ECE 110 Lab Syllabus

Location: Room 1005 and 1001, ECE Building, enter through 1005.
Course Director: Schmitz, Christopher <cdschmit@illinois.edu>

Lab Protocol

Please read through the entire lab prelab and procedure BEFORE attending your lab class. Things go much smoother if you know what to expect and have questions ready for your TA. To make sure that you start thinking about some of the issues you will encounter, each lab (except the first one) has an associated prelab assignment.

- **Prelab** - Before the upcoming lab each week, you must answer all the prelab questions. At your prescribed lab time, you will enter 1001 ECEB (the lab) through 1005 ECEB (lecture room next to the lab). You will have **five minutes** to place these items on the center bench:
    - **Your prelab document**
    - **Prelab hardware constructed for that day's exercise**

  You need to return to 1005 ECEB for instruction from one TA while the others grade your prelab. If you come late to lab (after prelab grading has begun) you can expect to lose points.
- **Lab** – Lab begins with instruction in 1005 ECEB. You will also be assigned to a lab "team" at the beginning of the semester and you will be assigned a lab partner from that team each week of the semester. After instruction in 1005 ECEB, you will return to the center benches in the lab, 1001 ECEB, and (often) complete a student Breakout Session before completing the remainder of the lab procedures. Student breakout discussions are a community-building activity where approximately 8 students (two teams of 4) can brainstorm on course topics. During lab, you will be following the lab procedures in this manual. Read the directions and answer the questions using full, clear statements that provide the answer AND an explanation of why you gave your answer in the space provided.

  The TAs will provide more information about the timeline and use of GradeScope for the submission of Lab Experiments and their prelab exercises.

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Grading

- **Lab Experiments** - There are 9 guided labs that teach you how to use the lab equipment, conduct engineering analysis of circuits, and teach you the skills necessary for the end of semester design challenge. Each week, you will earn up to 10 points on the lab, including the prelab. The Unit 1 report is worth 10 points and the Unit 2 report is worth 10 points.
- **Final Design** - During the final weeks of the class you will complete an engineering design challenge and submit documentation in the form of a project proposal and a final report plus a lab summary for Exercises 10, 11, and 12. The final design challenge is *not* intended to be a "do or die" challenge. Students who produce excellent documentation and demonstrate an understanding of the design process can still receive high marks even if the design fails to work as desired. Failure to attend any session during the Final Design period will result in an automatic LOSS of 12 points from your semester score in addition to the loss of points of anything due that day. Failure to follow procedures or do the requested exercises will also result in a loss of points from your semester score.
- **Mini-Projects** - There are modular "mini-projects" provided as you go procedure through the semester that will enhance your learning and your ability to successfully complete your final design project. These mini-projects will concentrate on items like fundamental science, electronic devices, benchtop tools, useful circuits or microprocessor usage and are available on the course website. The best part is that you have *choice* in which mini-projects you pursue! Choose projects that interest you and will be best suited to future work you might undertake. While you may work ahead on Mini-Projects, there should be enough time to complete one per week. There will be due dates for minimum number of completed mini-projects be set by the TAs throughout the semester.
- **Participation –** The TAs will make regular observations throughout the semester. This percentage of your grade will reflect what they have noted about your performance. Are you on your phone? Do you attempt to bring food and drink into the lab? Are you rude to people? Or, perhaps, you are extremely helpful to others. The participation grade allows your TAs to provide their own perceptions of your behavior, good or bad, much as a boss would if you worked in industry. The points assigned here will be lost each time poor behavior is witnessed. On the other hand, a student who is helpful and friendly could earn a few points extra credit here and be recommended as a future course aide!

  Twice this semester, you will have the opportunity to assess yourself and the members of your team. Teammates are expected to be on time, remain engaged in the day's activities, share duties in both building circuits and operating equipment, be active in breakout conversations, be kind and helpful, etc. The peer assessments will be anonymous. They will help each student recognize their own strengths and weaknesses and provide them opportunity to grow professionally. The first assessment does not affect grades, but the second assessment will contribute to the participation score.

  Table 1 provides a breakdown of the points contributing to the so-called "lab" portion of your grade which accounts for 30% of your course grade. As per the course syllabus, you must earn ≥ 150 of the 300 semester points for the lab or you will automatically fail the course. Similarly, you must earn $\geq 50\%$ of the so-called "lecture" grade or you will automatically fail the course.

Table 1: Laboratory Grade Breakdown

<table>
<tr><th>Assignment Type</th><th>Assignment</th><th>Due Date</th><th>Value</th><th>Maximum Points</th></tr>
<tr><td>Lab Exercises</td><td>Experiments 1-9</td><td>Each week</td><td>10 points each = 90</td><td rowspan="3">110</td></tr>
<tr><td>Unit Report #1</td><td>Mid-term Report</td><td>At beginning of Lab 5</td><td>10</td></tr>
<tr><td>Unit Report #2</td><td>Mid-term Report</td><td>At beginning of Lab 10</td><td>10</td></tr>
<tr><td rowspan="4">Final Design</td><td>Experiment 10 Proposal</td><td>TBA</td><td>10</td><td rowspan="4">90</td></tr>
<tr><td>Experiment 11 Proposal</td><td>TBA</td><td>10</td></tr>
<tr><td>Final Report</td><td>Midnight 2nd day after demo</td><td>40</td></tr>
<tr><td>Video and Live Demonstration</td><td>Last full week of classes</td><td>30</td></tr>
<tr><td>Mini-Projects</td><td>10 Mini-projects total</td><td>As instructed by TAs, none accepted after demo day</td><td>5 points each</td><td>50</td></tr>
<tr><td>Participation</td><td>Daily attendance, participation, effort</td><td>Assessed throughout, determined at end of term with aid of CATME.</td><td>50</td><td>50</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>300</td></tr>
<tr><td colspan="5">The results of the 2nd peer evaluation (through CATME) can significantly affect your grade. You do not want to lose points due to being a poor partner. Strong performance can earn you extra credit and an invite to be a course aide!</td></tr>
</table>

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Academic Integrity

You learn well by collaboration (working together). You should work with your lab partner on content and be ever aware of where the contributions originate. Collaboration between students on all lab assignments (including prelabs) is encouraged and in many cases, required. All answers should be put into your own words and work must be shown for any problems involving calculations.

You do ***not*** learn well by sub-dividing the work and each student working separately. In the past, honest students have become entangled in plagiarism issues by sub-dividing work and then unknowingly submitting a report where their lab partner plagiarized material.

Plagiarism carries serious penalties, ranging from a grade of zero on the assignment to failure for the course. In all cases of plagiarism, a letter will be filed with the Dean of the student's college. If you are unsure if your work too closely resembles that of another student, ask your TA about it before turning it in. For further information about academic integrity please see Article 1, Part 4 of the University of Illinois student code (http://studentcode.illinois.edu/).

Plagiarism also includes using resources (figures, code, designs) from students outside your section, from a team in a previous semester, or from sources on the Internet; However, it is only plagiarism if you DO NOT PROPERLY REFERENCE YOUR SOURCE! It is okay to use these outside sources if you properly reference them. Proper reference includes a specific note specifying which materials came from a specifically named source. With this information, the TAs can grade you based on your own contributions and it does not appear that you are attempting to claim someone else's work as your own. If you have trouble seeing the difference, please talk to someone on the ECE110 staff.

Any students who may be retaking the course must complete a final project significantly different than in prior semester(s).

Lab Partnering

In addition to the strictly academic goals of this lab, you will also learn other valuable, less tangible skills, one of which is how to work constructively with other people. This semester, a tool called CATME will be used to form "teams" of 4 students. Each week, these 4 students will **pair** up in different combinations to work together on a specific lab procedure. Over the course of three weeks, each student will have worked with all other three team members. At this point, we will use CATME for peer assessment…that is, the team plus the TAs will assess each student on their performance as a teammate. The assessment will be anonymous. This first assessment is intended to provide feedback to each student on what he or she is doing well and on what they could improve upon. The feedback will allow each of you to grow in your professional development. Near the end of the

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semester, you will again provide a peer assessment of all your team members. That second assessment will be combined with your TAs' observations and used to determine your final participation grade.

Locker Policy

Each team in ECE 110 lab will be assigned a locker for storing car chassis and shared breadboards. Students are NOT ALLOWED to keep BNC/banana plug cables, alligator clips, test boxes, batteries and any other item from the lab that you have not been given express permission to store in your locker. Lockers will be checked regularly by the TAs and any violation of the above rule will be recorded and penalized by taking off participation points. You are actually encouraged NOT to the use the lockers to store your electronics kits. Prelab procedures will generally require that you have your own personal electronics kit with you and that you, personally, build a circuit before coming into lab.

Absence Policy

Labs meet every week starting the 3rd week of class (break excluded). Absences effect more than just you and your grade. You will more-than-likely have a lab partner who will be placed at a disadvantage each time you are not present. Even worse, your lab partner may come to lose trust in you and your willingness to be a productive member of the team. You may ***not*** choose to miss a lab in order to complete an assignment for another course, study for the exam of this or another course, or to take an exam for another course. When an exam conflicts with your regularly-scheduled lab, that course *must* be willing to offer a conflict exam.

A single lab absence may be excused (at your TA's discretion) if you

1. Alert your TA to your absence as soon as you are able. This should be done at least one week in advance for planned trips, just before the lab for illnesses, or as soon as you are stable if you encounter an injury (typically within a couple hours).
2. You obtain permission from your TA specifically for the Supervised Lab Play or an open bench in another lab session for purposes of making up the missed laboratory work. You must make it up before your next lab session.

For planned trips, you should do the lab procedure during the Supervised Lab Play or in another lab section with an open bench *prior* to the week in which your section will be doing that same procedure. If the TA decides the missed lab is not an excusable absence, you will still need to complete the lab for grading, but will lose a *minimum* of 10 points from your semester total. A second unexcused absence will cost an additional 25 points from your semester total and additional unexcused absence will each cost an additional 50 points from your semester total. Failure to make up a missed lab prior to the next lab meeting will

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cost 10 points per week until you have fully caught up. The entire semester lab earns only about 300 points, so missing lab is clearly a disadvantage.

The severity of this penalty is largely because of the ill effect it will have on a lab partner and the hassle it causes your TAs. The penalty is also assessed to students who have no lab partner out of fairness to all.

For lab meetings missed during the final project design, you should work with your lab partner to help catch up on lost time. Points are lost as described above.

Valid long-term illnesses may be treated differently upon review of a letter from the Emergency Dean (Dean of Students) or the DRES center. These will be treated on a one-on-one basis after reviewing the facts of the situation.

Food and Drink

Food and drink are prohibited in the lab, with the exception of water in bottles or containers with tight-fitting screw-top lids (not fast-food lids or even coffee from the shop). Beverages such as pop and sugary drinks can result in a sticky mess that ruins the furniture while posing an added danger to the (rather expensive) lab equipment, and should never be opened in the lab. Food should NEVER enter the lab.

Any exceptions to the food and drink policy (for instance, due to a diabetic condition) must be explicitly granted by the course director. Violations to this policy may result in deductions from your participation points or in more severe cases, you may be asked to leave for the day and receive a zero on that week’s experiment.

Accommodation Policy:

If you feel that you may need an accommodation based on the impact of a disability, feel free to contact your TA privately to discuss your specific needs. You are all guaranteed an equal opportunity in the class and no student is denied educational access, regardless of disability. If you need assistance or ever feel uncomfortable please see your TA right away. For more information please visit: http://www.disability.illinois.edu/

Disclaimer

All policies and assignments outlined in this syllabus are checked each semester. Anything that conflicts with policy stated elsewhere will be resolved as found during the course of the semester.

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ECE110: Lab Session and Semester Overview

There are 12 weekly laboratory meetings during this semester. The first lab meets for Experiment 1 **the third week of classes**. The final lab meets to demonstrate projects during **the final "full" week**.

A pre-lab exercise must be completed before coming to lab. At each laboratory meeting, you will enter through 1005 ECEB, **place your Prelab procedures in the lab (1001 ECEB)** and go back to 1005 ECEB where class discussion will begin strictly at 5 minutes "after the hour", that is, discussion begins at 9:05 am, 12:05 pm, 3:05 pm, or 6:05 pm. Students who are not ready for the start of class will likely lose credit for their prelab. The structure of each lab meeting will look roughly like the following table in hour:minute format.

Start	End	Time to Complete	Task	Comments
0:00	0:05	5 minutes	Prelab Setup in 1001 ECEB	Must be back in 1005 ECEB by 5 minutes after or lose points for prelab
0:05	0:15	15 minutes	Lab Guidelines for today	Time may vary to cover misconceptions
0:20	0:45	25 minutes	Group Breakout Session	Consult in **groups of 8** (two teams) on topics of improving prelab design. Not all labs include this first Breakout session.
0:45	2:00	75 or more minutes (tentative)	Lab core, Autonomous Car	Work with single partner as described to advance your autonomous car design. Consult with your Team as needed.
2:00	2:30	30 or less minutes (tentative)	Mini-Project Module(s)	As time allows, self-select from a group of fun and informative laboratory exercises! You may work with your teammate if you wish.
2:30	2:40	10 minutes	Group Breakout Session	Consult in groups of 8 (two teams) to build community, answer summary questions, and explore topics more deeply.
2:40	2:50	10 minutes	Cleanup benches and equipment	The next lab may be arriving to bring in their prelab so it is critical that you not "run long".

Table 1: Procedure for the 2 hours and 50 minutes in a typical ECE 110 lab.

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Portions of the first nine laboratory exercises are structured, cookbook-style labs where you are guided by the procedure and explicit questions. These core labs are augmented with ***Mini-Project*** modules which extend your understanding of the material and/or provide timely resources for moving forward to future labs. Some of these modules may be explicitly required (you must do them during the course of the semester), but most are only semi-required (you choose those which interest you). You will be required to complete at least 10 modules for full credit in the lab over the course of the semester.

While the focus of the lab's core procedure explores individual concepts in hardware, circuit theory, and the construction of an autonomous vehicle, the complete set of lab procedures including the mini-projects are designed to help you build a skill set in engineering exploration that will serve you well both in this class and throughout your engineering career.

The last few laboratory meetings are design-based where each lab group will design, build, and demonstrate an electronic device to accomplish a task. In this final-project phase of the course, you are required to utilize the skills developed in your earlier lab meetings to produce a written report. Additional mini-projects at this point are likely to provide tools specifically useful to your final project!

A short, tentative breakdown of your semester laboratory exercises are provided in the table below.

Labs:

1. A Lab Course Introduction
   - Assemble the robotic car chassis
   - Explore the breadboard
   - Play with DC (direct-current) equipment
   - Compare the battery to the benchtop power supply
   - Generate a "zeroth-order-model" of the car's motor
   - Student Exploration: ***Mini-Project***

2. Circuit Networks
   - Learn to "switch" your motors for control
   - Use current-limiting resistors to slow motors
   - Construct a resistor network for improved power dissipation
   - Student Exploration: ***Mini-Project***

3. Circuit Laws and Intro to Time-Varying Signals

- Learn to “switch” networks for fine-tuned speed control
- Use the oscilloscope to watch signals change across time
- Apply Kirchhoff’s Voltage and Current Laws (KVL and KCL) to real circuits
- Student Exploration: ***Mini-Project***

4. Time-Varying Signals
- Build a “cloud detector” using engineering design
- Improve oscilloscope usage
- Build a motor-drive circuit for improved engineering design through transistors
- Use a function generator
- Student Exploration: ***Mini-Project***

5. Oscillator
- Build an oscillator
- Use the pulsed oscillator signal for higher-efficiency motor-speed control
- Student Exploration: ***Mini-Project***

6. Improved Motor Modeling
- Explore the definitions of power and energy
- Build an improved model of the car motor
- Student Exploration: ***Mini-Project***

7. Pulse-Width Modulation (PWM)
- Alter the oscillator design to produce non-symmetric duty cycle
- Fine-tune motor speed control using PWM signals
- Student Exploration: ***Mini-Project***

8. Straight-Run Cars
- Build a circuit for speed control
- Build a circuit for wheel-speed balance
- Couple these circuit outputs to the motor-drive for straight-run races

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- Student Exploration: ***Mini-Project***

9. Autonomous and Elegant
- Plan and build a beautiful circuit
  - ✓Organized layout
  - ✓Intelligent wire-color choices
  - ✓Robust layout not prone to accidents
- Complete and demo a fully-autonomous maze-running vehicle
- Preliminary Proposal due
- Student Exploration: ***Mini-Project***

10. Modules and Project Design
- Project Proposal due
- Student Exploration: ***Mini-Project***

11. Modules and Project Design
- Student Exploration: ***Mini-Project***

12. Project Presentations
- Presentation by schedule, recommended to make your two-minute video in advance (as a backup)
- peer review of other projects

About the Final Project

The key to doing well on the final project is to learn the methods of experimentation in electronics. The early labs will prepare you. You will need to be able to

- Characterize a sensor you have never seen before by collecting circuit data.
- Use that sensor to accomplish a task

Your project proposal must be approved by your TA. Your TA will be looking for more explicit details to verify that your project is worthy of pursuit in ECE110 Intro to Electronics. Primarily, it must be of appropriate challenge and content. Structurally, it should very clearly consist of a minimum of these three parts:

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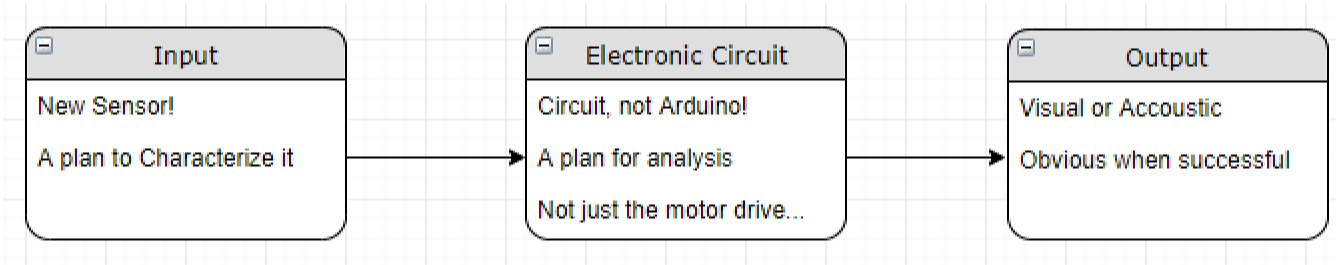

Figure 1: Three essential features of any ECE 110 Project. Arduino may be used, but cannot be a substitute for electronics.

1. A sensor not used in the ECE 110 core lab procedure and a plan to characterize it such that any engineer has a better idea of how it can and cannot be used in a circuit. To characterize a sensor, you will generally take measurements over a range of conditions, apply a model that predicts how that device will behave in an application, then verify your prediction by taking measurements of your circuit over a similar range of conditions.
2. An electronic circuit that generates a solution to the task at hand. ECE 110 modules will provide a vast array of circuits for solving a multitude of problems. Any of these may be applied or you can even find others in text books and online. Imitating a solution done elsewhere is allowed, but you must not merely copy their solution, you must use their proposal as only a guideline while using the parts available to you to generate your own design. Have a plan for analyzing this circuit…often by controlling the input using a function generator and observing the output on the oscilloscope.
3. An output that clearly shows the functionality of your design. Most commonly, these may be an array of LEDs, car motors, servo motors, or a loudspeaker, but an output that appeals to any of the human senses is acceptable!
4. Students occasionally have misconceptions about this course and the requirements of the final design project. ECE110 is **not a programming course**. Rather, it provides limited exposure to some scientific computing basics (using software to plot and model) and some physical computing basics (using Arduino as a measurement device and a digital controller). Only plotting (graphing) is a requirement in the final project. Other use of physical computing in the final project is purely up to the student team as most projects do not necessitate the use of a digital controller. In other words, <u>feel free to use Arduino as part of your solution, but "removal" of the Arduino should still reveal the three pieces (demonstrated in Figure 1) to be intact</u>.

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Course Notes: Etiquette and Safety

Etiquette

Etiquette is the set of rules or procedures that define polite behavior within a particular setting. The etiquette for the ECE 110 Lab is outlined below and has been specifically designed to foster a healthy and productive environment in the laboratory. Please take the time to read and follow the lab etiquette so that you and your peers will have the best possible experience in the lab.

Respect Your Peers

In the field of engineering, most projects are too large for any one engineer to accomplish on their own. As a result, most engineering projects (both the academic and professional) require the collaborative efforts of a team of engineers. Effective collaboration is not possible without respect between peers. Proper respect means that you should not show up late, sneak out early, or repeatedly miss lab periods.

Since the University of Illinois is both large and prestigious, you will find that your classmates come from wide variety of backgrounds. Although differences in cultural background or personality can sometimes lead to tension between peers, a diverse team benefits greatly from the diverse ideas it generates. Your classmates will approach problems differently and have strengths that are different from your own. Embrace your diversity, learn from the strengths of others, and allow others to learn from you.

Cooperate with Your Lab Partner

Laboratory courses are intended to be a place where students can gain “hands-on” experience with engineering concepts. Take turns with your lab partner leading hands-on activities within the lab. This should be done when wiring the breadboard, using laboratory equipment, and in using the computer for data analysis and graphing.

If you find that your partner is not participating enough or perhaps not letting you participate enough, communicate the issue to your partner or discuss the issue with one of your lab instructors.

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No Food or Drink

Food and drink are generally prohibited in the lab, with the exception of bottles of water with a tight-fitting screw-top lids. Other beverages such as pop and sugary drinks can result in a sticky mess that ruins the furniture while posing an added danger to expensive lab equipment. Food should <u>NEVER</u> enter the lab. Besides the risk of spreading germs through the practice of eating in a hands-on laboratory, there are other issues with respect to toxic-poisoning discussed below in Safety Considerations. Furthermore, it makes the lab look sloppy and unprofessional to those who observe through the windows and the financial supporters of ECE and its laboratory facilities.

Any exceptions to the food and drink policy must be explicitly granted by your head lab instructors. Most TAs will allow you to have food and drink in 1005 ECEB (the lecture area adjacent to the lab). Please finish your snack and dispose of trash **before** going into the lab as 1005 ECEB also gets used for office hours during lab time. Thanks!

Respect Property and Lab Equipment

Through each lab session, do your best to be respectful of the workspaces being used by your classmates and minimize clutter that might serve as a tripping hazard. At the end of each lab, your workbench (and any common bench areas you have used) should appear as if you had never been there. Place cables in their proper storage location, put away your circuit components and toss any waste into the trash can. A neat and clean workbench is much easier to use when troubleshooting. Show respect to the students in the other lab sections by helping them keep the lab clean!

Suggestion: Regularly conversing with others will enhance your education!

Collaborate with Classmates

Technical discussions and collaborative learning are among the most effective ways to build and affirm your command of the material. Discuss your experiment procedures, questions, and observations with other lab groups. Take time to talk with your neighbors regularly to ensure good scores on your assignments.

Cheating

Collaboration does ***not*** imply that you may submit work done by your lab partner or another classmate. Collaboration is a give-and-take procedure where two-way discussions enhance student understanding of the material. One-way conversations (like asking for an answer to a question or copying from your teammate or another student's lab report) is just ***cheating***. Any student caught cheating will be subject to disciplinary action.

The following list contains just a few actions prohibited in ECE110 and subject to disciplinary action: copying pre-lab answers from your lab partner or another student in ECE110, submitting data recorded by another lab team, submitting code or graphs written or produced by another lab team from this or any past semester. Furthermore, you must not mislead the grader with respect to the amount of design work accomplished by your team. For example, while it is generally good to research and utilize interesting circuits from outside sources, **you must not submit** these aspects as part of your final project design **without crediting the source**! To do so would amount to plagiarism.

Dealing with Problems

Although the vast majority of students in ECE110 are considerate, hard-working, intelligent young adults, some may have picked up bad habits. Others may make a serious error in judgment when under the pressures that a top institution like the University of Illinois may present. If you encounter a difficulty with a teammate or another student in the course that cannot be resolved, you have several actions of recourse. Meet with your professor or an advisor in ECE where he/she can act as a moderator to help rectify the problems. In any case, it is better to address any issues as soon as they appear.

Safety Considerations

What are the hazards in an electrical engineering laboratory? Here, we explain how several (specific to ECE) may affect you.

Electric shock

Some of the instruments are capable of providing currents high enough to cause ventricular fibrillation of the heart (greater than 0.1 A through the heart). Fortunately, the lower voltages (< 10 V) provided by this equipment coupled with the typically-high resistance of the body to current flow makes this risk very low in ordinary conditions.

A greater concern is involved when plugging something into the 110-V, 60-Hz wall socket which is capable of providing much higher currents. Never remove the case of any electrical device or design your own system that draws power from a wall outlet without proper supervision. Do not assume that because you are training to be an engineer, that you are inherently trained to handle high-power devices.

Large capacitors (like those also found in large appliances like CRT televisions or microwave ovens) are also capable of providing high voltages and correspondingly-high current. Many other devices contain marginally-large capacitors, but are often discharged automatically by a “bleed resistor”. If you find yourself in the presence of a capacitor much thicker than your little finger, you should ask your lab instructor if it is safe to handle or use in your project.

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Comment: Using someone else’s code on the final project is not necessarily cheating. It is okay as long as you make it clear to the grader that certain portions are accredited to another person and are not part of your own contribution to the work. ALWAYS credit another person’s work.

If you ever feel discouraged and don’t know who to turn to, contact the course director, Prof. Schmitz, at cdschmit@illinois.edu

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Burns and Fire

While the power drawn from the sources in the lab are not typically a shock hazard, they can indirectly cause burns. Electrical devices are designed to dissipate a certain amount of electrical power without overheating. If a device is pushed beyond these limits by being wired incorrectly or being supplied with too much power, they can become very hot to the touch and often begin to burn and produce smoke. If you smell something burning and suspect it might be your circuit, quickly ***disconnect the power from your circuit***. Be careful when disconnecting power from a circuit in this situation as the power source itself (a battery, perhaps) may be very hot. The best practice is to use a pencil or other non-conducting object to physically disconnect the power source. ***DO NOT TOUCH*** any part of the circuit as it may remain hot for some time, but rather look for wiring errors, melted plastic or visibly burnt devices. If you find none, have your TA present before you plug it back in.

Suggestion: Use a pencil or other non-conducting object to physically disconnect the power source from a hot-smelling circuit.

The most common serious mistake in wiring is connecting directly connecting the positive and negative terminals of a battery (generally called a *short*) through a non-obvious path on the breadboard. Most desktop power supplies have protective circuits that will limit the current or disable the output when the positive and negative terminals are shorted. Batteries typically have no such protection and can supply enough current to burn up components or melt a breadboard. Shorting a battery not only can cause burns due to hot devices, but can even result in the battery bursting into flames. Our batteries should be augmented with a thermal fuse, but do not rely on it! Be sure to use care with batteries. **Transport or store batteries in a manner in which they cannot short**.

Suggestion: Transport or store batteries in a manner in which they cannot short.

During the semester, several students may wish to take the opportunity to learn the basics of soldering. While most people recognize the inherent danger of the hot end of the soldering iron, they often fail to recognize how much of that heat is transferred to the solder joint and adjoining metal parts of the circuit and how long it may take for those parts to cool. The larger the volume of metal being joined, the longer it will take to heat and then cool the parts when soldering. **Allow at least three times as long to cool as it took to heat and solder the joint**.

Suggestion: When soldering, allow at least three times as long to cool as it took to heat and solder the joint.

Chemical Poisoning

Soldering is closely related to main source of chemical danger in the electrical engineering laboratory, lead (chemical element Pb). This heavy metal, when inhaled or ingested, is highly toxic and can lead to a multitude of problems affecting the nervous system and internal organs and can even cause death. Women who may be pregnant should remain especially mindful of the damage lead poisoning may cause to a developing fetus.

Warning: Students found with food or drink in 1001 ECEB (the lab side) will be automatically deducted 2 lab points for that day and repeat violations will result in 10 points lost!

Many solders today are produced lead-free (but not necessarily toxin-free), but it is highly recommended that you learn proper soldering techniques that protect you from the ill-effects of potential toxins. Take precautions to **avoid breathing the fumes**

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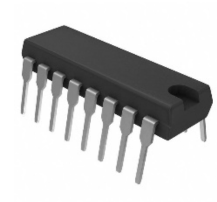
when soldering and always **wash your hands** as soon as possible after soldering or handling soldered components. It should be evident that you should **never bring food** into any electrical engineering laboratories!

Cuts and Puncture Wounds

There are a few sharp objects in the lab that students are likely to handle. Carelessness around such sharp objects can lead to unnecessary injuries and possible infections.



The ends of the wires and legs of chips (often called *leads* and pronounced LEEDS) of the different components used such as resistors and integrated circuits are often sharp enough to puncture skin when enough pressure is applied. It is important to handle all components with care.

A wire stripper is a scissors-like device with notches cut into the blades to allow the experimenter to remove wire insulation without cutting the wire by mistake. Handle the wire strippers as you would scissors and be careful to keep your fingers away from the sharp cutting edges.