An independent guide to
Interning in the Financial Industry
Interview with Prof. Gary Eden
Developments in iFoundry
Selling Yourself to Graduate Schools
ECE course guide additions and updates

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Issue #3, Spring 2011
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About the Cover

The conglomerate of numbers in “ECE” on the cover represents the main courses taken by electrical engineers (E), computer engineers (C), and both (E). Special thanks to a Spring 2011 HKN initiate group for the idea. The connected buildings on the diagram represent the physical ECE neighborhood, looking forward to a new ECE building that is still not fully funded.
From the ECE Department Head

Dear Readers,

I am delighted with the opportunity to contribute to the Spring 2011 edition of Dr. Everitt’s Neighborhood. In this article I would like to reflect upon two things pertinent to this guide, which is produced by the student members of the Alpha Chapter of the Eta Kappa Nu (HKN) electrical and computer engineering honor society.

The first one concerns the name of the guide, “Dr. Everitt’s Neighborhood.” The second concerns the guide’s objective of bringing the students’ perspective to the ECE Illinois experience. As it happens, both considerations are intimately related to the bold prediction about engineering education in the 21st century, articulated by Dr. Everitt himself exactly 50 years ago. Let me explain.

In the article, Engineering Education – Circa 2012 A.D., which was written in 1961 and published a year later in the Proceedings of the IRE, Professor William L. Everitt, then Dean of the College of Engineering at the University of Illinois at Urbana-Champaign, predicted—with inspirational vision and remarkable foresight—that “Engineering will be acknowledged as the most learned profession by 2012 A.D.”

With the certainty of an unswerving optimist, the confidence of a perfect judge of human talent, and the boldness of a visionary leader, Dean Everitt articulated in that article the education and training that 21st-century opportunities and challenges will demand from its engineers. In addition, in that article, a reprint of which appeared in the August 1999 issue of the Proceedings of the IEEE (Digital Object Identifier: 10.1109/JPROC.1999.775423), Dean Everitt predicted with remarkable accuracy how state-of-the-art electronics, computing and communication technologies in the early part of the 21st century will revolutionize information gathering, processing, and accessibility, and, through them, transform the way we train and educate engineers.

Our HKN students could not have picked a better name for this guide. The sense of close community conveyed by the word “neighborhood” and the aspirations to excellence stemming from Dr. Everitt’s name, remind us of our duty, as members of the ECE Illinois community, to contribute to the cultivation and advancement of an environment conducive to outstanding scholarship and engineering innovation.

Neighborhoods depend upon the collective involvement of their members for their well being, their stability and their prosperity. Thanks to the rich talent and international constitution of our community, our Department is uniquely positioned to demonstrate the importance of brightening the education and training of future engineers through a multifaceted prism of the multi-cultural global perspective of societal needs and challenges. To be successful we need each and every member of our neighborhood engaged and committed to this objective. Dr. Everitt’s Neighborhood inspires the requisite level of engagement and commitment.

Next, I would like to turn to the objective of the guide. As stated on its home page, the guide’s “philosophy is that it is important not to simply repeat the department’s published information, but to supplement it by adding students’ perspectives.” In this manner, the guide becomes an “Independent Guide to ECE at Illinois,” consistent with Dr. Everitt’s prediction that the student would “… assume more responsibility for his own educational development than was common in the first half of the twentieth century.”

Our students’ willingness and initiative to critically review and discuss their experiences as members of the Department is both elating and reassuring. Critical review and open deliberation of propositions, practices
and processes that impact mankind are the essential ingredients for the responsible and ethical practice of the engineering profession. Given the escalating pervasiveness of technology in everyday life, the open and informed deliberation of any new products, new services, or new practices enabled by engineering innovation is now more critical than ever.

The objectives of Dr. Everitt’s Neighborhood are consistent with the spirit of transparency and informed deliberation that must guide the practice of the engineering profession. More importantly, they inspire our students to complement their engineering education with educational experiences from the humanities and the social sciences that will inform their understanding of how technological innovation influences mankind’s path to the future and nurture their ethical pursuit of new knowledge and engineering innovation. As Dean Everitt anticipated in his 1962 article, in the 21st century “the importance of emphasis on the humanities and social sciences will be recognized from the grade school on through the highest levels of engineering education, as society relies more and more on engineers for leadership in business and affairs of state.”

I look forward with anticipation and excitement to the future issues of Dr. Everitt’s Neighborhood. I hope that in the years ahead an increasing number of our students will take advantage of the opportunity to contribute to its objectives and, through their contribution, benefit their fellow students, provide useful feedback to the Department and, most important, forge their leadership skills through the fire of open deliberation.

ANDREAS C. CANGELLARIS

M. E. Van Valkenburg Professor of Electrical and Computer Engineering
Department Head of Electrical and Computer Engineering
What is Dr. Everitt’s Neighborhood?

Purpose

Dr. Everitt’s Neighborhood is an independent, student-run guide intended to provide all sorts of useful knowledge about life as an ECE student. Our philosophy is that it is important not to simply repeat the department’s published information, but to supplement it by adding students’ perspectives. At the same time, we work closely with the department to ensure that Dr. Everitt’s Neighborhood is as useful to them as it is to the students.

Disclaimer

Engineers thrive on the fact that there is always more than one way to do something well. Accordingly, some of thoughts and suggestions expressed in this guide, while respectful, are different from the ones you will hear from the advising office. We encourage you to make your own judgment based on advice from several sources, such as this guide, the advising office, professors, professionals, alumni, friends, and upperclassmen.

In addition, various ECE student organizations offer services that give such advice to students. For example, each semester, IEEE offers a “Gripe Session”, in which IEEE collects student opinions on various courses and communicates these opinions to the ECE department. HKN and the ECE Student Advisory Committee (ECESAC) usually offer peer advising services at the beginning of each semester and around class registration time, respectively.

Getting Involved

Dr. Everitt’s Neighborhood is an independent resource written for ECE students, by ECE students; under the oversight of Eta Kappa Nu, the ECE honor society; and with the support, but minimal involvement, of the ECE department.

Ultimately this resource is what you, the fellow ECE student, make of it. It may help you choose courses, research interests, learn more about professors and their personal and professional interests, stay informed on student opinions, etc. Accordingly, this resource lives on the feedback and ideas of the students in ECE.

If you can think of other articles or features to include, we want to know, and if you want, you can even help write them.

If you would like to get involved with this guide, please contact Sumit Dutta at sdutta3@illinois.edu.
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Dr. Everitt’s Neighborhood: Features
Apply for internships and full-time positions at http://microsoft.com/university
An Internship Experience in the Financial Sector

Learn from EE senior ANDY KONG about his entry into the financial industry!

Key Facts

- **Company**: JPMorgan Chase
- **Where**: Chicago, IL. Other interns were also located in New York (majority), Ohio, Florida, and Texas
- **When**: Summer 2010
- **Most exciting feature**: Working with colleagues from across the world on a daily basis
- **Salary**: Comparable to other financial sector internships
- **Job description**: Computer programming

How I Got This Internship

This past summer I interned with JPMorgan Chase in downtown Chicago. I applied for the internship on Engineering Career Services’ Symplicity job board. Interested in a technical position, I applied for the Technology Analyst Intern position. When I applied for this position, it automatically placed me into consideration for the three main entry-level technology roles offered at JPMorgan Chase. They are the Application Development Analyst, Application Service Development Analyst, and Business Systems Analyst positions.

The Application Development Analyst role was the position I was placed into last summer, and it is the bank’s main computer programming role. According to my colleagues at JPMorgan, Application Development Analysts are the most highly sought of the three entry-level technology roles. The Application Service Development Analyst role is more service- and support-oriented. Analysts in this role would perform tasks like installing, maintaining, monitoring, and troubleshooting applications and computer systems used by the bank. Finally, the Business Systems Analyst role is to assess and acquire the bank’s business requirements. This role is vital to ensuring that technology can be accurately created, implemented, and maintained to support the bank’s products. While the specific technical skills I have learned in my ECE classes are not generally used in these roles, the general problem solving and critical thinking skills I have obtained in these courses helped during my internship.

I interviewed with JPMorgan Chase in early February 2010. My interview was mainly behavioral with some focus on computer programming topics. The technical questions were not overly difficult for an EE major, but my CS 225 experience and prior IT internship with a small company definitely helped with my interview performance. Fortunately, JPMorgan Chase holds only one round of interviews to select interns, which is uncommon for most companies. By not having to visit JPMorgan Chase’s local office, I was able to focus on my studies. The tradeoff is that I could not learn more about the company before starting work there. I maintained contact with my interviewer after the interview, starting with sending a thank you email within 24 hours of the interview. I received an offer from JPMorgan after about a month. I subsequently accepted the offer and began my internship in mid-June. The company reputation and close location to my home factored in heavily in my decision to accept their offer.

The Internship

The official description of an Application Development Analyst is the following: “You will design, develop, code, test, debug, and document programming applications to satisfy requirements of one or more user areas. You will translate business and technical requirements into technical application specifications.” I can definitely state that I participated in every aspect listed in the description of the position. I spent the first two days in corporate training sessions to get used to the overall company. After the corporate training sessions, I was introduced to my immediate team. I began acquiring the necessary resources for me to complete my assigned project. This included meeting many new people who are subject matter experts in the fields related to
my project. My main project over the summer was to data mask a test environment’s database in order to reduce risk. My immediate manager collaborated with another manager, giving me a paired programming internship experience. Another intern and I assisted each other with our respective projects. It was a very interesting experience in that I had a large number of meetings for both my project and my fellow intern’s project. I would say the biggest challenge during my internship was managing my time between gathering requirements and updates in meetings, learning about the company, learning the necessary technical skills like a new programming language, and attending corporate intern activities. The corporate intern events were a good opportunity to interact with other interns in the Chicago area and even upper management through programs like the senior speaker series. Overall, my internship experience was both enjoyable and challenging. It was definitely a worthwhile part of my career.

After the Internship

At the conclusion of the internship, I interviewed for a full-time position with JPMorgan Chase at the Chicago location where I worked. This full-time interviewing process is available to all high performing interns who are expecting to graduate by the following summer. This interview and my internship performance convinced my recruiters to extend me a full-time job offer at my desired location. I accepted this offer.

How You Can Apply for Financial Internships Like This

While online job boards in general may seem like a black hole, Symplicity is the exception because employers know that only top-notch UIUC students are in that database. You can apply for the JPMorgan Chase internship by logging into the ECS’s Symplicity job board and searching for “JP Morgan Chase” jobs. The main prerequisites are a 3.2 or greater GPA, knowledge of a common programming language (C++/C#/Java), strong leadership skills, and a desire to work in the financial sector. Exact prerequisites are specified in the job postings. On a side note, a majority of internships in industry require at least some computer programming knowledge. While ECE 190 is a programming class, taking CS 225, data structures, is invaluable in acquiring that first internship or full-time job. Much of JPMorgan’s newer software is developed in C# and Java, so having knowledge of these languages would be beneficial to interested applicants.

It is vital to have strong leadership skills to be successful in a financial internship. Large corporations like JPMorgan Chase require their individual employees to take initiative to get projects completed. I sought out colleagues and resources without having to speak with my manager every time. In addition, you must have a strong desire to use technology to help better the financial institution’s products and processes. Understanding the line of business you are working in definitely helps you gain a better perspective about the projects you are given and about how you are helping the company as an individual. During an interview, displaying strong leadership skills and a desire to work in a financial setting are as important as knowing the necessary technical skills.

If you would like to apply for the JPMorgan Chase internship, you should be aware that JPMorgan Chase recruits interns early in the spring semester of every academic year. I applied for the position over the winter break, and their interview was the first interview I had that spring. While interested applicants should meet JPMorgan recruiters, they should not wait for the recruiters to show up at the career fair to apply for the internship position. It is usually too late by then. For the University of Illinois, JPMorgan Chase usually recruits interns for the Chicago offices and not the New York offices. If you are interested in a New York position, you can try to reach out to a recruiter before the application deadline to see if you can be considered for a New York position.
Can you briefly tell us about your childhood, teenage years, and college experience?

I was born in Washington D.C. and raised in suburban Maryland. My father worked for the Bell System, which was part of AT&T. He was the one who introduced me to electronics. After World War II and even into the early sixties, there was a considerable amount of electronic equipment available as surplus and my Dad would bring home old radar systems and other electronics. They weren't functional, but they exposed me to basic circuits and components. When I was 10 or 11, a friend introduced me to amateur radio. His father was an amateur radio operator, and I had never heard of anything like that. My friend took me to the basement of his home where his father had a radio station. I recall one evening when his Dad was talking to someone in Europe. Today, it is difficult to appreciate what that meant to me because we didn’t have cell phones at that time and international phone calls were extremely difficult and expensive. This experience completely overwhelmed me as a young person. I decided to spend the next 6 months learning everything I could about amateur radio. I learned subjects like Morse code, which was required for a license. Over the next several years, I obtained several radio operator licenses from the Federal Communications Commission (FCC) and spent my teen years learning about antennas and transmitters. Amateur radio had a big impact on me.

So Why ECE Illinois?

For my undergraduate work, I went to the University of Maryland at College Park because I received a scholarship from the Maryland State Senate. I came from a large family, and my parents weren’t able to assist me financially in school. When I was an undergraduate, I worked in Electrical Engineering research laboratories fixing electronic equipment. My background in amateur radio helped me to fix oscilloscopes and power supplies. The school paid me on an hourly basis and I used the income to pay for tuition and books. When I was close to graduation, I wanted to go to one of the best schools and Illinois was ranked number 2 or number 3. In December of 1970, my future wife and I visited Illinois because of a conference that was being held on the campus. The conference was attended by several University of Maryland students; and, during the conference, I took my wife-to-be to Everitt Laboratory. When we walked through the building and saw the laboratories, I was overwhelmed. I looked at facilities on the engineering campus and decided that Illinois was the place I wanted to be. This was one of the best decisions I made in my life. After applying for admission, I was offered research assistantships in several laboratories and so I talked to several professors. I knew close to nothing about lasers, but was excited about the opportunity. That’s how I came to do my graduate work at Illinois.
What are some of your experiences working in the research laboratory as a graduate student in lasers and optics?

After considering the possibilities, I decided (and a difficult decision it was) to work under the guidance of Profs. Verdeyen and Cherrington in the field of lasers. When I was a graduate student, my current lab was called the Gaseous Electronics Laboratory, but it is now known as the Laboratory for Optical Physics and Engineering. The lab is located west of Wright Street in Champaign. When I was nearing the completion of my doctoral thesis, I received an award from the National Research Council, a postdoctoral research associateship at the Naval Research Laboratory in Washington, DC. I accepted the award and was fortunate to arrive there in the fall of 1975 just as a number of lasers were being discovered. Those lasers turned out to be the dominant lasers in the ultraviolet spectrum, which are used in a wide variety of applications. One application is LASIK, the eye refractive surgery procedure that corrects vision with an ultraviolet laser. These lasers are also used in all state-of-the-art lithography systems, VLSI, and other circuit fabrication processes.

What kinds of research are going on in this area?

Our traditional strength has been in laser physics and the discovery of new laser systems. We are happy to say our lab has discovered about a dozen laser systems because of our bright graduates and post-docs. We have performed experiments with which we study the basic atomic and molecular physics that occur in lasers. Our goal is optimizing that system and using that information to develop new sources of light. Over the past 15 years, we have done a lot of research in what is called ultrafast laser physics, where we use short laser pulses son the order of 100 femtoseconds or $10^{-13}$ seconds. These pulses are used in the same way that a strobe light is used at a party. Strobe lights have the effect of making dancers (for example) appear to be frozen in time. A flash of light is short compared to the time for any motion a person might make, so it appears as if the dancers have stopped. We do essentially the same thing in my laboratory, but literally 10 million times faster. We can actually make the motion of atoms and molecules appear as if they have stopped. We can observe very detailed interactions between atoms and molecules that were not possible in the past. The third area that we have devoted an increasing amount of effort to is microplasma devices. In this research, we devised ways to trap plasma inside cavities and make large arrays of these plasma-containing cavities. Not just one, but thousands of them. We do a number of things other than the projects I mentioned, but that’s a pretty good description of what we do.

You are the co-founder of a startup called Eden Park Illumination. Could you tell us more about that?

The company, Eden Park Illumination was a direct outgrowth from research done in our laboratory in 1996. I believe it was the first time our lab demonstrated micro-plasmas. Our first micro-plasma results were very crude, but we were amazed at the properties of the plasmas and knew the studies were definitely worth the subsequent refinement. We devoted enormous amounts of energy and time to fabricating what we call microcavity plasma devices in a wide range of materials including glass, polymer, and even aluminum foil. We succeeded in making large arrays of these that carry a great deal of light. My partner, Professor Park, and I talked about forming a company for several years. We were approached by investors and formed the company in April 2007. We started with our first employee, Jeff Putney. We started at the University of Illinois Research Park, at the incubator facility called EnterpriseWorks during the summer of 2007. About a year and a half later, we moved to northwest to North Country Fair Drive in Champaign, and that is where the company is now. We encourage anyone to stop by.

Out small business has 15-20 employees. The facility is about 6,000 square feet. Presently, we are manufacturing lamps that are thin, flat, and incorporate an array of microcavity plasmas. The standard size is 6 by 6 inches square. We are excited about this technology because we think it is an answer to the number of lighting needs that industries have had for many years. When the arrays are fully packaged, they are less than 4 millimeters in thickness. We can probably make them more than a third of that fairly easily. The weight of one of these squares that we call a light engine is less than 200 grams, and we think we can cut that by a factor of 3. They are so light that a five-year-old can throw one as though it were a Frisbee. We are also pleased that they are completely non-toxic. They contain no mercury, unlike fluorescent lights. The arrays are mostly glass and aluminum. The recycling processes for glass and aluminum of those materials are the most highly developed of any material, which was important to our design. We are hoping to go into full production in 1-2 years. Thus far, we only have had limited production runs from 100 to 200 lamps at a time.
Are you looking to replace all the fluorescent lights?

We would hope to eventually. Our goal at the moment is to make an impact on the lighting market, which is very large. In the US, the market for just the lamps is about 15 billion dollars as of 2 years ago. If you include the market for fixtures in which the lamps are mounted, the figure roughly doubles. The world wide market for lighting is over 100 billion dollars. Our goals are more modest than replacing whole lighting certainly in your time, but we think it offers lighting architects technology that they did not have access to before. We are very excited about the possibilities.

We believe that the day will come when you will tell your grandchildren that you remember when lights were round tubes made out of glass and put in bulbs.

Tubes and bulbs don’t make sense from a fundamental perspective. It’s driven by technology. Edison told the glass blower that he had to have an envelope for his filament. What would a glass blower blow? A bulb! It’s how it works right?

From a fundamental perspective, flat lighting is versatile. You could put it on top of a table if you want. You can place flat lamps under the bottom side of the table. You can light the floor, you can light the walls. Most of our lighting is associated with the ceilings and I think that is going to change as well. I think we are going to see more wall affixed lighting. The intensity will be lower because that’s the way natural lighting works.

Are there any undergraduate opportunities in your area?

Absolutely! I worked for the university for 32 years, and throughout that entire time, we have enjoyed having undergraduates in the laboratory throughout that time period. We have had several undergraduates in the past and they have done a great job. They bring a dimension to the lab that simply does not exist if you only have post-docs, graduate students, and faculty. Graduates students have been researching for a while and it is more like a job to them. Undergraduates have never seen this technology so they have more of a “Gee Whiz” reaction to it. A beam of light comes out of a laser, and undergraduates say “Wow, that’s really neat.” We are always looking for enthusiastic top students in our laboratories.

What kind of courses would you expect the student to have taken to work in your lab?

In truth, students don’t really need to have a certain amount of coursework before they work in the lab. We’ve had many freshmen start in our lab and work all the way through, not only until they graduate but many elect to go to graduate school and stay in the lab. If they happen to be further down the road, we recommend that they take a good number of courses in electromagnetics. I teach an introductory course in lasers called ECE 455. There is also a nice laboratory class, called the optical communication system laboratory (ECE 466). There are a number of excellent courses that Professor Carney, Professor Boppart, and Professor Coleman teach. The university offers a lot of great courses, but a student starting in the lab need not wait until they have all of that background because then they will become a senior and have less time to accomplish something.

About how many semesters would you expect a project under you to complete?

That’s a difficult thing to say. I usually tell incoming undergraduate students that I am happy to pay them to wander around in the lab and chat with different graduate students over coffee to find out what they do. I find that that’s a lot better than giving something to the student. I have given projects when a student prefers it, but most of the time, the best point of entry is simply to start working with a graduate student whose work just thrills them. Then they can move from there to other things as they gain new knowledge. They begin to understand what the laser is, how it functions, and what could be done with it. Then they can move from there. So those are the students who have been with us for a while. They see something that fascinates them, and I’m pleased to give them the equipment and supplies they need for their research pursuits.

Are there any weekly or hourly requirements to work in your laboratory?

I really don’t have one. We tell students if they are not able to devote at least 5 hours a week, it is really difficult for them to make progress because too much time goes by between their afternoons in the lab that it is
My family is very important to me. I’m married and have 3 children. We have 4 grandchildren and a fifth is on the way. I enjoy spending time with my grandchildren. My wife and I are active in the church in Champaign, so we spend a lot of time and energy in that. I enjoy gardening when I have time. I like to go out and get my hands in soil and see things grow. My mother taught my family about gardening. The vegetables from our garden were the main staple during the summer months, so she insisted that we became proficient in weeding. I enjoy gardening to this day.

In terms of relaxing, Steve Chu, the Secretary of Energy, was recently quoted in newspapers in a report by the Associated Press. Someone asked him how he relaxes, and he said one of the most relaxing things that he does is writing scientific papers. To others, that might sound nerdy, but I actually identified with his statement. Whenever I have time, I enjoy writing papers based on the data that my graduate students and post-doctoral students collect. I like teaching. I enjoy interacting with students. Maybe I don’t get as much relaxation as I should but those are the things I enjoy.

Do you have any favorite authors or famous quotes?

There is one quote from Calvin Coolidge that I give to all my graduate students:

“Nothing in the world can take the place of persistence. Talent will not; nothing is more common than unsuccessful men with talent. Genius will not; unrewarded genius is almost a proverb. Education will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent.”

Experimental research often tries one’s patience, to put it mildly, but let me hasten to add that it is more than rewarding. Experiments take a lot of determination and that’s what the quote says. I appreciate the last part of that quote, which I agree with most: “Persistence and determination alone are omnipotent.” We are fortunate here in our department. We have many brilliant young men and women, and I am grateful for them all, but to really excel in our field, there has to be an additional component beyond genius. That component is determination. That’s what’s important to me, and I find that those who are determined to be successful will be. I ask my graduate students to pin this quote on their wall and to think about it. There will come a time when you can use such quotes to get motivated when you are discouraged for any reason.

I remember a quote from Thomas Edison when he was trying to find material to make the light bulb. He tried literally hundreds of materials. There’s a story that just before he found the right one. A reporter came from New York to interview him. The reporter came down to Edison’s laboratory and asked Mr. Edison how he was doing. He replied with a statement to the effect that:
"We now know a thousand ways to not build a light bulb."

I’ll never forget this statement because a less determined individual might have given up long before that. Edison was convinced that his idea was of value, and it was just a matter of continuing the research and not giving up, which worked.

You have to have a lot of ideas. Many things we try in the lab do not work, but once they do work, it more than compensates for all the time, energy, and disappointment. It is amazing, I tell my students that when you discover something, your eyes are the first ones to have seen them. Just imagine, you are the first human to ever experience that. When a student begins to grasp that, he or she is changed forever. They are never the same. When you think about it, what other field can you do that in? Perhaps you can in a different scientific field, but there are many fields where it is not possible. We are fortunate to do what we do.

Do you have any general advice, wisdom, and/or suggestions for undergraduate students?

I strongly urge undergraduates to spend some of their undergraduate years working in a research laboratory. Lectures and labs are important, but I believe that a well-educated engineer must spend time in a research laboratory because it reflects reality. What I love about the laboratory is that the student is introduced to the whole process of discovery and innovation. The labs are truly egalitarian, because by definition, nobody knows the answer we are trying to seek. The faculty member has more experience, so maybe the probability of a faculty member knowing where to look for the right answer is higher, but in a lab, the graduate students, the post-docs, the faculty, and the undergraduates are all on the same level. This is one of the aspects that I most enjoy. The other aspect about the laboratory is that you build personal relationships that last a lifetime. People in the lab go into careers in different technical areas, working in administration, sales, marketing, and others in basic research. It is amazing how those relationships can last a lifetime. I still keep in touch with many people I went to graduate school with. They are all over the world right now. If a student’s education consists solely of attending classes, I don’t think they will receive the full measure of what an undergraduate education offers. I strongly urge each student to work in a research laboratory.
iFoundry Developments and How They Affect You

AMAN KAPUR, a sophomore in computer engineering, recollects his stake in the history of iFoundry and shares its future directions.

The Premise of iFoundry

The study of engineering was largely ramped up in the twentieth century as a purely technical field. Rooted in a curriculum that includes a boot camp of initial math and science courses and a set of specialized engineering courses requiring great time commitments, the whole concept of engineering education may seem to have been about separating the wheat from the chaff.

However, the real world is unlike this world of assumptions and individual centered engineering. While the students find many applications elsewhere for the technical skills they master at UIUC, they often are unaware of other fundamental human issues that may have been easily overlooked in instruction. The Illinois Foundry for Innovation in Engineering Education, or iFoundry, is an organization within the College of Engineering which aims to bridge the remaining gap between the real world and engineering education by increasing an emphasis on the “missing basics,” namely, human issues.

My Freshman Experience

Since iFoundry started in 2007, it has changed the core of Engineering at Illinois. In 2009, iFoundry accepted 71 new engineering students into a pilot program featuring a unique freshman year curriculum. I had the auspicious fortune to be a part of this group. When I entered UIUC my Illinois Engineering Freshman Experience (iEFX) started with iLaunch at the Allerton Park and Retreat Center, where we spent two days in team building activities. iFoundry created ENG 198 for us, an equivalent of the ENG 100 course required of all engineering students. In this course, we went into a rigorous stream of teamwork, real project experienced learning, and communal learning. The year also comprised of extracurricular class work. We were split into iTeams based on our liking. I was the World of Work Chair for the entrepreneurship and innovation team. As a part of this team, we founded a startup, attended a conference at Stanford University, and had our own conference in Chicago in the spring. Last year, the iEFX was expanded to 300 students who experienced a first year similar to mine. With some changes I will describe, the iEFX has now been fully accepted by the College of Engineering and will now be provided to all engineering freshmen.

iEFX Options for All New Engineering Students

Beginning in Fall 2011, all first-year engineering students experience four weeks of iEFX Foundations, an interactive course with sections no larger than 20 students. While the four-week course is required, one of several optional 12-week courses may be taken to build additional project-based experiences for the remainder of the semester. The 12-week courses are also kept to small section sizes and offer opportunities to meet with faculty, develop leadership skills, work on hands-on engineering projects, or learn more about globalization. The specific 12-week course options are described at http://iefx.engineering.illinois.edu/choice. While research opportunities and project opportunities can be pursued through individually meeting with professors or joining a student organization, iEFX options may help you approach that in a more informed way if not already providing you such opportunities. A 12-week course may also be a great option for new students that
have mostly large classes in their first year, because iEFX classes are intentionally kept small such that students can interact with one another and the instructor. A major goal of iFoundry is to enhance the experience of freshmen and sophomores, and iEFX embodies this goal with a variety of opportunities that are open for all new engineering students.

**iFoundry and Olin College**

iFoundry was established in partnership with the Franklin W. Olin College of Engineering located in Needham, Massachusetts. Olin claims to be a “boutique style” college which aims at creating engineers who can solve real world problems. They have a similar project based approach to engineering education. To extend those opportunities to UIUC, iFoundry started an Olin Illinois Exchange program (OIX) which enables engineering students at Illinois to go to Olin for a semester or two to take courses there. I plan to spend my entire junior year at Olin College to learn their engineering principles and apply them to computer engineering at Illinois. I plan to take a mixture of design, computer engineering, and software programming courses there. These courses will transfer to my current computer engineering curriculum. Experiences such as the OIX may be available to future students who show a strong aptitude for that learning style.

**New Course Opportunities and Future Directions**

iFoundry is also focusing on modifying engineering curriculum courses to better suit the needs of the real world. Towards this end, iFoundry has introduced two new courses open to all engineers to take: User Oriented Collaborative Design (UOCD), and Foundations of Business and Entrepreneurship (FBE). I took UOCD in my freshman year and found it to be my most favorite class. The course teaches you how to understand users and design products for them. This course has been adapted from Olin College. Apart from introducing new courses, iFoundry is also looking at modifying current ECE courses to make engineering a holistic experience.

Since its inception, iFoundry has always been a student centered organization. I came in as a freshman without knowing much of anything about engineering. Nonetheless, my opinions were allowed to influence the development of iFoundry such that the students’ needs are served. iFoundry creates a more enriching experience for the students where students play a crucial role in modeling their education. This is much in line with the vision of Dr. Everitt as reflected in the foreword. The future looks prosperous for iFoundry as the community gets larger and engineering curricula evolve.
How Do I Sell Myself to Grad Schools?

By Sujeeth Bharadwaj

The previous edition of DEN featured the article “Is grad school right for me?” Once you realize that graduate school is indeed the appropriate decision for you, the next natural step is to put together a very strong application. This article provides an overview of how you can cruise through the entire application process. I will cite instances from my own and others’ experiences along the way, and for that reason, some of my suggestions are bound to be biased. Keep in mind, that’s the point: to share certain facts of life held secret by admissions websites and guidance counselors.

It is impossible to embark on this daunting journey without making a timeline of requirements to be fulfilled. Schools vary in their criteria for selection, but the list generally includes some mix of standardized tests, transcripts, letters of reference, personal statements, research and work experiences, honors and awards, leadership positions, and extracurricular activities. As an applicant, you need to form much more elaborate guidelines of your own, tailored to your strengths and weaknesses. First and foremost, make a list of schools you want to apply to and fellowships you are eligible for. Spend some time and recall every single moment of your life since high school; freshmen, sophomores, and even juniors—start a diary. Spending half an hour periodically will make recollecting your past experiences much easier when applying.

Which schools are right for me?

Arguably, the hardest part of the entire process is picking schools. It requires you to analyze yourself the way the admissions committee would; after all, this is a game that you very desperately want to win. The consoling part is that you know the winning strategy. You are applying for a job where the only qualification is your likelihood of success in contributing to the scientific community, whether it is the academic realm with journal papers or the industry with inventions and patents.

Akin to undergraduate applications, you should apply to a wide variety of schools – one or two backups, a few where your chances of admissions are around 50%, and one or two that you think are nearly impossible to get into.

If you worked on independent projects and have research experience, top ranked programs such as MIT, Stanford, Berkeley, and U of I are within reach. Know-
ing this, you should start looking for research opportunities very early as an undergraduate—the earlier the better. Some of my peers started freshman year and had around three publications by the time they were seniors. Of course, not everyone is going to have such an impressive resume. You could also network with professors at conferences and other events. There are multiple avenues to reach your dream school.

Know, however, that this process is not about getting into the highest ranked school. You should evaluate your likelihood of success at various institutions and form a ranking list of your own. Key factors to consider: funding, faculty, labs (both within the institution and those affiliated with it), and geographical location (for example, Stanford is located at the heart of Silicon Valley). It therefore makes more sense to choose a specific group at Kansas rather than to cluelessly enter MIT. Of course, prestige never hurts and with all things being equal, selecting a higher ranked school is rational as it usually correlates with better opportunities.

**Standardized Tests**

My friend once said that GREs can only hurt you—he was partially right. It depends on the specific schools you are considering. MIT does not even accept the GRE. This is generally true for some of the other top programs—you can literally fail the GRE and still get into these schools. That’s because they scan for something entirely different. Some less popular schools require that you score at least a 600 on each section and they simply reject everyone below the threshold.

It is obviously very helpful to have a rough idea of your list of schools. It never hurts to do well, but sometimes, you can be constrained by time and other resources. If you are only applying to MIT, Stanford, and U of I, you can afford to spend a day or two studying; just make sure you don’t mess up the math section. You would need to spend months if you are applying to some of the less popular backup schools.

**Letters of Reference**

As with GREs, letters of reference are valued differently by different institutions; the underlying principle, however, is the same. A hiring manager will always rely on the words of his peers rather than a piece of paper. Likewise, professors value their peers’ opinions more than anything else. The best situation is to have three professors, all of them experts in their respective fields, identify you as one of the best students they have ever had.

Try to work with multiple professors so that they can all say something meaningful about your research potential. When you plan your courses, take a project oriented class such as ECE 420; through perseverance and hard work, impress your instructor with a mesmerizing final project. In classes that are less conducive to such interactions, make frequent visits to office hours. One of my friends was out of campus for a semester—he made it a point to keep in touch with his professors via email. Know that professors are really busy people and it is your duty to constantly remind them of your existence. There are many ways, and a particularly effective approach is to contact students within the group.

**Research Statement**

In roughly two pages, you are expected to summarize your entire life; well, at least your undergraduate career. This process can be less intimidating by following one simple and effective rule. Start early. You are only going to be busier in the future. Admissions committee members spend less than five minutes reading each essay—what will make you stand out?

First and foremost is flawlessness. Read and reread your essay until there are absolutely no spelling and grammatical errors—it shows that you didn’t just write something overnight and spent the time necessary.
More importantly, remember once again that this is a job application. Craft a story about yourself which will get you as many positions as possible.

Strike a balance between depth and breadth; if you are very specific about what you want to do and there aren’t any professors interested in that specific area, you won’t get accepted. If you are too broad and claim to be the jack of all trades, no one will want you; if you claim to be the master of all trades, no one will believe you. In general, you should only mention something if you have solid evidence. For example, saying you were once obsessed with chess is meaningless; instead, say that you were a FIDE master and used chess strategies to derive efficient algorithms (if that’s true).

Most of us were bored and annoyed whenever our middle school teachers told us “show, don’t tell.” I regret not having paid close attention to their words then, for that is exactly what you should do on your grad school app. Write a story around each of your achievements so that they complement your transcripts, references, and resume.

**Tips to Boost your Application**

There are certain things you can do to enhance your application. Remember that you need MIT or Stanford or UIUC much more than they need you—whichever you are, there are probably a hundred others just as good or better. The entire game is to maximize the attention given to you. Do whatever it takes, without breaking any laws or offending others.

Contact professors whose interests match your own and ask them about the possibility of working with them. This is analogous to the interview process while applying for a job; some won’t respond, some will reply with a blatant no, some will initially appear promising, only to later reject you; but be persistent until you hear from that one professor who feels you would fit perfectly well in his/her group. Your method of contact will also depend on what is geographically feasible; if the professor is nearby, try to meet him or her in person; otherwise, email is acceptable. Be careful to add substance to your email and avoid spamming.

Constantly call the admissions staff about your application. Most importantly, don’t hesitate to update each school about your achievements after submitting the application. For example, if you end up winning a fellowship or some national award, it is strictly to your advantage to call in and inform them.

**Fellowships**

If you are a US citizen or permanent resident, there are quite literally hundreds of fellowships you will be eligible for. Pick a few and apply. Government based fellowships such as NSF and NDSEG will support you for three years. In any case, the only thing that should stop an eligible candidate from applying is laziness—and as we all know, graduate school is certainly not the appropriate route for such folks.

**References**

Most of what I have shared with you is not new, but it helps to be reminded of the existing information. I have tried to make this guide as comprehensive as possible without making it too lengthy or boring. When I went through this process, I used several resources, mainly blogs maintained by graduate students and professors. I encourage you to visit them all as each provides advice from a slightly different viewpoint.

Dr. Everitt’s Neighborhood: Course Guides

Dr. Everitt’s Neighborhood attempts to supplement the ECE department’s official course descriptions with course reviews written by students who have taken the courses. These course reviews describe the courses in a way that someone who hasn’t already taken the course can understand. They also go into depth about professors, student opinions about the prerequisites, workload, and future opportunities that each course prepares you for.

Please note that the course reviews were written based on the way courses were taught in the past. The ECE department and professors can, and do change the way courses are taught.

If you see a course review that is outdated, let us know. If you think the author was crazy and the opinions are totally wrong, help us fix it. If you want to write a review for a course that doesn’t have one yet, get to it.
ECE 110 – Introduction to Electrical and Computer Engineering

Updated Fall 2009

Instructors:
This course is directed by Professor Brunet and Professor Haken. Professor Brunet teaches a section of this course every semester. Professor Loui and Professor Haken, however, are also experienced in teaching ECE 110. A separate professor directs the labs, Professor Patricia Franke, but most lab sections are taught by a teaching assistant (TA).

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.

When to Take It:
All ECE students take ECE 110 as freshmen, or immediately when they transfer to Illinois. Those who already have a solid foundation in math and physics from high school, who are eager to jump into engineering, should take it their first semester. Students often find it better to take the class first semester because the class opens doors to the next level of ECE classes. A large portion of the class is GE students during spring semesters. Students are often concerned about taking ECE 110 with ECE 190 in the same semester. For a discussion on taking both classes at once, please see the ECE 190 course review.

Class Content:
ECE 110 introduces students to various subfields in ECE. The course consists of a lecture and a lab. ECE 110 distinguishes ECE Illinois from other universities’ programs because it brings freshman into ECE laboratories during their first weeks on campus. Students immediately gain hands-on experience with electronic components like logic gates. Throughout the semester, students design circuits that control a small car, making it follow a path using sensors 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 transistor. From there, students learn about the application of transistors to digital computers and study encoding, encryption, compression, and logic gates. All topics are extensively described in the lecture notes, lectures, Mallard notes, and lecture transparencies. The lab experiments also 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 Mallard. Each week, students work on several graded online homework assignments. An interactive grader is used on Mallard 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. Overall, ECE 110 requires a smaller weekly time commitment in relation to other ECE courses.

Life After:
ECE 110 is the first ECE class students take, and helps students determine whether ECE is right for them. 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 (Computer Engineering). Any of these classes can be taken next, though ECE 190 precedes ECE 290.
ECE 190 - Introduction to Computing Systems

Updated Spring 2011

Instructors:
This course is taught by various CompE professors. Professor Steve Lumetta has taught this course multiple times. Professor Sanjay Patel is an author of the textbook for this course. They both are most experienced 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:
Officially, ECE 110 is listed as a prerequisite. A lot of students take both classes together and manage well. The digital logic material is the only real overlap between the classes. Digital logic design is explored in detail in ECE 110 while it is a small topic in ECE 190. ECE 110 is a useful prerequisite for freshmen who have not been exposed to the workload that ECE classes tend to have. ECE 190 is a programming intensive class and any background in programming will make this class easy 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 textbook. The class introduces the concept of Machine Problems (MPs), which are programming assignments to be electronically turned in. There are 5 assignments as follows: The first is a simple problem to be implemented in C. The second MP is done in machine language. The third is done in assembly language using the LC3 instruction set. The last two MPs are in C. Each MP is divided into 2 checkpoints, meaning that one checkpoint is due every week after the first month. The MPs take 10-20 hours a week, which varies with the difficulty of the checkpoint. There are three exams in the class and a cumulative final. Each exam has a written portion focusing on theory and 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. 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.
ECE 210 – Analog Signal Processing

Updated Spring 2011

Instructors:
This course is directed by Prof. Kudeki. Instructors vary from semester to semester. However, Profs. Trick, Basar, Franke, 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 that is required. Relevant topics from ECE 110 and PHYS 212 include basic circuit analysis and lab work involving breadboards, oscilloscopes, and function generators. Although MATH 285/286 can be taken concurrently with ECE 210, it is strongly recommended to take it before taking this course. Paying extra attention on topics like first order solution, Fourier series, Fourier transforms, and Laplace transforms will come in handy in ECE 210. An ability to understand topics in MATH 285/286 will be beneficial towards the latter half of the course when dealing with topics such as phasors, time-invariant systems, and Fourier and Laplace transforms approach to circuits.

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

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

Class Content:
ECE 210 will be, for most students, the first real synthesis of electrical engineering and mathematics. The first quarter of the course comprises a review of basic circuit analysis. Being able to apply and understand topics such as source-transformation, Thevenin/Norton equivalent circuits, and transient analysis is quite important. Students will learn that many analog circuits can be treated as a linear system. At this point, the course becomes increasingly mathematical when first-order differential equations, phasor analysis, Fourier series, and Fourier and Laplace transforms are introduced (in the order mentioned). There will be GE students taking this course as ECE 211 which only covers up to the part before the Fourier transform. EE majors will find many future uses of Fourier transforms, and should master their understanding of the topic. To complement the material covered in lecture, lab work involves the development of an AM radio receiver. An additional honors section is also available which teaches students to use MATLAB for signal processing purposes. Each week, students construct and analyze a component of the receiver using oscilloscopes and function generators.

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

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

**Life After:**
The proceeding required courses, ECE 313 and ECE 329, and 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 410 (Digital Signal Processing) and ECE 420 (Digital Signal Processing Lab) in the following semester, which takes frequency-domain analysis in a new realm. ECE 430 (Power Circuits and Electromechanics) builds on the power-related topics in 210 such as circuit equivalents, resonance, and phasors.
ECE 290 – Introduction to Computer Engineering

Updated Spring 2011

Instructors:
This course’s director Professor Brown has retired recently so the course’s material is undergoing changes. This course is often split between two professors. The current instructors are Professors Chan and Vasudevan. 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, combinational and circuits are covered and form a logical transition into discussion of counters, registers, and memory. The material culminates on the next level of abstraction, the LC-3 assembly language and its implementation. Towards the end of the course, ethics also become a focal point as students evaluate a case study.

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

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

Updated Spring 2011

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

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

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

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

Work:
The work consists of a total of 13-14 weekly problem sets, two midterm exams, and a final (which is usually worth 45% of the final grade). The assignments usually contain problems that are intended to be neither too challenging nor too trivial for students who are up to speed with the material. These problems are a mixture of simple calculation, application to real-world situations, and derivations of relations that may save time and work in the future. Old websites are archived, along with solutions to previous homework and exams. Please resort to this useful resource only if you are really stuck on a problem; the strategy of copying solutions does not work as well for midterms as finals. The exams will appear trivial compared with the homework problems. Past students have said they have spent between 4.2 and 13.2 hours per week for the course.

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

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**ECE 329 – Introduction to Electromagnetic Fields**

Updated Spring 2011

**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 210 are 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 and 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 313 appears intimidating; however, it is no more rigorous than ECE 210. In fact, ECE 210 and 290 will equip you with all the analytical skills necessary for success in this class.

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

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

**Life After:**
Wave and field behavior is relevant to topics ranging from theory to application in areas such as wireless communications, optics, GPS, and modeling of interconnects in circuits. ECE 329 provides students a better direction of their intellectual and professional interests in ECE. Knowing electromagnetics is beneficial in the solid-state electronics area. Simulation of electromagnetics in various media is a major research undertaking. The follow-on elective, ECE 450, takes a broader and more in-depth survey of lines, fields, and waves and their behavior in transmission lines and antennas, building on ECE 329 concepts. It is advisable to take 450 immediately after 329. As of Spring 2011, ECE 329 and ECE 442 are the prerequisites for ECE 453: Wireless Communication Systems. ECE 437: Sensors and Instrumentation also lists ECE 329 as a prerequisite.
ECE 361 – Fundamentals of Digital Communications

Updated Spring 2010

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

Prerequisites:
ECE 210 and ECE 313 are listed as the prerequisites. It is especially important to have a good background and/or interest in probability. Probability theory forms a sizeable bulk of this course—you will need to be able to work with continuous and (to a lesser extent) discrete random variables throughout this course. It will be helpful if you have taken ECE 410 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 Lab), 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). You should also consider MATH 415/416 (courses in linear algebra), MATH 444/447 (courses in real analysis), and/or ECE 493 (Advanced Engineering Math) if you wish to pursue digital communications at the graduate level.
ECE 385 - Digital Systems Laboratory

Updated Spring 2011

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

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

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

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

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

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

Updated Spring 2011

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 Lometta 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 handheld 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. 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.

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ECE 402 - Electronic Music Synthesis
Updated Fall 2008

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 410 is absolutely unnecessary, as long as you won’t get too upset about having difficulty with a small percentage of the material.

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

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

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

Life After:
Students who enjoy ECE 402 will likely also enjoy ECE 403, Audio Engineering. The job market for computer music engineers is primarily in the film industry, and is not overwhelmingly expansive. Professor Haken has introduced students to internships with Lucasfilm in the past.
ECE 410 (will be ECE 310) - Digital Signal Processing I

Updated Spring 2011

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, and Singer. 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 410—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 410 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.

Class Content:
As the title suggests, you will see everything in ECE 210 once again—but in digital form. Replace every integral you saw in ECE 210 with a summation and you have digital signal processing, sort of. In the first part of the course, students take an idealized look to the digital frequency domain and the discrete time Fourier transform, which is ultimately a special case of the Z-transform. Many of the characteristics of systems covered in ECE 210 such as linearity, causality, and stability along with operations such as convolution surface once again—only this time with respect to the digital domain. Analog to digital and digital to analog converters, along with considerations of aliasing are also discussed. Each of these topics forms a building block to digital filter design, in which students participate towards the end of the course. At this point, practical considerations are introduced regarding finite impulse response (FIR) and infinite impulse response (IIR) filter design methods and the advantages and disadvantages of each. Upsampling and downsampling are also covered. The course covers the FFT (fast Fourier transform), which has many applications. ECE 410 wraps up with discussions of application and other methods that can reduce the computational cost of filter implementation.

Work:
The workload in ECE 410 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 410, computations in these problem sets and quizzes can be complex and sometimes demand some time and thought. On that note, successful and timely completion of homework assignments generally suggests readiness for quizzes. The quizzes and the final exam are the only major factors in determining students’ grades. On some semesters, there will be three midterm exams instead of quizzes. By investing time each week into understanding the concepts and the homework, students can be successful in this class.

Life After:
ECE 420 (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 (Analog Communications), 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.

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**ECE 411 – Computer Organization and Design**

Updated Fall 2008

**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 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

Updated Spring 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-consum ing labs. If you loved ECE 391 and ECE 411, this class is for you.

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

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

Life After:
If you are fortunate enough to take this class in time for interviews, you will be highly sought after for digital hardware design jobs and embedded systems jobs. You would also be well prepared for a software job in low level device drivers, like the one written in MP2. FPGA design is growing while Integrated Circuit (IC) design is shrinking, because in many cases FPGAs are becoming cheaper to work with. While the class is taught with FPGAs, the concepts are applicable to embedded systems in ICs as well. If you enjoy hardware design, consider ECE 411 and ECE 462. If you stay for grad school, ECE 511 and ECE 512 are the follow-on courses. The defense industry employs a lot of FPGA engineers, including Boeing, Lockheed Martin, Northrop Grumman, and Raytheon. An enormous number of small and mid-size companies employ FPGA engineers, since IC design is too expensive for small quantities.
**ECE 420 (will be ECE 311) – Digital Signal Processing Laboratory**

Updated Fall 2009

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

**Prerequisites:**
The only prerequisite listed for the class is ECE 410. While ECE 410 is the only class that is absolutely essential, experience with assembly programming, C programming and MATLAB is a major plus. Students who have previously taken ECE 391 definitely have an advantage, but the exposure to assembly programming through ECE 190 is sufficient before taking this class.

**When to Take It:**
This class is usually offered every semester. Taking this class within a couple of semesters of taking ECE 410 is a good idea, as solid understanding of the material in ECE 410 makes this class a lot easier. Each week’s prelab and quiz typically involves questions from DSP theory. It might also be enjoyable to take this class after taking other electives in related areas such as imaging and communications so that you can do something cool for your final project.

**Class Content:**
This is a very enjoyable and rewarding lab for undergraduates. The class can be challenging, but the skills taught are very applicable. The focus is on implementing most of what is taught in ECE 410, so you deal with practical issues of DSP implementation such as quantization error, memory usage, floating point precision. You code in TI (Texas Instruments) Assembly code, C, and some minor work in MATLAB for this class—the assembly and C code are used to program the DSP chip, whereas MATLAB is mainly used for simulation before programming the DSP. The structured labs, which are available online on Connexions, walk you through implementing various DSP schemes, and the final project gives you the freedom to explore a project of personal interest under the guidance of the professor and TAs.

**Work:**
This is an open lab, meaning you will need to complete lab assignments at the DSP lab outside of class hours. The work required for this class is 5 required weekly labs, each of which includes a pre-lab assignment and a demonstration of the assignment. The pre-labs often deal with something from ECE 410. These weekly labs cover essentials such as implementation of FIR and IIR filters, FFTs, and up and down sampling. You will also be given an oral quiz on the weekly lab assignments. After the 5 labs, you work on the final project. For the final project, you will present a project proposal, a helper lab assignment, a design review presentation, and a demonstration of the final project.

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

**Life After:**
If you enjoy ECE 420, classes to check out include ECE 417/418, ECE 486, ECE 463. ECE 417/418 are classes that teach further signal processing theory and have associated lab work. ECE 486, the control systems lab, and ECE 463, the digital communications lab, are related electives. Students also may find the oral aspects of the course (quizzes and presentations) are integral for preparation for the workplace and beyond.
ECE 430 (will be ECE 330) – Power Circuits and Electromechanics

Updated Fall 2009

Instructors:
Professor Peter Sauer has been teaching ECE 430 for many years now. He is one of the most senior professors and an expert in the Power & Energy Systems area. Other professors namely Prof Overbye and Prof Garcia have taught the course in the past alongside Prof Sauer.

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 would form the basis for understanding more advanced concepts such as induction, synchronous and single-phase machines.

When to take it:
Take this course to satisfy the 3 out of 5 criteria or if you have an interest in power systems, power electronics, motors, drives or renewable energy systems. 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:
As I already mentioned, 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 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, 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. Electromechanical systems and their analysis is also an important topic that is covered. 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 much. 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, which should be manageable if the homework is done properly. There are often some questions on the quizzes that test the concepts of students. For these questions one can go through the past exams and solutions. Past exams since Fall 1999 are uploaded on the 430 website. These are a great help when preparing for both quizzes as well as midterms.

Life After:
ECE 430 opens the door to the power and energy area. You should take this course if you are interested in taking any advanced course in this area. You can take up ECE 464 (Power Electronics) and ECE 469 (Power Electronics Lab) in order to choose the drives and motors path. You could also take up ECE 476 (Power System Analysis) if you have an interest in power systems and analysis. Either 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 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 Energy/Renewable Energy Systems) is another great course that is offered every semester. If you are interested in alternate energy you could also take up Solar Decathlon. This course taken for two semesters, 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).
ECE 437 – Sensors and Instrumentation

Updated Spring 2011

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 440 (will be ECE 340) - Solid State Electronic Devices

Updated Spring 2011

Editor's Note: See the Spring 2010 Edition of DEN to read a feature article on ECE 440.

Instructors:
Prof. Leburton is the course director. Professors that have taught ECE 440 in the past year include Prof. Pop, Liu, Gilbert, and Tucker, to name a few. Most professors who teach this course specialize in device physics and nanoelectronics.

Prerequisites:
Officially PHYS 214 is listed as a prerequisite, while ECE 329 is listed as a pre-/co-requisite. ECE 440 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 440 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 440 to topics such as p-n junctions and carrier flow, but should be covered early enough in the semester if taken concurrently with ECE 440. 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 440, 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 440 as early as possible.

Class Content:
Much of the theory discussed in ECE 440 can be traced back to discoveries made in ECE at Illinois. The material in ECE 440 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 440 is the prerequisite to many courses in the area of solid-state electronics, including ECE 441 (Physics and Modeling of Semiconductor Devices), ECE 442/443 (Electronic Circuits), ECE 444 (Theory and Fabrication of Integrated Circuits), and ECE 482 (Digital IC Design).
ECE 442/443 (will be ECE 342/343) – Electronic Circuits/ Electronic Circuits Laboratory

Updated Fall 2009

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

Prerequisites:
The Department states that the prerequisite for 442 is ECE 440 – Solid State Electronic Devices. Though taking 440 previous is useful for having an intuition about the physics behind device operations in 442, it is not necessary for a student to do well in the class. In fact, many students take 440 and 442 concurrently, and do well in 442. 443 should be taken in concurrence with 442, as the topics taught in 442 are demonstrated in the lab of 443 – though some students do well without taking the classes concurrently. If you were able to apply the circuit fundamentals from ECE 210 without a hitch, you’ll definitely be fine taking this course.

When to Take It:
442/443 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 characterizing 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 440 power electronic devices. This course is important for anyone interested in how modern electronics works, and comes with a medium-to-light work load. You need to understand the equations that model these circuits, but the work is more conceptually difficult than computationally difficult.

ECE 443 is a closed lab, meaning that you should be able to complete labs within allotted periods. In the lab, will work with fundamental circuits such as an AC power supply and a CMOS amplifier. There are four major projects that are broken into typically three to four phases. Usually, the initial phases involve simulation via PSPICE and the later phases involve implementing designs on breadboards. There is no open-ended work (i.e. a final project) in the lab course. At the conclusion of each project, you write a lab report that often includes your simulation and actual results.

Work:
The course load for 442 is not too demanding. Homework can be decently challenging, but does not take too much of one’s time. The first test is mostly review from previous classes, and is generally easier than the later tests. As for 443, the work load is fairly light. There are four lab reports spaced fairly evenly throughout the semester. Be careful though when the deadline for a lab report is near, as the lab report could take up a substantial amount of time to complete. The labs are pretty simple overall and merely reaffirm the concepts learned in 442.

Life After:
Students who have taken and enjoyed ECE 442/443 are open to wide range of choices from the different subspecialties of ECE. For this reason, it is wise and feasible to take this course early on. Follow-on courses such include, ECE 453 – Wireless Communications Circuits, ECE 482 – Digital IC Design (typically offered only in the fall) and ECE 483 – Analog IC Design (typically offered only in the spring) and ECE 464 – Power Electronics.
ECE 444 - Theory and Fabrication of Integrated Circuits

Updated Fall 2009

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:
You need to take ECE 440 before ECE 444 in order to understand anything at all about this course.

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. It is an opportunity you should make every effort to capitalize on. If you enjoyed ECE 440 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 440, 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 slab of Silicon. 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 pre-labs 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 440 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 450 (will be ECE 350) - Lines, Fields, and Waves

Updated Spring 2010

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.

Prerequisites:
The only formal prerequisite for the course is ECE 329, but the course requires mastery over integral calculus as well. If you liked ECE 329, then you’ll probably like this course. Make sure you understand concepts such as transmission line theory, wave interaction with dielectric media and Maxwell equations (plus boundary equations), as these core concepts are built upon in ECE 450. The new course focuses on antennas and electromagnetic (EM) wave propagation and wave interactions, so ECE 450 will feel like an extension of ECE 329.

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

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

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

Life After:
For those of you who want more than a sample of these topics, you can specialize in wireless communications or electromagnetic waves or photonics. If you found the section on antennas interesting, take the follow up course ECE 454 (Antennas) to further your understanding. If you would rather learn about designing radio systems to send and receive information, you can take ECE 453 (Wireless Communication Systems). If you need a lab, you can take ECE 451 (Advanced Microwave Measurements). In this course you will learn how to take high frequency measurements. On the other hand, if you're looking for ECE 329 part 3 then take ECE 452 (Electromagnetic fields). This course builds off of ECE 329 by covering advanced topics in electromagnetic waves, while also building off ECE450 by covering 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 459 — Communication Systems

Updated Fall 2009

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

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

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

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

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

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

Updated Fall 2008

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.

Prerequisites:
The listed prerequisite is ECE210. 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.

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

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

Life After:
Unfortunately, this is the only class on controls at the undergraduate level. Related classes include ECE 470, Math 415, ECE 410. ECE 470 is the class on robotics, Math 415 is a class on linear algebra, and ECE 410 is the class on discrete-time signal processing.
ECE 490 – Introduction to Optimization

Updated Spring 2011

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

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

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

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

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

Life After:
The class is targeted towards those interested in the theoretical aspects of signal processing, communications, and control systems. ECE 410, 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.
CS 225 - Data Structures

Updated Spring 2011

Instructors:
Cinda Heeren has been teaching this course for a couple semesters 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 before 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.

Work:
Students who enjoy programming will love CS 225. The entire 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; however, these lab assignments are purely for practicing new concepts. Labs are graded but solutions are provided too. Overall, this course requires a fairly larger weekly time commitment in relation to other courses in the ECE curriculum.

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