Safety

Safety in the electrical laboratory, as everywhere else, is a matter of the knowledge of potential hazards, following safety precautions, and common sense. Observing safety precautions is important due to pronounced hazards in any electrical/computer engineering laboratory. Death is usually certain when 0.1 ampere or more flows through the head or upper thorax and have been fatal to persons with coronary conditions. The current depends on body resistance, the resistance between body and ground, and the voltage source. If the skin is wet, the heart is weak, the body contact with ground is large and direct, then 40 volts could be fatal. Therefore, never take a chance on "low" voltage. When working in a laboratory, injuries such as burns, broken bones, sprains, or damage to eyes are possible and precautions must be taken to avoid these as well as the much less common fatal electrical shock. Make sure that you have handy emergency phone numbers to call for assistance if necessary. If any safety questions arise, consult the lab demonstrator or technical assistant/technician for guidance and instructions. Observing proper safety precautions is important when working in the laboratory to prevent harm to yourself or others. The most common hazard is the electric shock which can be fatal if one is not careful.

Acquaint yourself with the location of the following safety items within the lab.

Department	
Dean's Student Affairs	
Security	
Clinic	

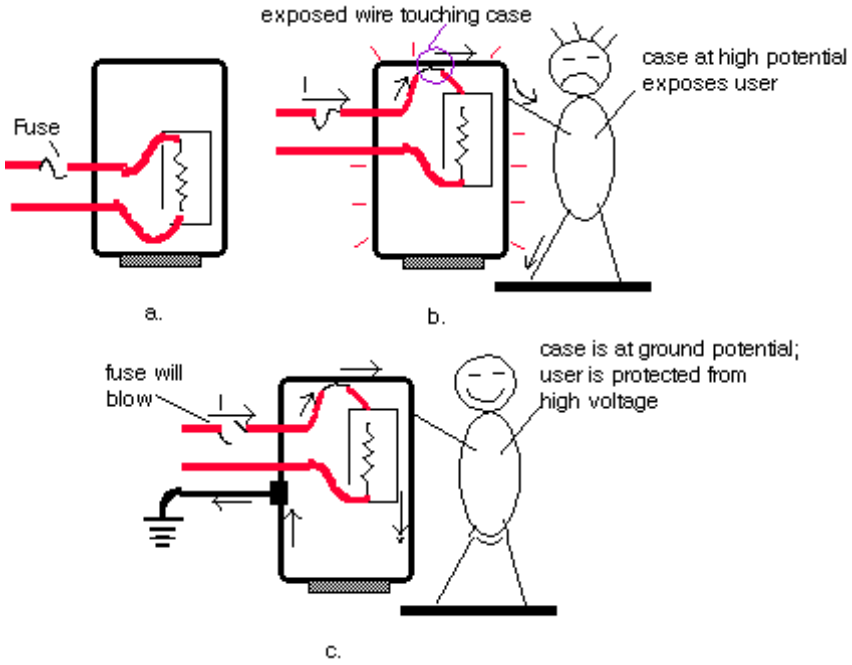
Electric shock

Shock is caused by passing an electric current through the human body. The severity depends mainly on the amount of current and is less function of the applied voltage. The threshold of electric shock is about 1 mA which usually gives an unpleasant tingling. For currents above 10 mA, severe muscle pain occurs and the victim can't let go of the conductor due to muscle spasm. Current between 100 mA and 200 mA (50 Hz AC) causes ventricular fibrillation of the heart and is most likely to be lethal.

What is the voltage required for a fatal current to flow? This depends on the skin resistance. Wet skin can have a resistance as low as 150 Ohm and dry skin may have a resistance of 15 k Ohm. Arms and legs have a resistance of about 100 Ohm and the trunk 200 Ohm. This implies that 240 V can cause about 500 mA to flow in the body if the skin is wet and thus be fatal. In addition skin resistance falls quickly at the point of contact, so it is important to break the contact as quickly as possible to prevent the current from rising to lethal levels.

Equipment grounding

Grounding is very important. Improper grounding can be the source of errors, noise and a lot of trouble. Here we will focus on equipment grounding as a protection against electrical shocks. Electric instruments and appliances have equipments casings that are electrically insulated from the wires that carry the power. The isolation is provided by the insulation of the wires as shown in the figure a below. However, if the wire insulation gets damaged and makes contact to the casing, the casing will be at the high voltage supplied by the wires. If the user touches the instrument he or she will feel the high voltage. If, while standing on a wet floor, a user simultaneously comes in contact with the instrument case and a pipe or faucet connected to ground, a sizable current can flow through him or her, as shown in Figure b. However, if the case is connected to the ground by use of a third (ground) wire, the current will flow from the hot wire directly to the ground and bypass the user as illustrated in figure c.



Equipments with a three wire cord is thus much safer to use. The ground wire (3rd wire) which is connected to metal case, is also connected to the earth ground (usually a pipe or bar in the ground) through the wall plug outlet.

Always observe the following safety precautions when working in the laboratory:

1. Do not work alone while working with high voltages or on energized electrical equipment or electrically operated machinery like a drill.
2. Power must be switched off whenever an experiment or project is being assembled, disassembled, or modified. **Discharge any high voltage points to grounds with a well insulated jumper. Remember that capacitors can store dangerous quantities of energy.**
3. Make measurements on live circuits or discharge capacitors with well insulated probes keeping one hand behind your back or in your pocket. Do not allow any part of your body to contact any part of the circuit or equipment connected to the circuit.
4. After switching power off, discharge any capacitors that were in the circuit. Do not trust supposedly discharged capacitors. Certain types of capacitors can build up a residual charge after being discharged. Use a shorting bar across the capacitor, and keep it connected until ready for use. If you use electrolytic capacitors, do not :

- put excessive voltage across them
- put ac across them
- connect them in reverse polarity

5. Take extreme care when using tools that can cause short circuits if accidental contact is made to other circuit elements. Only tools with insulated handles should be used.
6. If a person comes in contact with a high voltage, immediately shut off power. Do not attempt to remove a person in contact with a high voltage unless you are insulated from them. If the victim is not breathing, apply CPR immediately continuing until he/she is revived, and have someone dial emergency numbers for assistance.
7. Check wire current carrying capacity if you will be using high currents. Also make sure your leads are rated to withstand the voltages you are using. This includes instrument leads.
8. Avoid simultaneous touching of any metal chassis used as an enclosure for your circuits and any pipes in the laboratory that may make contact with the earth, such as a water pipe. Use a floating voltmeter to measure the voltage from ground to the chassis to see if a hazardous potential difference exists.
9. Make sure that the lab instruments are at ground potential by using the ground terminal supplied on the instrument. Never handle wet, damp, or ungrounded electrical equipment.
10. Never touch electrical equipment while standing on a damp or metal floor.
11. Wearing a ring or watch can be hazardous in an electrical lab since such items make good electrodes for the human body.
12. When using rotating machinery, place neckties or necklaces inside your shirt or, better yet, remove them.
13. Never open field circuits of D-C motors because the resulting dangerously high speeds may cause a "mechanical explosion".
14. Keep your eyes away from arcing points. High intensity arcs may seriously impair your vision or a shower of molten copper may cause permanent eye injury.
15. Never operate the black circuit breakers on the main and branch circuit panels.

16. **In an emergency all power in the laboratory can be switched off by depressing the large red button on the main breaker panel. Locate it. It is to be used for emergencies only.**
17. **Chairs and stools should be kept under benches when not in use. Sit upright on chairs or stools keeping the feet on the floor. Be alert for wet floors near the stools.**
18. Horseplay, running, or practical jokes must not occur in the laboratory.
19. **Never use water on an electrical fire. If possible switch power off, then use CO_2 or a dry type fire extinguisher. Locate extinguishers and read operating instructions before an emergency occurs.**
20. Never plunge for a falling part of a live circuit such as leads or measuring equipment.
21. Never touch even one wire of a circuit; it may be hot.
22. Avoid heat dissipating surfaces of high wattage resistors and loads because they can cause severe burns.
23. Keep clear of rotating machinery.

Precautionary Steps Before Starting an Experiment so as Not to Waste Time Allocated

a) Read materials related to experiment before hand as preparation for pre-lab quiz and experimental calculation.

b) Make sure that apparatus to be used are in good condition. Seek help from technicians or the lab demonstrator in charge should any problem arises.

- Power supply is working properly ie I_{max} (maximum current) LED indicator is disable. Maximum current will retard the dial movement and eventually damage the equipment. Two factors that will light up the LED indicator are short circuit and insufficient supply of current by the equipment itself. To monitor and maintain a constant power supply, the equipment must be connected to circuit during voltage measurement. DMM are not to be used simultaneously with oscilloscope to avert wrong results.
- Digital multimeter (DMM) with low battery indicated is not to be used. By proper connection, check fuses functionality (especially important for current measurement). Comprehend the use of DMM for various functions. Verify measurements obtained with theoretical values

calculated as it is quite often where 2 decimal point reading and 3 decimal point reading are very much deviated.

- The functionality of voltage waveform generators are to be understood. Make sure that frequency desired is displayed by selecting appropriate multiplier knob. Improper settings (ie selected knob is not set at minimum (in direction of CAL – calibrate) at the bottom of knob) might result in misleading values and hence incorrect results. Avoid connecting oscilloscope together with DMM as this will lead to erroneous result.
- Make sure both analog and digital oscilloscopes are properly calibrated by positioning sweep variables for VOLT / DIV in direction of CAL. Calibration can also be achieved by stand alone operation where coaxial cable connects CH1 to bottom left hand terminal of oscilloscope. This procedure also verifies coaxial cable continuity.

c) Internal circuitry configuration of breadboard or Vero board should be at students' fingertips (ie holes are connected horizontally not vertically for the main part with engravings disconnecting in-line holes).

d) Students should be rest assured that measured values (theoretical values) of discrete components retrieved ie resistor, capacitor and inductor are in accordance the required ones.

e) Continuity check of connecter or wire using DMM should be performed prior to proceeding an experiment. Minimize wires usage to avert mistakes.

f) It is unethical and unislamic for students to falsify results as to make them appear exactly consistent with theoretical calculations.

INTRODUCTION TO ELECTRONICS LAB -

1. Basic Guidelines
2. Lab Instructions
3. Lab Reports
4. Grading
5. Schedule and Experiment No. (Title)

1. Basic Guidelines

All experiments in this manual have been tried and proven and should give you little trouble in normal laboratory circumstances. However, a few guidelines will help you conduct the experiments quickly and successfully.

1. Each experiment has been written so that you follow a structured logical sequence meant to lead you to a specific set of conclusions. Be sure to follow the procedural steps in the order which they are written.
2. Read the entire experiment and research any required theory beforehand. Many times an experiment takes longer that one class period simply because a student is not well prepared.
3. Once the circuit is connected, if it appears "dead'' spend few moments checking for obvious faults. Some common simple errors are: power not applied, switch off, faulty components, lose connection, etc. Generally the problems are with the operator and not the equipment.
4. When making measurements, check for their sensibility.
5. **It's unethical to "fiddle" or alter your results to make them appear exactly consistent with theoretical calculations.**

2. Lab Instructions

1. Each student group consists of a maximum of two students. Each group is responsible in submitting 1 lab report upon completion of each experiment.
2. Students are to wear proper attire i.e shoe or sandal instead of slipper. Excessive jewelleries are not advisable as they might cause electrical shock.
3. Personal belongings i.e bags, etc are to be put at the racks provided. Student groups are required to wire up their circuits in accordance with the diagram given in each experiment.

4. A permanent record in ink of observations as well as results should be maintained by each student and enclosed with the report.
5. The **recorded data** and **observations** from the lab manual need to be **approved** and **signed** by the **lab instructor** upon completion of each experiment.
6. Before beginning connecting up, it is essential to check that all sources of supply at the bench are switched off.
7. Start connecting up the experiment circuit by wiring up the main circuit path, then add the parallel branches as indicated in the circuit diagram.
8. After the circuit has been connected correctly, remove all unused leads from the experiment area, set the voltage supplies at the minimum value, and check the meters are set for the intended mode of operation.
9. The students may ask the lab instructor to check the correctness of their circuit before switching on.
10. When the experiment has been satisfactory completed and the results approved by the instructor, the students may disconnect the circuit and return the components and instruments to the locker tidily. Chairs are to be slid in properly.

3. Lab Reports

a. Report format and Evaluation:

The following format should be adhered to by the students in all their laboratory reports:

(i)	Objective	(1 mark)
(ii)	Brief Theory	(2 marks)
(iii)	Results	(4 marks)
(v)	Discussion and Conclusion	(3 marks)

Of those listed above each section included in a report should be clearly nominated with the appropriate heading. The information to be given in each section is set out below:

(i) Objective

This should state clearly the objective of the experiment. It may be the verification of law, a theory or the observation of particular phenomena. Writing out the objective of the experiment is important to the student as it emphasizes the purpose for which the experiment is conducted.

(ii) Brief Theory

In this section, the related theory of the experiment must be discussed **briefly**. This section is important to assist student in making conclusion by comparing the experimental results to the theory.

(iii) Results

All experimental results which have been approved by the lab instructor (including graphs) must be attached in the report.

(vi) Discussion & Conclusion

Once the analysis of the results is complete, the student must forms some deductions on the results of his analysis. Usually this involves deducing whether the final results show that the aim of the experiment has been achieved or not, and if they verify some law or theory presented to the student during the lectures. **Comments and comparison asked in the lab manual must be discussed in this section**. In making a decision on the former point, the student should reread the aim; and on the latter, the text book should be referred to, to ascertain whether there is theoretical agreement or not.

The student should give considerable thought to the material that he intends to submit in this section. It is here that he is able to express his own ideas on the experiment results and how they were obtained. It is the best indication to his teacher of whether he has understood the experiment and of how well he has been able to analyze the results and make deductions from them.

It is recommended that the conclusion should be taken up by the student's clear and concise explanation of his reasoning, based on the experimental results, that led to the

deductions from which he was able to make the two statements with which he began the conclusion.

It is very rare for an experiment to have results which are entirely without some discrepancy. The student should explain what factors, in his opinion, may be the possible causes of these discrepancies. Similarly, results of an unexpected nature should form the basis for a discussion of their possible nature and cause.

The student should not be reluctant to give his opinions even though they may not be correct. He should regard his discussion as an opportunity to demonstrate his reasoning ability.

Should the results obtained be incompatible with the aim or with the theory underlying the experiment, then an acceptable report may be written suggesting reasons for the unsatisfactory results. It is expected that the student should make some suggestions as to how similar erroneous results for this experiment might be avoided in the future. The student must not form the opinion that an unsatisfactory set of results makes a report unacceptable.

b. Presentation of Lab Reports:

All students are required to present their reports in accordance with the following instructions.

(i) Reports have to be **written** for submission.

(ii) Writing should appear on one side of each sheet only.

(iii) The students' name & matric number, section number, lab session and the lecturer's name must be printed in block letters at the top left-hand corner of the first sheet of the report. This must be followed in the middle of the sheet by:

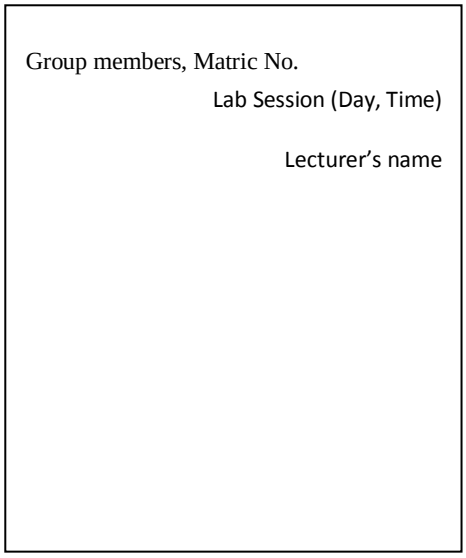
- The course code
- The experiment number
- The title of the experiment
- The date on which the student carried out the experiment.

(iv) All sections such as objective, brief theory and so on, should be titled on the left hand side of the working space of the page.

- Each type of calculation pertaining to the experiment should be preceded by a brief statement indicating its objective.
- All calculations are to be shown in sufficient details to enable the reader to follow their procedure.
- All formulas used are to be written in correct symbols prior to the substitution of the known quantities.

(vi) All graphs are to be drawn on graph paper in blue or black ink. Other colors may be used for identification. The abscissa and ordinate are to be drawn in all times and scaled with the value clearly indicated at each major division. The quantity at each axis represents and the unit in which it is calibrated should be clearly indicated. Each graph is to be titled so as to indicate clearly what it represents.

(vii) The cover of the report **must be** as follows:



4. Grading

The work in the Electronics related lab : The distribution of marks for Electronics Lab is as follows:

Lab Report	10 %
Practice Exam.	10 %
Theoretical Exam	**5%**

6. Schedule & Experiment No. (Title)

Tentative Week	Experiment No. (Title)
2	Experiment No. 1 Diode Characteristics
3	Experiment No. 2 Zener and LED Diode Characteristics
4	Experiment No. 3 (Half Wave Rectifier)
5	Experiment No. 4 (Full Wave Rectifier)
6	Experiment No. 5 Clipper Circuit
7	Experiment No. 6 Clamper Circuit
8	Experiment No. 7 Voltage stabilization with Zener diode
9	Experiment No. 8 BJT Characteristics
10	Experiment No. 9 (Common-Emitter Transistor Amplifier)
11	Experiment No. 10 (JFET Characteristics & Common Source Amplifier)
12	review
13 & 14	Exam