Mbarara University of Science & Technology
Faculty of Applied Sciences and Technology
Department of Electrical and Electronics Engineering

Laboratory Procedures, Instructions and Manual

Course Name:	Circuit analysis and design
Course Code:	BME2202
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1. Laboratory Rules and Regulations

A. Accessing the Laboratories

a) Unauthorized entry into laboratories is strictly prohibited. No entry into the labs will be granted after closing hours and before opening hours

b) Entry and use of any laboratory and/or equipment is subject to availability, and timetabled practical sessions take precedence over personal work.

c) The lab technician reserves the right to refuse entry and access to the laboratory or to certain sections of the lab.

d) No equipment or furniture should be carried out of the laboratory without authorisation.

e) Vandalising and damaging lab equipment and furniture is strictly prohibited. Any such reckless activity will lead to the invocation of serious disciplinary action.

f) Strictly no food or drinks should be taken into the laboratory

g) Emergency exits should be kept clear at ALL times.

B. Laboratory Rules and Safety

1. Before the Lab Session

a) Always wait for instructions from your instructor before proceeding with the lab exercise

b) Risk assessment and identifying hazardous material: always assess the riskiness of equipment and materials by studying the danger and warning labels. Always read identification labels:

- What is it?
- What harm can it cause?
- Basic precautions for storage, handling, and use

Never handle any substance unless:

- You know what it is
- You know how to handle it

c) Compressed air

- Hoses under pressure have to be secured.
- Only use appropriate air nozzles with relief valves
- Improper nozzles can inject air into the skin
- Air can enter the blood stream, reach the heart, and cause heart failure and/or death

2. During the Lab Session

a) Turn off and unplug equipment before removing the protective cover to clear a jam, replace a part, or troubleshoot. Always ask a qualified person to open equipment if this will create exposure to energized parts operating at 50 volts or more.

b) Ensure that the power is OFF before you start connecting up a circuit. Get your circuit diagram approved by the instructor first, and then connect up the circuit strictly as per the approved circuit

c) Do not use an electrical outlet or switch if the protective cover is ajar, cracked or missing.

d) Only use DRY hands and tools and stand on a DRY surface when using electrical equipment, plugging in an electric cord.

e) Never put conductive metal objects into energized equipment. Avoid wearing metallic, loose jewellery such as rings, watches, neck chains, bracelets, etc.

f) Always pick up and carry portable equipment by the handle and/or base. Carrying equipment by the cord damages the cord's insulation.

g) Unplug cords from electrical outlets by pulling on the plug instead of pulling on the cord.

h) Re-route electrical cords or extension cords so they are not run across the floor, under rugs or through doorways, etc. Stepping on, pinching, or rolling over a cord will break down the insulation and will create shock and fire hazards.

i) Do not overload extension cords, multi-outlet strips and wall outlets.

j) Heed the warning signs, barricades and/or guards that are posted when equipment or wiring is being repaired or installed or if electrical components are exposed.

k) Always wear closed, rubber-soled flat shoes in the laboratory. Restrain long hair and refrain from wearing loose clothing.

l) Only handle volatile chemicals under a fume hood and use mechanical transfer devices for toxic chemicals.

m) In case you notice any abnormal condition in your circuit (like insulation heating up, resistor heating up, etc.) switch off the power to your circuit immediately and inform the instructor immediately

n) Always keep hot soldering irons in their holders when not in use.

3. After the Lab Session

a) Clean up all workspaces and properly dispose of waste in the waste bins

b) Return any equipment and apparatus to their designated storage positions

c) Lock/tag out any equipment found to be defective

d) Turn off:

- Water, gas, and power supplies
- Heating apparatus
- Lights

e) Lock the door upon exiting

C. Handling Emergencies

a) Ensure that you know the location of all emergency exits, and keep these clear of obstacles at all times

b) In case of a fire, exit the laboratory and building immediately. Do not attempt to put out the fire using materials other than the fire extinguisher.

c) Contact your instructor/lab technician immediately in case of any injuries or accidents

2. Laboratory Notes

All students are encouraged to purchase a Laboratory Notebook. As a part of training to be a scientist, students should maintain a personal notebook just as a research scientist does. This lab notebook will not be graded, but the student must have one and use it. A lab notebook with a sewn-together binding is preferred.

Here is a guideline for lab notebooks: a notebook should contain sufficient detail so that useful information and data can be obtained at a later time when you are writing your lab report, which will be marked. In the notebook, the student should:

- Draw a schematic diagram for every circuit that is built. Label this diagram with part numbers, pin designations, output/input designations, show the major connections to external power supplies, etc.
- List the instruments used by type and model, oscilloscope, multimeters, function generators, etc.
- Draw the appearance of the oscilloscope display, if used and indicate the vertical and horizontal scales, with units record a table of all measurements. include units (e.g. mV) for inputs and outputs.
- Always list more than one measurement as an error check

3. Preface

3.1 Aims and Objectives

To examine the working of 3-terminal regulators as amplied to power supplies.

3.2 Equipment

- Prototyping board
- Power supply
- Digital multimeter
- Variac
- 3-terminal regulator 78L05 in TO-92 package [for 3-term. regulator]

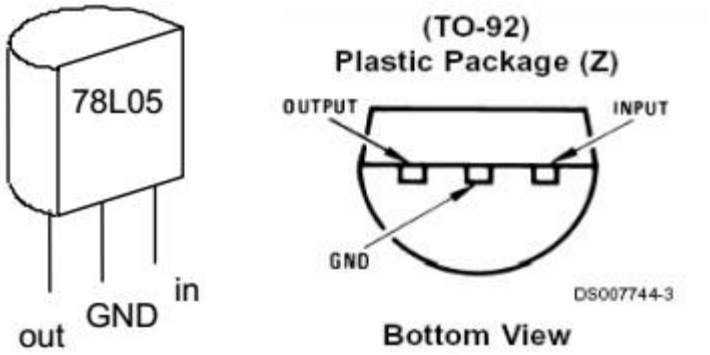
3.3 References

This lab handout is intended for use with the following textbook:

4. Experiment Guidelines and Instruction

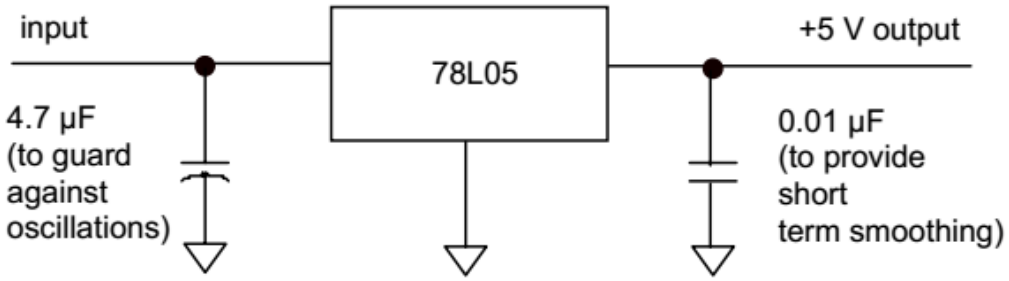
Voltage regulation with 3-terminal regulator

3-terminal voltage regulators are easy to use. From the outside it looks like a transistor, but on the inside there is a good regulator that makes use of negative feedback. It features thermal protection so that it is hard to burn up.



(a) Simple test

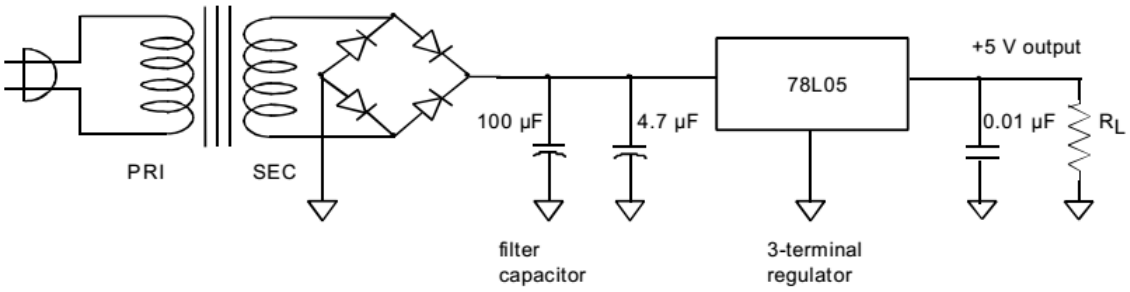
- Connect the 78L05 regulator on your prototyping board, as shown below. For an input, use the +12 Volt power supply that is built into your prototyping board, or an external power supply set to about +10 V.



- Confirm that the output is +5 Volts.
- An ideal voltage regulator supplies the same output voltage,
  - regardless of the input voltage, as in test (c), below
  - regardless of the output load, as in test (d), below

(b) Use as a power supply regulator

- Now connect the input of the 78L05 regulator, as shown below, to the output of the power supply you built in step 3. Include a 1 kΩ load resistor.



- Turn on the power supply, and observe the output voltage.
- Compare to the filtered output without regulation, as measured in step 2.

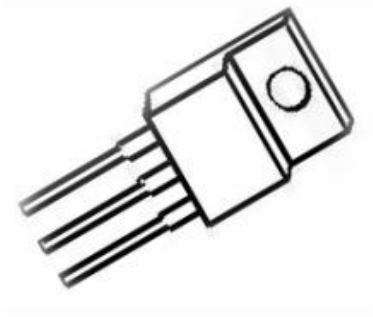
(c) Regulation as the input voltage is varied

- Now plug the transformer of your power supply into a variac instead of into 110 VAC. Connect a multimeter to measure the Volts ac from the variac
- Set RL to 1 kΩ.
- Adjust the variac output voltage, beginning at110 VAC and going downward, using the printed scale on the top of the variac. (Caution: Do not operate the variac at voltages above 110 V)
- Confirm that the regulator maintains the same +5 Volt output over a wide range of AC voltage (typically from 80 to 110 VAC).

(d) Regulation as the load is varied

- Disconnect the variac. Connect your multimeter to measure current through the load. **CAUTION**: In this step, to protect the decade box, always keep 50 or 100 Ω switched in while you adjust the other scales. This precaution will keep you from accidentally setting the decade box to zero resistance. **CAUTION**: As always, measure current beginning with the meter set to the highest scale.
- Set RL to about 10 kΩ, and vary it downward.

TO-92 package



TO-220 package

- Note the load resistance at which ripple begins to appear. What current value does this correspond to? (This is the maximum regulated current.)

(e) Thermal protection

- Continue to decrease the load resistance. Does the output of the regulator shut down when the current exceeds a certain threshold? This is the current limit of your regulator. [To work, this shut-down test requires using a regulator in the TO-92 package; don't use a larger package like TO-220 (LM78M05CT) for this lab -- it won't shut down under these conditions.]
- An advantage of these three-terminal regulators is the shutdown feature. Another alternative for voltage regulation is the zener diode in the next experiment, but zeners do not have thermal protection, so you must be careful to select the right one and use it within its design parameters.

3 Lab Report Format

For each Lab, students will individually prepare a lab report for grading. This report is **not** the same as the lab notebook, and the notebook is not a substitute. Reports should be organized as a brief introduction, and then an experimental section that is organized according to the section number.

- **Preface**: a brief introductory paragraph, ≈30 words, describing the report's theme
- **Experiment**: Apparatus, Procedure (a maximum of three sentences to explain: what was **measured**, how it was measured, what was varied, how errors were estimated*
- **Results**: where it is appropriate, this should include: table and/or graph of results, label each curve and draw smooth curves through data points, label axes and indicate units, sketch or print of the oscilloscope display, if one was used.
- **Discussion**: Briefly answer the questions (if any) posed in the lab procedure. Also discuss, in a few sentences the features of the outputs to demonstrate that you understand their significance
- **Conclusions**: Draw conclusions from the results you obtained and give reasons/explanations for any discrepancies noted. Provide recommendations (if any).
- **Appendix**: In this section, attach any screenshots, photos of graphs, etc that are too long to fit in the main body of your report.

Handwritten lab reports are adequate, but typewritten reports are also welcome. Be brief, but write in clear, complete sentences.

<u>Report Grading Breakdown</u>

Executive summary	20%
Discussion of results	20%
Sample calculations	20%
Conclusions	20%
Appendix	10%
English usage, completeness, neatness	10%