Dear Reader,

As you open the fifth print issue of Dr. Everitt’s Neighborhood, I want you to read this not only as an advising aid, but as a tool for what options lie before you. Contained within these pages is an overview for nearly every ECE and CS course at your disposal. As you plan your future semesters at University of Illinois, keep in mind that your options should never be limited, as the expansiveness of this guide should demonstrate.

Dr. Everitt’s Neighborhood, or DEN for short, is an independent course guide to ECE at Illinois. The guide is a collection of student written articles discussing courses from the students’ advising perspective. The initial idea was sparked by MIT’s “Underground Guide to Course VI.” The initial print of DEN was in Spring 2009 by Chris Li, a member of the HKN Board at the time. Since Chris, DEN has evolved to encompass CS as well as ECE, and with the move from primarily print to wiki format, DEN has incorporated additional advising tools as well.

With the fifth edition of Dr. Everitt’s Neighborhood, we have begun to reach saturation of new courses within ECE and CS. At this point, much of the work is refinement; course formats are always changing, the new Computer Engineering Curriculum is moving in, and articles will always need to be edited. New this issue is a more expansive “Should I Take X with Y” section, where students have written articles about the advantages and disadvantages of taking specific courses together, pending department approval.

I would like to thank all previous editors of DEN, who have laid the groundwork for this invaluable tool. Furthermore, the HKN Alpha Chapter has provided assistant editors, authors, and ideas that have enabled DEN to flourish, and for that I am extremely thankful.

If you have an idea for contributing to DEN, the wiki can be found at bit.ly/DENHKN, and you may reach me at buerckl2@illinois.edu. We are always looking for new ideas to help improve DEN.

Happy reading!

Sincerely,

Samuel Buercklin

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

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- PHYS 212 - University Physics, Electricity and Magnetism
- PHYS 213 - University Physics, Thermal Physics
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Engineering Core

This section contains information about the core Math, Chemistry, and Physics courses that all engineering majors are required to take.
PHYS 211 - University Physics, Mechanics

Instructors:

Instructors vary every semester, but Professor Selen and Professor Stelzer have taught most sections recently. These two professors are two of the creators of smartPhysics, the online tool used for all the University Physics courses.

Prerequisites:

The official requirement is credit or concurrent registration in MATH 231.

When to Take It:

For many students, this is the first Physics course taken at the UIUC. It is a great introduction to the class format that will be used for the University Physics sequence. Students should take this course as early as possible since it is a prerequisite for PHYS 212, and thus for most ECE courses. Like most introductory courses, this course is offered every semester.

The course requires strong mathematical skills to be able to correctly apply formulas to different scenarios, derive formulas when none fit nicely, and to interpret numerical results as actual physical situations. There will be some Calculus based problems, but the math will be sufficiently simple to tackle them with MATH 221.

If this is the first time a student has taken a calculus based Physics course, the student might want to consider taking PHYS 100 (Thinking about Physics) first; in fact, there is a Physics placement test given to incoming Engineering students, the results of which are used to recommend whether or not they should take PHYS 100; if the college recommends you take PHYS 100 as a result of this placement test, it is advisable to follow their advice.

Class Content:

The course starts with mathematical representations of motion in 1D and 2D; these relations are then extended to circular motion. With a grasp of how a body should move, the course introduces Newton's three laws of motion, which are the main recurring concepts for the entire semester. These laws introduce the concept of force, which is then extended to the different types of forces and how they interact. Students learn how to perform vector analysis and to draw correct Free-Body Diagrams to determine the correct component of the forces in each direction. Afterwards, the students visit the concepts of work, energy, and momentum, and how they relate to collisions between particles. Once the student has a solid understanding of linear situations, the concepts are extended to rotations, torque and angular momentum. Finally, the course closes with harmonic motion, waves and a brief introduction to fluid dynamics.

Work:

This course has a significant time requirement and considerable busy work. Each student has to enroll in weekly lectures, discussions and labs. Before the lecture, students are expected to watch a 10-15 minute prelecture that introduces the concepts that will be covered in lecture. These prelectures are a required component of your grade for the class. Once a week, students must complete a homework assignment and attend their lab and discussion sections. The discussions and labs last 1 hour and 50 minutes each. In general, students should spend roughly 10-12 weekly hours on this class. Going to lecture will require 2 hours per week, attending to the mandatory discussion and lab sections will require 2 hours each. The time it takes to complete homework and review topics varies from student to student, but a student can normally expect at least 3 hours of work at home.

The homework usually consists of roughly 5-8 multi-step problems on smartPhysics. It is easy to score high marks on homework since you get infinite attempts at each question and you get immediate feedback from most problems. If the student does not understand the problem, he can try many times or consult with a TA for help.

Discussions involve solving a challenging problem set in groups, then closing the section with an individual quiz. The problems are meant to test your understanding of the concepts and to encourage discussion amongst the students. For this reason, they tend to be more challenging than the problems that the students solve on their own.

There are 8 labs in total for the class, roughly one every other week. Before coming to lab, the student has to complete a pre-lab problem set which consists of roughly 5 problems. Each lab consists of series of detailed exercises that the students should complete in groups of approximately 4. For each section of the labs, the students come up with predictions for the expected outcome, and then test those theoretical values with empirical evidence. Each lab takes roughly 2 hours, but sometimes students finish early. The lab-work covers the following topics:

- Lab 0: Introduction to laboratory equipment and 1D kinematics
- Lab 1: Additional experimentation with kinematics.
- Lab 2: Force and Newton’s laws of motion.
- Lab 3: Friction
- Lab 4: Energy
- Lab 5: Collisions
• Lab 6: Rotational Dynamics
• Lab 7: Rotational Dynamics II
• Lab 8: Periodic Motion

The general philosophy used to teach this course is:

1. Introduction (prelectures)
2. Untangle (lecture)
3. Challenge yourself (homework)
4. Play with it (lab)
5. Close cycle (discussion - quiz)

Life After:

The next logical course is PHYS 212; ECE students (especially Electrical Engineers) should take PHYS 212 as soon as possible to be able to start working on the ECE curriculum. Students who really enjoyed this course should consider taking PHYS 225 and PHYS 325, especially if they are interested in working towards a Physics minor.
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, Kirchoff'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 derives 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 prelecture 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 213 - University Physics, Thermal Physics

Instructors

Professors Kwiat and Budakian usually teach this course, sometimes concurrently. Both are great lecturers.

Prerequisites

The prerequisites for PHYS 213 are MATH 241 (Calculus III) and PHYS 211 (University Physics, Mechanics). PHYS 213 will expand on kinetic theory, mechanics and energy introduced in PHYS 211, which does not involve material learned in PHYS 212 (University Physics, Electricity and Magnetism).

When to Take It:

PHYS 213/214 are generally taken in the sophomore year. While some choose to delay PHYS 213 until the final semester because the concepts covered in Thermal Physics are only marginally relevant to later ECE courses, it is best to get it out of the way at the same time as PHYS 214 (University Physics, Quantum Physics). This is because both of these courses are half semester courses that complement one another with roughly equal workloads; taking them concurrently will make scheduling a manageable workload a lot easier. When paired with PHYS 213, ECE 313 (Probability with Engineering Applications), as the abstruse statistical mechanics part is a subset of probability theory – if you don’t understand what’s going on, at least you’ll be able to do the math on the exam. CS 173 (Discrete Structures) and MATH 213 (Basic Discrete Mathematics) also deal with several combinatorial concepts which can help to explain some of the strange mathematical formulas that appear in Thermal Physics; however, it is not strictly necessary to have taken one of these classes prior to taking PHYS 213.

Class Content:

The class begins with a bottom-up approach to constructing the universe – starting with atoms. Yep, atoms. How the energy is stored in atoms and molecules (kinetic theory of gases and equipartition) is expanded through statistical mathematics to deduce macroscopic phenomena such as heat capacity, conductivity, diffusion, and entropy. The class then switches gears to focus on heat exchange, black body radiation, and later culminating with the heat engine. Scientifically important ideas such as the Boltzmann distribution and the laws of Thermodynamics are dealt with. There is then a brief discussion of lattices and semiconductors, both of which are relevant to ideas in ECE 340 (Solid State Electronic Devices). The course concludes with discussion of phase transitions, which integrates various concepts introduced in the duration of the course.

Work:

PHYS 213 has recently been upgraded by SmartPhysics to parallel the structures of PHYS 211 and PHYS 212, to include Prelectures, Online Quizzes and “Ask the Profs.” The workload now looks like this:

- Lecture – show up, stay awake, click a few times for points. Three times a week, one hour each. During the summer this is condensed to four lectures per week each lasting 1 hour and 20 minutes.
- SmartPhysics Prelectures – a series of short lectures consisting of narrated graphical animations that gives you a primer on the following lecture’s material due at 8AM on the day of lecture. While they are helpful and thus recommended, you can also click through to rack up the points at 7:59, and watch them again after lecture. Usually three per week.
  - Online Quizzes – a mixture of short answer and multiple-choice questions, usually no more than four per quiz. These check for understanding of the material presented in the accompanying Prelecture – so watch the Prelectures!
  - Homework – you can expect to spend anywhere from 2-6 hours on each week’s homework set, depending on your aptitude with the course material. Each student receives different variables for their problem set, so matching answers is no longer viable, but learning the procedures during office hours is not as bad as it sounds – just find a nice TA.
- Lab – same drill as PHYS 211 and PHYS 212. Pre-lab is worth 5 points, quick and easy, turn it in at the start of lab. The labs work in PHYS 213 is long, find a good group and don’t slack, or you might not finish in time; lab reports are due at the end of each 2 hour lab. Four labs total.
- Discussion – as for PHYS 211 and PHYS 212, don’t show up late, or you don’t get the 20 point quiz at the end of each discussion. One 2 hour discussion each week.
- Exams – one midterm and one final. The midterm usually catches students off guard, if they didn’t learn from PHYS 214 already. Study hard for the midterm, and even harder for the final because the final is worth more than a third of the grade.

Life After:

Enjoy life, you’re done with thermal physics. While some of the ideas related to molecular phenomena such as diffusion and heat transfer appear in ECE 340 (Solid State Electronic Devices) and 400-level courses related to physics and device modeling, the focus on these concepts in ECE courses is quantitative, while PHYS 213 is conceptual. If you really enjoyed PHYS 213, you may want to consider taking PHYS 225 (Relativity & Math Applications) and PHYS 325 (Intermediate Classical Mechanics I), the
first few courses needed for a Physics minor; students who are interested in learning more about statistical mechanics in particular may want to consider taking PHYS 427 (Thermal & Statistical Physics), most likely as part of a Physics minor.
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 (University Physics, Thermal Physics), since they are both 8-week courses (PHYS 214 is taken in the first 8 weeks, and PHYS 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. Schrödinger's Equation is solved for both the infinite and finite potential well, which should be an easy concept to grasp when MATH 286 (Introduction to Differential Equations Plus) is taken concurrently with this course. Schrödinger'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 CHEM 102 (General Chemistry I)) arise as a result of the quantum nature of matter and energy is covered last.

Work:

PHYS 214 has recently been upgraded by SmartPhysics to parallel the structures of PHYS 211 and PHYS 212, to include Prelectures, Online Quizzes and "Ask the Profs." The workload breaks down as follows:

- Lecture – show up, stay awake, click a few times for points. Three times a week, one hour each. During the summer this is condensed to four lectures per week each lasting 1 hour and 20 minutes. Professor's will work through easier/similar/harder versions of questions in your homeworks and exams.
- SmartPhysics:
  - Prelectures – a series of short lectures consisting of narrated graphical animations that gives you a primer on the following lecture's material due at 8AM on the day of lecture. While they are helpful and thus recommended, you can also click through to rack up the points at 7:59, and watch them again after lecture. Usually three per week.
  - Online Quizzes – a short quiz accompanying each Prelecture. These are a mixture of short answer and multiple-choice questions, usually no more than four per quiz. These check for understanding of the material presented in the corresponding Prelecture – so watch the Prelectures!
  - Homework – you can expect to spend anywhere from 2-6 hours on each week's homework set, depending on your aptitude with the course material. Each student receives different variables for their problem set, so matching answers is no longer viable, but learning the procedures during office hours is not as bad as it sounds – just find a nice TA.
- Lab – same drill as PHYS 211 and PHYS 212. Pre-lab is worth 5 points, quick and easy, turn it in at the start of lab. The labs work in PHYS 214 is manageable, be diligent and you will be fine. Lab reports are due at the end of each 2 hour lab. Four labs total – one of them is a computer based exercise where you work with a simulation of quantum wells in the Loomis Computer Lab. Make absolutely sure that you study for that lab, or you will either a) spend a lot more time than you would like, or b) get a low score for that lab.
- Discussion – as for PHYS 211 and PHYS 212, don't show up late, or you don't get the 20 point quiz at the end of each discussion. One 2 hour discussion each week. Quiz covers material similar to discussion problems. Good TAs will make sure you know which problems matter.
- Exams – one midterm and one final. The midterm usually catches students off guard, if they didn't learn from PHYS 214 already. Study hard for the midterm, and even harder for the final because the final is worth more than a third of the grade. They will photograph the room and run statistical analyses on your bubble sheets - cheating is for idiots.
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 (Quantum Physics I) and PHYS 487 (Quantum Physics II). Those looking for a more device oriented course may want to take ECE 485 (MEMS Devices & Systems).
MATH 220 - Calculus

Instructors:

Bob Murphy (Appears as Robert F. Murphy in class registration but mostly known as Bob) is typically the professor for this course. He has taught the course for most semesters in the past few years.

Prerequisites:

This course is for those who have no calculus background at all. A score of 70% or above is required on ALEKS Math exam for placement into this course.

When to Take It:

This class should be taken first semester if you do not have credit for it because it is a prerequisite for pretty much every technical course you will take. It is offered every semester.

It may be wise to take this course even if you have some calculus background from high school and are eligible for MATH 221. A high grade in this 5-credit course will give you a good start in your college GPA.

Class Content:

MATH 220 and MATH 221 are very similar in terms of content except that the 1st chapter of the Stewart Textbook is covered in MATH 220 and omitted in MATH 221. This chapter includes a brief cover of functions, exponentials and logarithms. MATH 220 is a 5-credit course whereas the latter is 4-credit. Because of this there are 43 lecture hours for MATH 220 as opposed to 29 in MATH 221. Material is covered at a slower pace.

Starting with an overview of high school material, which are functions, exponentials, logarithms and trigonometry, the class moves on to 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 and finding average value of a function. Riemann sums and approximation techniques (e.g. Simpson's Rule) are not covered in this course and are materials for MATH 231.

Work:

The work for this class is usually quite manageable. Problems from the textbook are assigned for practice, but they are not collected. WebAssign is not used either. Instead of homework grade, there are weekly quizzes in the discussion sections. There are two discussion sessions and one quiz per week. Attendance is pretty strict for discussions and failure to attend a certain number of discussions will lead to failing the course. The amount of time spent outside the class is significantly reduced if you are already familiar with the topics but generally you can expect at least 2-3 hours of work per week outside class.

Life After:

This course prepares students for Calculus II (MATH 231), which continues the ideas of Calculus by teaching how to integrate more complicated functions, among other things. The material from Calculus is fundamental to many ECE, Math, and Physics classes that ECE majors must take. Make sure to learn integration material well as the majority of the content of future calculus classes consist of further integration techniques. Especially MATH 231 will focus chiefly on integration both in application and theory. Grasping the idea of integrals (knowing the definitions, being able to visualize the integral etc.) is important in addition to just knowing how to solve the integral problems for future calculus classes.
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 covers 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 was 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 (or a 5 on the AP Calculus BC test) is a prerequisite for Math 241. Much of the material from Calculus II, however, is never mentioned in Vector Calculus: although it is extremely important to be comfortable with techniques for integration, sequences and series barely show up in this course, if they show up at all. 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.

There is also an honors section of this course that the Math department advertises to freshmen coming in with the AP credit. The exact content of the honors section varies, but encompasses everything ordinarily taught in Math 241 and more. Students who have a strong math background (beyond just doing well in high-school Calculus) and want to see some of the more theoretical side of multidimensional calculus, should consider the honors section; students who are not interested in the theoretical aspects (e.g. those expecting to just learn how to compute more integrals and derivatives) typically don’t enjoy the honors section.

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 textbook.

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 I, 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.

The honors version of this course often uses a different textbook, but covers topics in a very similar order. The exact contents are up to the professor, but often the honors section will include additional material from linear algebra, such as linear functions and matrices, and often also includes differential forms, which are an algebraic structure that allows the traditional Calculus 3 theorems (Green’s Theorem, Stoke’s Theorem, and Divergence Theorem) to be summarized in the “generalized” Stoke’s Theorem; notably, differential forms can be used to express the change of variables formula for multiple integrals in a simpler fashion.

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. Students who take and enjoy the honors section should consider further Math classes such as Math 347, Math 444 (Elementary Real Analysis) or Math 424 (Honors Real Analysis), and Math 425 (Honors Advanced Analysis) (where differential forms are covered in detail).
Math 285 - Intro Differential Equations


Instructors:

A. Manfroi and J. Baryshnikov are professors that teach this class. Manfroi speaks clearly and walks students through multiple examples each lecture period. He takes some time and has a short conversation each class getting to know the students i.e. “How was your weekend?” Also, Manfroi takes the time to thoroughly answer questions and reexplain concepts; Baryshnikov’s teaching is very similar.

Prerequisites:

Math 241 is the prerequisite. It is necessary to be familiar with integration and differentiation methods as well as fluent in solving algebraic equations. Multiple integrals (double and triple integrals) rarely appear if at all in this course as the focus is on solving basic differential equations. More complex differentiation techniques (trig. substitution) also are rarely if at all needed in this class for the same reason.

When to Take It:

Math 285 is the next class to take after completing Math 241. It is offered every semester, and most students take this class during Sophomore year. However, if students have AP credits for Calculus, then this class can be taken during Freshman year. Concurrent enrollment in PHYS 212 is helpful in gaining a better understanding of the differential equations discussed in this class as many of them are involved with resonance and waves.

Class Content:

Topics Covered:
- Differential Equations (Separable Equations, Linear First Order Equations, Second-Order Equations, Second-Order Linear Equations)
- Slope Fields
- Substitution Method
- Homogeneous and Nonhomogeneous Equations
- Mechanical Vibrations, Forced Oscillations and Resonance
- Periodic Functions and Trigonometric Series
- Fourier Series and Convergence
- Application of Fourier Series
- Eigenfunctions, Eigenvalues
- Heat Conduction, Laplace’s Equation
- Vibrating Strings and One-Dimensional Wave Equation

Practice exams are made available online a week before a test, and they allow students to better prepare as they reflect the tests’ difficulty level.


Chapters covered: 1, 2, 3, 9, and part of 10

Work:

There are around 8 homework assignments given over the course of the semester with on average 4 to 5 problems. These problem sets will typically take 2-3 hours, and they are usually slightly more difficult than the examples worked out in class. Students can also expect to spend a couple of hours preparing for each test, usually by working through the practice tests which are given a week in advance to each test.

There are 3 midterms as well as a cumulative final.

Midterm 1 topics: Chapter 1, sections 2.1-2.3, sections 3.1-3.3.

Midterm 2 topics: Midterm 1 topics as well as chapter 3, excluding section 3.7, sections 9.1-9.2.

Midterm 3 topics: Midterm 1 and 2 topics as well as chapter 9.

Final exam: Cumulative, everything covered in class.
Life After:

This class may be the last required math class in several majors, but the topics covered will be applied in other classes such as ECE 210, PHYS 214. However, if students are going to continue taking math, Math 415 (Applied Linear Algebra), or Math 463 (Statistics and Probability I), or Math 441 (Differential Equations) are classes that continue the topics covered in this class.
MATH 286 - Intro to Differential Eq 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 for are the Mathematica sections, where 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 ODE's, 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 and 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.
Instructors:

The head instructor for this course is Bruce Carpenter. However, virtually all of your interactions will be with a graduate student TA named Tayyab Nawaz (as of Fall 2013), however you may also be assigned an undergraduate TA, Lavin Devnani. Tayyab is responsible for grading your homework assignments and he also holds “office hours” via an online chat system that features audio chatting and screen-sharing, which allows him to see and control your computer screen. He is very knowledgeable about the course material and whenever he doesn’t know the answer to a question he is diligent about finding out and getting back to you. His spoken English is not perfect, so if it is difficult to communicate with him via audio, just tell him that you prefer to type your questions rather than use the microphone.

Prerequisites:

The only listed prerequisite is . You definitely want to have a solid grasp on the basic concepts of Calculus to succeed in NetMath 286. You will be expected to take partial derivatives and perform integration, and more importantly, you will need to have a qualitative understanding of these basic concepts. Near the end of the course there is also some overlap with topics covered in Linear Algebra such as eigenvectors and eigenvalues, but Linear Algebra is not a prerequisite and is certainly not necessary to succeed in Differential Equations.

When to Take It:

The course is a self-paced online offering that can be started at any time. The course must be completed within 16 weeks of the start date. The registration process goes through UIUC’s office of Online and Continuing Education (OCE) and it may take about 2 weeks from the time you register until you can actually begin your lessons, so plan accordingly. This course is listed as a prerequisite for ECE 210, which in turn is a prerequisite for virtually every subsequent ECE course, so the sooner you take Math 286 the better.

Class Content:

The course content is delivered completely online using a Mathematica-based platform called Making Math. The Making Math subscription costs $79 (as of Fall 2013)---think of it as analogous to buying a course textbook. The course content is composed of 9 units as follows.

- **Unit 0: Getting Started**
  - This is a quick intro to the Making Math / Mathematica system. Not graded.
- **Unit 1: The Exponential Differential Equation**
- **Unit 2: The Forced Oscillator Differential Equation**
- **Unit 3: Laplace Transform and Fourier Analysis**
- **Unit 4: Modern Differential Equation Issues**
  - Euler’s method of approximating solutions to differential equations
  - Flow plots for analyzing differential equations
  - The predator-prey model
- **MIDTERM EXAM 1**: Covers Units 1 thru 4
- **Unit 5: First Order Differential Equations**
  - Phase lines for analyzing differential equations
  - Autonomous differential equations
  - Bifurcation plots of differential equations
  - Sensitive dependence on starter data
- **Unit 6: Systems and Flows**
  - Systems of differential equations
  - Trajectories and vector fields
- **Unit 7: Eigenvectors and Eigenvalues for Linear Systems**
- **Unit 8: Linearizations**
  - Using linearizations to approximate nonlinear differential equation systems
  - Lyapunov’s rules
  - The pendulum oscillator
- **MIDTERM EXAM 2**: Covers Units 5 thru 8
- **Unit 9: The Heat Equation and the Wave Equation**
- **FINAL EXAM**: Cumulative

Each unit is composed of a lesson, a tutorial, and a lengthy homework assignment, all delivered via Making Math. The Making Math platform is difficult to describe, but you can think of it as an online interactive textbook. Below is a screenshot from the
first lesson to give you an idea.

All of the content is authored by Bill Davis, an Ohio State mathematics professor, and Jerry Uhl, a late UIUC mathematics professor. They do an excellent job of mixing in interesting applications of the material and some comic relief.

The exams are the only part of the course that is conducted in-person. You are responsible for finding a proctor and scheduling your exams. If you are on campus, it is easy to schedule proctored exams through the UIUC Office of the Dean of Students (ODOS) Testing Center located at 601 E. John St. If you are off campus you just have to submit a proctorship approval form to the NetMath program and schedule your exams far enough in advance for the test booklets to be mailed to your proctor.

*Note: NetMath 286 and Math286 cover about the same material, but it may vary depending on the professor for Math286.

Work:

As mentioned above, there are 9 units, each composed of a lesson, a tutorial, and a homework assignment. Most of the units have 2 weeks allotted to them, but a few of the shorter units are expected to be completed in just 1 week. Since the course is self-paced you can certainly complete the units faster if you wish. You may also be able to work at a slower pace, but it is best to check with the TA to make sure you will not be penalized for missing “due dates,” and keep in mind that there is a 16-week limit for the entire course.

The homework is the only part of each unit that is submitted for a grade, but expect to spend a lot of time completing these assignments. For most assignments you will be given the opportunity to hand in your homework a second time after your first try has been graded and returned to you. Although the lesson and tutorial at the beginning of each unit are not submitted for a grade, plan to dedicate significant time to these as well. The lesson and tutorial are where you actually learn the material before attempting the homework, and time spent on the lesson and tutorial is much like time spent in the classroom of a traditional course.

The number of hours required to complete each unit varies greatly. Longer units (such as Unit 2) may require ~25 hours of work to complete, whereas shorter units (such as Unit 9) may require only ~6 hours. On average over a 16-week semester, the work comes out to about 8.5 hours per week. The course can also be completed over the summer on an accelerated timeline.

Life After:

Math 286 is a prerequisite for ECE 210 Analog Signal Processing, which is directly or indirectly a prerequisite for much of the
rest of the ECE curriculum. After taking it you will notice that the concepts pop up everywhere, even in courses that do not list Math 286 as a prerequisite.

Beyond the ECE department, Math 286 will allow you to take upper level physics courses in mechanics (e.g. PHYS 325), electromagnetics (e.g. PHYS 435), and quantum mechanics (e.g. PHYS 486). It is also a prerequisite for Math 442 Intro Partial Differential Equations.
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 and will not receive the single credit hour for 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.
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 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 Schmitz, 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. In fact, students are recommended to take it in the fall semester because a large portion of the class is GE and IE students during spring semesters. This fact becomes important when you choose your lab partner. Your ECE 110 grade will heavily depend on your lab performance so choosing your only lab partner is important, but most GE/IE students do not take ECE 110 lab seriously and/or have no prior knowledge in breadboard/circuits. 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 greater 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 should precede ECE 290, if not taken concurrently.
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. Bear in mind that much of this time will be spent debugging your code. Because the later MPs tend to be long and complicated, it is advised that students not only start early, but seek help early as well. There are only so many TAs, and surveying a student's code can be time-consuming, which leads to situations where many students need help debugging, but there aren't enough TAs to help them all. It also helps to code meticulously, using comments often and making sure you know what each line of code does.

There are three exams in the class and a cumulative final. 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 198KL(220) - Computer Engineering II

Instructors:

Professor Steve Lumetta is the original instructor for the class and is responsible for much of the course material and homework. Professor Sayan Mitra, who has previously taught ECE 190, is currently teaching the class for Fall 2013 and should continue in Spring 2014. Other instructors for the class in Spring 2014 are Professor Yih-Chun Hu (another ECE 190 professor) and Sanjay Patel, the co-author of the class textbook.

Prerequisites:

ECE 198JL/120 is a prerequisite for the class. ECE 198KL/220 is a programming-focused class but it assumes no prior programming experience besides the introduction to LC-3 assembly found in ECE 198JL/120. However, any prior programming experience should help students understand some of the concepts taught in the class more easily.

When to Take It:

ECE 198KL/220 should be taken the semester immediately after taking ECE 198JL/120, as the class is meant to be a continuation of ECE 198JL/120. As such, it is not advisable to take ECE 198JL/120 and ECE 198KL/220 concurrently, though there may be some special cases. In general, it is recommended for students to take this sequence as soon as possible, as these classes are part of the core ECE curriculum.

Class Content:

The main goal of ECE 198KL/220 is to provide students with a bottom-up approach to learn a solid programming base to lead into future courses such as CS 225 and ECE 391. The class starts out by refreshing students on the LC-3 ISA and quickly adds new concepts such as I/O, subroutines, TRAP operations, and the stack. Around the first midterm the course shifts into learning the C programming language, often referencing LC-3 and sometimes even breaking down pieces of code in C into LC-3 assembly. After learning some of the basic syntax and operators of C, students learn concepts such as pointers, arrays, I/O, and recursion. The course has a small amount of data structures built into it, starting from structures and enumerations and leading into dynamic memory allocation and linked lists. Towards the end of the class, the curriculum focuses on a few core differences between C and C++, looking at concepts such as classes and object-oriented design, inheritance, access control, and dynamic memory management.

Work:

ECE 198KL/220 is a four hour class, but the weekly time commitment can vary greatly based on programming skill. Students are given a machine problem (MP) every week. Usually the MPs task students with writing a certain function (or multiple functions) within a larger program. The first few MPs are in LC-3 assembly, with the majority of the MPs being in C, and the last few being written in C++. The MPs generally take up to 10-15 hours of work a week, though some students may find them to take much less time. MPs are individual assignments, though students are free to communicate with each other. However, sharing code is definitely not acceptable.

The class has three evening midterm exams and a cumulative final. Each exam is generally split into two parts. The first part is in short-answer form typed into a .txt document, with questions ranging from topics discussed explicitly in class to other questions meant to test how students can apply knowledge to different situations. Some short-answer questions may have students analyze code and explain a bug found within the code. The second part of the exam is a programming portion, usually multiple problems, where students must write some function, similar to the MPs assigned in the class. Preparation for exams of course depends on the student, but in general it is recommended to have full understanding of the assigned MPs. In the past, there have been practice exams given in the lab section in order to give students an idea of what to expect on the exam. In general, understanding the MPs and going through class notes generally should provide enough preparation. Students should expect to devote at least a few hours before each exam.

Life After:

This class is likely the first class entirely focused on programming that students will encounter. Many CompE students continue after this class to CS 225, a required CompE course. At this point, students also have the possibility of taking ECE 391, though many tend to wait longer before taking the class. In general, ECE 198KL/220 is an important introduction to programming which allows students to advance into other programming-related topics. ECE 298 - Digital System Design Lab is the next step in the ECE core curriculum, which applies some programming concepts but does not require extensive use of LC-3 assembly or C.
ECE 210 - Analog Signal Processing

Instructors:

This course is currently directed by Prof. Kudeki. Instructors vary from semester to semester. However, Profs. 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 PHYS 212 and MATH 285/286 and 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. 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.

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 310, 329, 330, 340, 342 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 as soon as possible or 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 methods of working with linear systems, including the analog circuit as a linear system, with the inputs being voltage/current sources and the outputs being voltages and currents. 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 technical computing, using the material of this course as a basis. 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 significantly 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.

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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 semesters, 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. Once you take this course and realize that you are interested in becoming an Electrical Engineer, you will have a better idea on what to specialize in Electrical Engineering after you take the 300 level EE courses, especially with the technical cores classes and the "3 of 5" technical classes.
ECE 290 - Computer Engineering I

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:

In recent semesters, there has been some experimentation with the work given for the course; most notably, in Fall 2012, Professor Herman tried replacing the two midterms and some of the homework with group projects. The usual workload is described below.

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 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 298 - Digital System Design Lab

Instructors:

Prof. Chen Deming taught ECE 298 for the course’s first semester. He had previously taught ECE 385 in spring 2012/2013.

Prerequisites:

ECE 298 is the third class of the new Computer Engineering course sequence. The previous courses are ECE 198JL and ECE 198KL. This class is a project-based application of concepts learned in the earlier courses. As such, the lab experience from ECE 110 is also helpful.

When to Take It:

This class can be taken the semester after ECE 198KL. For some students, this will be as early as the first semester of sophomore year, however it can be reasonably taken as late as first semester of junior year. Those who take this class later will not be significantly affected in eligibility for future courses, but some of the skills learned in this class are desirable for CompE internships related to hardware design. The course is therefore recommended to be taken as early as possible if the subject is appealing.

Class Content:

This class is based on ECE 385, and much of the material remains the same. The course is focused on constructing circuits using material from the previous two courses in the series. The first three projects are circuits using TTL chips on a breadboard. These are similar to the projects from ECE 198JL, but are paced more quickly. The class shifts to the use of a field-programmable gate array(FPGA) using the SystemVerilog hardware design language. The first four projects serve as an introduction to SystemVerilog and each last one week. The next two projects last two weeks each, and are more challenging. ECE 298 emphasizes the importance of the relatively recent emergence of “System on Chip” design methods. The last five weeks are used for a final project which is a unique project chosen by each team of students. The final project is graded based on both the difficulty and degree of completion of the chosen project. Many students choose to design a game for this project, however creativity is encouraged.

Work:

ECE 298 is a 3 hour class. There are one hour classroom meetings on Monday and Wednesday, and a three hour lab meeting on Friday. The time required to complete a normal project varies between weeks as some projects are naturally more challenging than others, but labs often take between 10-20 hours. As such, the lab should be finished outside of class. The time spent on the final project will depend on the difficulty of the project you choose to work on. Regular meeting times with your partner are recommended. The lab session serves as an opportunity to demonstrate your completed project for grading, and to make small modifications if the need arises. The classroom sessions are used to refresh the concepts relevant for the week’s project and to administer in-class quizzes and a short “final exam.” The quiz/exam material is a review of the core ideas of the projects and the abstract concepts discussed in class to ensure understanding by both members of each team.

Life After:

Students who enjoy this class should take ECE 391 as soon as possible since 391 is a prerequisite for ECE 411. ECE 411 uses VHDL, another hardware design language(HDL). Many of the core syntax features of HDLs are very similar, so switching to a new HDL should be simple. The experience with SystemVerilog in ECE 298 and other HDLs gained from similar classes is very appealing to potential employers. The “Life After” section for ECE 411 elaborates on career opportunities.

This is also the last required computer engineering course for electrical engineers, so EEs should be able to focus more on their individual interests after completing this course.
ECE 313 (MATH 362) - Probability with Engineering Applications

Instructors:

Prof. Hajek is the course director. Other instructors usually in the areas of communications, systems, or signal processing have also taught this course in the past, such as Profs. Hasegawa-Johnson, Viswanath, Singer, Bresler, Milenkovic, etc.

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. 210 is also useful to get some exposure to convolution, which is used in the later part of the course. 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 summation of geometric series and Taylor series; your poker instincts should also help you succeed.

This course also uses basic set theory and combinatorics (counting), especially during the first few weeks of the course. Taking a discrete math course beforehand, such as CS 173 or MATH 213, can be very helpful in understanding mathematical notation used throughout the course notes.

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, or 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 pursuing a math minor, note that the math department routinely makes an exception to permit students to use ECE 313 towards the math minor, as long as the student still has 6 hours of advanced credit for the minor not counted towards his or her major. Note also that taking both STAT 400 and STAT 410 provides two courses towards the math minor.

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 engineering applications 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 cumulative 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. The first half of the course focuses on relatively few concepts, mainly discussing how to characterize a single random variable. The introduction of multiple random variables begins the meat of the course and requires both learning a new way of thinking and extending the concepts of the first half of the course.

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. It is crucial to make a serious attempt at the problems, especially to gain the most from office hours. The course notes are available at Professor Hajek's Website. 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 will not serve well to understand the material or do well on exams. The exam questions will seem trivial to a student prepared to do the homework problems, emphasizing understanding over ingenuity or long calculations. Past students have said they have spent between 4 and 13 hours per week for the course.

A note on the changes as of Spring 2014:

Currently, ECE 313 is testing a new style of teaching, centered around active learning, which was first used in ECE 310 for the Spring 2013 semester. Instead of having three lectures a week, only 1-2 class periods are spent on learning new material. The rest of the time is used by working in small groups of 3 to 4 students, usually either from the homework problem sets or problems given from the professor. Instead of turning in weekly problem sets, quizzes are held every Monday with a random question from the homework assignment. The format of two midterms and a final stays the same, but the weekly grades come from quizzes and what is known as the concept matrix. The concept matrix is a list of material students are supposed to learn
in a given week, usually 4 or 5 topics. These topics are the same as in previous semesters, but students must demonstrate mastery of this material to a TA in office hours each week. The time required for this demonstration varies, but small groups of students can usually complete this in about five to ten minutes. Between reading the class notes, working on assigned problems, and office hours for the concept matrix, this class requires around 3 to 5 hours of work per week (not including studying for midterms). It is as of yet unknown whether this format will be continued in future semesters.

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 contain both calculations and derivations of expressions. Past exams have been known to contain at least two problems from homework; study them 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 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 classes. 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 and ECE 456: Global Nav Satellite Systems also list 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, but VHDL proficiency and knowledge of FPGAs is a very desirable skill for getting internships.

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 6th 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.
STAT 410 - Statistics and Probability II

Instructors:

This course is typically taught by Professor Stepanov, but also has been occasionally taught by other professors such as Huang, Martinsek, and Douglas. Professor Stepanov does a great job at explaining the subject matter. He can usually clarify abstract concepts pretty well and is very approachable and helpful as long as your questions indicate that some effort is being made on your part.

Prerequisites:

The official prerequisites are STAT 400 (Statistics and Probability I) or MATH 461 (Probability Theory) and STAT 100. Experience from either STAT 400 or MATH 461 (Probability Theory) is absolutely imperative for success in this class, as it is a continuation rather than an introduction. One must be knowledgeable in multivariable calculus (MATH 241 (Calculus III)) and every prerequisite for it, as many topics rely on multivariable differentiation and integration. It also helps to be well versed in dealing with infinite summations, which are taught in MATH 231 (Calculus II). For students coming from MATH 461, STAT 100 knowledge would be helpful, but not strictly required for students who are willing to put in some extra time studying (especially towards the end of the semester when hypothesis testing is covered).

When to Take It:

ECE majors who take this class generally do so instead of ECE 313 (Probability with Engineering Applications). However, ECE 313 tends to have more in common with the prerequisites of this class, either MATH 461 or STAT 400, so it is in general not necessary to take STAT 410 before classes requiring some probability knowledge, such as ECE 361 (Fundamentals of Digital Communications), CS 438 (Communications Networks), or ECE 459 (Communications Systems). Most students who opt to take STAT 410 instead of ECE 313 do so because the combination of MATH 461 & STAT 410 or STAT 400 & STAT 410 can be used towards a Math minor, but STAT 410 also serves as a good class to take for those interested in delving further into statistical theory.

Class Content:

The course begins with a brief review of discrete and continuous random variables and common distributions, as well as conditional densities. Expectation and variance are also re-introduced. The class then dives into more advanced concepts, such as moment-generating functions and how to deal with pairs of dependent random variables - a couple weeks will be spent on computing probabilities by integrating over regions, and some time is also spent on covariance, correlation, transformations of random variables, and bivariate normal distributions. Several of these topics require Calc 3 concepts, such as setting up iterated integrals to evaluate a double integral or Jacobians for computing the joint density of transformed random variables, but the in-class review & examples are usually adequate. The class also spends some time reviewing important distributions, such as the Normal, Poisson, Exponential, and Gamma distributions. Student's T distribution and the Chi-squared distribution are also covered.

Towards the second half of the semester, the class moves on to point estimation, covering topics such as maximum likelihood estimators and method of moments estimators; students will learn how to evaluate the properties of estimators in detail, computing their expected values and variances, and their asymptotic behavior; some of the theoretical limitations of point estimators are covered. Some time is also spent understanding the meaning of different types of convergence of random variables, which is often found to be one of the most difficult concepts in the class; this knowledge is applied towards understanding the asymptotic behavior of sequences of random variables, and is especially useful in understanding the Weak Law of Large Numbers and the Central Limit Theorem. The semester winds down with some practice building exact and approximate confidence intervals, and a quick visit of binary hypothesis testing and some of the theory behind it (i.e. how to find the most-powerful test).

While some students call this class more "theoretical" than other probability classes, what they really mean is that the class spends some time on explaining the theoretical limitations of our methods, and how to evaluate the theoretical quality of our methods (usually through computation). While some theorems are taught in the class, the class focuses on how to do computations, not on how to prove the theorems.

Work:

Lecture examples are posted on compass, but it helps to be in class because these topics are detail-oriented and one may not be able to glean every detail from examples alone. Many concepts emphasize algebraic "short-cuts" that will be taught to you which, when used properly, can save lots of time on the homework.

The homework assignments are the majority of the work for this class. Each is around 8-10 questions and graded out of 10 points; there are usually about 12 of them throughout the semester. The lowest two homeworks are dropped. The assignments are generally challenging and can take many hours; some weeks it can be difficult to do the homeworks ahead of time because the lecture sometimes does not cover all the necessary time-saving tricks until the day before the homework is due. Expect to average at least 4-6 hours a week on homework and occasionally spend as much as 8-10 hours on a single assignment.
There are 2 midterms and a final, none of which are curved. However, the questions are generally straightforward, and if students can do the homework, they should be fine on the exams. Usually there is a little extra credit available to boost grades, and, if the Professor deems it necessary, the letter grade cutoffs may be lowered.

Life After:

Students who like STAT 410 may also enjoy STAT 420 (Methods of Applied Statistics), which focuses on applications of the techniques learned in STAT 410 and more in depth theory. STAT 410 is also essential for other upper-level STAT courses, such as STAT 424 (Analysis of Variance), STAT 426 (Sampling and Categorical Data), STAT 428 (Statistical Computing), and STAT 429 (Time Series Analysis); People who enjoy this course should consider seeking a statistics minor.
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 the 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. In recent semesters, the class has also taught basic concepts of parallel programming such as how to write parallel code and solve race conditions introduced by parallel programming.

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 concepts from lecture such as trees, recursion and parallelism. Labs are graded but solutions are provided too. Overall, this course requires a fairly large 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, such as CS 418 (Interactive Computer Graphics) and ECE 448 (Artificial Intelligence). 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 357 (MATH 357) - Numerical Methods I

Instructors:

Many different professors have taught this course in past semesters, including Prof. Shaffer, Hirani, Gambill, and Yershova. None of them have taught it for more than one semester.

Prerequisites:

The course has some prerequisites. These are a 100-level computer science course (e.g. CS 101, CS 125, or ECE 190); MATH 225 (Matrix Theory) or MATH 415 (Applied Linear Algebra); and MATH 241 (Calculus III). As the prerequisites suggest, this is more of a Mathematics course than a Programming course.

When to Take It:

CS 357 is offered during Fall and Spring semesters. It is relatively important to have a good mathematical background, so it is recommended to complete the Calculus series before taking this course. Students with earned credit in CS 450 (Numerical Analysis) may not receive credit for CS 357. Although programming is not an essential part of the course, it is useful to have some MATLAB experience. It is very useful to have taken MATH 415 before, as some concepts are shared between the courses, and some other concepts build up from those of MATH 415.

Class Content:

The course is an introduction to numerical methods, studied from a purely mathematical point of view. Students will learn the theoretical foundations of numerical methods used to solve complex mathematical problems. The course starts with a review of fundamental concepts, such as Taylor series, approximation of numbers, and binary to decimal conversion. The main part of the course includes floating-point computation, characteristics of square matrices, and systems of linear equations. The final part covers approximation of functions and integrals, nonlinear equations, interpolation, numerical solutions of ordinary differential equations, and eigenvalues and eigenvectors. The amount of coding required for this class is insignificant and, in most semesters, non-existent. In some semesters, there are a few programming exercises which require students to implement the numerical methods studied during the course.

Work:

The workload is not very heavy compared to the average ECE course. There are no labs on this course, and the format of the class is the classic lecture. There are weekly homework assignments, which should not take a long time to solve if you have access to the course materials (either class-notes and/or textbook). It is helpful to have some experience with MATLAB, because it will allow you to solve homework problems faster. In case you don’t, professors usually offer a MATLAB tutorial by the beginning of the semester. There are two midterm exams and one final, which make up most of the grade. These exams are closed book, closed notes, and no calculator is allowed. You are supposed to demonstrate knowledge of the fundamental methods studied, but there are no hard computations - many of the questions on the tests are multiple-choice. In recent semesters there have also been several projects throughout the semester which can be done within a group of three to four people.

Life After:

This course is an overview of numerical methods to solve complex mathematical problems. This is particularly useful to solve many kinds of problems in engineering, and it is a suggested non-ECE tech elective for those students interested in areas so diverse as Power or Microelectronics, as well as Computing Systems. Many students will be involved in numerical computing to some extent, regardless of which area one is focused on. This course is also a prerequisite for CS 457 (Numerical Methods II).
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 411 - Database Systems

Instructors:

CS 411 has been taught by various instructors in the CS department, and none of them have taught more than one semester consecutively. Recently it has been taught by Peixiang Zhao, Anna Yershova, Saurabh Sinha, Ryan Cunningham, and Kevin Chang. It is worth noting that person teaching the course isn't always a tenured professor, and can sometimes be a PhD candidate.

Prerequisites:

CS 225 Data Structures is the only listed prerequisite for the course, but the overlap is limited. Specifically, there is a brief discussion of B-Trees in CS 225 that becomes relevant in CS 411. However, most, if not all, of the material is reviewed in lecture.

More important than the intuition for data structures for this course is some practical programming experience in a web stack, similar to what many Computer Science majors get in CS 242 Programming Studio. There is a final project in which you create a database driven website, and there is no special treatment given to those who don't know how to go about making that happen. Though it's possible to pick it up, going in with some experience with PHP, Django, or some other web framework that can connect to a SQL database will make the final project far less painful. Alternatively, pick a partner who has some experience with a web framework.

Additionally, in recent semesters, MPs have been added to the course. While some of these are MySQL and relatively straight forward, others have been in Python, and were not as trivial to understand. Some experience with Python syntax, structure, and paradigms will help make the MPs more about Database Systems and less about learning Python. However, it is unclear if these MPs will remain a part of the course in the coming semesters.

When to Take It:

You can take this course whenever you want once you're ready for it. This course is not a major time commitment compared to most 400 level ECE & CS courses, so it's good to take if you need to squeeze a tech elective into a busy semester. Again, it's helpful to be comfortable with practical web programming before enrolling, but any specific skills required (JavaScript for client side anything, CSS/HTML, etc.) can be picked up along the way.

This course is typically offered every semester.

Class Content:

The course first covers relational models and algebra, and then the principles behind quality database schema design. The second part of the course then applies these concepts to SQL (Structured Query Language). Finally, the practical considerations of implementing a Relational Database Management System, including the considerations of hard disk design, query optimization, and database indexing. If there is time at the end of the course, sometimes the instructor will go into advanced topics, like MinHashing, the algorithm behind recommendation systems.

Work:

Each section of the course has an associated homework assignment (and sometimes an MP). Two weeks are given for the homeworks, and one week for the MPs. In terms of actual work, the amount of time required varies wildly based on the amount of experience you come into the course with, but if the material is well understood post-lecture, homeworks shouldn't take more than 5 hours total, and the MPs shouldn't take more than 5 to 8 hours.

The course typically has one midterm and one final, which share a similar format of having both multiple choice questions, short answer, and some other written problems. Typically the kinds of problems closely mimic those that have been on the semester's homework. Because there is high instructor turnover, current instructors also often look to previous midterms and finals for problem content.

Finally, there is a semester long project where teams of 2 to 4 create a database driven website. The expectations for quality are set fairly high. Apart from minimal functionality, grading TAs also look for a certain amount of polish. This requires some real effort, especially if nobody on the team has web programming experience.

Typically, there is also a requirement for advanced functions in the project, which is where team members without web programming experience can shine. These advanced features are sometimes a native mobile app, but can also be things like applied digital signal processing, machine learning, or other algorithmic data manipulation which doesn't strictly require knowledge of web implementation.

Life After:
Data driven websites are everywhere. Having experience with SQL, relational databases, and the practical web programming done in the semester long project opens up a lot of practical opportunities in industry. The project can be extremely beneficial for learning other practical topics, like data scraping and UI design as well.

Though this course focuses primarily on relational databases, it briefly covers NoSQL, and many real world applications use NoSQL databases. CS 425 (ECE 428) Distributed Systems covers some of the considerations when implementing a NoSQL database. On occasion, there is a CS 498 Special Topics course on Web Programming that also covers NoSQL topics.
CS 412 - Introduction to Data Mining

Instructors:

Dr. Jiawei Han is a highly acclaimed professor in the field of Data Mining. His explanation of the material ensures a very thorough understanding and his slides include a lot of detail which is very helpful when reviewing for the exam.

Prerequisites:

CS 225 (Data Structures) is the only listed prerequisite for this course, and it is definitely required to understand the many algorithms covered in this course; a good understanding of data structures is important to be able to do well in this class. Any probability/statistics courses would be a great help too - usually the ones required by the curriculum are more than enough - MATH 461 (Probability Theory), STAT 400 (Statistics and Probability I) or ECE 313 (Probability with Engineering Applications). These skills help to keep up with the course content.

When to Take It:

This course is offered in the Fall Semester only. Typically, it is taken during one’s Junior/Senior year, particularly when exploring the various fields of Computer Science to figure out what is of interest.

Class Content:

This class starts off with basic data management/preprocessing techniques and builds into Data Warehousing. Warehousing techniques are covered in some detail, and the advantages of setting these up are also compared to other ways of storing data. Then the course digs deeper into OLAP technology such as data cubes, where the different ways of parsing the data cube to use stored information, as well as optimizations to these algorithms, are covered in great detail. It then proceeds with frequent pattern mining, classification and clustering. Many algorithms for each of these are covered in great detail, and they are compared to understand exactly why some algorithms are better suited for some data sets. These are all widely used techniques beneficial to anyone dealing with data analysis. The latter half of the class, which includes pattern mining, classification and clustering, definitely seemed more interesting, but the level of difficulty was also much higher.

Work:

The workload really depends on how interested you are in the course. If you like the material and the field, you would probably spend a lot more time on it, but if not, a minimum weekly requirement lies between 4-5 hours of keeping up-to-date with the readings & doing homework. There is a lot of reading involved, and not keeping up can really take its toll during the exams. There is only one MP, typically in the student’s choice between C++ or Java, so knowing how to program in one of those languages is essential. There are three problem sets, each spanning about 3 weeks. These also require reading the textbook and keeping up with lectures.

Life After:

This class leads the way into Data analytics and Data Mining. Those interested can consider going on to take CS 512 which requires a project as well. This class is considered part of both the Databases track and the Artificial Intelligence track, so students who enjoy it may want to consider taking other database classes such as CS 411 (Database Systems) and CS 410 (Text Information Systems) or other AI classes such as CS 440 (Artificial Intelligence) and CS 446 (Machine Learning).
CS 418 (CSE 427) - Interactive Computer Graphics

Instructors:

John Hart has been teaching this course for 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 and data structures (CS 225), vector calculus (MATH 241), and some matrix theory (MATH 225 or MATH 415 or MATH 416).

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 should 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 421 - Programming Languages & Compilers

Instructors:

This course has recently been taught by Sam Kamin in the spring and Elsa Gunter in the fall. However, Professor Kamin has retired after the Spring 2013 semester, so this pattern is sure to change in the future.

Prerequisites:

CS 232 Computer Architecture II and CS 373 Theory of Computation are listed as the official prerequisites for this class. It is a good idea to be familiar with basic computer architecture concepts (such as machine-language instructions) and lower-level software concepts (such as the stack and heap) in order to understand the motivation behind many of the concepts discussed in the class. Additionally, experience with data structures (namely trees) and programming experience in at least one language is essential to complete the MPs; all MPs are done in OCaml, a functional language. As such, ECE 290 Computer Engineering and CS 225 Data Structures are strongly recommended before taking this class. During the Spring 2013 semester, few concepts were directly taken from CS 373, so students of sufficient mathematical maturity may be able to take both classes at the same time.

When to Take It:

As CS 421’s follow-up course, CS 426 Compiler Construction, is only offered during the fall semester, it is likely best to take CS 421 during the spring semester of junior year.

Class Content:

CS 421 begins by introducing the functional language OCaml. Unlike languages like C, the body of a function in OCaml is simply its return value; OCaml also provides for powerful functionality such as pattern-matching, allowing programmers to express more complex concepts in fewer lines of code. The class then discusses lexing and parsing, two steps needed to transform the plain text of a source file into an Abstract Syntax Tree (AST), a compiler-internal representation of a program. Topics such as interpretation, compilation, and type-checking using Structural Operational Semantics (SOS) rules are then discussed. The class also briefly covers topics such as garbage collection and lambda calculus.

Work:

In Spring 2013, the class was broken up into 12 different assignments, 10 of which were MPs in OCaml and 2 of which were written assignments. Each assignment was relatively short, often requiring less than 100 lines of OCaml code, and took from 3-8 hours to complete. Assignments were assigned roughly weekly. The class also had two 75-minute midterm exams and one final, which was cumulative in the Spring 2013 semester.

Life After:

This class is a useful look into salient compiler concepts and will likely expose students to useful programming techniques; while many students may not need to implement full compilers in the future, lexing and parsing knowledge can be applied to many situations where the given representation of program input is not convenient for internal use. This class can be followed up by CS 426 Compiler Construction, which deals with the compilation process in more depth and introduces the concept of compiler optimization.
Instructors:

CS 423 has been taught by various professors from the CS department. Most recently, it has been taught by Professors Nahrstedt and Abdelzaher.

Prerequisites:

The official prerequisites for this course are ECE 391 (Computer Systems Engineering) or CS 241 (System Programming). Students who have taken CS 241 have a slight advantage during the first few weeks of the semester, as they have more experience working with synchronization constructs. Helpful topics to remember from ECE 391 are synchronization and deadlocks, scheduling, virtual memory, and filesystems.

When to Take It:

Students interested in operating systems should take this class by the second semester of their junior year, or at the very latest, by the first semester of their senior year in order to take more courses in the field before graduation. While the officially listed prerequisites are somewhat useful, the class can certainly be taken without them if you are willing to put in a little more effort at the beginning of the semester. However, before taking this course, you should be well-versed in C programming and in synchronization concepts, i.e. deadlocks, race conditions, etc.

Class Content:

If you are looking for another course like ECE 391, this is not it. Unlike ECE 391, CS 423 does not work with x86 or any other form of assembly. The class takes on a CS-based, somewhat higher-level approach to kernel programming. The course uses the standard form of kernel C libraries, as used in the Linux Kernel. Most of the lower-level and hardware interaction is already covered by pre-existing C functions and libraries. The student's focus is on finding the best ways of implementing these functions from a design and engineering perspective.

Lecture begins with an introduction to operating systems and kernel programming, including concepts such as processes, threads, and interrupts. The class soon dives into synchronization and scheduling (which is covered in more depth than in ECE 391), followed by virtual memory (i.e. paging and memory) and filesystems. The weeks after Spring or Fall Break cover virtualization (i.e. virtual machines and virtualized environments) and distributed computing concepts, ending the semester with an overview of parallel computing and security in operating systems.

Additionally, throughout the semester, students are introduced to trending topics in the field, such as cloud computing and the Google Filesystem.

Work:

The workload for CS 423 varies. There are one or two homework assignments during the semester, each requiring about 5-6 hours to complete. MP's are assigned on a monthly basis, totaling 4 MP's – each requiring about 15 to 20 hours of time, working in groups of two or three. The MPs given vary by professor. Professor Nahrstedt's MP's one semester were:

- MP 1: Intro to kernel programming - implementing linked lists in the kernel, initialize proc entries, set reading and writing buffers for files, etc.
- MP 2: implementing a real-time scheduler in the kernel.
- MP 3: Implementing a CPU utilization profiler; this involved some work with paging, as info had to be written by the kernel and read by user space.
- MP 4: distributed systems - running multiple instance of a Java or C++ program and load-balancing work over the network to complete the task as quickly as possible.

There is one midterm and, of course, one final exam.

Life After:

If you liked this course, consider a career in operating systems. Apart from your standard OS jobs with Apple and Microsoft, with the shift to cloud computing, there are plenty of emerging opportunities in distributed computing, virtualization, etc.

Interested students should consider taking additional courses in the field, such as CS 425 (Distributed Systems) and CS 523 (Advanced Operating Systems) though students should note that CS 523 is a graduate level course and cannot be taken for Tech Elective credit without permission from the ECE department.
CS 424 - Real-Time Systems

Instructors:

Professor Lui Sha, who has done significant research in the field and invented the Simplex architecture, teaches this class.

Prerequisites:

The listed prerequisite is CS 431 (Embedded Systems); however the course has since been redesigned to not depend on CS 431. But you do need a fair amount of coding experience since you're expected to do the labs rather independently. Just as for CS 431, you also need a basic understanding of how processors work. The labs are in Python; an introduction to the language is given in the first lab.

When to Take It:

You'll find a sizable number of graduate students in the course; most of the rest will be seniors. If you abide by the listed prerequisites, you probably won't get a chance to take the course until then.

Class Content:

This course offers a more conceptual approach to the same general topics covered in CS 431. Along with briefly revisiting things like feedback control and periodic scheduling, you'll study the difference between availability and reliability, dependency analysis, and other design principles for an embedded system reacting to real-time data from the surrounding world. Much time will be spent on the Simplex architecture principles that Prof. Sha invented, by which a complex but less-reliable program can be checked by a simple, more-reliable program. For instance, a complex routing program designed to find the ideal solution that sometimes fails can be checked by seeing that its path is less than that produced by a simple naive approach.

Work:

The class has a single midterm and a cumulative final, as well as about four homeworks and five labs. Just like in 431, the homeworks can be completed in a few hours each.

The labs (an extremely significant part of the grade!) build on one another to work up to programming the Roomba robot to move about the room following Android phone instructions while staying within safety limits (e.g. not bumping into things) per Simplex requirements. (After completing this, you can do an optional extension for a fourth credit hour.) You can probably do this in two or three hours per week, if you understand the concepts and can program well. The lab meets weekly, but you're only required to show up to demo the projects about every other week.

Life After:

Parts of this class are approaching the cutting-edge of research; you might be able to arrange a research project to follow up on topics learned. Also, this helps prepare you for various jobs in embedded systems.
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, Borisov, and Gupta.

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.

The MPs had a bit of an overhaul in Fall 2012 when Professor Gupta taught the class again. The professors all borrow MPs from one another so the same set of MPs may be reused. Rather than having separate MPs and tight specifications, the MPs built on each other to create a distributed processing framework similar to Hadoop. Any languages were allowed, so if you and a partner can agree on a high-level language you can avoid dealing with very low-level details (there were groups using C/C++, Java, Python and Go in Fall 2012). However, falling behind early on would make later MPs more difficult; while code was released for an MP when it was over, it's much easier to understand your own system than someone else's. This organization makes the MPs more challenging but also very rewarding, and gives a good sense of the challenges associated with working in distributed systems.

Life After:
Students who enjoy this class may want to consider CS 438 (Communication Networks). 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 431 - Embedded Systems

Instructors:

Prof. Lui Sha, who has done significant research involving embedded systems, teaches this course.

Prerequisites:

The listed prerequisites are either CS 241 or ECE 391, but you can get by without those as long as you know C programming really well and have a basic understanding of how processors work.

When to Take It:

Most people take this course as either junior or senior; you might see some grad students in the course as well.

Class Content:

CS 431 goes through various problems and concerns especially significant in embedded systems - small special-purpose computers inside larger devices, such as microwaves, cars, or the automatically-tilting tables you'll be working with in the labs. The implicit model for all the lectures, which becomes explicit in the labs, is that you're working with a limited-memory system that takes analog input from environmental sensors and outputs some result depending on the input values. The lectures teach you how to deal with issues significant in this sort of system, such as serial I/O, PID (proportional integral-derivative) feedback controls, timers, interrupts, and analysis of periodic task schedulability. In the labs, you actually implement most of these things as you build up to a tilting table controller which will tilt the table so as to move a ball placed anywhere to a given point.

Work:

The class has a single midterm and a final; be sure to review before both tests. In addition, there are about four homeworks (each of which can probably be done in about three hours) and weekly labs. The lab and lecture work together quite nicely; if you come to lab prepared, you should get the project done easily within the two-hour lab period.

Life After:

The logical sequel is CS 424 (Real-Time Systems), also taught by Prof. Sha. If you enjoy this field, there are many career options open to you after graduation.
CS 433 - Computer System Organization

Instructors:

Professor Sarita Adve has apparently taught this course for a long time. Among other accomplishments, she co-developed the memory models for the C++ and Java programming languages.

Prerequisites:

CS 232, Computer Architecture II, is listed as the only prerequisite. ECE 391 Computer Systems Engineering should be sufficient as the material CS 433 covers is very similar to that of ECE 411 Computer Organization and Design. Basic pipelining knowledge and cache coherency should be briefly studied before taking the course when coming from ECE 391.

When to Take It:

CS 433 should be taken after ECE 391 and within a semester before or after ECE 411. If taken prior to ECE 411, students should be able to focus more on the lab component of ECE 411, since they would already have the theory. If CS 433 is taken after ECE 411, students should be able to obtain an easy A.

Class Content:

Very similar to ECE 411, this course covers various topics in processor optimization. Knowledge of the basic 5-stage pipeline is assumed, then expanded to include multiple execution units, pipelined execution units and data forwarding between stages among other basic techniques. The full list of topics, referenced from the course website, is listed below. A major drive of the course is reordering instructions so that each clock cycle is utilized most efficiently while slower instructions cause delays. Presentations are given at the end by graduate students in the course that tie topics learned into modern-day CPUs and GPUs.

- Introduction – review of fundamental performance issues, power and reliability, cost vs. price, basic pipeline structure
- Instruction level parallelism – hardware and software techniques (e.g., dynamic scheduling, superscalar, static and dynamic branch prediction, VLIW, loop unrolling).
- Memory hierarchy – advanced concepts in caches (e.g., prefetching, lockup-free caches, and multi-level caches), main memory, and virtual memory.
- Multiprocessors/multicore – overview of different models, cache coherence with shared-memory systems/multicore (snoopy and directory solutions), synchronization, memory consistency models.
- Data parallel architectures – vectors, SIMD, GPUs – depending on available time
- Storage systems, I/O – depending on available time
- Recent advances in architecture and future challenges – depending on available time

Almost the entire class is covered, with more or less detail on most topics, in this YouTube video.

Work:

There are 7-8 homework assignments each semester, depending on how quickly material is covered in class, and each should take 3-5 hours. All information required for the homework is available from lecture; the book isn't necessary. As long as students attend lectures and do the homework, only a moderate review should be necessary before the midterm and non-cumulative final.

Life After:

This class has no benefits over ECE 411 unless a student is an EE and wants the knowledge of ECE 411 but not the lab component. A good number of graduate students tend to take the class, likely continuing on to CS 533, also taught by Professor Adve.
CS 438 (ECE 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 be 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 their length and breadth. Additionally, there are typically a few MPs in this class; in Spring 2012, there were 3: 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 & homeworks 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 440 (ECE 448) - Artificial Intelligence

Instructors:

A number of different professors have taught this popular course over the years. Recent professors to teach this class have been Eyal Amir, Lana Lazebnik, and Gerald DeJong.

Prerequisites:

CS 440 is cross listed as ECE 448. It lists CS 225 (Data Structures) or ECE 391 (Computer Systems Engineering) as a prerequisite. The prerequisite is to make sure students who take this class have a fundamental background in data structures and algorithms. Prior background in probability will also be helpful, but not required.

When to Take It:

In recent years, CS 440 has been offered in both the Fall and Spring. It is usually taken by Juniors and Seniors as a technical elective, but it can be taken earlier if one is so inclined. If you plan on taking follow-up courses that are based on AI, like Machine Learning and Computer Vision, you probably want to take this sooner than later. Just make sure you have CS 225 under your belt first - ECE 391 really doesn't prepare you for this class, as you really need to know data structures and algorithms, not operating systems. Taking a course in probability beforehand will also help your understanding of certain topics in 440.

Class Content:

This course provides an introductory survey to the techniques and applications of AI. Subjects covered include: History of AI, Models and Search Algorithms (such as BFS, DFS, and A-star), Game-Playing Systems and Game Theory, Logic and Knowledge Representation, Planning and Reinforcement Learning, Probabilistic Reasoning, and Modern Applications of Artificial Intelligence. Every professor touches on these general topics in their own way, so the flow of topics and the exact content covered will vary from semester to semester.

Work:

Workload will vary depending on which professor you have. DeJong gives biweekly written homework assignments that have the occasional programming problem. Lazebnik's class consists of 4 MPs (including a Maze Solver and a Character Recognition System), and some extra credit, a reasonable workload for a tech elective. Amir's assignments were a combination of written problems and some programming problems which were basically MPs in their own right - a rather difficult and extremely time-intensive workload. Additionally, all the professors gave 1 midterm and a final exam.

Life After:

Students wishing to continue along with AI topics may wish to take CS 446 (Machine Learning), Computer Vision (CS 543 & CS 544), Natural Language Processing (CS 498 Special Topic & CS 546).
CS 446 - Machine Learning

Instructors:

Historically this class as almost always been taught by Dan Roth, but in Fall 2013 it was taught by Julia Hockenmaier. Both are experts in natural language processing and teach advanced courses in that area (CS 546 and CS 498, respectively).

Prerequisites:

Officially CS 373 (Theory of Computation) and CS 440 (Artificial Intelligence) are listed as prerequisites. CS 373 is largely for the mathematical maturity gained from writing and understanding proofs; Math 347 or an upper-level math class that includes proofs should be sufficient. CS 440 is useful as both motivation for machine learning and as a brief introduction to the material of this class.

When to Take It:

This class is only offered in the fall and CS 440 is very useful to have taken beforehand, so plan accordingly. Most students would probably take this class their Senior year or as a first-year graduate student, but with planning it can be taken Junior year. The course is about 2/3 graduate students and 1/3 undergrads. The course content is fairly mathematical, so mathematical maturity, ideally in the field of computer science, is essential. Linear algebra is also an unstated requirement for this class; it’s not essential you take a class like Math 415, but some familiarity with the ideas of linear algebra are useful or you should be prepared to do some background reading on your own.

Class Content:

Make no mistake, this is a theory course. The course expresses learning as a problem of search in a hypothesis space. Specific algorithms such as decision trees and variants of the perceptron are covered.

Work:

Workload – what do you spend your time on in this class? About how many hours per week is the homework/labs/mps? How many tests are there?

Life After:

What classes/jobs does this class prepare you for? I.e. what is this class a prerequisite for? What would someone who likes this class be interested in? Please link course numbers to the corresponding DEN pages when possible.
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 461 (ECE 422) - Computer Security I

Instructors:

Computer Security I has been taught by various professors in the CS and ECE departments. Most recently, it has been taught by Professors Hinrichs, Borisov, and Nicol.

Prerequisites:

The official prerequisite for this class is ECE 391 (Computer Systems Engineering) or CS 241. However, this course is perfectly doable without having taken any classes on architecture or assembly level languages as the concepts learned in these classes (such as kernel and user stacks) are mentioned only briefly. That being said, students are required to analyze code, so programming intensive courses should be taken before registering for this class.

When to Take It:

This class is typically offered during the Spring and Fall semesters. The class is a prerequisite for CS 460 - Security Laboratory and CS 463 (Computer Security II). Therefore, students interested in specializing in computer security should have taken this class by the Spring semester of their junior years, or by the Fall semester of their senior year at the very latest. Students who are passionate about Computer Security might even want to take this course earlier on, even as early as sophomore year to allow for more time for Cryptography and other related mathematical courses.

Class Content:

CS 461 is an introductory course to Computer Security. The course introduces many important concepts in Computer Security, though it does not go too deep into the details. The class starts off defining what computer security is and why there is a need for computer security. The course covers ethics, risk analysis, privacy and confidentiality, encryption, certificates, and key distribution in the first few weeks. After that, the class focuses on malicious code, commonly known attacks, networking security, communication protocols, and access matrices. The course concludes with trusted computing models, auditing, and accreditation standards. Depending on the time remaining, students might have guest lectures related to trending topics in Computer Security.

Work:

CS 461 is only an introductory course and is not too time consuming for a CS/ECE course. Average time commitment outside class may be 1-3 hours per week, with the amount of homework assigned varying as the semester progresses. The bulk of the course grade comes from the two midterms and a final, which only cover concepts mentioned in lecture. Attending class and paying attention during lecture will go a long way towards getting an A in the course.

Life After:

Students who enjoy this course may be interested in a career in Computer Security. If so, the next course in the curriculum, CS 463 (Computer Security II), introduces students to more advanced security concepts. Those interested in practicing and implementing what was learned in CS 461 should consider taking CS 460 - Security Laboratory.
CS 463 (ECE 424) - Computer Security II

Instructors:

In the last few years, Computer Security II has been taught mostly by Professors Carl Gunter and Yih-Chun Hu.

Prerequisites:

CS 461/ECE 422 - Computer Security I is the officially listed prerequisite. However, if you already have some knowledge of IT Security, you shouldn't have any problem taking this class without Security I. An ability to think creatively and analyze systems creatively is ultimately what is important in this class and in this field. Students coming in from ECE should be forewarned that all programming in this class is done in Java and requires a working knowledge of Socket Programming for server-to-client communication. Make sure you know how to do this beforehand, or you will end up spending a lot of time on the first MP.

When to Take It:

Please check the Illinois Course Guide regularly for updates regarding semesters when this class is offered. Though Security II was typically offered both in the Fall and Spring semesters, there have been changes in faculty lately because of which this is no longer the case.

Students should not take this course until they have some significant programming experience as the MP's require good programming and debugging skills. Ideally, you should take Computer Security II immediately after Computer Security I, while the material is still fresh in your head. If you are seriously interested in Security, consider taking this class at the same time as CS 460 (ECE 419) Security Laboratory.

Class Content:

CS 463 builds up on concepts learned in CS 461. While in CS 461 were exposed to a bit of everything, CS 463 concentrates on fewer topics in more detail. The emphasis is shifted from following commonplace security practices to analyzing key issues in Computer Security and thinking of novel and creative ways to address them. We start off with the more traditional security topics, i.e., formal security evaluation techniques, DoS attacks, botnets, and spam. After those first few weeks however, the lectures focus on more recent issues in the field. The class covers Social Networking, DRM, Anonymity on the Internet, Information Flow and Leakage, Identification issues, and flaws in VoIP. The content covered in the last few weeks of the semester depends on the professor. Professor Gunter has been known to focus the last few weeks on Cloud Security, Smart Grid Security, and security in the Healthcare industry.

Work:

The class consists of two 90 minute lectures a week. Attendance is mandatory, and points are awarded for student discussion. There are three machine problems.

The MP's vary by semester as they depend on the professor and his/her research interests. For the semester of Spring 2013, students were asked to create an application capable of encrypting files using AES-128 and uploading them to a server. The goal of the machine problems was to create an encrypted service that would prevent all unauthorized access to the data, even from the server admin. The first MP was an individual assignment asking students to implement this basic client-server setup. For the second MP, students could work in up to groups of three, and were required to make improvements to the application to allow authorized users to search the files while they were stored on the server. Finally, the third and last MP asked students to minimize leakage about the files; i.e. metadata leakage using the paper published on Searchable Symmetric Encryption (Curtmola, Garay, Kamara, Ostrovsky).

Expect to spend about 10 hours on the first MP for the entirety of the assignment, but a lot more if you are not familiar with Java and socket programming. The last two MP's are a lot more challenging and may require up to 10 hours of work per teammate per week while they are going on. A good team is essential to these assignments. Lastly, there are no midterms for this class. There is one final exam.

Life After:

If you are interested in Computer Security and if you have already taken Computer Security I and the Computer Security Lab, consider taking CS 563 - Advanced Computer Security. Please keep in mind that this is a graduate level course, and that you will need to seek permission from the ECE department before you can receive Tech Elective credit for this course. There is also plenty of research in Security at the U of I; consider doing undergraduate research.

With recent shifts to the cloud and with how everything is becoming digitalized, there is an increasing need for experts in Computer Security. Job openings are on the rise in both the private and public sector.
CS 465 - User Interface Design

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 (CSE 414, MATH 473) - Fundamental 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. The amount of time spent on homeworks can vary drastically depending on the difficulty of the questions, familiarity with the material, and, most importantly, quality/dedication of your other group members; the more-difficult homeworks can easily take 20-25 hours of time, so having a group to share the work with is essential; the easier assignments tend to be closer to 10-15 hours of work. It is recommended, though not required, that students typeset their homeworks in LaTeX.

In addition, there are weekly quizzes 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 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 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.
CS 598PS – Machine Learning for Signal Processing

The following information is relevant as of Spring 2014.

Instructors:

This course is taught by Paris Smaragdis. Prof. Smaragdis regularly teaches CS and ECE courses related to signal processing, machine learning, and audio engineering (specifically, ECE 310 and ECE 403 in recent semesters). His research deals with these areas, and he is particularly fond of audio-related projects, but has ample experience processing all kinds of multimedia.

Prerequisites:

You are expected to have some linear algebra background (MATH 417) and some engineering probabilities knowledge (ECE 313). Additionally, Prof. Smaragdis assumes you have zero knowledge of “signal processing” or “machine learning”, and both fields of study will be introduced from the bottom up.

While there is no course that corresponds with this, you should take this class only if you have strong MATLAB or Python skills. The assignments in the class are primarily programming-related and test your ability to implement feature extraction and classification algorithms and to perform training on a large set of data and provide results.

When to Take It:

This class can be taken at any point after which you have gained maturity with signal processing or machine learning topics. It will definitely help to have taken ECE 310, ECE 417, CS 440, and/or CS 446 prior to taking this class. There is significant topical overlap between this class and ECE 417 and CS 440.

The class is offered only in the fall. The prerequisite requirements can be disregarded if you have a very strong interest in this field of study. For detailed advice, feel free to contact the professor as he is very accommodating and is willing to work things out with students.

Class Content:

In this class, you will learn how to decompose, analyze, classify, detect and consolidate signals (audio/image), and examine various commonplace operations such as finding faces from camera feeds, organizing personal music collections, designing speech dialog systems and understanding movie content. The course consists of lectures and student projects/presentations. In the lectures, Prof. Smaragdis introduces an algorithm or a concept and explores real-life applications frequently. His lecture slides are provided online on the course website and are available for download.

The final project is done in groups of two to three over the course of a couple weeks. Your project requires an accompanying report formally explaining your problem statement, your methods, and your results. The presentation component is done through in-class presentations and possibly a poster symposium in Siebel.

The class content becomes more significantly technical with each passing week, as the lecture topics delve further into applications and algorithms. In general, you are not expected to understand all of the material presented to you; simply understand as much as you can, ask questions, develop an interest in the subject, and make use of it for your final project.

Work:

Relative to most three-hundred or four-hundred level undergraduate classes, the workload of this class is very light. There are two or three homework assignments over the course of the semester, as well as a final project. You are often given a week or two to complete the assignments. These homeworks are primarily programming exercises, so make sure you are MATLAB or Python proficient. Assignments approximately take anywhere from 5 to 10 hours to complete, depending on your understanding of the material. Utilize office hours to clarify implementation issues.

There are no quizzes or exams in this course. Your grade is solely determined based on attendance (20%), homework (30%) and a small team final project (50%).
ECE451 Advanced Microwave Measurements

Instructors:
Professor Jose Schutt-Aine is both the course director and the primary lecturer. The course website is available here.

Prerequisites:
The only prerequisite is ECE 350, but it may be useful to take other classes such as ECE 453, ECE 457, or ECE 447, due to the overlap in some concepts like S-parameters and transmission line analysis. Many transmission line concepts from ECE 329 are heavily used throughout the course.

When to Take It:
Most students take this lab course during their junior or senior years. It is not necessary to take it right away, but the lab skills may be useful for finding RF related internships. It is typically offered in the fall semester.

Class Content:
The lectures start out with a review of transmission line concepts, including Smith Chart usage. S-parameters are quickly introduced, and are combined with the flow graph representation to derive various error models used in RF measurements and calibration. From there topics like extraction of transmission line parameters, calibration methods, time-domain reflectometry, on-chip measurements, and eye diagrams are covered. Many lectures are devoted to power amplifier analysis to introduce non-linearity and measurement techniques for non-linear systems. Finally, X-parameters are introduced to deal with non-linear measurements. X-parameters are a new addition to the class, and it being taught in an undergraduate level class is fairly unique in electrical engineering programs.

Work:
ECE 451 is primarily a lab course. There are weekly labs, each with a lab report due the following week. Labs typically involve either taking measurements on a network analyzer or using Agilent ADS software. There may or may not be prelabs due before each lab session. Lab reports are fairly involved, and are a determining factor in your final grade. Expect to spend 5+ hours working on the lab reports for each week.

There is homework due every couple of weeks that cover lecture topics, but is fairly straightforward and not too challenging. There is a midterm and a final, both in-lecture.

Life After:
The hands on nature of this class makes it a great class for students looking for jobs or internships in RF circuits and high frequency measurements. Some companies include Motorola, Freescale, Silicon Labs, Intel, National Instruments, Apple, Qualcomm, etc. Students who enjoyed the class should consider other courses in the 450 series in the ECE department. ECE 457 covers transmission line applications and theory in more detail. ECE 447 is another hands on lab course. ECE 453 is also a lab course, but with a substantial lecture section that covers a wide array of topics related to radio systems (modulation, impedance matching, stability, non-linearity, S-parameters, etc). Professor Schutt-Aine also teaches a graduate class, ECE 546, on advanced signal integrity every couple of years that goes more in-depth on these topics.
ECE 304 - Photonic Devices

Instructors:

This course is taught and directed by Prof. Kent D Choquette. Professor Choquette is an incredibly engaging lecturer. He is constantly relating the course content to topics that students care about such as achieving faster internet speeds and longer smart phone battery life. Professor Choquette leads the Photonic Device Research Group (PDRG) and the focus of his research is vertical cavity service emitting lasers (VCSELs). As of fall 2013, the TA for this course was Tom Fryslie, a PhD candidate in the PDRG.

Prerequisites:

PHYS 214 (University Physics, Quantum Physics) is listed as a prerequisite for this course. The relationship between wavelength, frequency and energy of light comes up repeatedly in this course, so the knowledge gained in PHYS 214 really does come in handy for ECE 304. Although PHYS 213 Thermal Physics is not an official prerequisite, the introduction to semiconductors at the end of PHYS 213 is also useful in ECE 304.

When to Take It:

Taking this course as soon as prerequisites are met will be beneficial if you are interested in lasers, LEDs and communications. Just like ECE 340 (Solid State Electronic Devices), this course builds on the basic understanding of semiconductors from PHYS 213 (University Physics, Thermal Physics). Some knowledge about diffusion of electrons and holes (from PHYS 213), quantum wells and energy (from PHYS 214) will be used in ECE 304. So it will make life easier to have PHYS 213 and PHYS 214 beforehand. However, these concepts will be reviewed at the beginning of the semester before the class goes into semiconductor and photonic devices. This course has up to 50% overlapping content with ECE 340 (Solid State Electronic Devices), and will be easier when the two courses are taken together. Also be aware that as of 2014, this course is only taught in the fall.

Class Content:

This course is mainly about applications of semiconductors in photonic devices. In order to understand how photonic devices work, basic knowledge of semiconductor physics is required. In the beginning, the course content is motivated by discussing numerous applications of photonic devices such as optical fiber, cell phones, cameras, solar cells, etc. After a couple lectures focused on introduction/motivation, the course covers the following topics in detail:

- Interaction between matter and light
  - Formation of energy bands in solids
  - Dielectric materials
  - Semiconductors

- P/N Junctions
  - Charge transport: drift & diffusion
  - Built-in potential
  - Depletion region
  - Energy bands under forward & reverse bias

- Interaction between light and semiconductor
  - Light absorption in semiconductor
  - Light emission by semiconductor
  - Quantum well confinement of charge carriers

- Diode photonic devices
  - Photodetectors - light absorption
  - Solar cells - light absorption
  - Light Emitting Diodes - light emission

- Optical display
  - Emission arrays
  - Spatial light modulators

- Semiconductor lasers
  - Edge emitting lasers
  - VCSELs

- Optical waveguides
  - Cylindrical waveguides
  - Optical fiber properties

- Optical communication
• Optical links
• Multiplexing & modulation

The topics are taught with an emphasis on qualitative understanding, which is complemented by quantitative analysis. Topics are taught cumulatively, with later topics building upon previous ones. In particular, the P/N Junction and Band Gap are two topics that virtually all later topics will link back to.

The course is taught primarily via PowerPoint slides. There is no official textbook for the course, but supplementary readings from various sources are posted on the course wiki for each topic.

Work:

Homework: There are 9 homework assignments, each due one week after it is assigned. Most homework assignments require 2-5 hours of work. The homework problems are approximately half quantitative-half qualitative. Even the quantitative questions are designed to stimulate critical thinking about the material (e.g. what assumptions can we reasonably make to simplify this calculation? What conclusions can we draw from this result?). Most of the questions can be answered by referencing the content delivered in lectures (combined with the aforementioned critical thinking), while a few questions are based more on the supplemental readings posted on the course wiki. Seeking guidance from the TA during office hours may occasionally be necessary to complete an assignment and it is certainly always helpful. Sometimes simulations in nanoHub are required for the homework, which makes these assignments more time-consuming. Homework is worth 20% of the course grade.

Class participation / "pop quizzes": Class participation is worth 15% of the final grade. Most (or perhaps all) of this is based on "pop quizzes" that are given on random days throughout the semester. These quizzes only count for attendance—they are not graded for correctness. The quiz questions serve as a check-on-learning for recently covered topics, and students are encouraged to discuss their answers with the people seated around them. The quiz questions along with the homework problems give a good indication of the types of questions to expect on the exams.

Exams: There are three in-class hour exams. Each is worth 15% of the course grade. The final exam is worth 20% of the course grade. All the exams are a mixture of quantitative and qualitative questions. The exams are challenging, but they are written so that time is not an issue.

Life After:

If you have not already taken ECE 340 (Solid State Electronic Devices), that course will build on some of the topics covered in ECE 304. If you are interested in further study of photonic devices, you may want to plan to take ECE 455 (Optical Electronics) and/or ECE 495 (Photonic Device Laboratory) in the future. Also, taking ECE 444 (Theory and Fabrication of Integrated Circuits) after this course will provide a good perspective on fabrication of semiconductor devices.
ECE 310 - Digital Signal Processing

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 lab supplement, ECE 311 Digital Signal Processing Lab, 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 Matlab—which is the de-facto industry standard computer tool for signal processing. It is also a fun course, in which you will get hands-on experience with the concepts taught in ECE310. The past semesters have clearly demonstrated that students who take ECE311 concurrently with ECE310, do much better in ECE310. Historically, the two course were parts of a one 4 hour course ECE410 for more than 20 years. They have been separated recently because of the elimination of 4 hour courses - but taking the theory and practice parts together still makes the most sense now as it did before.

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, after a brief review of continuous time domain transforms (ECE210), 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. It is very important to understand the concepts and the reasoning behind the formulas; some students find it hard to to relate the different types of Fourier Transform/Series and sampling methods to have a comprehensive understanding of the whole system. Students are also expected to have very strong mathematics background as the questions from the problem sets and quizzes requires large amount of math derivation and calculation.

While the class work often emphasizes math computation students are expected to understand the concepts by the final exam. More so than in most other classes, digital signal processing builds on itself a great deal. Early on the class reviews the discussion of the Fourier transform and systems covered in ECE 210 in order to transition from the Continuous Time Fourier Transform to the Discrete Time Fourier Transform (DTFT), which captures in a deep way the essential difference between analog and digital signal processing. The DTFT is key to understanding the rest of the course and the field itself, a point that isn't necessarily obvious from the coursework.

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. In some semesters, there will be three midterm exams instead of quizzes. There are also weekly recitations offered throughout the semester to cover the solutions for quizzes and homework sets. By investing time each week into understanding the concepts and the homework, students can be successful in this class. The final exam is comprehensive and focuses on the understanding of concepts.
In Spring 2013 the course was overhauled and taught in a very different way. Weekly homework was given along with the solutions and not collected or graded. The course was divided into a set of a few concepts each week. Students had to demonstrate "mastery" of these concepts each week by going to office hours and solving some problems, which were checked by the TAs. Each Friday a short 10 minute quiz covered the concepts for the week. The only exam was the final. This course organization places a great deal of emphasis on students to pace themselves and keep up with the content: feedback is greatly reduced since there is little graded individual work. On the other hand, it is flexible in not requiring any busywork for students that feel they understand the material.

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 Global Satellite Navigation Systems, 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). 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 summer (ECE310 is offered in the summer 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).
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 electromagnetic 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 course 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 - Electronic Circuits

Instructors:

This course is taught by a 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 (Analog Signal Processing). 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 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.

Work:

The course load for 342 is not too demanding. Homework is usually due weekly and 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.

Life After:

Students who have taken and enjoyed ECE 342 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 include, ECE 453 (Wireless Communication Systems), ECE 482 (Digital IC Design) and ECE 483 (Analog IC Design) and ECE 464 (Power Electronics).
ECE 343 - Electronic Circuits Laboratory

Instructors:

This class is usually led by TAs who are graduate students in the microelectronics or electric circuits fields. Over the past several semesters the course head has been Professor Chandra Radhakrishnan, who usually comes in at the beginning of lab sessions to overview that day's procedure. Expect most instruction to come from the TAs, though.

Prerequisites:

The prerequisite for this class is ECE 342 (Electronic Circuits). It is often taken concurrently with ECE 342. A solid knowledge of circuit analysis is necessary for this class.

When to Take It:

This class should ideally be taken along with ECE 342, but it is also practical to take it during a following semester. It is offered each semester, including the summer term, and it counts as a lab class for EE majors. This class should be taken as soon as possible by any students interested in hardware and circuit design, as it provides excellent experience in design, simulation, and optimization of electronic circuits.

Class Content:

Material in this lab is closely related to that of ECE 342. Students will work with fundamental circuits, investigating the different parts of each circuit and seeing how changes in components affect output characteristics. Main topics include network analysis of "black box" circuits, evaluation of CMOS circuit characteristics such as noise margin, propagation delay, and power dissipation, use of rectifiers, filters, and voltage regulators to design an AC/DC power supply, and design of an op-amp using MOSFETS. Most material is covered in 342 before it appears in the lab, but there are some cases where students will encounter topics first in the lab, depending on the professor's pace in 342.

Except for the first project, which is designed for students to brush up on their circuit analysis tools, each project follows a general structure. Given a circuit and a set of design parameters, students must perform analysis of the circuit by hand to determine initial components. Once these components are found, PSPICE software is used to model and simulate the circuit. Students often manipulate the circuit in some way, such as changing the value of a resistor or the width of a MOSFET, and evaluate how the circuit characteristics change as a result. It is then necessary to optimize the circuit in order to satisfy all of the design parameters. Physical circuits are also built and bench tested to verify simulation results. This process of designing to meet performance specifications is similar to that in the hardware and circuit design industries, giving students valuable design experience.

Work:

The workload for this class is fairly light. ECE 343 is a closed lab, meaning that students should be able to complete each lab phase within the allotted three hours each week. There are four major projects which make up the lab, each of which is usually broken into three or four phases. At the conclusion of each project, students are expected to write a lab report which includes their analysis, simulations, and bench test results. These reports are spaced evenly throughout the semester due to each project being completed over the course of several weeks. Be careful about putting off the reports, though, as each one can take a substantial amount of time to complete. It is highly recommended that students work on the report as each phase is completed, rather than wait to write the entire report in the week between the final phase and the due date. There is no open-ended work for this lab (that is, no final project).

Life After:

Students who have taken and enjoyed ECE 343 are well prepared for a variety of courses related to hardware and circuits. ECE 343 is a prerequisite specifically for ECE 469 (Power Electronics Laboratory), so students interested in power should consider taking 469 and its companion, ECE 464 (Power Electronics). Students interested in circuit and hardware design should also consider classes such as ECE 482 (Digital IC Design), ECE 483 - Analog IC Design, and ECE 453 (Wireless Communications Systems).
ECE 350 - Fields and Waves II

Instructors:

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.

When to take it:

If you liked ECE 329 (Fields and Waves I), 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.

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), which builds off of ECE 329 and ECE350 by covering Maxwell's 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. Viswanath. It is the results of modifications over the years to what was ECE 461 and ECE 398PV. Profs Sarwate, Viswanath, 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 (BIOE 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 microcontroller/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. One thing you will not learn is how to make EDM type music.

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

Editor's Note: This class has not been taught since Fall 2009.

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 414 (BIOE 414) - Biomedical Instrumentation

Instructors:

This class has been taught by Dr. Ken Gentry for the past few semesters and is available both in spring and fall semesters.

Prerequisites:

Credit in ECE 210 (Analog Signal Processing) is the only prerequisite for this class.

When to Take It:

Students interested in bioengineering can take this class as soon as they are done with ECE 210. This course is a good introduction for those interested in bioengineering, since it covers so many topics. This class borrows many analog signal processing techniques from 210 - students are expected to know how to analyze op-amp circuits, create low, band or high pass filters, and analyze circuits with capacitors and inductors in the frequency domain.

Class Content:

Students start with introduction to engineering aspects of the detection, acquisition, processing, and display of signals from living systems. Afterwards the course deals with biomedical sensors for measurements of biopotentials, ions and gases in aqueous solution, force, displacement, blood pressure, blood flow, heart sounds, respiration, and temperature. Towards the end students learn about therapeutic and prosthetic devices as well as medical imaging instruments - there is a single lecture overview for each of x-ray, nuclear, MR, and ultrasound imaging.

Work:

The homework load for this course is relatively low compared to other classes. There are only 5 problem sets, including both problems written by instructor and problems from the book. Students are expected to use a graphing software to complete the graphing portions of the homework. Some questions are designed to take extra research time to find information that is not in the book, so it is not advisable to start the homework right before it is due.

There is no final for this course; however, there will be a group research project which will have the weight of a final where students are asked to review articles about a biomedical instrument they are interested in and write a report about it.

There are 3 midterms and, while they are pretty straightforward, they ask about lot of information not covered in the book. In order to do well on this course, attending lectures is recommended, since lectures thoroughly cover a lot of topics from the book.

Life After:

After taking this course, students may choose to pursue further bioengineering-related studies; possible courses include ECE 416 (Biosensors), which focuses on cell-level sensing for proteins and pathogens, or imaging-related classes such as ECE 380 (Biomedical Imaging), ECE 472 (Ultrasound Imaging), or ECE 480 (Magnetic Resonance Imaging).
ECE 416 (BIOE 416) - Biosensors

Instructors:

This class was started by Professor Brian Cunningham in 2006 and has been offered every Spring Semester since then under his direction. He is an expert in the field of bioengineering and has considerable academic and entrepreneurial experience. As part of the class, invited experts in related areas also come to talk about the latest developments in their work.

Prerequisites:

Credit in ECE 329 is the only prerequisite for this class.

When to Take It:

Part of this class has to do with electromagnetic radiation and waveguides, so students will benefit the most from it if they take ECE 350 either before it or concurrently. Those who are considering going into the Biosensor/Bioengineering realm should take this class as early as possible. The skills and knowledge taught in this class will allow students to navigate comfortably when doing undergraduate research and exploring other classes.

Class Content:

The class starts with fundamental concepts used to measure the performance of detection methods such as accuracy, resolution, and response. Students will then learn about various sensing technologies and their principles, such as acoustic, fluorescence, electrochemistry, the most relevant optical/electromagnetic methods, and will briefly go over imaging. Part of the course is also dedicated to genetics, where students will see the latest methods for DNA sequencing. Students will also learn another important aspect of this field: surface chemistry.

This course is updated constantly, so the most current methods are always covered. Included are a few class-organized trips to visit Bioengineering scientists in their labs. They perform experiments with the tools and methods students learn in the class. Here, students will have the chance to ask questions and obtain some of the information they will need to answer class assignments.

Work:

Even though the work in this class is well balanced, it continues evolving to find the right balance between theoretical and practical learning. Up until Spring 2012, the course work was structured with bi-weekly non-cumulative quizzes intermingled with bi-weekly homework. Some of the assignments included modeling with software commonly used in this field. A class paper is due on the last day of the semester, though various installments are due throughout the semester. The paper is about reporting on a novel Biosensor technology and recommending an improvement, or finding a new use for a technology. Writing this paper is fun and very instructive for those who work on it throughout the semester, but it can be a great weight if put off until the last minute. There is no final exam in this class, but there is a final quiz that weighs slightly more more and it is cumulative.

Life After:

After taking this class, many students choose to focus on technologies based on electromagnetism, biomedical imaging and MEMS devices. There are various classes that go deeper into electromagnetism theory related to Bioengineering applications such as ECE 531 (Guided EM Waves), ECE 467 (Biophotonics) and ECE 455 (Optical Electronics). ECE 310 (Digital Signal Processing), ECE 380 (Biomedical Imaging), ECE 460 (Optical Imaging) and ECE 472 (Ultrasound Imaging) are good courses to take for those inclined towards imaging and signal processing. Those who liked the hardware and circuit design aspect of Biosensors will find ECE 485 (MEMS Devices), ECE 447 (Microwave Circuit Design) and ECE 414 (Biomedical Instrumentation) useful.
Instructors:

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

Prerequisites:

The only prerequisite listed for the class is ECE 310 (Digital Signal Processing). 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 (Computer Systems Engineering) definitely have an advantage, but the exposure to assembly programming through ECE 190 (Introduction to Computing Systems) 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 a substantial amount of work, but the skills taught are very applicable. The focus is on implementing most of what is taught in ECE 310 and students deal with practical issues of DSP implementation such as quantization error, memory usage, floating point precision; these few practical concerns are the main new concepts. Students don’t need to remember all concepts from ECE 310, but they are expected to know or learn concepts necessary for implementation. Students must code in TI (Texas Instruments) Assembly code and C for this class, as well as some minor work in MATLAB---the assembly and C code are used to program the DSP chip, whereas MATLAB is mainly used for simulation before programming the chips. In weekly lectures, the professor introduces new theories related to DSP or reviews old concepts from ECE 310. What the lecture covers depends on the professor. The structured labs, which are available online on Connexions, walk you through implementing various DSP schemes. The final project gives you the freedom to explore a project of personal interest under the guidance of the professor and TAs. Students usually learn new concepts and algorithms related to their projects at that time.

Outlines of each lab are listed below (details can be found on course website):

- Lab 0: This lab is for hardware introduction, students will learn how to use Code Composer (IDE in this course) to program DSP chips. They also learn how to use MATLAB to design filters and check output error.
- Lab 1: In this lab, students implement FIR filters on chip. They will learn some basic instructions in TI Assembly Code.
- Lab 2: In this lab, students implement Upsampling and Downsampling with cascaded FIR filters on chip using C, which interfaces with previously used Assembly code. The students are expected to figure out the syntax for passing values between the two languages.
- Lab 3: In this lab, students implement IIR filters on chip. The original IIR filter is 4th order and they are required to use two lower order filters to get the same output as the original filter. Since the chip can only represent numbers between -1 and 1, the main challenge is to use gain factors to avoid overflow and then compensate the reduced output amplitude caused by the gain factor. Another challenge is find a way to overcome the large filter coefficient problem. This lab is implemented entirely in C.
- Lab 4: From this lab, students start programming in C on the Android platform and learn how to process data in blocks of multiple samples. The main goal is to implement a spectrum analyzer application. Most of the analyzer code is given so students only need to write the C code that implements the analysis.
- Lab 5: In this lab, students are given code that takes camera input from the Android device and displays it on the screen in grayscale in real-time (as a video). The students’ task is to take the color information from the camera input and map it from the YUV420sp colorspace into the RGB colorspace for color display, and also to implement a histogram equalization of color intensities in each frame of the video.

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 (no write-ups). 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. Before demonstrations of each lab, students take a written quiz. Each quiz has a few short questions related to the concepts introduced in the lab about to be demonstrated.

After the 5 labs, you’ll have a 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, ECE 418, ECE 486 (Control Systems), and ECE 463. ECE 417 and ECE 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.
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 431 - Electric Machinery

Instructors:

Philip Krein teaches ECE 431 and uses his background in machine control and electric drives to bring some extra material to the course in addition to the textbook. He likes to bring in examples of each machine you learn about so that the students can see how they work in practice. He also likes to show up to lab on occasion and takes the entire class on a field trip mid-semester. He uses the board in lecture most of the time, but sometimes uses projector slides or his computer to show code.

Prerequisites:

The official prerequisite to ECE 431 is ECE 330 Power Circuits and Electromechanics. From that class, a student should be familiar with equivalent circuits of machines, as well as the concept of energy and co-energy. These concepts will be reviewed, but it will be helpful to remember the concepts. Another important class to have taken is ECE 210 Analog Signal Processing, as there will be some circuit analysis involved. ECE 329 Fields and Waves I is not a prerequisite, but it will help you understand the rotating magnetic fields inside of electric machines. A student should know how to use Excel extensively or another programming language in order to do the machine simulations.

When to Take It:

Many people take ECE 431 as a senior, though there are some juniors in the class. It is certainly senior level material, but the most important thing for a student to think about when considering this class is how much free time they have available. This class has both a lecture and a lab, with an assignment from both every week. Do not try to take this class at the same time as ECE 330 because without ECE 330 beforehand, you will not understand the methods used to derive equivalent circuits for the machines.

Class Content:

Much of the course time is spent learning about different electric machines and transformers. A student will learn about single and three-phase transformers, different transformer connections, and the equivalent transformer circuit. The different machines taught in the class include synchronous, polyphase induction, variable reluctance, DC machines, stepper motors, and reduced phase motors. A portion of the class is also dedicated to power electronics and control, a subject that Professor Krein is an expert in. One of the most advanced machine control techniques is presented, the dq0 transformation, which is a concept usually reserved for graduate students. Another topic in the class is power systems, which includes a lab where a small power system is set up and is subjected to several stresses. Outside of the actual content, a student will learn how to write a formal lab report including sources and an appendix. This class is especially valuable to a student who is interested in graduate school, since there is a large amount of writing for the lab.

Work:

The class includes a weekly homework assignment, a weekly lab report, and three tests (two midterms and a final). The homework is not too stressing, but the lab reports will take up at least four hours every week. There is a pre-lab every week as well, but they do not take more than half an hour to complete. The tests are structured so that students can bring anything they want, even books and the lab manual. Later in the semester, the homeworks will include machine simulations using Excel, which take a little longer, but usually Krein will assign fewer problems to offset the increase in complexity. Overall, this class will take about seven or eight hours of time in addition to the lectures and lab.

Life After:

This class is the official prerequisite to ECE 432 - Advanced Electric Machinery, which has not been taught since 2010. The material seen in this class will also be present somewhat in ECE 333 Green Electric Energy and ECE 476 Power System Analysis. This class is great for job-seekers as well: machine control is an increasingly important topic; this class and ECE 486 Control Systems will make a strong portfolio for students looking for jobs in that area.
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 Semicond Dev

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 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 that are introduced in the course.

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 used 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 595.
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

Instructors:

Professor Carney is currently the course director, but other professors have taught the class as well. Professor Singer taught the class in Fall 2012.

Prerequisites:

The only official prerequisite is senior standing at the university. This requirement may be flexible for Computer Engineers and students with previous project experience. Students in other majors, even outside engineering, are encouraged to take this course with the understanding that their project will have a component catered to their individual specialty.

When to Take It:

Electrical engineering students must pass either this course, ECE 496/499 (senior thesis) or an approved section of ENG 491 (interdisciplinary design project) in order to graduate. The majority of students take this course senior year, and it is offered every semester.

Class Content:

Students work in groups of 2 or 3 to complete a design project from start to finish. Groups come up with their own project ideas and do the design, fabrication, and validation.

Work:

Most of the time working is spent trying to design, build, and test your project. Weekly meetings are held between your assigned TA and your group to ensure steady progress and express concerns or seek advice. Everything is to be well documented in a lab notebook.

After finding partners, groups must submit a project proposal within the first two weeks of the project. A week after the proposal is due, a more complete proposal is required. This second proposal should contain the objectives of the project, a high level block diagram of the hardware, a list of requirements and verification, a cost analysis, and a work schedule. A couple of weeks after the second proposal, the design review is due. The design review is a complete blueprint for your project. It must contain a fully fleshed out electrical design, including schematics, simulations, more detailed requirements and verification, cost analysis, work schedule, and assessment of ethical issues. This design review contains a substantial amount of writing and documentation. Half way through the semester, each student will have to submit an individual progress report that details his or her specific contributions to the project. Simulations, schematics and diagrams, and quantitative results should be presented. A final demo, which constitutes a large portion of the course points, is held near the end of the semester to showcase the projects. A final presentation is also given to course staff to evaluate the project and discuss the project in a formal manner. A final written report is due at the end of the semester, and is similar to the design review, but updated to reflect the state of the project.

Life After:

Students who wish to continue working on their projects are encouraged to take independent study: ECE396, ECE397, ECE497, or ECE 499.

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 447 - Active Microwave Circuits

Instructors:

Professor Milton Feng teaches the lecture section for this class. Graduate TAs teach the lab sections.

Prerequisites:

Both ECE 453 Wireless Communication Systems and ECE 457 Microwave Devices and Circuits are listed prerequisites, but most students take it with only ECE 453. It is not advisable to take 447 without 453, as it is assumed that you are familiar with the 453 material in both lab and lecture. Some topics from 453 that one should be familiar with are impedance matching, stability, S-parameters, sources and management of noise, and non-linear effects. 457 material is helpful in understanding impedance matching using transmission lines and transmission line modeling (particularly microstrip). Taking 457 beforehand provides familiarity with some of the lecture content that may be new, but a good grasp of transmission line concepts is sufficient.

When to Take It:

Because of the ECE453 prerequisite, almost all undergraduates take this class as seniors. There are also a handful of graduate students who take this class. It is offered every spring.

Class Content:

The lecture section is an overview of transmission lines and RF circuit concepts, and covers a wide array of material. In short, all the material in 453 is covered, but viewed at from a high frequency design and analysis point of view. Concepts like S-parameters, stability, amplifier design, and transistor biasing should be familiar to students of 453. New concepts include signal flow graphs and microstrip modeling. Most of these concepts are explained in the context of how they differ from their low frequency counterparts and how to factor in these concepts when trying to take measurements on high frequency devices.

The primary experience is the lab section, where the goal is to create a transistor amplifier circuit that operates at 1.5GHz with a partner. Students start by fabricating a 50 ohm microstrip line on Duroid substrate, adding circuit components and taking measurements with each new lab. Each new lab focuses on a concept like the bias network, impedance matching, using Agilent ADS software, or taking a series of measurements. Calibration of lab equipment and measurement techniques are also heavily emphasized, as they are crucial in taking accurate measurements at high frequencies.

Work:

Lecture is once a week, and there are written homework assignments for the first few weeks of lecture. After that, the entirety of the work is contained in the lab section. Each week's lab has a lab report to be written and placed in a lab notebook. There are around 10 labs total. There is a final exam that covers material from the lab section, circuit concepts, and RF/transmission line concepts. The final exam is open lab notebook, but no other notes are allowed, so having a well kept notebook should be a high priority. Expect to spend at least a couple of hours working on the written homework and writing each lab report. If your amplifier circuit is not working, expect to spend time outside of lab to troubleshoot your circuit. The work load is fairly light, but there may be a fair amount of self-studying to master the material.

Life After:

This class will prepare students who are interested in RF or high frequency circuit design. Some companies that might be interested are Motorola, Nokia-Siemens, Intel, Apple, IBM, the list goes on and on. Given the high demand for engineers to work in wireless communications and high frequency devices, this class is great for students looking to go into those fields.
**ECE 452 - Electromagnetic Fields and Electro-Optics**

**Instructors:**

Professor Shun Lien Chuang teaches this class, and he is an excellent teacher (Professor Cangellaris has also taught the course in recent years). 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 if 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 emphasis 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 Communication Systems

Instructors:

Professor Franke is both the course director as well as the lecturer. Professor Minin is the lab director.

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 the transistor circuit models learned in ECE342, as well as familiarity with small signal analysis.

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 various gains. 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, and then some. Particularly, besides learning how the impedance and spectrum analyzers how, much detail is gone into on PCB and component design in the RF spectrum. Learning how resistors, capacitors, inductors, and crystals behave across the frequency spectrum.

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 and Matlab, which are both available on the EWS computers.

The lab meets weekly for 3 hours. There are no written prelabs, but there are 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. Following that, there is a self-decided final project for the last lab.

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-Mobile, 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. 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 (Fields and Waves II) is the only prerequisite listed, however it is a fairly loose requirement. Since many graduate students without prior experience in E/M take this course, it will suffice to just have PHYS 212 (University Physics, Electricity and Magnetism) or ECE 329 (Fields and Waves I).

When to Take It:

If you are interested in lasers, this course is essential. Don't be fooled by the title "Optical Electronics." This class should instead be called "Laser Electronics." It is typically offered in the Fall.

Class Content:

This course focuses solely on lasers. 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 research paper due. It is typically a 15-20 page report on any hot topic in laser engineering that you find interesting. Graduate students (or undergraduates who take the class for 4 credit hours) are also expected to present their paper for the extra credit they receive. Professor Eden takes these papers and presentations very seriously, and expects students to prepare and deliver them in an academic conference style format. The homework is challenging, but very reasonable, and certainly doable given the lecture notes and book material. Homework will typically take about 5-6 hours a week (there are usually 8 assignments in a semester). There is a "homework final" at the end of the course that presents a complete laser design problem. This problem will test your knowledge of all of the topics covered in lecture, and will take more effort and time than a regular assignment to prepare for. Office hours are incredibly important for adequate understanding and completion of the homework, as the TA generally goes over problem solving methodology (which is not covered as in depth in the lecture).

The exams are relatively fair, assuming you've read the book, understood the lectures and can do the homework yourself. Professor Eden typically posts exams from the previous 5 years, minus the solutions. Again, office hour attendance helps tremendously with exam preparation.

The class is generally taken by large amounts of graduate students from all STEM majors. Grades are curved at the end of the semester (graduate and undergraduate combined), so in order to do well, it is important to stay on top of the material. Because none of the material is very hard to comprehend, exam averages are usually high.

Life After:

If you are interested in semiconductor lasers, ECE 304 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, or if you prefer to stick to the semiconductor variant, check out Professor Coleman's graduate class, ECE 535.
ECE 456 - Global Satellite Navigation Systems

Instructors:

Professor Makela has taught this section in the past, but in recent semesters it has also been co-taught with Professor Gao, a newly hired professor in the aerospace engineering department. Professor Gao's lectures focus on orbital dynamics and the basics of the navigation message while Professor Makela focuses on the signals, signal propagation through the atmosphere, and differential techniques.

Prerequisites:

The listed prerequisites are ECE 329 (Fields and Waves I) and ECE 310 (Digital Signal Processing). Material from both prerequisites are usually not directly applied to the material in this class, but having knowledge of wave propagation and signals processing will help with understanding global navigation at the systems level.

When to Take It:

This class doesn't lead directly to any other class offerings, and the material is not a direct extension of either of the prerequisites. For students interested in working in this area, it can be taken junior year. For students who just want to learn how satellite navigation systems work, take it when it will fit conveniently into the rest of your schedule.

Class Content:

The course covers every aspect of satellite navigation systems, primarily focusing on GPS. After discussing what exactly a navigation solution is, the first quarter of the class covers the orbital dynamics of the satellites. This includes topics like different reference systems and converting between coordinate types. The second quarter covers the structure of the data being sent from the satellites to the GPS receiver, how to recover useful information from it, and calculate a navigation message from the received data. The last half covers the source of errors and how to mitigate those errors. Some examples of these error sources are ionospheric effects and relativistic effects. Techniques like differential GPS and using WAAS for error correction is covered. Verterbi decoding is also quickly covered since WAAS uses Verterbi encoding for error correction. The last few lectures go over the other satellite systems, like the GLONASS (Russian), Galileo (European Union), and Compass/BeiDou (China) systems that already exist or will exist in the future.

Work:

There are weekly homeworks that cover the lecture material. Much of the homework involves manipulating data and writing programs in MATLAB. Expect to spend 2-4 hours a week on the homework. There is also a lab section, which is also centered around manipulating gps data in MATLAB. The lab differs from the homework in that the data is taken live by GPS receivers. Lab is once every two weeks, and each lab has a lab report associated with it. Expect to spend 4-8 hours on the lab reports. There is a midterm, but no final exam. Instead of the final exam, each student will do a final project exploring an aspect of global navigation that was not covered in depth during lecture. Some examples of final projects are tracking modern satellite signals, alternative computational methods, tracking satellites in sub-optimal environments, and implementing receivers in software.

Life After:

Satellite navigation has experienced an explosion of usage among the civilian population in the past decade. Companies that make consumer GPS devices might be interested in hiring successful students, but also defense contractors like Lockheed Martin have hired students in the past.
ECE 457 - Microwave Devices and 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 - Communications 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 recent years.

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 there is some topical overlap between ECE 459, ECE 453: Wireless Communication Systems, 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), phase-modulated (PM), and frequency-modulated (FM) communication systems. Topics covered on these modulation schemes include the frequency spectrum, efficiency, modulation from base band, demodulation to base band, and jamming applications. 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, in theory, an 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, a variety of digital modulation schemes, and matched filtering.

Work:

Homework is assigned weekly. Usually these consist of 6 problems from the textbook or problems made up by course staff. 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 is taught by Professor Shobha Vasudevan. She has prior industry experience and thus knows 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 ECE 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, as algorithms used by electronic design automation (EDA) tools are the main focus of the course, along with post-silicon testing.

Students who have taken CS 225 (Data Structures) may be disappointed to find that, although this course is primarily about algorithms, no big-O analysis is done. Students who have taken CS 373 (Theory of Computation) will notice quite a bit of overlap between Finite Automata (in CS 373) and Finite State Machines, though this isn't a large portion of the course. More notably, the occasional proofs required by this class are usually nowhere near as difficult as those required in CS 373 and CS 473 (Fundamental Algorithms).

Class Content:

Although many students come into this class expecting ECE 290 part 2, this class really isn't so much an extension to ECE 290 as a tangent to it; it's not so much about advanced logic design techniques, but rather focuses on algorithms used in EDA tools (such as Quartus II, used in ECE 385) to automatically minimize the logic for combinatorial and sequential circuits. Additionally, some time is spent on teaching students the basics of equivalence checking and post-silicon testing. If you are looking for advanced logic design techniques, chances are the class you want is ECE 411 (Computer Organization and Design).

The course begins with logic optimization, starting with K-maps from ECE 290 and discussing algorithms for optimization such as the Quine-McCluskey method - a lot of time is spent discussing this algorithm (despite it's high computational complexity and thus, questionable utility); binary decision diagrams, which are data structures that represent combinatorial functions, will also be discussed in depth, along with the boolean algebra concepts they are based on. Then finite state machine optimization and algorithms to compare two finite state machines are discussed. The class also covers hardware verification techniques used before a circuit is fabricated. Fault detection and correction is then discussed in the context of post-silicon testing, and algorithms to produce tests for faults are discussed. Finally, the class covers technology mapping, which involves optimizing logic (for area or for timing) using a predefined set of logic gates, and multi-level logic synthesis.

Work:

The course has a light workload. As of Fall 2012, the homework starts out being due every Thursday, but after the first exam two weeks are given for each assignment instead of one. Homework assignments typically involve working through algorithms by hand or doing some simple boolean-algebra proofs; occasionally tougher proof problems or algorithm design problems appear. Students are allowed to work together on the assignments, in groups of at most 3. The course has no labs or MPs - so you never really get to apply what you learn.

ECE 462 has two midterms and a final. The problems given on these exams are similar to the ones given in the homework, and are for the most part straightforward. However, there are a couple of proofs on each exam, which can be difficult to prepare for but are not graded very harshly and do not make up a large portion of the exam. Overall, the course is designed to be a fairly small weekly time commitment.

Life After:

ECE 462 is one of the few courses that teaches students the algorithms used in EDA tools, as well as verification and testing. Anyone considering a career in verification and testing, hardware design, or EDA software design would benefit from ECE 462.
ECE 464 - Power Electronics

Instructors:

Robert Pilawa teaches this course and has been doing so for several semesters. He's very knowledgeable about the subject and very helpful. The textbook used for the class has been written by Phillip Krein, another UIUC professor who is responsible for developing the current power electronics curriculum at Illinois.

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, all the way up to a large inverter that forms the link between a solar farm and the power grid. In the later half of the semester, you begin to cover more design problems, dealing with various sources of loss such as ESR or winding loss, as well as different materials that construct these components. 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. Other recommended classes are ECE 486 and ECE 483, if one wishes to look into different aspects of circuit design. Having these design skills at both the board and IC level is a very desired trait for circuit designers. 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 469 - Power Electronics Laboratory

Instructors:

This course has recently been taught by Professor Pilawa.

Prerequisites:

The prerequisites for this course are ECE 343 (Electronic Circuits Lab) and credit or concurrent registration in ECE 464 (Power Electronics).

When to Take It:

ECE 469 is the lab course for ECE 464 (Power Electronics), so it is best to take them at the same time. It is, of course, possible to take it later, but ECE 464 and ECE 469 are meant to stay in sync - the material in ECE 469 helps with the material in ECE 464 (and vice-versa). There is no rush to take this course because there are no undergraduate power courses that follow it. The prerequisite for ECE 464 is ECE 342 (Electronic Circuits), which is not absolutely necessary, but the lab experience from ECE 343 (especially the power lab) can be useful.

Class Content:

There are about ten lab projects, each a week long. You'll work in pairs, and stick with your partner the entire semester; you might want to find a partner before you take this course.

The first three labs cover rectifier circuits, in which you will take an AC signal and rectify it to a DC value through combinations of diodes, and then filter the output. The next several labs cover DC-DC converters, and you will build a buck, boost, and possibly other simple topologies. The lab then moves on to inverters, which are DC-AC converters, and introduces PWM converters at the same time (there is significant overlap in the content). The last labs before the final project require measuring the non-idealities of inductors and capacitors (most notably, the equivalent series resistant, ESR). Finally, the last several weeks are dedicated to building the final project converter.

Work:

There is a three hour lab once a week, and a one hour lecture at the beginning of the week to introduce new material. Prelabs are usually turned in during the lecture; the prelabs are fairly reasonable, with only a couple of parts to one or two problems. After two or three lab projects, students write a report (about six pages per project) according to a rather rigid format and take a decent amount of time - but an all-nighter the night before they're due is usually sufficient (though not recommended).

There is a final project at the end of the semester for about three to four weeks where you are assigned a converter to build with your partner (graduate students are typically assigned tougher converters, while undergrads are usually assigned basic DC-DC converters). You are expected to meet specifications for ripple and voltage, etc. by working around the limitations of real components; then, you must build a feedback network into your converter which stabilizes it. The projects are graded according to their difficulty, so more difficult projects are given more leeway for not meeting their specifications.

Life After:

No undergraduate classes depend on ECE 469, but it is extremely useful for talking to companies about power electronics. Many companies, even those that don't do anything about power electronics, love for you to know how basic things like DC-DC converters work.
ECE 470 (AE 482, ME 445) - Introduction to Robotics

Instructors:

The course director and lecturer is Prof. Seth Hutchinson, whose specialty is control theory. Labs are led by various TA's.

Prerequisites:

The officially-listed prerequisites are MATH 225 (Matrix Theory), MATH 286 (Intro to Differential Equations Plus), MATH 415 (Applied Linear Algebra), or MATH 418 (Intro to Abstract Algebra II). You really do need to know matrix algebra; almost every concept taught in the class depends on it. However, differential equations aren't really required. Several homework assignments also require Matlab programming, which is not explained in the course.

When to Take It:

This course is offered pretty much every Fall. If you're interested in robotics, you might want to take it early after Math 286 (or equivalent prerequisite) so you can move on to further robotics courses; otherwise, you can put it off until later.

Class Content:

Despite the name, this is not a complete overview of robotics. Rather, it covers motion planning: forward kinematics (given a "shoulder" and "elbow" bent at certain angles, where does the robot's hand end up?), reverse kinematics (what angles must the shoulder and elbow be at to put the hand at a certain position?), and velocity kinematics (how do we move the hand at a certain direction and speed?). Finally, you will briefly study computer vision: selecting objects from an image based on threshold levels and determining their position in the world given their position in the camera's image (and position, orientation, and focal length of the camera). Virtually all of this is done through detailed matrix algebra and repeated conversions between the coordinate frames of the different arm joints.

As you study different concepts in the lecture, you will carry them out in the lab working with an actual robot arm.

Work:

There are two hour-and-a-half lectures per week, plus a two-hour lab. The lab length is probably sufficient early in the semester, but you will probably need to spend about two more hours per week on them as the semester goes on. Also, there is one midterm and a final exam (the second of which was, at least in Fall 2012, open-book.)

Most of your time in this course will probably be spent on the five homework assignments. Problems must be set up very carefully, and the work is quite involved; exact time spent varies dramatically between students.

Life After:

Mathematically, this course is related to control theory; students who enjoy this might wish to continue in that direction, with ECE 486 (Control Systems) and GE 420 (Digital Control Systems). Some other robotics-related courses are CS 431 (Embedded Systems) and CS 424 (Real-Time Systems) which focus more on the software-side of things, and GE 423 (Mechatronics). At the graduate level, some related courses are ECE 550 (Advanced Robotic Planning) and ECE 549 (Computer Vision).
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 483 - Analog IC Design

Instructors:

As of spring 2014, this course was taught by Professor Pavan Hanumolu.

Prerequisites:

ECE342 (Electronic Circuits) is the only prerequisite for this class. As the course name states, only the analog part from ECE342 will be carried over to this class.

When to Take It:

It is actually recommended to take this course right after taking ECE342 since most of the analog circuit parts from ECE342 will be reused in this class. However, if you’re interested in IC design in general, taking circuit design classes in order of ECE342 - ECE482(Digital IC Design) - ECE483 could also be a good idea. ECE483 is only offered in spring semester.

Class Content:

At the beginning of the semester, this class will teach about passive electronic components which is not covered in ECE342. It'll talk about more realistic cases where the values of resistors and capacitors can vary depending on the sizing error and the voltage across them. During this time, this class will briefly talk about Total Harmonic Distortion which is already taught in ECE210. After this, the class will finally move on to ECE342 material. The class will first talk about the characteristics of MOSFET and BJT, and teach how to find out the resistance and transconductance of circuit which includes several MOSFETs and BJTs. By the time you are used to calculating these values, the class will start to talk about biasing transistors and how that can affect the voltage swing of the circuit. The first midterm is likely to be taken at this point.

After the first midterm, you will learn about the basic concepts of differential amplifier. The class will introduce you to various kinds of amplifiers with their advantages and disadvantages and you will need to apply all the concepts you’ve learned before to understand these. The second midterm could be taken at this point.

By the end of the semester, you will learn about the capacitance of transistor and how that can affect on bandwidth of analog circuit. If you’ve learned ECE482 before, it will be slightly easier to understand how the sizing of transistor can affect the capacitance of the transistor. Also, transfer function of analog circuit will be taught in this point. This overlaps with the material taught in ECE486 (Control Systems) so it will be easier to follow the class if you’ve taken the course before or you are taking it concurrently.

Work:

The total grade of this course is consist of homework, two midterms, one project, and a final exam. It is likely to have no homework during exam week, but this may vary by semester. Midterm materials are closely related to homework problems so it will be a good idea to do the homework by yourself and understand the concepts behind the problems thoroughly. Homework is tend to be hard and time consuming at the beginning of the semester. It will be easier on later, but this is because the final project is assigned by the end of the semester. It can take very long time to do the homework for the beginning of the semester, but all the materials from the former homework will be reused again and again in later class so it is important to finish it.

The final project will ask you to design a certain analog circuit which requires all the knowledge you’ve learned in this class. The project assignment will tell you what analog circuit you need to design and the following specification. The rest of the design decisions is up to you.

Life After:

Analog circuit design is still the main concern of IC design and most companies are looking for engineers who are willing to solve the problem. If you still think you like learning about analog circuit after taking this class, taking ECE581 - Advanced Analog IC Design could be a good idea. However, since the class is a graduate level class, you might need confirmation from professor to take the class.
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:

This is the only ECE class on controls at the undergraduate level; the logical next undergraduate controls class is GE 420 (Digital Control Systems). Related classes include ECE 470 (Introduction to Robotics), Math 415 (Applied Linear Algebra), ECE 310 (Digital Signal Processing I). 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 (CSE 441) - 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, 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.
Graduate Courses

This section is dedicated to 500-level ECE courses. With departmental permission, undergraduates 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 520 – EM Waves & Radiating Systems

Instructors:

Professor Jin teaches this class. He is also the author of the textbook used for this course.

Prerequisites:

An officially listed prerequisite is ECE 452, but it is not enforced at any level. In general, a student interested in taking this class should already be familiar with Maxwell’s Equations. In addition, being comfortable with vector calculus is essential to doing well in this course. Undergraduates considering this course should consider taking ECE 452 prior to taking ECE 520.

When to Take It:

Graduate students interested in studying electromagnetics should consider taking this course as one of their first graduate courses. It is typically offered in the fall only.

Class Content:

This course starts with a quick overview of Maxwell’s equations in the time domain, boundary conditions, and material properties. It then discusses time harmonic (frequency domain) versions of Maxwell’s equations, and brings up power and energy in the context of time harmonic fields. Auxiliary potential functions are derived and applied to a variety of example cases, which smoothly transitions into far field approximations for radiating structures with wire or loop antennas. A variety of fundamental ideas such as the uniqueness theorem, reciprocity, equivalence, and their applications in image theory and scattering problems are covered. Plane waves and their properties are covered rigorously, including the reflection and transmission of plane waves through isotropic and anisotropic media.

The course then shifts to the study of Maxwell’s equations and its applications in more specific applications. These applications are used the introduce the solutions of Maxwell’s equations in rectangular, cylindrical, and spherical coordinates. The rest of the course goes through different waveguide, scattering, and radiation problems that can be solved analytically using these frameworks.

Work:

There is about a homework every week from the textbook involving around 5 problems each. The homework usually involves applying concepts or proving mathematical relations discussed in lecture. There are 2 midterm exams and a final exam. All exams are cumulative, though they primarily feature material covered since the previous exam.

Life After:

A common course to take after 520 is ECE 540, Computational Electromagnetics, the other course that Professor Jin teaches. 520 is a prerequisite for many other graduate courses, ranging in topics from continued study of electromagnetism to optics and so on.
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 (FEM) and Method of Moments (MoM) techniques, computational stability and optimization are covered in class. In addition to these approaches to simulating electromagnetics, other topics such as absorbing boundary conditions and perfectly matched layers are discussed. You will apply what you learn to standard physical problems. Examples are radiation from an infinite line of current, electric fields of point sources, scattering off of perfect electric conductors (PEC), scattering off of dielectric materials, waveguide analysis, and transmission line analysis.

Work:

You will be required to produce three publication quality projects during the course of the class, in addition to regular homework assignments and a final presentation. The three projects are based on writing your own simulators for FDTD, FEM, and MoM in a programming language of your choice. The time required will vary depending on your initial preparation (prerequisites, experience, etc.), but most students should expect to put in at least 10 hours of preparation a week in order to fully understand the material and finish the homework assignments. Significantly more time will be invested when completing the three course projects and the reports.

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.
Should I take X with Y?

Some courses complement each other, even if they may not be corequisites. This section discusses some of these combinations, although whether combinations are allowed is up to the department.
Should I take CS 225 with ECE 391?

Relevancy:

Both courses are required for CompE's, although CS 225 focuses on high level object-oriented paradigms in C++ whereas ECE 391 focuses on low level operating system topics in C and x86 Assembly. The two courses are at best tangentially related, although it is not uncommon for topics from one class to appear in the other, such as stack implementation and memory management showing up in CS 225 or linked lists, trees, and Big-O notation showing up in ECE 391. It is generally recommended that students take CS 225 before taking ECE 391 for the sake of programming maturity, although most of what students need to know as far as data structures are concerned for ECE 391 is already covered in ECE 190. A good portion of students take ECE 391 without having taken CS 225 beforehand and do quite well in the course.

Workload:

Students in the past tend to average 20 or more hours a week on ECE 391, although this can change at the halfway point of the semester depending on how well your group works together on the third MP (which comprises of the remainder of the semester). There are only two classical "homework assignments" in the course which serve as prelabs for the first two MPs, and then the rest of the work is all MPs, which typically have checkpoints every Monday. These MPs aren't terribly difficult from a coding perspective, although they are very difficult to get your head around. Reading online documentation and thoroughly understanding the code they provide you accounts for approximately half of the time you will spend on MPs. You may spend a couple of hours writing code then, but the rest of the time is spent debugging, and this is where students tend to get burned out.

CS 225 has a much easier workload, coming in at approximately 5 to 10 hours a week, with seven MPs stretched out through the entire semester due on Fridays and weekly two-hour labs due on Sundays. These MPs are much less open-ended than the ECE 391 MPs, as most often, you will be given a list of functions you have to implement with the framework already created for you. These MPs serve as the primary learning mechanism for the course, and while the MPs only take 5 to 10 hours a week, it can be very easy to fall behind and be left with an MP due at midnight.

Recommendation:

Taking these two courses together can be very difficult because of the sheer amount of time you will spend between the two classes, which in a given week can easily range from twenty to thirty hours a week. If you are a good programmer, or if you did well in ECE 190 (Introduction to Computing Systems), you should find the combination of these two courses to be very manageable. That being said, it is very important to find a good group for ECE 391's MP3, as some groups have been known to spend 30+ hours a week scrambling to finish checkpoints. Additionally, the remainder of your schedule beyond CS 225 and ECE 391 should be fairly light, as both lack of sleep and lack of time have a tendency to hinder efforts to finish homework for other classes when taking this combination.

If taking the two courses together sounds daunting, it is fair to only take one of CS 225 or ECE 391 and pick up another technical elective instead. Both courses are equally important for the topics they cover as well as for their roles as prerequisites to upper level courses and potential to help you get a job, so it does not particularly matter which you take immediately. If you can find a good group for ECE 391 before the course starts however, it may be best to take that instead, as the value of having a functioning group for MP3 cannot be understated.
Should I take ECE 110 with ECE 190?

Relevancy:

Both ECE 110 and ECE 190 lay the foundation for the remainder of your ECE experience here, so it is important to take the courses slow and ease yourself into the workload. ECE 110 is a survey of both Electrical and Computer engineering, and the digital portion of the class teaches basic Boolean algebra and digital logic manipulation. ECE 190 jumps right into digital logic at the start of the course, so the material is covered sooner in ECE 190 and with the assumption that you will have seen it before. The rest of ECE 110 and ECE 190 are isolated from one another, although acclimation to the ECE department through ECE 110 is expected before tackling ECE 190.

Workload:

ECE 110 has weekly online homework assignments, but ECE 190's workload is more sporadic. ECE 190 has weekly programming labs, but the labs are a minimal investment. ECE 190's MPs, however, do take significantly more time commitment than anything else in either ECE 110 or 190, and the workload associated with the MPs should not be underestimated. The exams in ECE 190 are also known to be more difficult than most students are comfortable with, and as such extra time should be put into studying for ECE 190. Both the MPs and the exams in ECE 190 detract from time that students have to put into learning the foundational material from ECE 110 which is a more consistent weekly investment. Towards the end of the semester, when the ECE 110 lab is coming to an end and the final MP for ECE 190 is released, students taking both courses may find themselves swamped with two major projects which they need to do work on.

Recommendation:

This combination of courses is usually not recommended, since many students who attempt these courses concurrently tend to underestimate the difficulty of the combination. Any prior experience in circuit analysis, digital logic, or programming can help students decide if they are comfortable with taking both courses together. If the student has previous programming experience, then some of the initial learning curve associated with ECE 190 goes away, but ECE 190 still remains a difficult (though much more manageable) course. However, a student who understands how to solve circuits and how digital logic works prior to ECE 110, or has a strong background in programming, may be capable of doing well when taking the courses simultaneously, as material which takes some students weeks to master will already be familiar.

If taking ECE 110 second semester, then the student should evaluate how their first semester went to decide if they want to push their boundaries on courses this early in college. It is more important to learn the material in these two courses than to attempt to get ahead if the student is uncomfortable with material. Additionally, ECE advisers may be able to help the student decide if they are ready, and the department has prepared a page specifically to help out with this situation.
Should I take ECE 190 with ECE 210?

Relevancy:

Both courses are introductory ECE courses that cover vastly different areas. ECE 190 is an introduction to computer engineering. Students taking ECE 190 will learn about the basics of computer architecture and how to write programs in both C and the LC-3 assembly language. ECE 210, on the other hand, covers analog signal processing. Students taking ECE 210 will learn a lot of signal processing & linear systems, and how to apply this theory by building circuits used in an AM radio. These two courses have no overlap at all and are both fascinating introductions to two different parts of ECE.

Workload:

ECE 190 is often described as one of the hardest introductory courses in engineering. This statement is true if one has no prior programming experience. For the first couple of weeks, ECE 190 has written homework assignments, which are no harder than any of the assignments in ECE 110. However, the course picks up quickly afterwards, and for the rest of the semester programming is the main focus. ECE 190 has 5 MPs in total and 3 of them are hard enough to require more than 10 hours of coding. When the course becomes intense in the last few weeks, some students will not do those MPs, as they count for 1% of the grade. ECE 190 also has labs related to the weekly topics, which are important for understanding the material and may take longer than one would expect.

ECE 210 has weekly homework and 5 labs in the whole semester. It’s not a very work-intense course, but for those who want to do well it is important to read the textbook and do the homework, as those resources provide good preparation for the exams. The labs are supposed to be finished during the lab sessions so students will not spend a lot of time on the lab reports.

Recommendation:

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 EEs can begin to take upper level classes after ECE 210 is completed); the combined workload is even more manageable for students who have prior programming experience - though prior experience isn't required to be able to do well taking the courses together. Students who have some background in programming and feel confident about math should have no problem taking these courses together. Those people who don’t know how to write a hello-world and who struggled a bit in ECE 110 are probably better to focus on just one of these courses at a time.

It is worth noting that these courses can help students choose between Computer Engineering and Electrical Engineering - ECE 190 is the first CompE course, and ECE 210 is a very fundamental EE course. Exploring your interests in ECE through these two courses is important, so taking both sooner rather than later is advisable.
Should I take ECE 210 with ECE 290?

Relevancy:

The two courses are unrelated. ECE 210 is an introduction to signals and circuits, which teaches you math to process and translate signals, as well as linear circuit theory. ECE 290, on the other hand, focuses on logic design and how LC3 really works - it is primarily a Computer Engineering class. There is no overlap between the two classes - they are completely unrelated.

Workload:

ECE 210 has weekly homework and 5 labs in the whole semester. It is not a very intense course, but still you have to read the text book and finish your homework, which will maybe take 3-6 hours a week. The labs are supposed to be finished during your lab session so you won't spend a lot of time on them, though you will have prelabs to do on your own time that maybe take an hour each, and you'll also have to finish the lab worksheets in your own time if you don't finish filling them in during the lab - but this doesn't take much time either.

ECE 290 has been changed up a few times in the past few semesters. Normally, when it is taught by Professor Brown, the class has weekly written homeworks and online mallard homeworks/quizzes; this combination usually takes 8-12 hours a week (6-8 hours on written homework and 2-4 hours on Mallard); the course also has 7 lab assignments, which you have to do on your own time, and take about 3-5 hours each; these are assigned roughly every two weeks, but the pace picks up towards the end of the semester. The course also has 2 midterms and a final; the midterms (especially under Professor Brown) aren't terribly difficult, but their length makes it very challenging to actually finish in the hour-and-a-half time period. Overall, the course took about 10-15 hours of work a week, so it is not advisable to take it with another time-consuming course.

Fall 2012 the course was taught by Professor Herman, who replaced the midterms with three group projects; the minimum projects did not take a lot of time, so generally are regarded to make the course easier/less time-consuming than it has otherwise been in the past. It is unknown what structure the coming semesters will take.

As ECE 210 isn't a very time-consuming course, this pairing of courses is fairly reasonable. It is worth noting, however, that both courses usually have homework assignments due on Wednesday mornings, so planning ahead is important - don't try to do both homework assignments on Tuesday nights. The total workload of this combination usually comes in near 15-20 hours a week, which is reasonable considering these two classes should be about half of your total workload.

Recommendation:

If you are thinking about taking these courses simultaneously, 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 (Introduction to Electrical and Computer Engineering) and ECE 190 (Introduction to Computing Systems). 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 far worse. If you've already exhausted most of the basic math and physics requirements for ECE, there really is no reason to put off ECE 210 and ECE 290. 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 - ECE 210 prepares students for upper-level Electrical Engineering courses such as ECE 342 (Electronic Circuits), ECE 310 (Digital Signal Processing), ECE 329 (Fields and Waves I), and ECE 330 (Power Circuits and Electromechanics), whereas ECE 290 prepares students for upper-level Computer Engineering courses such as ECE 385 (Digital Systems Laboratory), ECE 411 (Computer Organization and Design), and ECE 391 (Computer Systems Engineering) - all of which are prerequisites for higher-level courses.

Some people have taken to calling this combination "ECE 500", which sometimes scares underclassmen away from it; this nickname really isn't deserved - while the combination does include a good deal of homework, it's not nearly as bad as "ECE 500" suggests. If you aren't taking any other time-consuming courses, this pair is completely manageable. Many students, especially sophomores, try this combination and usually are pretty successful with it; some students have even successfully taken these courses with one or two other technical courses, though whether or not that is a good idea varies from case to case.

Additionally, if you are still debating about whether to be an EE or a CompE, which of these two courses you like more will probably determine which major you end up choosing.
Should I take ECE 311 with ECE 310?

Relevancy:

ECE 310 and 311 serve as the gateway courses to the area of signal processing. Material covered in 310 is investigated in 311 using MATLAB, the industry standard tool for signal processing. Students will work on problem sets in 311 which lead to better understanding of topics such as continuous and discrete Fourier Transforms, the z-Transform, windowing and convolution, frequency response of systems, and digital filter design. Taking 311 concurrently with 310 will help students make connections between the equations derived in 310 and their actual representation and usage in the digital world. In general, most material is covered in 310 before it appears in 311.

Workload:

In 310 there will be weekly homework assignments that involve computations based upon the derivations learned in lecture. Students in 310 can also expect quizzes or midterms, as well as a comprehensive final. In previous semesters, completion and knowledge of the homework assignments each week has been sufficient preparation for quizzes.

Taking 311 concurrently with 310 will not add a huge amount of work to your semester. ECE 311 usually consists of 7-8 labs which are due every two weeks, most of which can be completed using only a few extra hours outside of the regular weekly lab sessions (4-5 hrs/wk including lab time). Most problem sets are not very difficult, and a quick introduction to necessary MATLAB knowledge is provided for those without previous experience using the software. Lab reports simply consist of copying the MATLAB code you've written and the plots it generated into a document, along with the occasional answer to a theoretical question. There is also a take-home final lab which covers all the concepts from the previous labs.

Students who are concerned about overloading their semester by taking these courses together should still consider taking ECE 311 the following semester. Overall, it is a very beneficial class and should definitely be taken by anyone enrolled in ECE 310.

Recommendation:

Any student with an interest in signal processing should highly consider taking these courses concurrently, especially the semester after taking ECE 210 - Analog Signal Processing. ECE 311 will provide not only a better understanding of the concepts in signal processing, but also an in-depth look at a tool used extensively in the industry. The experience in MATLAB gained by taking 311 will greatly benefit anyone looking to find a research position, as well as provide solid skills for future signal processing classes, such as ECE 417 - Multimedia Signal Processing, ECE 418 - Image & Video Processing, and ECE 420 - Embedded DSP Laboratory. Even those without an interest in signal processing should still find 311 beneficial to their understanding of concepts in 310.
Should I take ECE 329 with ECE 210?

Relevancy:

ECE 210 and ECE 329 are both core requisites for all ECE students. They both deal with mathematical rigor related to electrical engineering. ECE 210 is listed as the official prerequisite to the ECE 329 course. This is mainly because some concepts from ECE 210 such as phasors, sinusoidal waves and circuit fundamentals are used in several parts of ECE 329. However, exceptional students who have excelled in Calculus and Physics may find it feasible to take ECE 210 and 329 concurrently due to the manageable overlap.

Workload:

ECE 210 is one of the first 200-level classes ECE students take, and therefore might seem quite mathematically rigorous. ECE 329, being a 300-level class, is even more mathematically challenging and also requires good understanding of Physics 212 on top of that. Therefore, ECE 210 is a prerequisite for ECE 329, largely because ECE 210 paints a good picture of how much workload will be required in other 300-level classes (such as ECE 329). Both courses expect you to allocate a good amount of time in order to complete weekly homework, to prepare for 3 midterm exams and to understand the concepts from the 3 lectures per week. ECE 210 also has a lab portion on top of that. Since ECE 329 has weekly homework due Tuesdays, while ECE 210 is due Wednesday, it is not too difficult to work on both. Note that waiting until Tuesday before starting on the ECE 210 homework might not give you enough time to complete it. Exam schedules change from semester to semester, but there is a possibility that you will have to take both of the exams on the same day.

Recommendation:

It is not very difficult to start ECE 329 before completing ECE 210. They are not related that much in terms of concepts. The biggest mathematical tool that you will learn in ECE 210 that will be used in ECE 329 are phasors. Therefore, it might be wise to try to understand phasor domain before the last third of ECE 329, in case it is still not covered fully in ECE 210 by that time. Otherwise, ECE 210 deals mainly with the circuit level analysis while ECE 329 provides a deeper understanding of electromagnetic level. At the same time, ECE 210 is designed to prepare students for mathematical rigor in ECE 329. They both require quite amount of time and work to really understand the fundamental concepts. With that being said, it is possible to take both courses at the same time, if one has good understanding of Calculus for ECE 210, Calculus (3) and Physics 212 for ECE 329. Many students who have chosen to take ECE 210 and ECE 329 together do well in both of them as long as they put in the time and effort to succeed.
Should I take ECE 342 with ECE 343

Relevancy:

ECE 342 and 343 provides fundamental concepts for IC circuits. ECE 343 is designed to complement the materials covered in 342 where students can exercise these materials through Cadence PSpice simulation. ECE 343 starts off with basic circuits like CMOS inverters and ends with a CMOS Op-Amp. Students who take 343 along with 342 will usually have a better understanding in 342.

Workload:

Taking 343 along with 342 doesn't add too much additional workload to students schedule. The lab is splitter into four projects with each one consists of multiple phase. Students will be using PSpice to simulate circuits as well as actual bench tests to retrieve datas. Lab reports are due at the end of each projects so students will have roughly two to three weeks to work on it. It is encouraged for students to work on these reports on a per phase basis as the lab report could get very complicated and time consuming.

Recommendation:

Anyone with an interest in circuit designs should take these two concurrently as they enforce both theoretical and physical concepts. ECE 343 provides actual circuit simulations allowing students to observe how the circuit reacts to certain parameter while ECE 342 covers the theoretical concepts of MOSFET, BJTs, and other circuit components. The experience in 343 can help students prep for ECE 483 (Analog IC design).
Should I take ECE 385 with ECE 391?

Relevancy:

Both courses are important upper-level Computer Engineering courses, though ECE 385 is about the hardware whereas ECE 391 is about the software; the courses have some overlap in concepts in that both talk about how to interface with different devices, though 391 does it from a software/driver level and 385 does so from the hardware perspective; however, the courses cover mostly topics that are at best tangentially related. Taking these courses together builds a great understanding of the hardware-software interface; ECE 391 and can help with ECE 385 in that by understanding how the software uses the hardware will make it easier to design easy to program software-hardware interfaces (e.g. for the ECE 385 final project). Having said this, both courses work very well when taken independently, and it fairly common to take ECE 385 before ECE 391.

Workload:

Both courses are very time-intensive. ECE 391 has 3 MPs throughout the semester, but they are all fairly large projects - even the fastest students often spend 20 hours a week on these MPs. ECE 385, on the other hand, is typically about 10 hours of work per week, since each week you have to design and build the circuit for the next lab and finish your lab report for the previous week's lab; both these classes can take significantly more time if you are not good at debugging your MPs & digital circuits. The main thing to know, though, is that you'll be spending at least half your time on labs & MPs if you take these classes concurrently.

Additionally, both courses have open-ended final projects. 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 ECE 391's MP3, which is a group MP in which students get to design their own Unix-like Operating System.

Recommendation:

The combination of these two courses is very difficult mostly because of the time commitment each course involves. 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. The final projects in each class 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. However, if you did very well in ECE 190 (Introduction to Computing Systems) and ECE 290 (Computer Engineering I), you may be up to the challenge; if you love hands-on projects, the high time commitment from these classes may even be somewhat enjoyable. If you do decide to take on the challenge, be sure to find a good lab partner for ECE 385 and a good group for ECE 391's mp3; without these, both courses will be significantly more time consuming.

If you are still thinking twice about taking these courses together, a good alternative would be to take ECE 391 and a technical elective (there are a lot of CompE tech electives you can take after ECE 190, ECE 290, and CS 225 (Data Structures) which aren't huge time sinks). Why not take ECE 385 first, you might ask? Well, there are many classes that depend on ECE 391, whereas almost none require ECE 385. If you are really interested in digital hardware, ECE 411 (Computer Organization and Design) is really the must-take course - which, strictly speaking, doesn't have ECE 385 as a prerequisite.
Should I take ECE 453 with ECE 459?

Relevancy:

Both ECE 459 and ECE 453 serve as mid-level courses for communication systems. Material in ECE 459 covers basic signal and linear system analysis, basic modulation techniques such as linear modulation and angle modulation, random processes based on statistics knowledge, and some topics related to digital communication such as data transmission in noise and signal noise ratio. Basically, ECE 459 is more related to ECE 310 (Digital Signal Processing) and ECE 313 (Probability with Engineering Applications), which requires background knowledge of math techniques. On the other hand, ECE 453 is more based on ECE 329 (Fields and Waves 1) and ECE 342 (Electronic Circuits), so it can be considered as a circuit course. Although ECE 453 mentions modulation, it puts more of an emphasis on RLC networks, oscillators, matching networks and 2-port parameter analysis.

Workload:

Both ECE 459 and ECE 453 have moderate workloads. ECE 459 has homework due every week, except the week of the midterm; these usually consists of 4 to 6 problems. Expect to take 5-8 hours to complete the ECE 459 assignment every week. For ECE 453, Professor Franke always assigns several problems each week; however, he only collects 2-4 problems each week, so it is not as time consuming. The homework for ECE 459 is due on every Thursday and the homework for ECE 453 is due on every Wednesday. Therefore, there will not be a big conflict for the homework of these two courses as long as students manage their time well to complete the assignments. Both ECE 459 and ECE 453 have two midterms, with ECE 459 midterms being earlier than the midterms of ECE 453. For both courses, the midterm will test how well you have understood the materials in lecture and homework.

Recommendation:

Even though these two courses are not highly related, taking these courses together works well since each will help you understand the other. Students who are interested in studying communication systems are especially recommended to take both courses; taking them concurrently is a reasonable thing to do. While ECE 453 provides basic circuit understanding for ECE 459, ECE 459 gives students who are taking ECE 453 necessary background math techniques for solving problems. For students who are planning to take these two courses together, completing ECE 310, ECE 313, ECE 329, and ECE 342 before these two courses may be useful because these courses will provide necessary background knowledge for ECE 453 and ECE 459. Students who are interested in signal processing and circuitry are also recommended to take these two courses because ECE 459 is related to ECE 310 and ECE 453 provides knowledge for designing RF circuits.
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.
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.
MCB 150 - Molecular and Cellular Basis of Life

Instructors:

Brad Mehrtens 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.
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.
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.
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.
MCB 252 - Cells, Tissues, and Development

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.
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 once you have the prerequisites. ECE students aren't required to take any TAM (Theoretical and Applied Mechanics) classes like students in 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's 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.
- 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.
- 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.
MATH 424 - Honors Real Analysis

Instructors:

This class is typically taught by professors who have an interest in Analysis. In recent years, it has been taught by Professors Tyson, Erdogan, and Reznick.

Prerequisites:

The official prerequisites are an honors section of MATH 416 or an honors section of MATH 347, and consent of the Math department.

When to Take It:

This class is taught every Fall. Most of the students in it are juniors or seniors in Mathematics, but a few are Engineering majors. This class involves a lot of hard proofs, so you need experience at least equivalent to MATH 347; MATH 221 (Calculus I) and MATH 231 (Calculus II) are also essential. If you don't consider yourself good at writing proofs, this class is not for you. Experience in other 400-level math classes, such as MATH 416 (Abstract Linear Algebra), is highly recommended. Some students take this class after MATH 432 (Set Theory and Topology), which gives them a headstart on the Metric Spaces section of the class.

Class Content:

This class covers all the theoretical aspects of basic Calculus; as an abstract, rigorous theory course, it is one of the hardest Math classes offered at the undergraduate level. It starts off with the field axioms and the construction of the real numbers - the only complete ordered field. From here, the class quickly dives into the theory of metric spaces (essentially, a set, and a distance function on that set), where most of the first half of the class is spent. Topics include open and closed sets, subspaces, compactness, sequential compactness, limits, continuity, uniform continuity, and convergent sequences. During this part of the class, the epsilon-delta definition of the limit is introduced in terms of open balls. One of the memorable homework problems involved proving that a metric space could be partitioned into the interior of S, the boundary of S, and the exterior of S (for an arbitrary set S in that metric space).

After rigorously covering metric spaces and basic limits, the class begins theoretical treatment of differential and integral calculus. The class briefly covers intermediate value theorem, mean value theorem and differential calculus, after which it dives into the theory of integration, rigorously defining the Darboux and Riemann integrals and proving many theorems about when they exist and ultimately the equivalence of these two types of integration. Taylor series are also studied rigorously, as are interchange of limit operations. If there is extra time at the end of the course, lectures may cover additional topics such as the convergence of Fourier series, the Weierstrass function (an everywhere-continuous, nowhere differentiable real-valued function), or the solvability of first-order differential equations (though this last topic is covered in MATH 441 (Ordinary Differential Equations)).

Work:

This class typically has weekly homeworks, which usually consist of about 5 problems, each of which require you to prove something. The difficulty of the homework varies, depending on how fast you can figure out the necessary steps for each proof - some problems may only take an hour, whereas the problems which you find more difficult could take up to 5 hours - it isn't uncommon to have a few problems that take most of the week to figure out. Many students find one half of the class to be harder than the other for them - this depends on the student's background. This class typically has a midterm and a final, which typically contain problems similar to those seen in class and on the homework. It is not unusual for the tests to have A averages, but this is probably because the class only contains students who want to be there.

Life After:

Many students in this class continue on in the Math honors sequence; the next logical class is MATH 425 (Honors Advanced Analysis), which covers multivariate analysis. Students who enjoyed the metric space portion of this class should consider MATH 432 (Set Theory and Topology). Additionally, many students go on to take MATH 428, the special topics honors course, or MATH 427 (Honors Abstract Algebra).
MATH 415 - Applied Linear Algebra

Instructors:

The professors who teach this course usually vary every semester. For the 2012 Academic Year, Professors Bergvelt, Carpenter and Muncaster had sections in both the Spring and the Fall. Every single instructor is highly qualified to teach the course. Some sections instruct with Mathematica, but these quickly fill up.

Prerequisites:

The only prerequisite for this course is MATH 241. This course deals entirely with linear systems, so advanced calculus is not explicitly needed. However, the geometric interpretations that are developed in Calc III are useful to visualize the concepts. Additionally, the linear transformations taught in Calculus are a great prelude to what this course is about.

When to Take It:

Although this is not a prerequisite, it is very useful to take this course before MATH 286 or ECE 210 since it will give you tools to quickly solve linear systems and provides you with an intuition of a system's behavior. Even though this course is a 400 level course, it is very doable for a second-semester sophomore. This course is required for many classes in ECE and CS that deal with graphics, robotics and linear system. Some classes that require Math 415 are ECE 490, CS 418 (Interactive Computer Graphics), CS 450, and ECE 470; if you plan to take one (or more) of these classes, you should take this class.

Class Content:

The course starts with solving simple multivariate linear systems and matrices through Gaussian Elimination, and a discussion of the existence of solutions for singular and non-singular systems. These concepts then are used to develop a geometric interpretation of all the possible solutions for a given system; which leads to the definitions for vector subspaces and the dimensions of the solution. The course then reinforces the concepts by approaching solutions in a direct algebraic manner as well. The algebraic approach is used to introduce concepts as the inverse and the determinant of a matrix. Several techniques, such as Graham-Schmidt, change of bases, projections and least squares approximations are taught and used to solve different types of linear systems. The course culminates with the introduction of eigenvalues, eigenvectors and diagonalization of a matrix. Time permitting, the course will apply these concepts to Single Value Decomposition to obtain more information about the system and its solutions from a single representation of the matrix.

Work:

There is weekly homework for the course that contains about 20 to 25 problems. So, it is a good idea to start the homework at least a few days before it is due. However, the assignments are fairly straightforward and do not take too much time. It is safe to assume that doing all the problems will take up to 2.5 hours per assignment. There are two exams and a final for the course, and the rest of the grade (slightly less than one midterm) comes from homework. The course grade breakdown for Fall 2012 is: 100 for each midterm, 200 for the final, and 80 for homework.

Life After:

The course is very useful for programming applications related to matrices and manipulating them, and therefore it provides good supplementary material for ECE 190 and CS 225. It is not required for lower level ECE courses, but it is a prerequisite for more advanced courses such as ECE 418, ECE 470, CS 418 (Interactive Computer Graphics), CS 450 (Numerical Analysis), and ECE 513.
PHYS 486 - Quantum Physics I

Instructors:

This course is taught by a few different professors in the physics department. Recently, the course has been lectured by Prof. El-Khadra and Prof. Dahmen.

Prerequisites:

The listed prerequisites for this course include MATH 285 and PHYS 214. MATH 415 is also listed as a co-requisite. A good understanding of calculus and differential equations is absolutely necessary to make any degree of progress in this course while knowledge of the basic principles of linear algebra will help with later parts of the course. While PHYS 325 is not listed as a requirement for this course, students are expected to have taken it by this point in their college career and references are made to it on occasion.

When to Take It:

For students working on a Physics major or minor, PHYS 486 is generally taken after PHYS 325 and 435. However, neither of these courses are necessary to understand the material. This, along with the prerequisites, tends to place the course somewhere in the junior or senior year. PHYS 486 is only intended to be taken as a prerequisite to PHYS 487; if you are looking to take only one course in quantum mechanics, you should consider taking PHYS 485 instead.

Class Content:

PHYS 486 starts off by discussing the basis of quantum physics, the Schrodinger equation. From here, the course continues to focus on this equation for the entire semester (and then continues talking about it all the way through PHYS 487). That being said, throughout the course students learn solutions to the Schrodinger equation for a large variety of situations ranging from the simple one dimensional, time independent infinite square well to more complex systems that can only be estimated by methods such as perturbation theory.

Work:

The material of PHYS 486 is presented to students in biweekly, hour and a half lectures. These are supported by weekly hour and a half discussion sections in which students work on various problems in groups of four; some semesters, there are quizzes in discussion sections. The bulk of the coursework consists of weekly homework assignments which are turned in to a drop box on the second floor of Loomis, and the quizzes, if any are given. While the difficulty and length of the homework assignments can vary significantly from week to week, students should plan to spend at least a few hours on each assignment. The remainder of the student's grade is determined by a single midterm and a final exam. The midterm exam is taken during lecture and, as one would expect, cover about half the material of the course. The final exam is cumulative, but heavily focuses on the material from the last half of the course.

Life After:

It is highly recommended that those who have taken or are planning to take PHYS 486 follow it by taking PHYS 487, Quantum Physics II. In PHYS 487 students will learn to apply the basic principles on quantum physics that they learned in PHYS 486 to more realistic situations, such as the hydrogen atom, by learning how to better approximate solutions that cannot be easily solved by analytic means.
ASTR 210 - Introduction to Astrophysics

Instructors:

ASTR 210 has in the past been taught by Professor Brian Fields, and has recently been taught by Professor Neal Dalal. All professors in the Astronomy department are passionate about their work, and Professor Dalal is no different, and is happy to help any student wanting to know more about the cosmos. There is generally only one graduate TA for the course.

Prerequisites:

From the Fall 2012 Syllabus:

"Credit or concurrent registration in PHYS 212 (University Physics: E&M). Students are expected to be familiar with mechanics (at the level of PHYS 211), vector algebra, geometry, and basic calculus."

Familiarity with PHYS 212’s material will make it easy for ECE students to relate the laws governing the movements of planets and the laws governing particles. If the formula for describing the force of gravity between two bodies is as of yet foreign to you, then finishing the required 200 level physics courses is advised.

When to Take It:

This course doesn't have any direct ECE applications, but for those students who have aspirations of working at organizations like NASA and SpaceX, having a deeper understanding of the nature of objects in space can be extremely beneficial. Taking this course as soon as possible is advised.

Class Content:

ASTR 210 is a heavily computational course. While the concepts of astrophysics are important to understand for this course, doing calculations to explain these phenomenons is essential. Homework tends to reflect this, while exams fall back on some concepts and far easier calculations.

Topics of discussion include:

• The View of the Night Sky
• Laws of Gravitation
• Orbital Energetics
• Tidal Forces
• Planetary & Stellar Nature, Composition, Formation, and Lifetime
• Kinds of Stars
• Black Holes
• Dark Energy

The course starts with phenomenon that occur close to Earth, then the Solar System, then on to bigger and bigger spheres of consideration.

In the past, practicums where students were required to view & collect data on the actual night sky were required, but recently (as of Fall 2012), they are no longer part of the course.

Work:

Professor Dalal has recently been tweaking the course's architecture, so this section may not accurately reflect this course in the future.

Currently (Fall 2012), all lectures are online on YouTube.com & for download from Compass2G. The amount of lecture material usually varies, but there is generally between 1 & 2 hours of material, split into several easily digestible sections based on content. Therefore, class is held only two of the three scheduled times, and these sections are dedicated to solving example problems, which generally reflect the kind of problems on exams.

Based on these lectures are small, 2-4 questions multiple choice quizzes on the concepts covered available on Compass2G. Two attempts are allowed, so it's easy to get 100% for each one.

As with most computationally based courses, there are weekly written homeworks with conceptual and computational problems, generally due on Fridays in class. These homeworks are generally short and do not require the same sort of time that homeworks in core ECE classes generally require. These homeworks are weighted between 45% & 50% of the course grade, so doing them is important for more than just understanding the material.

There are two in-class midterms and one final. In addition, for extra credit, students have been given the opportunity to do an extra credit computational project, worth up to an additional 20% of their course grade. For a more programming-minded ECE
student, this is an easy way to keep your C++ or MATLAB skills sharp and get some significant extra points.

In total, it takes 1-2 hours to watch the lectures and do the quiz and 2-3 hours maximum to do the homework, for a maximum of 5 hours a week outside of class.

Life After:

ASTR 210 prepares students for 300 & 400 level Astronomy courses; those that count as approved Non-ECE Tech Electives are:

- ASTR 404 - Stellar Astrophysics
- ASTR 405 - Solar System and InterStellar Medium
- ASTR 406 - Galaxies and the Universe
- ASTR 414 - Astronomical Techniques
- ASTR 450 - Astrochemistry

Additionally, there are occasional ECE courses that are oriented around Astronomical topics like satellites. Students interested in Spacecraft, Satellites, and what goes into building them should investigate the courses affiliated with the CubeSat Project, including Tech Electives and even a Senior Design Replacement Course.
PHYS 487 – Quantum Physics II

Instructors:

Prof. El-Khadra and Prof. Dahmen teach this course. They usually teach this course the semester after teaching PHYS 486.

Prerequisites:

The prerequisite of this course is PHYS 486. Besides that, students are expected to know how to do linear algebra, so MATH 415 should be taken as well. Students should also be very good at differential equations and calculus, as some of the problems in this course require a lot of skill in those areas.

When to Take It:

This course is the continuation of PHYS 486. Ideally, one would want to take it right after PHYS 487. Students who wait a long time before taking PHYS 487 will likely forget 486 course material and will have a hard time in the beginning of the semester. It is offered in both the spring and fall semesters, but not during the summer.

Class Content:

This course has more applications of quantum mechanics compared to PHYS 486. For the first few weeks the course focuses on many particle systems. Then, it focuses on degenerate perturbation theory and a few kinds of perturbation on hydrogen atom. After that, time dependent perturbation theory is introduced along with emission and absorption. The last few weeks are on quantum scattering.

Grading changes each semester. For spring 2013 grades are based on performances on the quizzes (35%), the midterm exam (20%), the final exam (30%), the checkpoints (10%), and discussion attendance (5%). Homework will count for extra credit. Up to 15% can be added to your score for homework.

Work:

This course has two lectures once a week and a discussion section. Both lecture and discussion sections are 1.5 hours long. Attendance is taken in discussion section and in some semesters quizzes are given in discussion. During discussion the TA will first give a short lecture to go over some important topics that have not been fully covered in the main lecture. After that, students will work on problem sets in groups. Homework generally takes 3-8 hours and is harder than 486 homework. The course material can be very hard to understand, so one might need to spend a few hours reviewing the course material per week. There is one midterm and one final exam. The final exam is cumulative but is weighted more towards the second half.

Life After:

This course prepares students for Quantum Mechanics at the graduate level; the next course in quantum physics is PHYS 580 (Quantum Mechanics I).
GE 423 - Mechatronics

Instructors:
The course has been taught by Dan Block who is also the lecturer for ECE 486

Prerequisites:
For this course it is recommended that you have taken a controls course and have had C programming. However there have been students that have taken this class without an equivalent controls class and still did well. C programming is a necessity as the labs heavily involve programming embedded devices with C.

When to Take It:
It is recommended that you take this class sometime your late sophomore year (For those with a good technical background) or later.

Class Content:
This particular class covers a variety of materials that range from basic I/O with embedded programming to making a robot with computer vision. A semi-complete list is shown below.

- Microcontroller Programming (MSP430 and Dual Core ARM/DSP hybrid chip)
  - Timers and Digital I/O Registers
  - Scheduling: Single Process Application, Hardware Interrupt Scheduler, Real-Time OS, DSP/BIOS Scheduler
  - Time Loading Diagrams
  - Priority Structure
  - Serial Communication
  - ADC and DAC Usage
  - Shared Memory & Cache

- Misc Hardware
  - Usage of Optical Encoder
  - PCB Design
  - Servo Motor Usage
  - Digital Compass Usage
  - Rate Gyro Usage
  - IR Sensor Usage
  - LADAR (Laser Range Finder) Usage
  - Ultrasonic Sensor Usage
  - Soldering and Prototyping
  - CMOS Camera Usage

- Controls Topics
  - Implementation of Dead-Reckoning
  - Coordinate Transforms
  - Dealing with drift from sensors
  - Landmark Finding
  - Kalman Filtering
  - Path Planning
  - Obstacle Navigation

- Vision Topics
  - Color/Brightness Following
  - Centroid Calculation
  - BAYER Format
  - Distance Finding
  - Landmark Recognition
  - Obstacle Recognition

- Misc Topics
  - Interfacing Robot with Computer and iPodTouch/iPhone
  - Using a "Retro" version of Visual Basic

Work:
It's a good deal of work requiring many hours of work outside of lab at times. Homework have hardware components that requires construction on your own time plus a written portion that focuses on math and theory is given as well. Mileage may differ depending on your technical skills.

Life After:
After taking this class you should be familiar with the above topics to the point where you can use them as tools for another project/problem. This class also teaches you how to pick things up fairly quickly and implement solutions to solve a variety of problems.
MATH 412 - Graph Theory

Instructors:

Professor Kostochka has taught this course for many years, and is a very good instructor. Currently, this course is being taught by Professor Stolee.

Prerequisites:

The official prerequisite for this class is MATH 347 (Fundamental Mathematics), MATH 348 (the advanced-composition version of MATH 347), CS 373 (Theory of Computation), or equivalent experience.

When to Take It:

It is essential that students going into this class understand the basics of proof-writing, which is taught in all of the prerequisite classes, since this class is fairly heavy on proofs. It would also be beneficial to have taken a class in discrete math beforehand, such as MATH 213 (Basic Discrete Mathematics) or CS 173 (Discrete Structures), though this is not strictly necessary. As a non-ECE technical elective, this class may be taken as soon as a student is ready for it; the only classes with it as a prerequisite are graduate-level math courses, so there is no rush to take it. This class is an excellent choice for students who enjoy reading and writing proofs and are interested in graphs. It has been offered every semester.

Some Computer Science students have chosen to take this class at the same time as CS 473 (Fundamental Algorithms); many of these students end up dropping this course, since both courses are fairly involved and focus a lot on graphs; unless you absolutely love graphs, taking the two courses together is not advisable.

Class Content:

The class follows the textbook (Introduction to Graph Theory, by Douglas B. West) fairly closely, covering roughly the first 6 chapters of the book. It starts by introducing undirected and directed graphs, covering how both are formally defined. Many basic concepts arising in graphs such as paths, walks, trails, and isomorphic graphs are covered. After the basic vocab lesson, the class jumps into proofs, starting with simple lemmas (such as all u,v-walks contain a u,v-path), and quickly building up to characterizations of bipartite graphs and Eulerian graphs (graphs with Eulerian circuits); many other basic but interesting theorems are proved, including theorems about triangle-free graphs and graphic sequences.

The class then dives into chapter 2 of the book, which focuses on trees and distances, covering characterizations of trees, their centers, Prufert codes, and minimum spanning trees. In chapter 3, the focus moves to matchings in undirected graphs - sets of edges where any pair shares no endpoints; both Hall’s theorem about matchings in bipartite graphs, and the more general Tutte’s theorem (about matchings in general graphs) are fully proved. Various other theorems relating sizes of maximal independent sets, largest matching, and maximal vertex and edge covers are also proved, and some other interesting results and extensions of matchings are also covered. From here, the class dives into connectivity with chapter 4. Various notions of connectivity are covered, as are some interesting characterizations of graphs with different levels of connectivity; following this, network flows are studied in detail, covering max-flow/min-cut theorem and the Ford-Fulkerson Algorithm for finding the max flow of a network.

From here, the next chapter covered is up to the Professor; in Spring 2011 we skipped chapter 5, and instead covered planar graphs (chapter 6); this involved many theorems about what graphs can and can’t be drawn without edges crossing in a plane; this included Euler’s formula relating vertices, faces, and edges, and several theorems relating planarity to the number of edges and vertices in a graph. After covering chapter 6, we finished the semester by going back to chapter 5 and talking about graph colorings - where each vertex is assigned a color which must be different from all the adjacent vertices; one of the key results here is that all planar graphs are 4-colorable; however, in class only 6-colorability or (time permitting) 5-colorability will be shown. The famous 4-color theorem was proven here, at Illinois, as one of the first accepted proofs requiring computer assistance.

Work:

This class is primarily a proof-based class, with the main objective being to get students comfortable writing proofs in discrete mathematics; the main workload, besides keeping up in lectures, is the weekly homework. The homework is typically 6 problems, of which students are allowed to choose to skip one. Occasionally there is a problem that requires you to draw some special graph and use some property of the graph to solve a problem (e.g. the De Bruijn graph), but most problems require proofs. Students who are good at proofs can expect to spend 5-6 hours a week on the homework; typically, the class has 12 or so homeworks, of which the lowest 2 scores are dropped. The textbook for this class is well-written and very helpful - reading it for a few hours a week is a good way to review. The class has 3 midterms and a final, though Professor Kostocha often offers a 4th midterm and drops the lowest of the 4 scores.

Life After:

Students who do enjoy this class may be interested in further 400-level math classes or further study in Graph Theory. For a more algorithmic approach to graphs, students should consider taking CS 473 (Fundamental Algorithms). The next step in the
Math curriculum for Graph Theory, though, would be 500-level courses in Graph Theory, such as MATH 581 (Extremal Graph Theory) or MATH 582 (Structure of Graphs).
CHEM 232 - Elementary Organic Chemistry I

Instructors:

Dr. Nicholas Llewellyn teaches this class; he is a helpful, approachable professor. This class is taught online, but he does have his own office hours. There are SI leaders (students who have done well in the class earlier) who have their own office hours. Everyone running the class is pretty helpful and knowledgeable.

Prerequisites:

CHEM 104 and 105, or CHEM 204 and 205. AP credit for these should suffice; not much knowledge of organic chemistry is needed before hand, the class itself reviews and goes through everything starting from the very basics.

When to Take It:

This course is part of the pre-med requirements and also required for a BIOE minor. The majority of people take it sophomore year, either in the fall or in the spring. Thus, if you take it as a sophomore, you’re more likely to have peers to study with. This course is a lot of work if you want to do well, so it is a good idea to do it earlier in your college career when you have more motivation. A lot of classes (biology related especially) build off of orgo, so it is a great starting point, especially since most other pre-med or BIOE minor courses will build off of material from this class.

Most pre-med/chem minor students also take CHEM 233 (Organic Chemistry Lab I) concurrently with CHEM 232, although some do take it the semester after 232. CHEM 233 doesn't overlap or parallele 232, although some of reaction mechanisms are ones you will learn at some point in 232. CHEM 233 isn't a part of the BIOE minor however, just the chemistry minor or pre-med sequence.

It is worth noting that Chemistry majors take a separate course, CHEM 236 (Fundamental Organic Chem I); credit is not given for both courses.

Class Content:

The course is split into 3 sections. The first one covers basic concepts about the building blocks of organic chemistry (period 2 elements, functional groups, isomerism), and then moves onto bonding and orbital theory. The second section introduces you to basic mechanistic steps: you will learn all of the basic steps that comprise organic chemical reactions (example: substitution, elimination, addition to alkenes, etc.) The third section then focuses on combining the basic mechanistic steps into typical reactions. You will study specific pathways in this section.

The first section (exam 1) is the most basic, although most students find the molecular orbital theory confusing. The second section (exam 2) is probably the hardest, and by the third section (exam 3), everything that you have learned should be coming together, so it should be clearer.

Work:

The workload is pretty heavy if you want to do well (heavier than CHEM 104/105); since all of the lecture videos are online, it is basically self paced. There are optional Problem of the Days (POTDs) that are HIGHLY RECOMMENDED. This is how you will learn the material basically: by doing the POTDs. There are weekly quizzes due on Monday nights. Discussion is also online, and also recommended; this is where you will go over POTDs. With all of the lecture videos, POTDs, weekly quizzes, and discussions, the workload is around 10-15 hours per week.

There are 3 exams and a comprehensive final, so you really need to know the material. There is a "final exam modifier," where if your grade on the final is higher than your total class grade after the final, that becomes your final grade. Example: if your final grade after the final is a B+, but you got a B+ on the final, you will get a B+ in the class as your final grade. However, you should do your best throughout the whole class, since the final is cumulative and you shouldn’t really depend on it. Just know that it’s there.

Life After:

This class should prepare you for future bioengineering courses, such as CHBE 471 (Biochemical Engineering) and CHBE 473 (Biomolecular Engineering), other chemistry courses such as CHEM 360 (Chemistry of the Environment), CHEM 312 (Inorganic Chemistry), and CHEM 440 (Physical Chemistry Principles), and any other classes where you will need to know properties of organic reactions/compounds, molecular bonding, orbitals, energy levels, and reactions.

If you like this class, you might like CHEM 332 (Elementary Organic Chemistry II), which is not required for a BIOE minor but is a requirement for pre-med students.
Math 446 - Applied Complex Variables

Instructors:
The instructors for the course vary by semester. Recent professors include Rosenblatt, Wu, Bradlow, and Berndt.

Prerequisites:
The only prerequisite for the course is MATH 241. One should feel comfortable with calculus in general going into the course; use of just about every core topic will show up (differential and integral calculus, series). Minimally, one should be able to quickly take partial derivatives of large functions without error, as well as understand partial fraction decomposition, path integration, and Taylor series.

When to Take It:
This course is offered every semester. Taking it anytime after MATH 241 is acceptable. The only requirement is being comfortable with calculus. It will offer deeper insight into several topics covered that appear in ECE 310 (specifically, bilinear transforms and z-transforms as a Laurent series). However, the related content in 310 is presented from an applied standpoint, so much of the theory is skipped and therefore it is not necessary for success -- taking it before, after, or concurrently is acceptable. Additionally, MATH 446 is listed as a officially suggested technical elective for the electromagnetics, remote sensing, signal processing, communication systems, control systems, microelectronics/photonics, and circuits subdisciplines.

Class Content:
At the heart, this is a calculus course -- but with complex variables instead of real variables. The topic progression is very similar to that of the traditional calculus sequence. The complex analogs of differential calculus, integral calculus, and series are presented and contrasted to their real variable counterparts. Time is also spent covering the calculus of residues, an important result concerning integration around isolated singularities that is commonly used in engineering. Lastly, conformal mapping is covered, which is another topic that frequently appears in engineering (examples include the bilinear transforms that appear in digital filter design, and the Smith Chart).

Work:
The workload can vary depending on the professor. However, past semester homework loads typically include weekly sets of 10-15 textbook problems evenly divided between calculation problems and guided proofs taking anywhere from 3 to 5 hours. The textbook is rather helpful, and reading it will augment the lectures nicely. Additionally, many of the assigned problems have partial answers in the textbook to help you. Exams are generally a race to the finish line, and favor quick application of the techniques learned along with simple proofs -- when you can do problems quickly and accurately, you are ready for the exam.

Life After:
The class isn't a hard prerequisite for any ECE core or elective course. The content and techniques learned are fundamental to the complex number system and will show up in any technical course that uses complex numbers at the calculus level. As mentioned above, several digital signal processing concepts (mostly those taught in ECE 310) utilize techniques rooted in complex analysis and apply them in digital filter design.
GE 420 - Digital Control Systems

Instructors:

The course has a lecture and a lab portion. The lecture has been taught by Prof. Stipanovic while the lab portion is taught by Dan Block.

Prerequisites:

The listed prerequisite is GE 320 (Control Systems); however, you are not required to have taken this class in order to perform well. It is recommended to have knowledge in analog and discrete signal processing as well as C programming. For the lab portion, you will be working with a balancing robot, which relies on C programming done in Code Composer. In addition, the root locus and Simulink tools of Matlab are introduced and used to implement the design of your controller. No prior experience is needed in Code Composer, but it would be helpful to know some Matlab beforehand.

When to Take It:

It is recommended that you take this class sometime your junior year or later. You need to have taken at least ECE 190 (Introduction to Computing Systems) (or equivalent) and ECE 210 (Analog Signal Processing). It would also help to have taken ECE 310 (Digital Signal Processing), but it is not necessary. Taking ECE 486 (Control Systems) would also help your understanding.

Class Content:

This class covers digital control systems with a review of analog control systems, which should be covered by the prerequisite (GE 320). The lecture will teach you tools learned in discrete signal processing, such as z-transforms, ADC/DAC, and transfer functions. In addition, you will learn the theory and techniques for control of dynamic processes by digital computer; linear discrete systems, digital filters, sampling signal reconstruction, digital design, state space methods, computers, state estimators, and laboratory techniques. Also, you will learn how to design a controller, which will be implemented in the lab portion. The types of controllers that you will work with are proportional, proportional integral, proportional derivative, and a combination of proportional integral and derivative. You will be using Code Composer to learn about scheduling, ADC, DAC, and DSP/BIOS scheduler.

Work:

For the lecture portion, you will be assigned a homework assignment every two weeks or less, which are straight forward and provide practice over the design concepts covered in class. The lab assignments are assigned almost every week, but some last for two weeks except for the final design lab assignment. Each lab teaches you a portion of the final design, which is to design the controller for a robot to balance a stick upright. Although most of the labs can be finished within the lab period, you are allowed to work on your project at any time during the week.

There are two exams: one in-class midterm and a comprehensive final exam. The midterm is open notes and open book. You can also use your laptop to access notes, but internet is not allowed. The final exam will be take home and thus open notes/book as well.

Life After:

After taking this class, you will be familiar with design discrete controllers, which have the same applications and concepts as an analog controller. An option would be to take ECE 486 (Control Systems), if you want to focus on control systems. Another possibility would be to take ECE 420 (Embedded DSP Lab) to learn more about coding and embedded systems.
Math 423 - Differential Geometry

Instructors:

Jeremy Tyson, E. Lerman, P. Albin have recently taught the course.

Tyson is an excellent lecturer for the course both in terms of planned out lectures and on the fly responses to questions. He has excellent knowledge of the course material, which is in his field of research. Clear and engaging.

Prerequisites:

Prerequisite is MATH 241 - Calculus III.

The course indeed requires vector calculus topics of the prerequisite. Do not attempt to circumvent. Techniques of differential equations are not required for computation in the class, but are useful for understanding proofs of theorems and general understanding. Besides Math 241 knowledge the required machinery is taught in the course.

When to Take It:

Offered Fall only

It is suggested to take this course after differential equations. The course offers enhanced insight into geometrically sophisticated coursework but the techniques of the course have not been directly applicable to any courses this author has taken (physics, math, CS).

Class Content:

General topics in order

- Calculus on Euclidian Space (new topic differential forms)
- Frenet Frame (describes how curves bend in space)
- Operations on surfaces and between surfaces
- Shape operator, Gauss and mean curvature (describe how surfaces bend in space)
- Theorems based on knowledge of previous

Applications: determine properties of surfaces, graphics

Use of course machinery is easy, proof of machinery is hard. Material is interesting but hard to apply in engineering.

Work:

The course has 3 one hour lectures per week. The books is fairly useful but lectures cover all material. There were quizzes (about every 2 weeks, not difficult) which were announced a few days before hand. There were 2 exams and a final. The homework consisted of computation using the machinery developed in class and in the text as well as proof of theorems. The homework usually was low in volume but required an 'insight' and could vary in time to completion from 30 mins to 5 hours. The exams were significantly more difficult than the homework or quizzes.

Life After:

This course gave enhanced understanding in CS 418 (CSE 427) - Interactive Computer Graphics. The specific computational techniques have not been useful to this writer in other courses, but the intuition is valuable. The computational machinery developed in this course would be necessary for research in geometry.