1.0 ECE 3200 Electronics II: Safety and Laboratory Guidelines
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1.1 SAFETY

Safety in the electrical laboratory, as everywhere else, is a matter of the knowledge of potential hazards, following safety precautions, and common sense.

There are a number of hazards present in any electrical engineering laboratory. Therefore, for you and your partner’s personal safety, as well as the safety of the equipment, it is imperative that you observe a number of basic precautions when working in this laboratory.

Death is usually certain when 0.1 ampere or more flows through a person's head or upper thorax. Currents of one quarter to one half this value have been fatal to persons with coronary conditions. The current depends on body resistance, resistance between body and ground and the voltage source. If the skin is wet, the heart is weak, the body contact area with ground is large and direct, then 40 volts could be fatal [1]. Therefore, never take a chance on a “low” voltage.

Always observe these precautions when working in the laboratory.

FAILURE TO OBSERVE ALL SAFETY RULES WILL RESULT IN YOUR REMOVAL FROM THE LABORATORY AND FAILURE IN THE LAB AND THUS THE COURSE.

General

1. Always wear safety glasses!

2. Substantial footwear is required. No flip-flops or sandals are allowed.

3. In an emergency ALL BENCHTOP POWER SUPPLIES in the laboratory can be switched off by depressing the large red buttons ON THE WALLS. Locate these switches. The MAIN AC breaker on the main breaker panel removes ALL LAB POWER. These controls are to be used in emergencies only.

4. Never operate circuit breakers on the main panel except as in item 3 above.

5. Chairs and stools should be kept under laboratory benches when no one is sitting on them.
6. Whenever possible avoid having two lab groups working back-to-back. Be extra careful when two groups must work back-to-back.

7. Never use water on an electrical fire. If possible first switch laboratory power off, then use a CO2 or dry type extinguisher. Identify the location of all extinguishers in or near the lab.

8. 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.

9. Running or practical jokes are not tolerated.

**Electrical Circuit Safety**

1. Do not work alone on energized electrical equipment.

2. Power must be switched off whenever an experiment or project is being assembled or disassembled. Discharge any high voltage points to ground with a well-insulated jumper. Remember that capacitors can store dangerous quantities of energy.

3. Make measurements in live 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.

4. Never touch electrical equipment while standing on a damp or metal floor.

5. Never handle wet, damp or ungrounded electrical equipment.

6. Wearing a ring or watch can be hazardous in an electrical laboratory since such items make good electrodes for the human body.

7. Never lunge for a falling part of a live circuit such as leads or measuring instruments.

8. Never touch two pieces of equipment simultaneously.

9. Never touch even one wire of a circuit; it may be “hot” (i.e. capable of delivering an electric shock).

10. Avoid heat dissipating surfaces of high wattage resistors and loads because they can cause severe burns.

11. Some components (particularly large wattage resistors) have exposed metal that is electrically “hot.” Take extra care when working with these components.

12. Ask the instructor to check out your constructed circuit before applying power.

**High Power and Machinery Safety**

1. When using rotating machinery, stick your necktie or necklaces inside your shirt or better
yet, remove them completely.

2. Keep clear of rotating machinery. Do not be fooled by stroboscopic effects.

3. Never open field circuits of DC motors because the resulting dangerously high speeds may cause a “mechanical explosion”.

4. 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

1. Fuse circuits to protect ammeters and wattmeters for the current range being used.

2. Do not drop or bang instruments on the lab tables. They are delicate.

3. Never short circuit a power source.

4. When using instruments which are connected to the power line, connect all ground leads to the same point. Otherwise, a short circuit may result.

5. When using a voltmeter or ammeter, begin with the highest range and work your way down to a suitable range.


7. Keep instruments away from the edge of the work bench.

OTHER RULES

1. Use safe laboratory practices at all times.

2. No food or drink is allowed in the laboratory.

3. Do not write on bench surfaces or equipment.

4. Report defective equipment and blown fuses to the instructor.

5. Students must not replace blown fuses, move instruments from one station to another, or turn on the main or secondary circuit breakers.

6. The instructor has to inspect and initial your data before circuit disassembly.

7. Put all wastepaper, newspapers, etc. in the wastebasket.

8. Return all equipment and supplies to proper storage locations.

References
1.2 TYPICAL LABORATORY SEQUENCE

This section outlines the steps needed for completion of a typical ECE 3200 laboratory.

1. Well in advance of the lab, students complete any pre-laboratory exercises. Pre-labs must meet the requirements for submitted assignments as described in section 1.3 and are due at the beginning of the laboratory session. Frequently information in the pre-lab is needed during the experiment, such as simulation results, theoretical analyses, formulas, etc. HENCE YOU SHOULD PLACE A COPY OF SUCH INFORMATION IN YOUR LAB NOTEBOOK BEFORE LAB. This will enable you to verify that your experimental results are consistent with your pre-lab analysis.

2. Students come to the lab, sign the attendance sheet, and turn their pre-labs in. THERE MAY BE A QUIZ ON THE CONTENTS OF THE LABORATORY.

3. The lab instructor may lecture on the lab. This information, as with all information gained from the lab, goes in the lab notebook.

4. After the lecture by the lab instructor, students work in groups of two’s (ONE group of three is allowed for the case of an odd number of students) on the experiment. Experimental data MUST be compared to the theoretical analysis/simulation results WHILE YOU ARE IN THE LAB. All work is recorded in the laboratory notebook (refer to section 1.4). Plot your experimental values on your simulation results. This provides you with a high degree of confidence that you conducted the experiment properly or indicates a problem with either your theoretical and/or experimental results.

5. After completing the lab, have the lab instructor initial your results. ALL LABS MUST BE INITIALED WITHIN TWO WEEKS OF THE ASSIGNED LAB DATE TO RECEIVE CREDIT. ALSO, DO NOT DISASSEMBLE YOUR CIRCUIT UNTIL THE LAB HAS BEEN SIGNED OFF.

6. THE LAB INSTRUCTOR WILL LET YOU KNOW WHEN A PARTICULAR REPORT FOR A PARTICULAR EXPERIMENT IS DUE. Reports must be prepared according to section 1.5.

1.3 Pre-Laboratory Assignments

Pre-laboratory assignments should be stand-alone documents. Arrange your pre-lab assignments in the following order:
1. cover sheet
2. summary - concisely describe what was done in the pre-lab and provide important results (e. g. component values used in your design, key circuit parameters, etc.). Use tables whenever possible. Some SPICE output might appear here (e. g. important figures).
3. Calculations, SPICE results, etc.

Be sure to include a schematic (with node assignments as used in SPICE simulations). Include SPICE listings as an APPENDIX. Simply turning in SPICE listings/results will earn no credit. If the pre-lab includes a design problem, demonstrate how closely your design meets the specifications (do not blindly trust SPICE — find a way to verify the results!). Also use the check list included in section 1.6.

1.4 The Laboratory Notebook

Laboratory notebooks provide a convenient tool to maintain a permanent and accurate record of your laboratory work. Such a record is essential and is often required by employers. Remember that the person most likely to refer back to these notebooks several weeks or even years later will most likely be you! A notebook is invaluable in documenting and organizing research. You may find that using a notebook is also useful in other personal and professional activities.

ECE 3200 LABORATORY NOTEBOOK REQUIREMENTS AND GUIDELINES

1. The notebook must be permanently bound (not loose-leaf) with a minimum of 60 sheets. Each sheet should have a square grid (4 or 5 divisions/inch is convenient) and be of 8.5 x 11 inch size. A spiral bound notebook is preferred since it will easily lie open on the lab tables. If the pages are not numbered, number them. Be sure to reserve several pages at the beginning for “global” information and a table of contents which may be entered as you fill the notebook.

2. The table of contents must consist of three columns: (1) date(s) that the work was performed, (2) title of the laboratory, and (3) space for the instructor to initial your notebook data for that lab.

3. Use a PEN for ALL entries in the notebook.

4. Put your name, the name of your lab partner, course number, and section number both on the cover and on the first page. If your lab partner changes, appropriately and clearly note the name of the new lab partner and the date of change.

5. Each page of the notebook must be numbered and contain material pertaining to only one experiment. Entry dates must be indicated.
6. If additional materials such as graphs and computer outputs are entered into the notebook, fasten them (e.g. tape or paste) securely and trim edges to prevent their protrusion from the notebook.

7. Enter data and calculations into the notebook **AS YOU WORK. DO NOT** take data on loose sheets or scraps of paper and later copy it into the notebook. Erasure of notebook entries is bad practice and is discouraged. Simply cross out mistakes, do not obliterate them. Often what appears at first to be a mistake will later be found to contain useful information.

8. Laboratory instruction sheets may be attached to pages of the notebook, however the sheets should be trimmed so that they do not protrude from the notebook.

9. Neatness and legibility are **VERY** important.

10. The following is a list of items that would appear in a well planned and executed laboratory notebook for **EACH** laboratory exercise. Use this list as a guide for your entries:
    a. Title, date, and name of lab partner
    b. Pre-lab calculations
    c. Measurement preparations and circuit diagrams
    d. Lab lecture notes
    e. Original data
    f. Calculation of theoretical values and data analysis
    g. Data presentation clearly showing discrepancies between experimental and theoretical values
    h. Answers to questions and conclusions, i.e. discuss discrepancies between experimental and theoretical values and on this basis clearly assess whether the objectives of the experiment were attained.

1.5 The Laboratory Report

The laboratory report is often the primary means of communicating the results of your work to your peers and superiors. A well organized report permits them to easily and quickly understand your work and it is also a reflection of **YOUR** ability to accomplish objectives and communicate information. You will be required to prepare several reports in this course.

The technical level of the report should be varied depending on the background of the reader. Frequently the reader’s background will be similar to yours and the reader **SHOULD BE ABLE TO DUPLICATE THE ENTIRE EXPERIMENT USING ONLY YOUR REPORT.**

Reports will be arranged as follows:

1. TITLE PAGE
2. TABLE OF CONTENTS
3. TABLE OF FIGURES
4. LIST OF TABLES
5. SUMMARY
A summary must concisely state at least the following:
   a. What the author has done
   b. How it was done (if that is important)
   c. The principle results
   d. The significance of the results

6. RESULTS
   This is the main body of the report. Describe your results, how you obtained your data, theoretical analyses, simulation results, etc.

7. CONCLUSIONS
   Present conclusions supported by the results of the laboratory.

8. REFERENCES
   DO NOT PLAGIARIZE! Be sure to cite any references used in the preparation of your report. Number each reference and use this number to identify the source of paraphrased information, direct quotes, and figures as they are introduced in the report.

The report should be typed but may be carefully written longhand in ink or with a very soft pencil lead on plain paper. The report must be “reproducible” using conventional (black and white) photocopying means. Note that color coding is lost in black and white reproduction and hard pencil lead usually produces uncopyable characters. Use only one side of the sheet and DOUBLE SPACE ALL TEXT. Always leave sufficient room for binding. DO NOT “hide” text in the binding of punch binding holes in the text. These problems frequently occur when hard copy from computer programs is included in reports.

We will otherwise follow the guidelines in your technical writing reference for preparation of the laboratory reports. Use the list of section 1.6 to check your report before turning it in.

A RULE THAT SOMETIMES HELPS PRODUCE EXCELLENT RESULTS IS AS FOLLOWS:

Write your reports such that a student at a different university who is at the same stage in their education as you but who is not familiar with the details of the experiment, could, from your report alone, repeat the experiment, obtain similar results (both experimental and theoretical) and arrive at the same conclusions you did. As you write, modify and review what you’ve written, frequently place yourself in your reader’s “shoes” and make your modifications to best serve your reader.

1.6 Partial Checklist for ANY Submitted Laboratory Assignment

1. The first page of any assignment must include:
   a. Author’s name
   b. Due date
   c. Date of submission if different than due date
   d. Lab partner’s name if there was a lab partner for the assignment
   e. Name/title of the assignment
2. Include references used.
3. All text must be DOUBLE SPACED.
4. All pages must be numbered.

5. All graphs, charts, computer hard copy, etc. must have:
   a. a figure number (Arabic numeral) and a caption (DON’T group all figures together at
      some point in the report, disperse them appropriately throughout).
   b. a title
   c. labeled and enumerated axes
   d. a symbols key for multiple curve graphs
   e. notes of explanation

6. Do not “connect the dots” when plotting experimental values on graphs. Instead, plot each
   point using a suitable symbol. Use distinct symbols for experimental points obtained under
   different conditions. Provide a symbol legend.

7. All tables must have:
   a. a title
   b. a Roman numeral table number, e.g. “TABLE III”

8. Define symbols, parameters, and variables.

9. Show sample calculations where appropriate.

10. When instructed to compare numerical results, always calculate % difference or % error or
    some such numerical quantity making sure to indicate the reference parameter for
    calculation.

11. Write in the third person passive voice, not in the first person active voice.

12. If the report is to be bound along a complete edge, leave sufficient binding margin on each
    page. Avoid this problem by stapling only in upper left corner.

13. Don’t color code information that may be lost in a black and white copy. Geometric symbols
    can be used instead of colors for coding.

14. Briefly but clearly annotate your document in a way which will provide the document reader
    with information such as:
        a. which part of the assignment is this?
        b. what is being done and why?
        c. how was it done and what are the results?
        d. how was this equation obtained and how was it used?
        e. sample calculations and definitions of symbols and parameters.
        f. judging from the professional manner of information presentation in this document,
           this author obviously has a keen sense of professional pride.

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