Biomedical Engineering Laboratory (Russ Engineering Center 203) Safety Review

SAFETY PRECAUTIONS

In general, undergraduate biomedical engineering laboratory course experiments and projects do not use voltages greater than 30 V (± 15 V); therefore, the chance of receiving an injurious electrical shock is greatly reduced. However, all voltages do have the potential to burn materials and start fires, destroy electronic components, and present hazards to the person performing the operations. Common sense and an awareness of electrical circuits is important whenever you are working on these experiments.
An electronic technician or student may have to work with high voltages, power tools, and machinery. Before actual work is performed, sufficient instruction should be acquired in the proper use and safety requirements of all electronic devices.

CURRENT HAZARDS AND VOLTAGE

It takes a very small amount of current to pass through the human body from an electrical shock to injure a person severely or fatally. The 60-Hz current values affecting the human body are as follows:

Current Value	Effects
1 mA (0.001 A)	Tingling or mild sensation.
10 mA (0.01 A)	A shock of sufficient intensity to cause involuntary control of muscles, so that a person cannot let go of an electrical conductor.
100 mA (0.1 A)	A shock of this type lasting for 1 second is sufficient to cause a crippling effect or even death.
Over 100 mA	An extremely severe shock that may cause ventricular fibrillation, where a change in the rhythm of the heartbeat causes death almost instantaneously.

The resistance of the human body varies from about 500,000 Ω when dry to about 300 Ω when wet (including the effects of perspiration). In this case, voltages as low as 30 V can cause sufficient current to be fatal: Current = Voltage / Wet Resistance = 30 V / 300 Ω = 100 mA.

Even though the actual voltage of a circuit being worked on is low enough not to present a very hazardous situation, the equipment being used to power and test the circuit (that is, power supply, signal generator, meters, oscilloscopes) is usually operated on 120 VAC. This equipment should have (three-wire) polarized line cords that are not cracked or brittle. An even better safety precaution is to have the equipment operate from an isolation transformer, which is usually connected to workbench. To minimize the chance of getting shocked, a person should use only one hand while making voltage measurements, keeping the other hand at the side of the body, in the lap, or behind the body. Do not defeat the safety feature (fuse, circuit breaker, interlock switch) of any electrical device by shorting across it or by using a higher amperage rating than that specified by the manufacturer. These safety devices are intended to protect both the user and the equipment.

NEAT WORKING AREA

A neat working area requires a careful and deliberate approach when setting it up. Test equipment and tools should be set out on the workbench in a neat and orderly manner. Connecting wires from the test equipment to the circuit under test should be placed so as not to interfere with testing procedures. Before power is applied to a circuit, the area around the circuit should be cleared of extra wires, components, hand tools, and debris (cut wire and insulation).

HAND TOOL SAFETY PRECAUTIONS

Hand tools can be dangerous and cause severe injuries. Diagonal cutters, wire strippers, long-nose pliers, and crimping tools can pinch and cut. Use care in cutting wire since small pieces can become projectiles and hit another person in the face or eye. Screwdrivers should be held properly so that they do not slip and puncture some part of the body. Do not use them as chisels or cutters. A soldering iron should have a holder on which to place it. Care must be used not to burn the body or other materials. Be careful of hot solder, which can splash and cause severe burns, especially to the eyes and face.

IN CASE OF ELECTRICAL SHOCK

When a person comes in contact with an electrical circuit of sufficient voltage to cause shock, certain steps should be taken as outlined in the following procedure:

1. Quickly remove the victim from the source of electricity by means of a switch, circuit breaker, pulling the cord, or cutting the wires with a well-insulated tool.

2. It may be faster to separate the victim from the electrical circuit by using a dry stick, rope, leather belt, coat, blanket, or any other nonconducting material. CAUTION: Do not touch the victim or the electrical circuit unless the power is off.

3. Call for assistance, since other persons may be more knowledgeable in treating the victim or can call for professional medical help while first aid is being given.

4. Check the victim's breathing and heartbeat.

5. If breathing has stopped but the victim's pulse is detectable, give mouth-to-mouth resuscitation until medical help arrives.

6. If the heartbeat has stopped, use cardiopulmonary resuscitation, but only if you are trained in the proper technique.

7. If both breathing and heartbeat have stopped, alternate between mouth-to-mouth resuscitation and cardiopulmonary resuscitation (but only if you are trained).

8. Use blankets or coats to keep the victim warm and raise the legs slightly above head level to help prevent shock.

9. If the victim has burns, cover your mouth and nostrils with gauze or a clean handkerchief to avoid breathing germs on the victim and then wrap the burned areas of the victim firmly with sterile gauze or a clean cloth.

10. In any case, do not just stand there, do something within your ability to give the victim first aid.

Reference: Fundamentals Electronic Devices 2ed, Frederick W. Hughes, Prentice Hall 1990