetic Waves and Radiating Systems, i.e. ECE 329 part 4), which is a required class for many disciplines as an ECE graduate student. This class will make you solidly prepared for the middle third of ECE 520, which focuses on polarization, reflection and transmission, and will also help with the last third on waveguides. The department also offers various other courses in semiconductors and photonics, such as ECE 536 (Integrated Optics and Optoelectronics). Prof. Chuang teaches this very popular course out of the same text.
ECE 453 - Wireless Communications Systems

Instructors:
Professor Franke is both the course director and the lecturer.

Prerequisites:
The official prerequisites are credit for ECE 329 and credit or concurrent registration in ECE 342. While there are few topics in this class that require ECE 329, it is necessary to understand the context in which these systems exist. Concurrent registration or credit in ECE 342 is necessary because topics such as amplifiers and oscillators rely heavily on the transistor circuit models learned in ECE 342.

When to Take It:
Take this class if you wanted to delve deeper in the ECE 210 lab, which demonstrated a basic AM radio receiver; ECE 453 is a more involved study of such communication systems. This class is a must if you intended to go into wireless communications of any kind. Most of the students in the class are juniors and seniors. It is offered every semester.

Class Content:
The class starts with modulation, both AM and FM. Comparisons are made between the bandwidths, efficiency, and ease of modulation/demodulation. It quickly moves to how the superheterodyne receiver works, how to change the frequency of incoming signals to make them easier to demodulate, and the effects of spurious responses. The next topic is RLC networks, which covers the quality factor of a network, and series/parallel impedance transformations that will become useful when discussing impedance matching. Oscillators are also covered, particularly the Colpitts configuration. A large portion of time is devoted to introducing 2 port parameters, and S parameters in particular. A lot of analysis is done using S parameters, which is used to find things like input impedance and the power delivered to the load. Lastly, noise and non-linear effects are covered to show the limitations of receiver capability and design trade-offs.

The lab section covers almost every topic discussed in lecture, sometimes more in depth than the lecture itself. There are 4 labs, and the goal is to build a part of a radio receiver by the end of the semester.

Work:
The class consists of 2 midterms and a cumulative final. These exams make up the majority of the grade. There is usually homework due each week that consists of problems from the course notes and occasionally a new problem written by Professor Franke. They may require the use of software such as ADS or Matlab, which are both available on the EWS computers.

The lab meets weekly for 3 hours. There are no written prelabs, but there could be prelecture videos provided by the lab instructor to watch. There are 4 lab reports due throughout the semester. Plan to spend 10-20 hours on each lab report. There is also an exploration portion of the lab, where each student can investigate anything related to rf and write a short report on it.

Life After:
ECE 453 is a prerequisite for ECE 447, Active Microwave Circuit Design. This class is essential to understanding the basics of modern wireless communications. Anyone looking to work in analog circuit design of any kind will benefit from taking this class.
ECE 454 - Antennas

Instructors:

Professor Jennifer Bernhard teaches this course.

Prerequisites:

ECE 350 is the only prerequisite. 350 introduces concepts like vector potential and the Hertzian dipole that are important tools in conceptualizing antenna theory. Familiarity with calculus in spherical and cylindrical coordinates is a must.

When to Take It:

If this class sounds interesting, take it soon after you take 350. There is a short review of Maxwell's Equations at the beginning of the course, so it is not necessarily vital to take it immediately after taking 350. It is usually only offered in the fall.

Class Content:

After a review of Maxwell's equations, the Hertzian dipole is introduced as the most simple radiating element. The far field field patterns are discussed, and duality is applied to analyze the small loop antenna. Then, antenna parameters in both the radiating aspect as well as the circuit aspect are covered. These include concepts like gain, directivity, various measures of efficiency, and different measures of beam width on the circuit side. Ideas on the circuit model side consist of radiation resistance and mutual coupling. The rest of the course uses these basics to analyze and categorize other popular radiating systems. These include dipoles, folded dipoles, monopoles, loop antennas, microstrip antennas, slot antennas, horn antennas, and broadband antennas. In depth study of antenna arrays is also covered, similar to the section in 350 about antenna arrays, but with more attention to side lobes and grating lobes. The course emphasizes imperfect systems in addition to the ideal field patterns, and considers imperfect ground planes and lossy materials in the models.

There is also a design project at the end of the semester. The instructor will offer a scenario that deals with not just the antenna design, but the design of the entire communications systems. A comprehensive study on everything from design philosophy to technical and budget concerns is part of the report.

Work:

The class consists of around 6 homework sets, each on about 2 weeks of material. The amount of homework is enough to prevent students from doing it the night before, but is pretty reasonable if time is managed properly. Homework answers are not released, so going to office hours to learn from homework mistakes is encouraged. There is one midterm half way through the course, and the midterm is open notes and open homework. There is also a design project that results in a report of around 20 pages. Students can expect to spend 5-10 hours a week outside of class on homework and the design project.

Life After:

This class is a step towards working in antenna design at RIM or T-Mobilie, for example. A student interested in this area might consider taking other classes in the 450 series of the ECE curriculum, like 451 (Advanced Microwave Measurements), 452 (Electromagnetic Fields and Electro-Optics), 453 (Wireless Communication Systems), 457 (Microwave Devices & Circuits) or 458 (Applications of Radio Wave Propagation). Other complimentary courses might include 459 (Communication Systems) and ECE 310 (Digital Signals Processing) to improve the understanding of wireless communications systems from the signals perspective. Really any course related to wireless communication or remote sensing is helpful in gaining a full understanding of modern communications. Ambitious students can consider taking the graduate EM course, ECE 520 if they wish to further grow their understanding of EM waves and radiating systems. There is also a graduate level antennas course offered once every 2 years, ECE 577.
ECE 455 - Optical Electronics

Instructors:

Professor Gary Eden teaches this course. He is a great, enthusiastic teacher. He is very highly regarded in his field, and has been awarded significantly for both teaching and research. My thesis advisor called him an ‘optics God’. He teaches out of Laser Electronics, a book that was written by J. T. Verdeyen, who used to run the Laboratory of Optical Physics and Engineering here until Prof. Eden took it over. The book is well written and easy to follow, several chapters of which are heavily reviewed by grad students in lasers before taking their qualifying exam. The T.A. for the course, Gamma Tom, also gave some good lectures and exam preparation meetings (assuming he will still be the T.A.).

Prerequisites:

ECE 350 is the only prerequisite listed. While much of the theory on lasers is based on light propagation via Maxwell’s equations, you could get by in this course with only knowing the very basics of this (e.g., that the electric field is null at a mirror surface).

When to Take It:

If you are interested in lasers, this course is essential. It is typically offered in the Fall.

Class Content:

There are two essential components for a laser: a resonant cavity and optical gain. The first third of the course starts off with resonant cavities, including ray tracing, ray matrices, and how the light is distributed through the cavity. The second third of the course deals with the optical gain: lineshapes, absorption, saturation, threshold, laser dynamics, 3-4 level systems, Q-switching and mode-locking. There is typically a second midterm on this material. The final third of the course is on particular lasers, including: tunable lasers, rare-earth-ion lasers, gas-discharge lasers, non-linear processes and semiconductor lasers.

Work:

In the recent past there have been two midterms (down from three). One on the first third of the class, and the second on the second third of the class. In place of a final exam there is a paper due. Graduate students are also expected to present their paper for the extra credit they receive. The homework is challenging, but very reasonable, and certainly doable given the lecture notes and book material. The exams are relatively fair, assuming you’ve read the book, understood the lectures and can do the homework yourself. He typically posts exams from the previous 5 years, minus the solutions. Prof. Eden has high expectations on the paper/presentation, a laser topic of your choosing, so expect to spend a good deal of time preparing this.

Life After:

If you are interested in semiconductor lasers, ECE 398, KC or ECE 495 may be a good choice for some photonics theory and lab work. The semiconductor fundamentals would also be key, taught in ECE 340, ECE 441 and ECE 488. If you’re interested in gas lasers, Prof. Eden teaches a follow-on graduate level class, ECE 523.
ECE 457 - Microwave Devices & Circuits

Instructors:

Professor Bernhard is the course director and the lecturer.

Prerequisites:

The only prerequisite is ECE 350, but students can take this with just ECE 329 if they absolutely must fit it in their schedule. Coming in with an understanding of transmission line theory will make this class more manageable.

When to Take It:

Students who want to know more about transmission line theory and are interested in high frequency circuit design should take this class. It is usually only offered in the spring.

Class Content:

The course starts with an overview of transmission line theory. Formulas for line impedances and reflection coefficients are reviewed, as well as a review of the Smith Chart. The class then covers 2 port parameters (Z, Y, ABCD and S) and analyzes various lumped component and transmission line circuits using 2 port parameters. Students will learn to design a variety of filter circuits using both lumped components and transmission lines using all of the previous concepts. Next power divider, combiner, and coupler design is covered. Again, a wide variety of coupler types are analyzed. The last topic is the use and applications of PIN diodes as mixers and switches. A few lectures also go over noise in microwave circuits.

Work:

There is a homework assignment due every couple of weeks. All of the problems and due dates are posted at the very beginning of the semester, so there are no surprises. Most of the homework problems are from the textbook, but some problems are written by Professor Bernhard. There is one midterm and one final exam. Both are open note, open homework. Students are basically allowed to bring any notes with them, except for the textbook itself. Professor Bernhard does not release homework or exam answers, so students must go to office hours if they need help correcting your mistakes. There is also a 2-part design project. The first part involves designing some kind of microwave circuit; the second part involves analyzing a real set of data. Both steps make heavy use of the simulation program, PUFF, that is introduced during the course.

Life After:

Anyone going into high frequency circuit design will benefit greatly from taking this class. Note that this class only covers passive circuits, with the exception of diodes. ECE447 Active Microwave Circuit Design would be a logical next step after this course; however, ECE 447 requires ECE453 Wireless Communication Systems. While this class is grounded in electromagnetic theory and related to the rest of the 450 series of ECE classes, students interested in circuit design should also consider the integrated circuit courses: ECE 482 Digital IC Design and ECE 483 Analog IC Design.
ECE 459 - Communication Systems

Instructors:

This course is directed by Prof. Tangul Basar and is usually offered in the fall only. Dr. Christopher Schmitz taught this course in Fall 2008 and Fall 2009.

Prerequisites:

The only prerequisite to this course is ECE 313. You won’t really use any probability theory until the second half of the course, in which you deal with topics such as intro-level random processes and signal-to-noise ratio. You will use more probability theory when digital communications topics are covered.

When to take it:

If you are very interested in communication systems, you may be able to take this course at the same time as ECE 313—the topics involving probability in ECE 459 are not too complicated and will probably have been covered in ECE 313 by the time they are introduced in ECE 459. Otherwise, you may take this course after you have completed ECE 313. Note that ECE 361 (Digital Communications) is not a prerequisite to ECE 459 and vice-versa. Another thing to keep in mind is that ECE 459 is a topical prerequisite to the communications laboratory courses (ECE 453: Wireless Communication Systems and 463: Digital Communications Laboratory). Compared to ECE 361, ECE 459's topics are more related to those of ECE 453 and 463.

Class Content:

This course covers analog and (to a lesser extent) digital communications. In the first half of the course, you will learn about amplitude modulated (AM) and phase-modulated (PM) and frequency-modulated (FM) communication systems. Throughout this course, you will see various familiar topics from ECE 210, such as complex numbers, bandwidth and LTI systems. In the middle half of the course, you will learn a little about random processes and apply it to understand what constitutes a (theoretically) optimal communication system with respect to measures such as signal-to-noise ratio (SNR), probability of error, and power spectrum density. Another topic covered around this time is the phase-locked loop (PLL). Towards the end of the course you will learn about a few fundamental topics from digital communications, such as the additive white Gaussian noise channel, signaling with antipodal and orthogonal signals, and matched filtering.

Work:

Homework is assigned weekly and is completed and turned in by groups. Usually these consist of 6 problems from the textbook. In addition, there are two midterm exams. Usually, these exams will ask you to apply what you know to unfamiliar and non-idealized situations (such as communication channels with attenuation). Extra credit in the form of "discovery problems" is also offered several times and can be earned by completing open-ended projects, such as illustrating a communications topic in MATLAB.

Life After:

If you enjoyed this course, you will probably enjoy the communications-area laboratory courses: ECE 453 and 463. ECE 453 deals primarily with RF circuitry and 463 involves the implementation of communications components digitally in software (via LabVIEW). If you were interested in the digital communications topics, you should consider taking ECE 361 to supplement your knowledge of communications theory. When dealing with PLLs, you may have noticed that stability was a key consideration—not surprisingly, ECE 486 is a related technical elective. Also, you should consider taking ECE 420 (Digital Signal Processing laboratory) if you want to gain insight on the connection between signal processing and communication systems.
ECE 462 - Logic Design

Instructors:

The course it taught by Professor Shobha Vasudevan. She has prior industry experience and thus knowledge of how the course material relates to work after school.

Prerequisites:

The course is cross-listed as CS 462 and MATH 491. The prerequisite is ECE 290 or CS 231. ECE 290 is definitely necessary, as all topics build upon the digital logic design material.

When to Take It:

ECE 462 is only offered in the fall. Many of the topics such as logic optimization and finite state machines are carried over from ECE 290. It is very important to remember the logic design concepts taught in ECE 290, so taking this class soon after taking 290 is advisable, though the important part is remembering how to use concepts from 290 (ECE 385 and ECE 411 may help in this respect). Knowledge of hardware design will help you appreciate the concepts in this course, but is not necessary to do well.

Class Content:

Since the course is cross-listed with a computer science and math course, the material involves some algorithms and mathematical proofs. The course begins with logic optimization, starting with K-maps from ECE 290 and discussing software optimization methods such as the Quine-McCluskey method. Then finite state machine optimization and algorithms to compare two finite state machines are discussed. In addition to discussing finite state machines and logic optimization, the class also covers hardware optimization and verification techniques used before a circuit is fabricated. Fault detection and correction is then discussed in the context of post-fabrication testing. Finally, the class covers technology mapping, which involves optimizing logic using a predefined set of logic gates.

Work:

The course has a very light workload. The homework due about every two weeks and takes only a few hours. ECE 462 also has two midterms and a final. Students who understand the homework concepts should do well on the exams. Overall, the course is designed to be a fairly small weekly time commitment.

Life After:

Students that like this course, ECE 543 (Digital System Testing and Design for Testability) is the next course for you. This course (as well as ECE 543) are one of the few courses that teach verification and testing. Therefore, this course is useful for anyone considering those careers, as well as hardware design. The concepts discussed in this course are also used by design software in industry. The concepts taught in ECE 462 will help anyone in any career.
ECE 464 - Power Electronics

Instructors:

Philip Krein teaches this course and has been doing so for several semesters. He's responsible for developing the current power electronics curriculum at Illinois. He's very knowledgeable about the subject and very helpful. The textbook used for the class has been written by him and it's the single most important resource in the class, besides the professor himself.

Prerequisites:

ECE 342 is the only prerequisite for this class and it's a good idea to take it beforehand. Knowledge about circuit design, gathered in ECE 342, is advantageous in this class. A student with ECE 342 experience and ECE 210 prior to that should be in a good position to tackle this course. Many students who take this course are interested in the Power Systems area and have also taken ECE 330 and ECE 431 prior to taking this course, which helps them better appreciate the course content. Students who haven't taken ECE 330 and ECE 431 before this course, though, will not be at any disadvantage.

When to Take It:

This course is only offered in the Fall semester. Also, with the way the ECE curriculum is structured, the Fall of Junior year is, really, the earliest one can take it. It should be noted that taking the laboratory course (ECE 469) along with this is highly recommended. If a student is interested in power systems or circuits, courses in preceding semesters should be carefully planned out to accommodate both the lecture as well as laboratory courses.

Class Content:

This class, on a high-level basis, covers power converters. It goes over DC-DC converters such as Boost, Buck, Buck-Boost etc. first. AC-DC converters (or rectifiers) and DC-AC converters (or inverters) are covered next. Students learn to design these converters based on the application of the device which could range from a small rectifier that gets plugged into the power socket at home and powers your laptop to a large inverter that forms the link between a solar farm and the power grid. In the later half of the semester, design considerations for components that form a part of these power converters, such as resistors, capacitors and inductors is also covered. Taking the laboratory course (ECE 469) along with this lecture course really helps the student appreciate the subject and circuit design as a whole - for one thing, the student will get to appreciate electric power and its effects on circuits.

Work:

The workload for this course is moderate. There are weekly homeworks, two midterms and the final. The weekly homeworks are like any other ECE course - by going to lecture on a regular basis and the occasional office hour, students should learn enough to complete the assignments. The midterm exams are very reasonable and fair. Students should expect to spend an average of 5-10 hours per week on this course. Taking this course along with the laboratory course (ECE 469), however, increases the workload significantly.

Life After:

This is the only power electronics course available in the undergraduate curriculum, besides the accompanying laboratory course. Graduate level courses are the next logical step if a student is interested in furthering their knowledge on the subject. The power department has a wonderful network of connections and the professor and the laboratory engineer, Mr. Kevin Colravy, will frequently forward internship and full-time job opportunities to students in the class.
ECE 482 - Digital IC Design

Instructors:

This course is directed by Prof. Shanbhag. Most recently, this has been taught by Professor Rosenbaum. She is known for clear explanation of material and for having high expectations.

Prerequisites:

ECE 290 and ECE 342 are the two official prerequisites. In addition, the theory of MOSFETs, which is mainly covered in ECE 340, will be needed for circuit analysis in this class.

When to Take It:

ECE 482 is an advanced class on digital IC circuits. Both undergraduate and graduate students take this class. If you have a strong interest in digital circuit design and want to learn more, this class is for you. Generally, it is offered once a year in the fall semester.

Class Content:

The course starts by talking about basic MOSFETs, and slowly builds up to analyzing more complicated digital circuits - inverters, combinational logic gates, sequential logic circuits, semiconductor memory, etc. MOSFETs are introduced in ECE 110 and digital logic design is taught in ECE 290; this class picks up on the ideas taught in 110 and 290 by examining the close connection between MOSFETs and digital logic. Individual transistors are considered in various digital circuits. Both manual analysis using simple MOSFET I-V models and computer-aided design and simulation are used, giving you a brief idea and hand-on experience on how to optimize a digital circuit with regard to delay, power or compactness. State-of-the-art design approaches are covered as well.

Work:

The workload is manageable as long as you can keep up with every class. However, this takes time. Do not expect to rush through the reading assignments and homework problems in one night. Homework is assigned every week, most of which includes simulation using SPICE program and circuit layout using Cadence. Exams require clear understanding of class material. Be prepared to flexibly apply your knowledge to new ideas and designs. There will be a final design project on a team of four. Usually a VLSI subsystem is to be built, which includes everything from design, layout, simulation and optimization. As it is pretty large project, each team will be given more than one month to finish. The design project puts what you've learned into engineering practice and will definitely be valuable experience to talk about in an interview.

Life after:

Both advanced courses in digital circuits, ECE 425 (Intro to VLSI System Design) and ECE 482 overlap a lot. However, this class puts its emphasis on transistor level. It will equip you with fundamental knowledge and skills required for a digital IC designer.
ECE 486 – Control Systems

Instructors:

Faculty in the area of controls generally rotate as far as teaching this class. Prof. Meyn has been teaching the class for around 15 years now and does an excellent job of pushing students to learn the most they can while imparting a great deal of the philosophy of control. Prof. Meyn has since left UIUC, but Prof. Liberzon and Prof. Hutchinson have taught it most recently.

Prerequisites:

The listed prerequisite is ECE 210. This class is a lab class, so it might be wise to have taken ECE 385 before it to have an idea of the work a lab class entails. MATLAB experience is also a plus, but this class is one of the best places to learn MATLAB.

When to Take It:

This class is offered every semester. Take it in a semester when you have the time to devote 10 hours a week to this class. This is a great class and will change the way you think about systems, but there are no other control systems electives for undergrads, so it is not clear what the best time is to take this class. Talk to your adviser.

Class Content:

Through the lecture portion of this class, you will learn the basics of control theory, including dealing with system responses, how to design stable systems, using state-space models, and related mathematical concepts. In the lab portion of the class, you will use MATLAB and Simulink as you learn to model simple systems and ultimately program a controller that balances a pendulum in the inverted position. You also get to do fun things like riding a Segway.

Work:

This class requires an above average time commitment since it has both a lecture portion and a lab portion. In terms of regular work outside class, you will have to do one homework every week for the lecture section, and complete a pre-lab, lab report and sometimes work on lab experiments which take place every two weeks.

Life After:

Unfortunately, this is the only class on controls at the undergraduate level. Related classes include ECE 470, Math 415, ECE 310. ECE 470 is the class on robotics, Math 415 is a class on linear algebra, and ECE 310 is the class on discrete-time signal processing.
ECE 490 – Introduction to Optimization

Instructor:

For over a decade, this class has been taught by Professor P. R. Kumar, who is also the course director. He provides a slow and careful treatment of the topics, emphasizing fundamental concepts. A typical meeting consists of an ungraded oral quiz (ungraded) during the first ten minutes; this is followed by a 20-minute recap of the previous lecture and then an appropriate transition to the new material.

Prerequisite:

ECE 190 and MATH 415 are listed as the official prerequisites. However, no specific concepts from ECE 190 are discussed in the class and it suffices to have adequate programming skills, at the level of implementing an algorithm in C or Matlab. Likewise, with MATH 415, the class seldom relies on gory details beyond elementary matrix algebra, using only concepts like row reduction, determinants, and so forth. The only real prerequisite is “mathematical maturity,” for which there are many pathways to arrive at.

When to Take It:

The prerequisites (or the lack thereof) do not imply you should take the course early on. In fact, it is best to take it whenever you have an accurate picture of your future goals and interests. Optimization in itself is interesting, but it defeats the purpose of the course if you take it without any knowledge of specific applications. For example, you might find a use for optimization in research projects you do outside of class. It is therefore recommended that you take it in your junior or senior year, and perhaps even as a first year graduate student.

Class Content:

The class begins with an introduction to linear programming and its various applications within engineering and outside, such as in finance and economics. Techniques for solving them are discussed, and algorithms are implemented in homework problems. The class quickly adopts a more rigorous approach and discusses unconstrained optimization of arbitrary functions, along with necessary and sufficient conditions for optimality. Similar analysis is then repeated for constrained optimization and well-known results such as the KKT conditions are derived. The last few weeks are spent on special topics such as compressed sensing, simulated annealing, and so forth.

Workload:

As a semi-graduate level course, it entails a non-trivial amount of work. There are typically ten homework assignments, each of which is time consuming and may involve programming. There is a midterm and a final exam. Graduate students seeking a fourth credit hour may pursue an optional project. In the past, students have written detailed reports on special topics, backed by scholarly articles.

Life After:

The class is targeted towards those interested in the theoretical aspects of signal processing, communications, and control systems. ECE 310, ECE 361, and ECE 486 are all good courses to take concurrently with ECE 490, though not necessarily all of them simultaneously. Mathematics courses such as MATH 444/447 (Real Analysis) and MATH 448 (Complex Analysis) should be taken before, during, or after the course. Since many applications reside outside of ECE, economics and finance classes such as ECON 465 may broaden your understanding of the applications. ECE 491 (Numerical Analysis) is a must for those interested in efficient implementation of many of the methods discussed in the class. This is a theoretical course and does not lead to immediate job placement; however, since it is of fundamental importance, it will equip you with the skills necessary for any career—be it a quant or a power systems engineer.
Non-ECE/CS Technical Electives

This section encompasses all non-ECE/CS technical electives. The list of approved courses is gigantic, so this section is not meant to be comprehensive.
MATH 427 - Honors Abstract Algebra

Instructors

The instructors of the course vary from semester to semester. In Fall 2011, it was taught by Professor Jayadev Athreya.

Prerequisites

The prerequisites for this course are either an honors section of Math 416; or Math 415 with an honors section of Math 347. These prerequisites should be considered required since they will give the necessary mathematical background to succeed in the course. The most concrete examples in abstract algebra come from linear algebra.

When to Take It

For ECE majors, this is purely a voluntary course. Students pursuing a math minor (especially pure math) will be interested in the course. This course is only offered in the fall semester.

Class Content

The overall theme of the course is algebraic structures and how they arise from simple sets of axioms. Depending on how fast the course goes, the topics covered will be as follows:

- Groups
- Rings
- Symmetry Groups
- Fields

The following key concepts/theorems will be covered:

- Lagrange’s Theorem and related subgroup order theorems
- Sylow Theorems
- Classification of the plane symmetry groups
- Identification of quotient groups
- Polynomial fields

Work

As an honors course, the work will be rigorous and fast-paced. There is homework every week and 2-3 in-class exams depending on who the instructor is. The in class exams are 4 questions, to be completed in 50 minutes, coming in 2 flavors; prove a theorem or some property given so-and-so conditions; or, apply theorem’s to construct/work an example. There is a final project, which can be of any topic of your choice; it will need to be 5 pages long. There will be a take-home final exam which you are given a week to complete, in place of an official final exam during Finals Week. The concepts in abstract algebra are foundational to modern mathematics, and this course will equip you to understand upper-level pure mathematics. Every mathematician since the early 20th century is an expert on basic abstract algebra.

Life After

Math 427 is part of the Mathematics honors sequence (424, 425, 427, 428). Therefore, many students take Math 428 afterwards, which is a capstone course in a special topic chosen by the instructor, typically taught in the spring semester.
MCB 150 - Molecular and Cellular Basis of Life

Instructors:

Brad Mehrten is the professor who teaches MCB 150. He's been teaching the course since 2002 and is one of the best lecturers on campus.

Prerequisites:

Although no prerequisites are listed on the official Illinois page, it would be very wise to take CHEM 102/103 before taking this course, since the course covers chemical reactions that occur within the cell. Although good students can pick up all the various things that they will need to know, they will be much better off if they are already familiar with the basics of intermolecular/intramolecular forces and acid-base chemistry, as these are important to understanding protein folding, the creation of the plasma membrane, the effectiveness of enzymes, etc. Knowing some basic organic chemistry reactions, such dehydration synthesis and hydrolysis in relation to carbohydrates and proteins, is also useful, as these topics come up during the first unit of the course. Anyone familiar with all of these things will definitely be a step ahead.

When to Take It:

Those who are interested in bioengineering should take this course as early as possible since it is a prerequisite for almost every other MCB course.

Class Content:

The course starts with a basic overview of both the prokaryotic and eukaryotic cells. Students are introduced, briefly, to all the organelles and their functions, which are explained in more depth as the course progresses. The building blocks of life are also introduced: carbohydrates, nucleic acids, amino acids, and lipids. Students will be expected to understand their uses in the cell, as well as the kinds of reactions that they partake in and the various enzymes that catalyze these reactions. The first hour exam covers these topics.

The course then moves on to cover the ways that the cell uses energy - including glycolysis, the Krebs Cycle, the electron transport chain, and anaerobic respiration. After this, the organization of DNA inside the nucleus is studied, and the course eventually gets around to covering the "central dogma" of molecular biology - the flow of information from DNA to RNA to protein, and the ways that the cell makes this happen, including DNA replication, transcription, and translation. All of this is on the second hour exam.

The organization of DNA in the nucleus is expanded on again to begin the third part of the course. The nucleolus and how it plays a role in the production of ribosomes is of much more importance this time around. Various kinds of mutations are studied next, including frameshift, insertion, and deletion mutations, as well as mutations caused by external factors, such as UV light. The ways that the cell protects corrects errors caused by mutations is also studied. The secretory pathway is studied next, and the functions of the rough ER and the Golgi Apparatus are expanded on. This content is all on the third hour exam.

Before the final, a couple of more topics are covered, including the cytoskeleton and the structures that make it up as well as the cell cycle. The last few lectures cover a couple of "special topics"; in previous years these have included different types of viruses and how they infect cells, as well as recombinant DNA technologies.

Work:

MCB 150 covers a wide range of topics. Thus, it should be of no surprise that anyone taking this course will likely need to spend a lot of time outside of class studying the material. Many people taking MCB 150 have found that they need to listen to the lectures again, outside of class, to absorb all of the information that is taught. It is highly recommended that anyone considering taking MCB 150 should either buy a recorder and record the lectures for themselves, or find a friend who is also taking MCB 150 and borrow his/her recorded lectures.

This class has assigned readings in addition to the lectures, and there are always at least 2-3 questions on the hour exams that come directly from the reading. Besides that, most of the questions on the test come directly from lecture, and are more theoretical scenario type problems than memorization type problems. One practice exam for each hour exam is always available for review, and doing well is incredibly difficult without going over the practice exams. Also, the course curve can be deceptive: although only 880 points out of 1000 are required to get an A, this is not an easy thing to do.

This class has LON-CAPA homework due every Friday; these problems are generally not too bad, and 30 points are dropped from the LON-CAPA total. Students who regularly go to class should be able to easily get a perfect LON-CAPA score. There is also a weekly discussion section, which does not normally review lectures but instead tries to show students the real-world applications of the things they are learning in class. Attendance points are given for showing up, and students are only allowed to miss three discussion sections throughout the semester. However, there are several discussion sections dedicated to lecture review, and these are normally right before the exams. There are also two graded discussion worksheets that come up during the semester.

All in all, this is a pretty demanding course, so be prepared.

Life After:

ECE majors who enjoy MCB 150 may be interested in getting a bioengineering minor. Several courses are required for the minor, including MCB 244, MCB 246 or MCB 250, MCB 252, and MCB 253.
Instructors:

Usually Professors K V Prasanth and Fei Wang teach it in the fall, and Professors Michel Bellini and David Rivier teach it in the spring. From personal experience, Spring professors are excellent. In a lecture hall of 250 or more, they manage to keep students engaged and make a great deal of material very interesting.

Prerequisites:

Officially, MCB 250 is required. However, there is almost nothing in MCB 252 that relies on what's in MCB 250. ECE majors simply need an interest and general understanding of biology (e.g. central dogma of molecular biology), but otherwise, the course is completely self-contained.

When to Take It:

It is recommended to take this course sooner rather than later because it provides good exposure to biological concepts and provides foundation for many other courses in MCB as well as BioE, whether or not it may be a prereq for these. It's typically taken by 2nd year MCB majors and is offered every semester.

Class Content:

This course is the foundation for understanding cell biology (this is intentionally very broad). The topics covered over the semester include transcriptional and translational control of gene expression, intracellular interactions, and cell-cell interactions. These concepts build the foundation to understanding cell birth, proliferation, lineage, and death with a short discussion of current work in cancer and stem cell biology. There is a tremendous amount of material covered in the course, but every bit of it is enjoyable. As a side note, the professors aim to make the course more analytical than rote memorization, but in the end, there is a good amount of memorization.

Work:

There are 3 exams and a non-cumulative final. The course has 4 or so LON-CAPA “quizzes” as well as a discussion section that meets every week (worth some small number of points). Depending on one's ability to memorize, studying can take anywhere from 1 to 5 hours per exam. Often reviewing lecture notes, past exams that are posted, and asking questions during discussion to understand big ideas is a fine way to study.

Life After:

This course gives a great foundation for further classes in MCB and BioE as well as bio-related research opportunities.
PHYS 225 - Relativity & Math Applications

Instructors

This course has been taught in the past by Prof. Naomi Makins, Prof. Susan Lamb, and most recently, Prof. Jim Wiss. Prof. Naomi is also the chief advisor for LAS Physics. She can give you a lot of useful information if you are planning further study in physics.

Prerequisites

Credit or concurrent registration in PHYS 212 is required. Although Math 241 is not required, it can help greatly in the second part of the course.

When to Take It

This class is for students who want to go for physics minor or just want to explore Physics beyond the required University Physics classes (211, 212, 213 and 214). It is very important for students who want to take 300 and 400 level physics classes.

Class Content

This course is designed to help people get used to how things work in higher level physics courses. It is very different from Phys 211 - 214. Students need to understand course material to work on the problems. Simply grabbing equations and plug in numbers won’t work. All problems in homework and exams require steps, not just answers. In short, it is where real physics begin.

The title can be misleading. The math applications are not just for Special Relativity. It is about Math's applications to Physics in general. The first half of semester covers Special Relativity, which includes kinematics and dynamics. The second half of semester covers math applications, which includes vector analysis, series expansions, matrices, Fourier analysis, partial differentiation, three-dimensional calculus, and simple differential equations.

The course has a lecture section and a discussion section, which each meet weekly. Most of the course material is taught in discussion, where students work on the course package. The course package is divided into 14 well written discussion units. Each of the discussion units contains reading materials along with several questions; working through the questions helps students to grasp the ideas of the course. Basically, what students need to learn they derive by themselves. A small part of the discussion unit is called the challenge zone, which contains questions that can be hard to solve. In lecture, the instructor will go over material which many people are having trouble with (mainly challenge questions) and anything that is important, but not covered in discussion.

Work

About 5% of the grade is based on lecture attendance. Homework is assigned every week. You will also go over one discussion unit each week. 8-9 hours total work in one week is common. Homework is hard and requires quite a bit of thinking, so office hours can be very helpful, although they are often crowded and instructor may not have enough time to help everybody. Working with other people also helps students understand the material.

There is only one midterm in this course, which is an hour long; working quickly is necessary to finish on time. The final exam is 3 hours long and cumulative.

Life After

After this class, you are ready for high level physics courses; a common next step is Phys 325. For an ECE student, PHYS 486 and PHYS 487 are also good choices.
Phys 325 - Intermediate Classical Mechanics I

Instructors:

Many instructors teach this course; Prof. George Gollin taught this course recently. He is a very humorous and friendly person. Prof. Richard Weaver is instructor this semester; Professors Mark Neubauer and Susan Lamb have also taught this course before.

Prerequisites:

Phys 225; credit or concurrent registration in Math 285 or Math 286.

When to Take It:

Anyone who wants to get a physics minor should take this class after taking Phys 225. If you are interested in classical mechanics then this is also a good class to take.

Class Content:

This course covers many aspects of classical mechanics including newtonian mechanics, dynamics in three dimensions, systems of particles, oscillations, motion in rotating frames of reference, fluid dynamics, Lagrangians and the calculus of variations. It also relates to calculus, differential equations, linear algebra and Fourier series.

The first part in this course is review of what you learned in Phys 211. Once the course gets to oscillations, a great deal of new material will be covered in every lecture. Oscillations are a big part of the semester, which takes several weeks to finish; the math for them is pretty intense since this is probably the first time you see application of differential equations and Fourier series in a Physics course. There are a wide variety of oscillations and it takes time to study all of them. After that, the course teaches some cool stuff like Coriolis force and conservation laws in fluid dynamics. They are hard to understand, but math is simpler than before. At the end of semester, you will learn Lagrangian (kinetic energy minus potential energy in a system). It probably sounds not so useful at first, but it actually solves many problems and that will give you a new perception of physics.

Lectures are 1.5 hours long and contains a lot of information (600+ total pages in lecture notes). Missing any lecture will cost you greatly as it takes a lot of time to read the notes and catch up. There is also an 1-hour problem session every week. Attendance is taken in both problem sessions and lectures.

Work:

The work is much harder than in any lower level physics class. Going to office hours is highly recommended. It will be very helpful if you work with others in groups. Homework is assigned every week which takes 4-6 hours to finish (if you work with others; otherwise it might take forever if you don't get the idea). It is essential for understanding course material. Past exams are not provided, so you certainly need to use homework for reviewing.

Exams focus more on testing how well you understand the course than on your math skills, although you still need to be good at math to do the problems. The formula sheet is useless unless you know the meaning behind the formulas.

Life After:

Phys 325 is the first half of classical mechanics sequence. Many people take Phys 326 (the second half) after this. For the Physics minor, Phys 326 is not required.
ChBE 472 - Techniques in Biomolecular Engineering

Instructors:

Professor Deborah Leckband teaches this course. She is an engaging lecturer and is genuinely interested in teaching her students. She lectures primarily from powerpoints -- so students that don't learn well from them will be at a great disadvantage. She holds office hours every week -- not many attend, but those that do really learn a lot.

Prerequisites:

Officially the following courses are required: CHEM 202, CHEM 203, CHEM 204 or equivalent; MATH 220 or MATH 221; PHYS 211, PHYS 214 or equivalent; MCB 450.

For students that have a genuine interest in biology/chemistry/bioengineering, everything necessary will be taught in class. There are a number of important basic concepts, like the central dogma of molecular biology, which are necessary to begin understanding the material, but nothing that a student couldn't learn by himself/herself while enrolled in the course.

When to Take It:

There is no need to rush to take this class, but it's only offered in the Fall semester. Some understanding of chemistry and biology (AP Chemistry and Biology) should be enough. There are always students who drop this course, so if it fills up, just start attending the lecture and add at a later date.

Class Content:

This class covers the a variety of topics in biotechnology from nucleic acid sequencing to enzyme design with an emphasis on engineering principles including thermodynamics and stability of macromolecules, recombinant and DNA sequencing technology, protein production and purification, designing and evolving enzymes, and antibody technology. The lectures refresh fundamental concepts and, for many, introduce a quantitative method for assessing biological problems (sometimes absent in MCB courses). Each topic includes an overview of historical and current methods as well as their uses both in research and in industry. For an engineer, the class is particularly enjoyable since the course includes an emphasis on the feasibility of potential solutions (eg. cost-effectiveness). The class is taught through PowerPoint lectures, but Dr. Leckband often holds discussions and short calculations at the beginning or end of class. Many students find the class difficult, but equally interesting.

Work:

Expect to spend about 2 hours per weekly problem set. Depending on how familiar one is with the material, students spend anywhere from 2 to 4 hours studying for exams. There are two exams and a final. The exams are usually open book and open notes but no problem sets. The exams are usually pretty long, but with a thorough understanding of the material, they are manageable; students who do not understand the material well will waste a great deal of time looking through the notes. The exam problems usually are very similar to past exam problems or to problem set questions. Going to office hours is a great way to understand what's important and what's not.

Life After:

This class doesn't prepare for another one. It helps construct a framework for analyzing biological problems with an engineering mindset. It's a great class to take for students interested in biotechnology from any angle.
NPRE 429 - Plasma Engineering

Instructors:

Professor Ruzic teaches this class while Dr. Luo is the TA.

Prerequisites:

The official prerequisite is ECE 329, but the plasma dynamics discussed review topics from ECE 350 (dispersion relations and wave dynamics), PHYS 213 (entropy and free energy), PHYS 214 (quantum mechanics), CHEM 102/103 (rates of reaction and equilibrium), CHEM 104/105 (kinetics), and a variety of other concepts related to chemistry and physics.

When to Take It:

Take as it a non-ECE technical elective as a senior or advanced junior. There is a related lab class, NPRE 423, but there are some official prerequisites to that lab that are not satisfied with other ECE classes. Talk to professor Ruzic if you are interested in the lab class. It is usually only offered in the fall.

Class Content:

The course starts at the most basic level of describing a plasma: plasma density and plasma temperature. The plasma sheath is discussed in heavy detail, with a strong emphasis on describing electron and ion interactions. Collisions and rate coefficients are introduced to describe reactions that take place inside the plasma. EM wave propagation in plasmas and dispersion relations both outside of and in a magnetic field are continuously covered. Several lectures cover sputtering, what affects sputtering, and computational tools to help analyze sputtering. Some applications of corona discharges and their relation to plasmas are covered also. Another large series of lectures cover plasma sources, both DC and AC variations, and several applications of these sources. The last section covers processes for semiconductor fabrication that utilize plasmas. These include sputtering, physical vapor deposition, chemical vapor deposition, ion etching, and many more.

Work:

There are only a couple homework problems each week, but they are very challenging. These are not plug and chug types of problems, and require a high level of understanding of the lectures and the textbook readings. There is one midterm and one take-home exam in the middle of the semester. The final exam is non-cumulative, but there is also a take-home final. You should expect to spend at least 5 or 6 hours a week going over the lecture material and completing homework.

Life After:

In conjunction with ECE 444 Theory and Fabrication of Integrated Circuits, one would be well prepared to go into semiconductor fabrication or designing tools for semiconductor fabrication. A strong background in plasma engineering would also lend itself to the nuclear power industry and plasma research.
MSE 280 - Engineering Materials

Instructors:

A variety of professors have taught it over the years; Professor Aboukhatwa and Professor Martin have taught the course for the past few semesters.

Prerequisites:

The official prerequisites are CHEM 102 and concurrent registration with PHYS 214. A lot of the material builds on concepts from CHEM 102, such as atomic bonding.

When to Take It:

You can take this as a non-ECE technical elective as once you have the prerequisites. ECE students aren't required to take any TAM (Theoretical and Applied Mechanics) classes like most other engineering disciplines, so this is a nice way to be introduced to concepts that you normally wouldn't see. This class surveys the discipline for non material science majors. Taking this class concurrently with or prior to ECE 340 can be helpful.

Class Content:

- Atomic bonding. This is hugely important to the understanding of material science. All of the interactions that are going on at the atomic level determine everything about how the material acts. Atomic bonding is really the groundwork from which the rest of the course builds.
- Crystal structures. Many of the materials we commonly use are in some kind of crystal structure. One property of crystals is that they have a repeatable structure, allowing us to make some assumptions about the material properties to simplify analysis.
- Measures of stress, strain, material strength and how to test for these parameters. These are some of the topics that are touched in many TAM classes, but are never introduced to ECE majors. These basic measures of material strength are good to know as a part of general engineering knowledge.
- Ceramics, metals, and polymers. The composition and classification of these three types of materials are important, because they work differently at the atomic level.
- Composites. These materials can be applied for specific purposes. The benefits and trade-offs of using composites are discussed, including economic considerations.
- Phase diagrams and phase changes. A lot of time will be spent understanding phases, various types of phase diagrams, and the mechanics behind phase changes. Besides understanding the changes between gas, liquid, and solid, you also learn how different rates of cooling affect the final structure of a solid.
- Dislocations and failure mechanisms of ceramics, metals, and polymers. A large part of material science is devoted to understanding failure mechanisms. This introduces some of those mechanisms and the implications for optimal design.
- Properties of electronic and magnetic materials. A very short time is spent on electronic and magnetic materials, but most of this should be straightforward for ECE majors.
- Practical considerations and optimization of materials design. The final part of the class covers how to pick the right material for the application. All the design concepts from the class are used to show how one can create an optimization function that includes material properties, reliability, and cost.

Work:

There is homework due weekly. There are a couple of midterm exams throughout the semester, along with a non-cumulative final. The exams are very fair and cover mostly what is covered in the homework, so there should be no surprises. The course load is not very heavy, but most of the material will probably be new to ECE students. Expect 4 hours a week doing the homework and reviewing the material. It is generally encouraged to work on the homework with other students.

Life After:

The overview of crystal structures can help with the beginning of ECE 340 - Solid State Electronic Devices. Being skilled at reading phase diagrams will also come in handy in ECE 444 - Theory and Fabrication of Integrated Circuits. While the rest of the material may not directly aid you in your other ECE classes, a few students decide to pursue a minor in Material Science and Engineering in conjunction with their ECE major.
Miscellaneous Courses

These courses aren’t technical electives, yet aren’t required, but are still of interest to ECE majors.
ECE 200 - ECE Explorations

Instructors:

Professor Kudeki is the official instructor for this course, but the seminar format means that every class has a different guest presenter.

Prerequisites:

This course has no prerequisites, and everyone is welcome; however, for some of the lectures, knowledge of basic ECE concepts taught in ECE 210 or 190 will help you to understand some of the presentations.

When to Take It:

James Scholars are required to take ECE 200 once a year after their Freshman year. Anyone can sign up for it, and it can be repeated as many times as desired. The class is open to anyone who wants to show up, even those who are not officially signed up for it. Many people may prefer to come when they see that the topic is something that interests them. Each week the topic is announce in The Wire and on the course's webpage.

Class Content:

Presentations are on various topics. Past classes have included:

- Microsoft talking about development of Bing
- LinkedIn talking about development of their search mechanisms
- Professor Smaragdis about "Making Machines Listen"
- Professor Wasserman talking about his research in near-IR wave propagation in materials
- RIM talking about the development of Near Field Communication in cell phones
- CISCO talking about "The Quest for the Largest Known Prime Number"
- PowerWorld talking about the power grid and the idea of the "Smart Grid."

The schedules (and abstracts) from past semesters are available on the course website. At the end of class, the department usually serves pizza and soda.

Work:

The grading for this class is Satisfactory/Unsatisfactory and is based solely on attendance. Although typically scheduled 5-7pm on Wednesdays, most presentations end by 6pm (the Undergraduate Research Symposium is usually the exception). This class is 0 credit hours, so it doesn't count towards graduation.

Life After:

Many events are either corporations talking about what they do, or Professors talking about their research; thus ECE 200 is definitely a good networking opportunity. It is also a good place to relax and talk to fellow ECE students over free pizza.
ENG 198 - Honors Seminar

Instructors:

Professor Ravaioli taught both sections of this course during the Spring 2012 semester.

Prerequisites:

This course has no prerequisites.

When to Take It:

This class is a great choice for James Scholar students who need to fulfill their James Scholar requirement for the year. Students in the class range from freshman to juniors. Students who are not James Scholars can sign up for the class.

Class Content:

The class meets one hour every week. Each lecture consists of Professor Ravaioli speaking to the class about the topic of the course. Class discussion is encouraged so be prepared to speak about the topic.

Work:

There is no formal homework for this class; however, there are readings or videos assigned almost each lecture that will be very helpful for discussion during the lecture period. The course culminates to a reasonably lengthy paper due on the day of your final exam. The topic of this paper can be of your choice, but it must be approved by Professor Ravaioli.

Life After:

This class has a small class size in an intimate setting so it is a great way to interact and get to know high up professors and deans. Students who take it during the spring semester may have the chance to apply for a paid summer research position.
Math 461 - Probability Theory

Instructors:

This class is taught by a variety of Math professors each semester. In Spring 2012, it was taught by Kirkpatrick, Ivanov, Loeb, Bauer, and Ash, with an online section by Professor Carpenter.

Prerequisites:

The official prerequisite for this class is Math 241 (Calculus 3).

When to Take It:

Knowledge of multi-variable calculus (taught in Math 241) is definitely necessary to understand all the material in this course and is necessary for some of the later homework problems. Previous experience with discrete math (Math 213 or CS 173), probability, or statistics will make this class easier, but is not required. This class is offered every semester, and is generally taken by upperclassmen in Math, Engineering, and CS. Students who plan to take STAT 410 instead of ECE 313 may choose to take this class first, since it is one of the possible prerequisites for STAT 410.

Class Content:

The class spends the first few weeks exploring discrete mathematics, covering topics such as basic counting principles, combinations, permutations, inclusion-exclusion, and the like; then, the discussion of probability begins with the axioms defining probabilities, after which the class delves into discrete probabilities - probabilities of events such as results of flipping coins, rolling dice, picking balls out of a box, etc, exploring topics such as conditional probability and independence of events. Then the class moves on to discussing random variables; first, discrete random variables are discussed; Common discrete random variables such as the binomial, geometric, Poisson, hypergeometric, and negative binomial distributions are described.

It is at this point, around half-way through the semester, that the class moves away from discrete probabilities, starting with the study of continuous random variables. Common continuous random variables, such as the uniform, normal, and exponential distributions are discussed. Many of the concepts seen earlier in the class, such as independence and conditional probabilities, are reexamined, but now using continuous and discrete random variables (instead of events); joint and conditional density (and mass) functions are introduced during this discussion, and various computations are demonstrated with random variables (such as how to derive the distribution of a variable that is a function of another with a known distribution). This later part of the class is where the calculus material is needed, because every formula that uses a summation for discrete events uses integration for continuous events, and in some cases, double-integrals are required.

Towards the end of the course, a variety of topics such as covariance, correlation, and moment generating functions are discussed. The class ends by mentioning the Central Limit Theorem and the Law of Large Numbers; the former is not proved.

Work:

While this class does involve some in-class discussion of proofs, most proofs presented are relatively simple compared to what would be seen in other 400-level math classes. The weekly homework generally involves computing a few probabilities or probability functions - the homework does not involve proof-writing. Homework is generally pretty easy if you understood the examples in class, and only takes a few hours a week. This class has a few sporadic quizzes throughout the semester, which are meant to test students' understand of the material; they are usually fairly simple, if you can remember the correct formula to use.

This class does cover a lot of topics throughout the semester, but many of the later topics are rehashed versions of earlier ones, such as discussing independent continuous random variables (where independent discrete probabilities are discussed earlier in the semester), or discussing expectation of conditional continuous random variables (a combination of conditional probabilities, expectation, and density functions - but integrating because the random variables are continuous).

This class has 2 tests throughout the semester, as well as a final.

Life After:

This class is one of the possible prerequisites for STAT 410. After taking this class, students have a fairly thorough understanding of basic probability concepts and how to use them. Knowledge of probability can be useful for classes in communications and networking, such as CS 438 and ECE 361.
Graduate Courses

This section is dedicated to 500-level ECE courses. With departmental permission, undergrads can use these courses for technical elective credit.
ECE 515 - Control System Theory & Design

Instructors:

Instructors change every semester. This class was instructed by Daniel Liberzon in the semester reviewed.

Prerequisites:

ECE 486 (Control Systems) is listed as a required prerequisite, but there is little to no overlap between ECE 486 and 515. Only about two weeks of 486 are used.

Math 415 (Applied Linear Algebra) is not listed as a prerequisite, but it really should be as the material is impossible to understand without a strong knowledge of linear algebra. Higher level math classes are also strongly recommended, as this is exclusively a theory course after the first week.

When to take it:

This course is a lot of work, as is standard for grad-level classes. Therefore it should not be taken until grad school, and probably not the first semester of grad school either. It is very heavy in mathematical proofs and devoid of real-world examples, so take plenty of math classes first, especially Math 415.

Class Content:

The class’ unofficial name is “Linear Systems Theory,” and is taught as a high-level math course. During the semester reviewed, real-world examples ceased after the first week of lectures.

Topics in order:

1. System modeling and analysis
   a. State-space models of linear systems/linear algebra review
   b. Solutions to state equations
2. System structural properties
   a. Stability
   b. Controllability
   c. Observability
   d. Duality/Minimality
3. Feedback
   a. Pole placement
   b. Tracking and disturbance rejection
   c. Performance/measurements/sensitivity/etc.
4. Optimal control
   a. Dynamic programming and the HJB equation
   b. Minimal principle

The textbook for this course is a packet of course notes for sale through the ECE stores. During the semester reviewed, an optional textbook was also listed (Linear Systems Theory by Joao P. Hespanha) which was significantly more helpful than the printed lecture notes. The professor noted that he taught primarily from his recommended book, and was not 100% familiar with how things were presented in the printed notes.

Work:

This class has one homework assignment each week, which takes about 5-15 hours to complete depending on your knowledge of the material. There are not that many problems per homework, but they are very technical and are frequently advanced mathematical proofs, requiring a lot of outside reading to understand how to solve them.

There is one midterm and one final exam for the course. The midterm during the semester reviewed was only three questions, but they were unlike what was seen in the homeworks - it tested knowledge of concepts and applying the material learned to new situations, not ability to solve problems or do proofs.

Life After:

This class a prerequisite for every other grad-level controls class in ECE. Good follow-up classes are:

- ECE 517 – Nonlinear and Adaptive Control (offered almost every Fall)
- ECE 528 – Nonlinear Systems (offered every Spring)
- ECE 553 – Optimal Control (offered almost every Spring)
- ECE 586 – Topics in Decision and Control (offered every semester, but content is different each time)
ECE 527 - System on Chip Design

Instructors:

ECE 527 is taught in Fall by various professors. This guide is based on the Fall 2010 offering with Deming Chen.

Prerequisites:

ECE 527 is a popular first-semester class for grad students. Before taking the class, students should have taken a basic RTL design class, and be familiar with either Verilog or VHDL. They should also be familiar with basic digital logic - logic gates and how they are represented with transistors. Other than that, the class does not have many required prerequisites.

For undergrads, ECE 391 and ECE 425 will provide sufficient background. ECE 411 can be useful, in that it provides additional exposure to hardware design concepts. However, the internals of processors will be treated as a “black box” for the purpose of the class and students will not be required to have detailed knowledge of computer architecture.

When to Take It:

527 is a good class for incoming ECE grad students because it's offered in Fall, it's not very advanced subject material (a lot of it should be review if you've completed a CompE BS), and because it's fairly light on workload. It is especially relevant if a student's research is going to be in RTL-level concepts, because they will learn how to use FPGAs and the associated design tools.

527 can also be a good class for ambitious undergrads if they are especially interested in digital logic. It can be considered the next step after ECE 425 in many ways. It's more practically oriented than most graduate-level classes, so it may be a good class to practice their VHDL if they are planning on going into industry after graduation.

Class Content:

The overall theme for the class is techniques used (both computational and manual) to design SoCs. Broadly, this means: (1) the sort of automated processes that go on when you synthesize digital logic (2) the techniques used to design and model an SoC from discrete parts. More specifically, the topics include:

- Hardware IP: Types of hardware intellectual property and issues encountered during IP reuse.
- Transaction-level modeling (and modeling in general): Ways to quickly model communicating systems at a high level without being concerned with low-level implementation details.
- High-level synthesis: Techniques for designing digital hardware at high levels of abstraction (behavioral RTL, C, etc.)
- Operation scheduling: Algorithms for the best ordering of computations on a processor's given limited functional units, and making tradeoffs between power, speed, and area.
- Layout: Algorithms for determining the optimal number of functional units for a processor and their layout on chip.
- CUDA: The high-level architecture of CUDA cores and the sorts of applications they are best suited to.
- FPGAs: The reasons to use FPGAs, a high-level overview of how they work, and the design issues associated with them.
- Hardware/Software co-design: Techniques for designing hardware and software concurrently for use together on an SoC.

The idea is to give you a feel for the techniques used in industry today for designing digital hardware and putting together SoCs from several discrete components such as processors, co-processors, DSPs, etc. The instruction is a combination of lectures by the professor and required readings. There is no required textbook.

Work:

There are two machine problems in VHDL which will have students implement something on an FPGA. In Fall 2010 it was a videoconferencing compression design that transmitted video from a camera through the serial port to a computer. Each MP has students complete a component which will be used for the overall design. Students are given about 2 weeks to complete each MP. They should expect to spend around 10-20 hours on each. Homework assignments test the material covered in lecture and the required paper readings. There's also a midterm and a final.

The majority of the assigned work in this class, like in most grad classes, is the research project. Students should start thinking about class project topics during the last half of the semester. Students decide their topic 6-8 weeks before the end of the semester and write a proposal outlining their approach and expected results. They will present their completed project in class at the end of the semester and write a report in standard IEEE conference format about the project. There may also be intermediate in-class presentations regarding the project. Since this class covers many areas, the topic of the project is pretty flexible. If a student's research is even tangentially related to digital design, they can probably use it for their class project. The project is usually done in pairs or occasionally triples. The amount of time spent on the project is varies greatly, but at least 30-40 hours per student is expected.

Life After:

Where you go after ECE 527 depends on your interests - there is no true successor class. A popular Spring class that many grad students take after ECE 527 is CS 533 (Parallel Computer Architecture). ECE 542 (Fault Tolerant Systems) is also a good class to take for students interested in digital logic.
ECE 540 – Computational Electromagnetics

Instructors:
This course is taught by Professor Jianming Jin. He is an expert in computational electromagnetism research and the author of many authoritative texts in the subject. Professor Jin is not only extremely knowledgeable about the subject matter, he also is very good at explaining the material, its history and how it connects to actual practice.

Prerequisites:
The prerequisites should all be completed in advance since the background skills will only be mentioned briefly in class. The recommended classes are Numerical Methods I (CS 357) and EM Waves and Radiating Systems (ECE 520). This is truly the bare minimum to make it through this class. You should also have a decent understanding of MATLAB, Python, C/C++ or any high level programming language with an accessible graphics library before attempting this class. You should also be very clear on vector calculus, partial differential equations and electromagnetism. The ECE 520 class should be very helpful in this regard. With that said, it is more important that you understand the fundamental electromagnetism than be the savviest programmer in order to do well in this class.

When to Take It:
Since this is a graduate course, the choice to take it depends on your future goals. If you have deep desire to know more about EM simulation from the ground up this course is invaluable, since you will undoubtedly encounter simulations in your career. Undergrads can take this course with permission whenever their schedule permits; but it is probably a good idea to take this class later in your degree if you wish to develop skill in this area. This class is usually offered in the spring.

Class Content:
The course is a survey of the most prominent EM simulation techniques, their strengths and weaknesses and the mathematical development of the computational techniques. The Finite Difference Time Domain (FDTD) method, Finite Element method and Method of Moments techniques, computational stability and optimization are covered in class. About a third of the class will be dedicated to Finite Element method, absorbing boundary conditions and perfectly matched layers. You will apply what you learn to standard physical problems i.e. infinite line and point current sources, dielectric materials and antennas.

Work:
You will be required to produce several publication quality projects during the course of the class, in addition to regular homework assignments and a final presentation. The time required will vary depending on your initial preparation (prerequisites, experience, etc.), but most students should expect to put in 20 – 25 hours of preparation a week in order to fully understand the material and finish the assignments.

Life After:
This class gives you the tools to understand and create accurate EM simulations. This is extremely helpful in the work and research space where simulation data is often presented without the specifics of the techniques explained. If you have a specific interest in computational research in electromagnetism, this is a very good first step into the field. You may also wish to consider ECE 571 (Electromagnetic Waves in Inhomogeneous Media) after this class.
ECE 547 - Topics in Image Processing

Instructors:

There is only one instructor for this course, Prof. Thomas Huang, and he’s been teaching it every fall since 2004.

Prerequisites:

The course page for this class says ECE 310 (Digital Signal Processing) and ECE 313 (Probability with Engineering Applications) are prerequisites. DSP builds a good base of knowledge that is needed going into this course, so it is indeed important to take it before this class. Some knowledge of probability and statistics is necessary for this course, but not at the level of ECE313, as the course only uses very basic statistical methods (in the few cases where they are actually used). Some prior knowledge of linear algebra will help as well, but is not necessary.

When to take it:

This course is best taken during graduate school or an otherwise light-workload-semester senior year. There are a few undergrads who take the class, but the workload is significantly greater than any undergrad classes with the same number of credit hours. This course is also easier for those who’ve taken more signal processing classes beforehand, like ECE 551 (DSP 2). A strong working knowledge of MATLAB is essential for the programming assignments.

Being a 500-level class, it will be difficult and take up a lot of time. Compared to other grad-level courses though, this course is easier than most. Because of this it is a good candidate for the first grad-level class to take, even for those who don’t want to go into image processing.

Class Content:

Subjects in order: (Some of the later ones might not be covered)

1. 2D Fourier transform
2. Fractal image/video coding
3. Waveform-based image/video coding
4. 3D model-based video coding and motion analysis
5. 3D Reconstruction – Reconstruction from projections
6. Phase retrieval
7. Image restoration – SVD, projection on convex sets
8. Order-statistics filters and mathematical morphology
9. Image segmentation
10. Texture, shape, structure
11. Image and video databases
12. Geometric optics
13. Optical Fourier transform

The course is taught off of a set of transparencies that have been put into a loose collection of “lecture notes” for sale at the campus bookstores. These lecture notes are straight copies of the lectures plus additional material, but are not organized into any logical sequence, so students spend almost as much time looking for the right pages of notes as they do reading them. Wikipedia is very useful for many of the coding techniques – some are actually explained much better on Wikipedia than in class.

After about midway through the course, the homework starts to diverge significantly from what is actually taught in class. Class will cover many novel ideas and inventions in the field of image processing, but the homeworks will test students’ practical knowledge of them, so students learn a lot of the material on their own.

Work:

One written assignment and one machine problem are assigned roughly every two weeks, due two weeks later. The written homework will usually expand on subjects taught in class, and the machine problems will test students’ abilities to apply those concepts in MATLAB. The written homework is at least partially different each semester, but covers the same topics. The material covered in the written homework will not always be presented well in class before it is due (or sometimes ever), so spend some time getting to know the TAs as they are very helpful. The MPs are the same every semester, so talking to someone who has previously taken the class can save a lot of headaches while trying to figure out how to code some of the more obscure theory.

Life After:

This class is better taken after ECE 551, but for those who haven’t taken it yet, ECE 551 a good follow up course. Otherwise, this course is a good step in the direction of becoming part of an image-processing lab on campus or beginning a search for an image-processing job.
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