

# ECE 2100 Circuit Analysis Laboratory: Safety and Rules

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## Laboratory Physical Address

WMU/Floyd Hall  
4601 Campus Drive  
Room B-215, Second Floor, West Wing  
Kalamazoo MI 49008

Safety when conducting electrical experiments, as well as any other activity, is a matter of knowing potential hazards, following safety precautions, and common sense. Given the high likelihood that you will work with electrical systems and/or devices in your engineering career, learning basic electrical laboratory safety is an essential element of ECE 2100 Circuit Analysis. There are strict standards for electrical system design, e.g. [1]. Just as you will find as an employee, safety is paramount, and there can be very serious consequences if rules and procedures are not followed.

There are a number of potential hazards present in any electrical engineering laboratory. Therefore, for your safety and the safety of those around you, as well as preventing damage to the laboratory equipment and facilities, it is **imperative** that you observe a number of basic precautions when working in this laboratory.

**ANY EVIDENCE THAT SUGGESTS YOU HAVE FAILED TO OBSERVE ALL SAFETY RULES WILL RESULT IN YOUR IMMEDIATE FAILURE IN THE COURSE. THERE WILL BE NO EXCEPTIONS.**

*Current kills, not voltage.* Currents above 100mA “can be considered lethal” while currents at one-fifth that value are “very dangerous” [2]. The current depends on body resistance, resistance between body and ground and the applied voltage. Even a 42V (constant) DC supply can be fatal [2]. **Therefore, never take a chance on a “low” voltage.**

**Always** observe the following safety rules.

## SAFETY RULES

### General

1. **CALL 911 in the event of an emergency.**  
Be sure that you know your physical address to report to the emergency dispatcher.
2. In an emergency the **MAIN AC** breaker on the main breaker panel located at the front of the lab removes **ALL LAB POWER**. *These controls are to be used in emergencies only.*
3. **WEAR YOUR SAFETY GLASSES WHILE IN THE LAB.**  
Always wear safety glasses! This is **critical**. One potential risk is ejected debris from a failing component or simply bits of expelled wire if you trim wires and component leads (not required). *You must wear safety glasses while in the lab even if you are done with your experiment!*
4. At the conclusion of working on your circuit and after putting your components away,

**WASH YOUR HANDS.** Some components may contain hazardous substances, such as lead.

5. Closed-toe footwear is **required** when working on your circuits. (Flip-flops or sandals are therefore not adequate.)
6. Chairs and stools must be kept under laboratory benches when no one is sitting on them.
7. Students **MUST NOT** plug or unplug test equipment or computers (computers are plugged into blue outlets and all other equipment is plugged into black outlets).
8. Whenever possible avoid having two lab groups working back-to-back. Be extra careful when two groups must work back-to-back.
9. Never use water on an electrical fire. If possible first switch laboratory power off, then use a CO<sub>2</sub> or dry type extinguisher. There is a fire extinguisher in the hallway outside the lab.

*All dwellings are recommended to have a fire extinguisher.*

10. In case of an electric shock, quickly remove the victim from the circuit without endangering yourself. If the victim is not breathing, administer CPR while someone else phones public safety (911) to call for an emergency vehicle. Continue CPR until the victim is revived.
11. No practical jokes of any kind are allowed.

### **Electrical Circuit Safety**

12. Working on an electric circuit deserves your full and serious attention.
13. Do not work alone on energized electrical equipment.
14. Power must be switched off whenever an experiment or project is being assembled or disassembled. After power is removed discharge any high voltage points to ground through an adequately sized and well-insulated resistor.
15. Capacitors can store dangerous quantities of energy, perhaps at a high voltage, even after power is removed. After power is switched off, discharge capacitors through an adequately sized and well-insulated resistor.
16. Make measurements in energized circuits with well insulated probes and one hand behind your back. Do not allow any part of your body to contact any part of the circuit or equipment connected to the circuit. An added advantage of this essential safety practice is that it prevents you from adding an unexpected current path that could compromise the accuracy of your measurements.
  - *To measure voltage or current, connect your multimeter to the circuit prior to applying power.*
  - *Remember that a multimeter configured as an ammeter is a short.*
  - *Never use an ohmmeter in an energized circuit.*
  - *After using a multimeter as an ammeter or ohmmeter, return the multimeter to a voltage measurement configuration.*

17. Never touch electrical equipment while standing on a damp or metal floor.
18. Never touch two pieces of equipment simultaneously.
19. Never handle wet, damp or ungrounded electrical equipment.
20. Wearing a ring or watch can be hazardous in an electrical laboratory since such items make good electrodes for the human body.
  - *Remove all conductive jewelry and watches during your experiments.*
21. Never lunge for a falling part of an energized circuit, such as leads or measuring instruments.
22. Never touch heat dissipating surfaces of high wattage resistors and loads because they can cause severe burns.
23. Never touch even one wire or component of an energized circuit; it may be electrically “hot” (i.e. capable of delivering an electric shock) or hot enough to cause severe burns. Note that even low-voltage small components can become very hot.
24. If your circuit becomes hot (often detected by an odor), immediately turn off and/or disconnect power if it is safe to do so.
25. Some components (particularly large wattage resistors) have exposed metal that is electrically “hot.” Take extra care when working with these components.
26. **NEVER SHORT A BATTERY** as a large dangerous current can flow and the battery can overheat. Insure battery terminals will not touch each other; for example, a piece of non-conductive electrical tape should be placed over 9 V battery terminals during storage. Measure the resistance between battery connection points *before connecting the battery* to be sure that there is a substantial resistance.
27. **NEVER SHORT A POWER SOURCE** (includes a battery, see previous item) as a large dangerous current can flow. Measure the resistance between power source connection points *before connecting the power source* to be sure that there is a substantial resistance. If your power supply has an adjustable current limit, set that control to the lowest setting that provides sufficient current for your correctly-operating circuit.
28. Ask the instructor to check your constructed circuit before applying power.
29. *If you have ANY concerns about a lab procedure, contact your instructor before proceeding!*

### **High Power and Machinery Safety**

30. When using rotating machinery, remove neckties or necklaces.  
Tie-up long hair to prevent hair from becoming entangled in machinery.
31. Keep clear of rotating machinery. Do not be fooled by stroboscopic effects.

32. Never open field circuits of DC motors since the resulting dangerously high speeds may cause a “mechanical explosion”.
33. Keep your eyes well away from arcing points. High intensity arcs may seriously impair your vision and a shower of molten copper may permanently injure your eyes.

### **Laboratory Instrument Safety**

34. Fuse circuits to protect ammeters and wattmeters for the current range being used.
35. Do not drop or bang instruments. They are delicate.
36. Never short circuit a power source.
37. When using instruments connected to the power line, connect all ground leads to the same point. Otherwise, a short circuit may result.
38. When using a voltmeter or ammeter, begin with the highest range and work your way down to a suitable range.
39. When using an ohmmeter, never measure resistance in an energized circuit.
40. Keep instruments away from the edge of the work bench.

### **OTHER RULES**

41. Use safe laboratory practices at all times.
42. No food or drink is allowed in the laboratory.
43. Do not write on bench surfaces or equipment.
44. Report defective equipment and blown fuses to the instructor.
45. Students **must not** replace blown fuses, move instruments from one station to another, or turn on the main or secondary circuit breakers.
46. Put all wastepaper, newspapers, etc. in the wastebasket.
47. Return all equipment and supplies to proper storage locations as applicable.

### **References**

1. A. L. Clapp, *NESC Handbook: A Discussion of the National Electrical Safety Code*. New York: IEEE 2006. [Online resource](#).
2. “How much current is fatal?” *Popular Electronics*, p. 31, January 1972. Available [here](#).

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Adapted from material developed by current and former ECE faculty, including S. Durbin, J. Kelemen, and D. Miller. S. Masihi contributed to this document.

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