# EE 1001 - Introduction to ECE: A Re-Introduction

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## Abstract

Addition of Electrical & Computer Engineering degree to the department of Electrical and Computer Engineering has required a full revision of the "EE 1001 - Introduction to ECE" class. The intent of this class has always been to give the students an overview of the field they have chosen. Also, it provides an introduction to the tools and methods used in the workforce. Using commonly available/free hardware and software tools, we are looking to increase students' exposure to these frequently used techniques/tools so the students can be prepared for what the next four years has to offer. In conjunction to these tools the students will experience lectures from guests that work in the fields of Electrical and Computer Engineering as well as the faculty. These lectures and tool training sessions are used to immerse the student in the field to assure they feel like they belong in this field.

## Keywords

Education, Engineering Tools, Team Work, Project Learning

## Introduction

With the introduction of the Computer Engineering degree to the EE Department at The University of Tulsa, it became necessary that the introductory class "EE 1001" to be revamped to include an introduction to computer engineering. In the past, the class has been a mixture of presentation, guest lecture, and hands on projects to introduce the new students to what they will experience in the field of electrical engineering. "Project-based learning is a comprehensive approach to teaching and learning that is designed to engage students in the investigation of authentic problem[1]." The general outline of this course will not change. There will still be presentation and guest lectures followed by a corresponding project and homework.

The main focus of the remap of this class is to get student engineers to experience the technologies and tools they will see in the workforce including physical tools and software. In addition, they will learn how to work with other engineers and learn how to present their ideas and findings in an engineering environment. This style of course has been shown to display "a definite and measurable increase in student awareness and understanding of the engineering profession[2]." This one day a week class is set up in a laboratory structure where there is a lecture followed by some experimentation with software or hardware.

The evolution of this class is based on the changes to the curriculum at the University of Tulsa as well as faculty and student feedbacks, and will continue to change to reflect changes in the subjects and engineering tools used.

## Software Tools

The software tools that are being used in this class are all freeware tools, which allows students to have the same versions of the tools they use for class at home. This allows the students to begin using the tools as soon as they feel the need, be it for class or personal projects. The two freeware tools that are used the most are Linear Technology LT Spice and Cadsoft Eagle PCB Design. Both of these tools have shown to be easy to use, easy for a student to obtain, and easy to get support if it is needed. In the modern times, students may miss several classes during a semester, this is due to the fact that students are traveling often and there are more non-traditional students. Of course, they may also get sick and miss a class or two. Due to these facts, it is important that the tools of the class are available on the go. The use of freeware and a decent laptop makes this possibility a reality. Along with LT Spice and Eagle, we are introducing our students to programming with the Arduino IDE using Arduino C. Again, this freeware tool is awesome at introducing students to programming and the online resources for support is nearly limitless.

## Hardware Tools

The hardware tools used in this class are the common tools that any Electrical and/or Computer Engineer would be comfortable with. Each student, as part of the curriculum, will be given a kit that includes a breadboard, wire strippers/pliers, jumper wires and other commonly needed devices that will be necessary/used throughout the next four years, shown in figure 1.

Included in this box is a basic multimeter, this is one of the most important tools needed for an electrical or computer engineer and will be used in almost every lab to come. Along with the personal electronic kit comes the basic training of how to use the equipment that is in the laboratory, which includes DC power supplies, Variable function generators, and oscilloscopes.

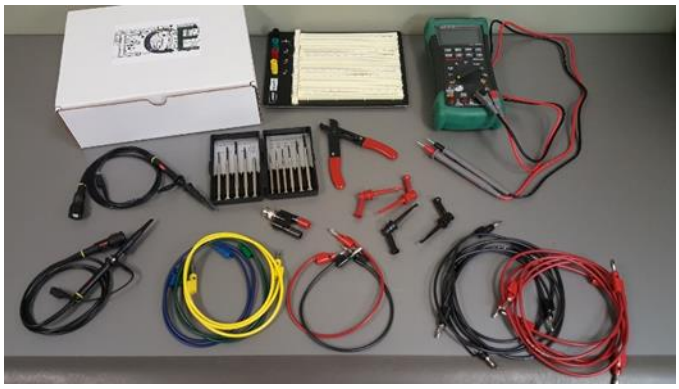


*Figure 1: Hardware Kit*

## Group Work

This class has an emphasis on working as a group. "Teamwork is described as a co-operative process that allows ordinary people to achieve extraordinary results. Teamwork is neither a new concept nor one that is unfamiliar to most people[3]." Every lecture and activity will be worked on as a team and the groups are assigned randomly with ECE Pioneer cards, which include faces of important people in the fields of electrical and computer engineering, shown in figure 2. This group learning is to enforce comradery between the freshmen, as well as prepare them for working in the engineering team environments commonly found in industry.

*Figure 2: ECE Pioneer Cards*

## Guest Lectures

With the introduction to ECE class students need to have an introduction to all the different aspects of ECE fields which includes the different specializations. Because the field is so wide, the class uses guest speakers to go over specific areas of ECE, and work an activity on their specialization. The areas of specialization represented in theses lectures include general Engineering, Electronics, Optics, Computer Architecture, RFID, Electromagnetics, Signals, Controls, Embedded Systems, and RF Engineering. Several of the Guest lecturers bring projects or examples to their discussions which help the students visualize the specialization.

## Projects

The importance of working on projects, especially in the engineering disciplines, is understated in most engineering curriculum. "Project-based learning lends itself to cooperative learning environments which enable students to discuss, explore, test ideas and concepts supported by a team environment[4]." Projects are used to support the interest of new students while they are still exploring the world of engineering. "Hands-on activity for freshmen engineering students is important to sustain the interest and motivation of these first-year students[5]".

PCB

The major, semester long, project is the design of a very simple printed circuit board (PCB) from start to finish. This project is given in small sections when we introduce the tools that will be used for that part of design. The first design comes after a lecture about basic circuits, the discussion goes over simple circuits principles such as Ohm's Law, Kirchhoff's Voltage and Current Laws (KVL and KCL, respectively), and basic diodes. Once basic circuits are discussed and described, LT Spice is introduced as the circuit simulation software.

Given the following description, the students are required to make the circuit in LT Spice. Translating between descriptions and schematics can be very difficult, therefore a relatively simple circuit was chosen for this design.

The circuit contains three parallel strings of varying length with LEDs in parallel. Each string of LEDs has, in series, a control resistor to regulate the current of the corresponding LED string. All three strings of LEDs are powered from a single DC power supply.

The required circuit design is made in LT Spice a transient analysis and DC sweep are required for analysis. Changing the parameters of voltage and resistance is recommended (and required for full credit) which allows the students to see the real world effects of voltage and resistance on current.

Figure 3 shows the schematic output of LT Spice which is one solution of the required schematic design. This extremely simple design is very good because it uses, when described in writing, a number of engineering vernacular which can be deceptive to beginning students.

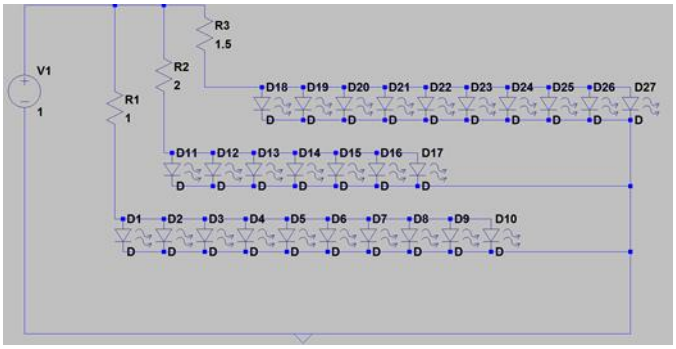


*Figure 3: LT-Spice Schematic for PCB Design*

Using the hardware kit, the students are given some LEDs and resistor and tasked with replicating, on a small scale, their LT Spice designs in the lab. This is not the first lab exercise since several of the guest lecturers' have laboratory and circuits activities in their lectures. For this part of the PCB design project, the students function independently of the instructors, using the rules previously discussed. Of course, instructors and teaching assistants are around watching to make sure everyone is being safe and the equipment is being treated properly.

Once the circuit designs are finalized and the students have worked out how they would make the board (within defined restrictions) the lectures move to PCB design using Eagle. The learning curve with PCB design is pretty steep so several hours are spent on making this transition as smooth as possible. Over this lecture we not only discuss PCB design recommendations, like ground planes and libraries, but general engineering practices such as version and revision control.

Figure 4 shows the final PCB design in Eagle for the PCB design project. The students are given the freedom to design the PCB layout on their design as they see fit. Due to cost and time restraints the above board design is printed beforehand and is the design that the students will be assembling in future sessions in the class.

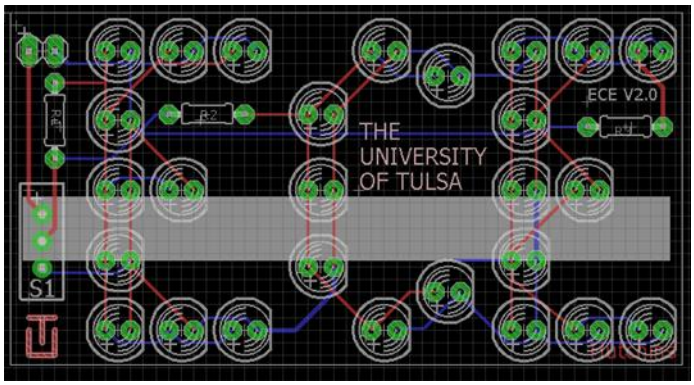


*Figure 4: Final PCB Design from Eagle*

The last lecture dedicated to the PCB design project is an overview of soldering. Since the board and components are ordered ahead of time students are able to move from PCB design to PCB assembly in a week which solves the problem of several weeks, if not month, lead time on PCB manufacturing.

Figure 5 shows a final completed board after assembly, one potential issue of this project is to make sure the students look at the datasheets for the different colors of the LEDs they use and adjust each letter's resistor for the appropriate current. For this example, the board was constructed with Blue and Yellow LEDs that closely resemble the University of Tulsa's colors, Blue and Gold.

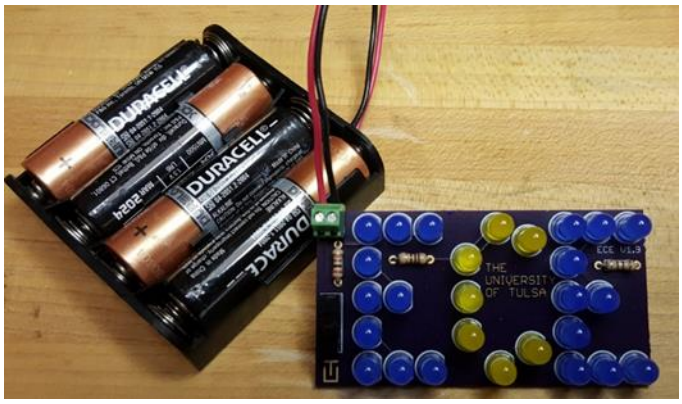


*Figure 5: Final PCB after full assembly*

IEEE paper

The second, significantly shorter, project is an IEEE format paper. It is important for the students to have an introduction into the IEEE format, which will help not only in writing papers in the future but also in reading papers of this format. This group paper not only introduces the students to IEEE format but introduces working on papers in teams. The groups are decided by shuffling the ECE Pioneer cards and passing them out, one to each student. The ECE Pioneer cards not only assign the paper groups but also the topic, the subject of the paper is to do a small biography over the person on the card assigned. The three-week due date is set to encourage the students into starting as soon as possible, since even short IEEE format papers can take a long time to complete.

Embedded Robot

The final project is a simple, Arduino powered robot. This robot is a simple 2 stepper motors, used in a skid steer configuration. The students are given the robot and an obstacle course and are told to program the robot, using dead-reckoning, to navigate the course. Since this project is on the last days, it is formed as a competition, putting the students in a head to head heat for top position drives the students to perform at their best. Pushing the robotics and autonomy side of the industry, after a complete dead-reckoning run, a limited number of sensors are provided to the groups in order to make the robot function at a higher level, in order to beat their own scores.

## Implementation and Conclusions

At the beginning of the fall 2016 semester the University of Tulsa ECE Department implemented the revisions to "EE1001: The introduction to Electrical and Computer Engineering", adding the before mentioned projects in tandem with guest lectures for ECE specializations and topics.

Of the comments that have been received on the revision, the two main issues that have been raised are 1) making the class two days a week allowing for a more distributed workload and 2) making smaller groups for the group projects allowing for students to work with a larger variety of their fellow classmates. The issues of moving the class to two days a week is in discussion with the university, which requires finding a time in the freshmen schedule and finding open rooms, but this is under discussion for feasibility. The limitation of the size of the groups, for most activities, has already been managed since it was as simple as splitting the larger teams into smaller teams, with the exception of the Embedded Robot activity. The Embedded Robot activity limit is a hard limit since, as a department, there is only 7 robot platforms available. The extra funding needed to obtain more units has been requested.

In conclusion, the reviews from everyone involved has been very positive. The students' feedback and professor observation show that the students are engaged with the activities and are actually enjoying the activities, rather than trying to finish as quickly as possible. Over the next few years following these changes, the class will be reviewed by the department for retention of freshmen students. This metric cannot be used in the time frame of less than one year but the current retention rate of the class is showing signs of improvement from previous years. This curriculum, just as the fields of Electrical and Computer Engineering, will be ever changing as technology becomes cheaper and more advanced. With the feedback that is received it is easier for us to maintain the curriculum and keep the students on the cutting edge**.**

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