Laboratory Manual

EE-153L – Introduction to Electrical Engineering

Fall 2025

Instructor

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Lab Engineers

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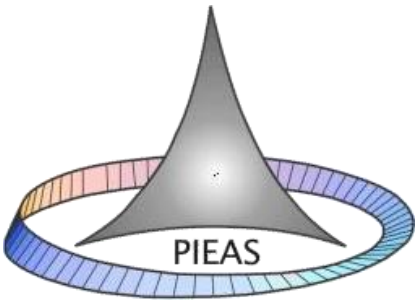

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LABORATORY REGULATION AND SAFETY RULES

The following regulation and Safety rules must be observed in Laboratory.

1. **Safety** is everyone's responsibility. Everyone must cooperate to create the safest possible working conditions. Where your personal life and good health are concerned, safety becomes your responsibility. Safety rules are common sense ideas that help prevent injury. When you work with electricity, treat it with respect. If electricity is properly used, it will work for you. Abuse it and you may have trouble.

   Be sure that all the equipment is properly working before using them for laboratory exercise. Any defective equipment must be reported immediately to the Lab Instructor.
2. **Instruction during Lab experiment:** Make sure that last connection to be made is your circuit is the power supply and first thing to be disconnected is also power supply. Before giving power supply, always check for short circuit conditions. Equipment should not be removed, transferred to any location without permission from the laboratory staff. Hold test probes by their insulated areas. Some components, such as Resistors, Heat Sinks can get very hot. Always give them time to cool before touching them.
3. **Responsibility:** It is responsibility of each student working on allocated work station: Switch off the equipment, place the tools & components on their proper place before leaving the laboratory.
4. **Lab Report:** Report of each lab experiment required to be verified before next experiment, late report submission will *NOT* be evaluated in the end. Follow the lab report format as recommended by Lab Instructor.
5. **Make Up Lab:** There will be *No* Make-up lab for individual or a group of students in case of Leave or absent from regular lab session.

EE-153 Electrical Engineering Lab CLOs

No.	Learning Outcome	Knowledge Domains
	Upon completion of this course, students will be able to	
1	FOLLOW experiment procedures and OPERATE laboratory instruments with confidence	P2
2	CONSTRUCT and ANALYZE basic circuits	P3
3	COMMUNICATE clearly and effectively through presentation and/or report	A2
4	JOINS team work affectively by active participation and cooperation	A3
5	MAINTAIN lab discipline and FOLLOW rules and regulations of the lab	A3

Course Learning Outcomes and their relation to the Program Learning Outcomes

Sr. No.	Criterion 2 - Program Learning Outcomes (PLOs)	Level of Emphasis of PLO (1: High; 2= Medium; 3=Low)	CLOs
(i)	Engineering Knowledge		
(ii)	Problem Analysis		
(iii)	Design of solutions	1	2
(iv)	Investigation		
(v)	Modern Tool Usage	1	1
(vi)	The Engineer and Society		
(vii)	Environment and Sustainability		
(viii)	Ethics	2	5
(ix)	Individual and Teamwork	1	4
(x)	Communication	1	3
(xi)	Project Management		
(xii)	Lifelong Learning		

Lab Rubrics

Electrical Engineering EE-153 L

CLO No.	Criterion (Points)	1 (Very Weak)	2 (Weak)	3 (Moderate)	4 (Strong)	5 (Very Strong)
1	**(FOLLOW) Pre-Lab (10 Points)**	• Pre-lab tasks not completed	• Pre-lab tasks partially completed with mistakes	• Pre-lab tasks partially completed	• Pre-lab tasks completed with mistakes	• Pre-lab tasks completed neatly and with no mistakes
	(OPERATE) Set-up and Equipment Use (10 Points)	• Set-up of equipment is not accurate; help is required with several major details • Often requires help from the instructor to use the tools and instruments	• Set-up of equipment is generally workable with several details that need refinement. • Sometimes requires help from the instructor	• Set-up of equipment is generally accurate with 1 or 2 small details that need refinement. • Requires help from the instructor to use the tools and instruments	• All equipment accurately placed • Can used the tools and instruments with some help by the instructor	• All equipment accurately placed, very neat and organized • Can use the tools and instruments without guide from the instructor
2	**(CONSTRUCT) Design Procedure (10 Points)**	• Lacks the appropriate knowledge of the lab procedures • Often requires help from the instructor to even complete basic procedures	• Demonstrates general knowledge of lab procedures • Requires help from instructor with some steps in procedures	• Demonstrates good knowledge of the lab procedures • Will ask peers for help with problems in lab procedures • Works to follow each step before moving on to the next step	• Demonstrates sound knowledge of lab procedures • Will discuss with peers to solve problems in procedures • Carefully follows each step	• Demonstrates very good knowledge of the lab procedures • Gladly helps other students to follow procedures • Thoroughly and carefully follows each step before moving on to next step
	(ANALYZE) Data Collection (20 Points)	• Measurements are incomplete, inaccurate and imprecise	• Measurements are somewhat inaccurate and very imprecise	• Measurements are mostly accurate • Observations	• Measurements are accurate with reasonable	• Measurements are both accurate and precise

CLO No.	Criterion (Points)	1 (Very Weak)	2 (Weak)	3 (Moderate)	4 (Strong)	5 (Very Strong)
		• Observations are incomplete or not included	• Observations are incomplete or recorded in a confusing way	are generally complete • Work is organized	precision • Observations are thorough	• Observations are very thorough and may recognize possible errors in data collection
3	**Report Structure and Format (40 Points)**	• Report has serious spelling, formatting, and grammar mistakes • Multiple sections of the lab report are missing • Symbols, units and significant figures are not included • Rubric sheet is not attached	• Report has many spelling, formatting, and grammar mistakes • Many sections of the lab report are missing • There are several minor errors using symbols, units and significant digits or a few major errors • Rubric sheet is not attached	• Report has some spelling, formatting or grammatical errors • All parts are present but not in correct order • Only 2 or 3 minor errors using symbols, units and significant digits • Rubric sheet is attached	• Report is typed but has few spelling, formatting or grammatical errors • All parts are present but some are not in correct order • Includes symbols, units and significant digits • Rubric sheet is attached	• Report is typed with good spelling, formatting, and grammar • All parts of lab report are present in correct order • Includes appropriate symbols, units and significant digits • Rubric sheet is attached
4	**Team Work (10 Points)**	• Team member doesn't pay attention to the lab objectives while others are working	• Limited contribution to achieving lab objectives. • Lacks engagement and initiative.	• Contributes to achieving lab objectives. • Engagement and initiative are inconsistent.	• Actively contributes to achieving lab objectives. • Demonstrates good engagement and initiative.	• Consistently and actively contributes to achieving lab objectives. • Demonstrates a high level of engagement and initiative.
5	**Punctuality, Dressing, and Safety Compliance**	• Consistently arrives late and unprepared for	• Frequently arrives late and/or unprepared for	• Generally, arrives on time, but occasional	• Almost always arrives on time and	• Consistently arrives on time and well-prepared for

CLO No.	Criterion (Points)	1 (Very Weak)	2 (Weak)	3 (Moderate)	4 (Strong)	5 (Very Strong)
	(30 Points)	lab sessions. • Consistently disregards lab attire guidelines. Appearance lacks professionalism. • Consistently disregards standard safety procedures. Demonstrates a lack of understanding of safety priorities.	lab sessions. • Frequently deviates from lab attire guidelines. Appearance occasionally lacks professionalism. • Frequently deviates from standard safety procedures. Shows limited understanding of safety priorities.	lateness or lack of preparation. • Generally, follows lab attire guidelines, with occasional lapses. Appearance is mostly professional. • Generally, follows standard safety procedures, with occasional lapses. Demonstrates a basic understanding of safety priorities.	adequately prepared for lab sessions. • Usually adheres to appropriate lab attire guidelines. Maintains a professional appearance. • Mostly adheres to standard safety procedures. Prioritizes safety in the majority of lab activities.	lab sessions. • Always adheres to appropriate lab attire guidelines. Demonstrates a high standard of professionalism in appearance. • Demonstrates excellent adherence to all standard safety procedures. Consistently prioritizes safety in all lab activities.

Experiment 2

Introduction to Electrical Laboratory, Trainer Board, DC Sources, Meters, Probes and Connectors

2.1 Objective

The objective of this exercise is to become familiar with the operation and usage of basic DC electrical laboratory devices, namely DC power supplies and digital multimeters.

2.2 Equipment

- Digital Multimeter Model: _____
- Analog / Digital Trainer Model: _____
- Adjustable DC Power Supply Model: _____

2.3 Bread Board

The breadboard is a tool used for prototyping and testing circuits without soldering. It consists of two main sections: bus strips and terminal strips. The bus strips, also called power rails, are long rows usually located along the top and bottom edges of the breadboard. They are used to distribute power (Vcc) and ground (GND) throughout the circuit. The terminal strips**,** located in the center area, are used for placing components such as resistors, LEDs, and integrated circuits (ICs). These holes are grouped in rows of five connected points, which makes it easy to interconnect components. The center of the terminal area has a divider that electrically separates the two sides. The holes are spaced 0.1 inch (2.54 mm) apart, which is the standard spacing for most electronic components. For connections, solid core hookup wires of 22–24 AWG are recommended. Using wires that are too thick may damage the breadboard's contacts, while wires that are too thin may not form secure connections.

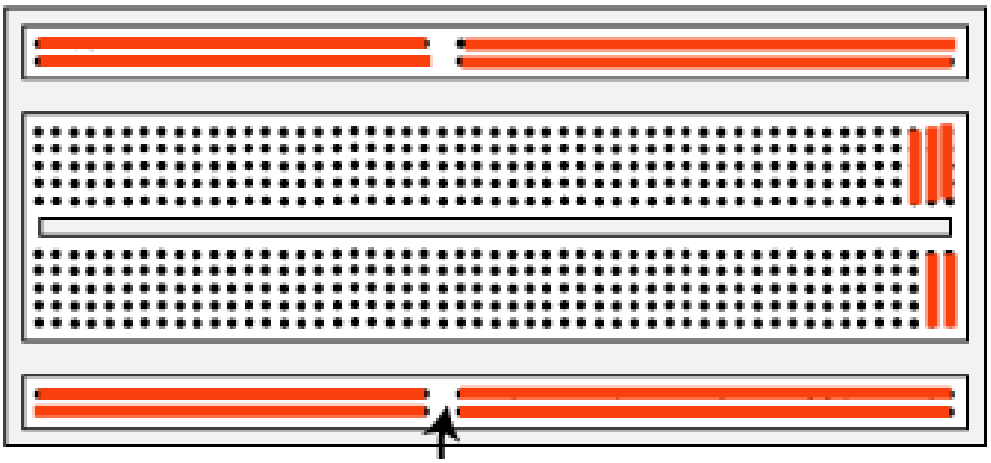

Figure 2.1: Bread Board

2.4 Analog / Digital Trainer

- Multi-rail DC power supply
- A four range digital volt meter.
- Function generator along with a large area of breadboard.
- Logic switches and LED indicators.
- Bread Board

Figure 2.2: Analog / Digital Lab Trainer

2.5 Digital Multimeter

Multi Meter is an instrument used to measure current, voltage, resistance etc. Below table indicate the rotary switch positions

V~	AC Voltage Measurement (UT61D only)
V⎓	DC Voltage Measurement (UT61D only)
Ω	Resistance Measurement
⊣◀	Diode Test
•))	Continuity Test
⊣⊢	Capacitance Test
Hz %	Frequency and Duty Cycle Test
℃	Temperature in Celsius (UT61B and UT61C only)
℉	Temperature in Fahrenheit (UT61B and UT61C only)
hFE	Transistor (UT61A only)
μA ≂	DCA and ACA Measurement
mA ≂	DCmA and ACmA Measurement
10A ≂	10A DC and AC Measurement
EF	Sensor Test (UT61A only)
OFF	Power off

Table 1.1: DMM Rotary Switch Positions

Figure 1.3: Digital Multi Meter

- **DC/AC Voltage Measurement**
    - Insert red test lead into the V terminal and black test lead into the COM terminal
    - Set the rotary switch to V; DC measurement is default or press BLUE button to switch between DC and AC measurement mode.
    - Connect the test lead across with the object being measured. The measured value shows on the display.
- **DC/AC Current Measurement**
    - When the testing leads are connected to the current terminals, do not parallel them across any circuit.
    - Insert the red test lead into the mA or A input terminal and the black test lead into the COM terminal.
    - Set the rotary switch to A, mA, or A.
    - The Meter defaults to DC current measurement mode. To toggle between DC and AC current measurement function, press BLUE button.
    - Connect the test lead in serial to the return circuit to be tested. The measured value shows on the display.
- **Measuring Resistance**
    - Insert the red test lead into the terminal and the black test lead into the COM terminal.
    - Set the rotary switch to resistance measurement (Ω) is default or press BLUE button to select measurement mode.
    - Connect the test leads across with the object being measured. If there is lead on the resistor. The measured value shows on the display.
- **Testing for Continuity**
    - Insert the red test lead into the Ω terminal and the black test lead into the COM terminal.
    - Set the rotary switch to and press BLUE button to select measurement mode.
    - The buzzer sounds continuously if the resistor to be tested is <10 Ω.
    - The buzzer does not sound if the resistor to be tested is >35 Ω.
- **Testing Diodes**
    - Insert the red test lead into the Ω terminal and black test lead into the COM terminal

- Set the red rotary switch to ⊣⊢ and press BLUE button to select ⊣⊢ measurement mode.
- For forward voltage drop reading on any semiconductor component, place the red test lead on the anode and black lead on the cathode. The measured value shows on the display.

2.6 DC Power Supply

- This is a triple output DC Power supply.
- You can use the output voltage of 0-30Vdc dual with current rating of 0-3A and fix 5Vdc with the current rating of 3A.
- Before the connection in circuit adjust the variable voltage, the voltage reading will be displayed on the screen but verify the voltage using DMM.

Figure 1.4: DC Power Supply

- Measure the voltage between the positive terminal (red) and negative terminal (Black). For use of positive power supply shorts the negative terminal (Black) and ground terminal (Green).
- For use of negative power supply shorts the positive terminal (Red) and ground terminal (Green).
- Limit the current before using the power supply.
- Don't vary the voltage when the circuit is working.
- You can get two power supplies in series and parallel connection as mark Master and Slave on it.

Procedure

- Set the adjustable power supply to 2.2 volts. Use both the Coarse and Fine controls to get as close to 2.2 volts as possible.
- Record the displayed voltage in the first column of Table below. Using the DMM set to the DC voltage function, set the range to 20 volts full scale. Measure the voltage at the output jacks of the power supply.
- Be sure to connect the DMM and power supply red lead to red lead, and black lead to black lead. Record the voltage registered by the DMM in the middle column of. Reset the DMM to the 200 volt scale, re-measure the voltage, and record in the final column.

Voltage	Power Supply	DMM 20V Scale	DMM 200V Scale
2.2			
5.0			
9.65			
15.0			

2.7 Oscilloscope

An oscilloscope is an essential laboratory instrument used to observe, analyze, and measure electrical signals. It displays a graph of voltage (vertical axis) versus time (horizontal axis), allowing visualization of signal waveforms in real time. This helps in diagnosing circuit behavior, measuring amplitudes, frequencies, time periods, and detecting noise or distortion.

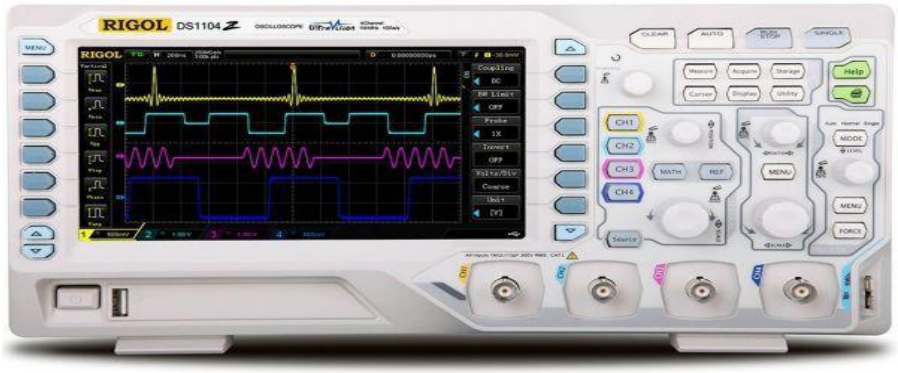

Figure 1.4: Digital Oscilloscope (Rigol DS1104Z) used for signal measurement and analysis

The front panel of the oscilloscope has several key control sections:

- **Vertical Controls**:
  - CH1 & CH2 Position Knobs: Adjust the vertical position of each channel's waveform.
  - CH1 & CH2 Menu Buttons: Turn waveform display on/off and access channel settings.
  - Volts/Div Knobs: Change the vertical scale to set how many volts each division represents.
- **Horizontal Controls**:
  - Horizontal Position Knob: Moves the waveform left or right on the display.
  - Time/Div Knob: Adjusts the time scale to show one or more cycles of the waveform.
- **AUTOSET Button**:
  - Automatically configures vertical, horizontal, and trigger settings to quickly display a clear, stable waveform.

Lab Tasks

Task 1

Explain the purpose of bus strips and terminal strips on a breadboard.

Task 2

Why should the output voltage of a DC power supply be adjusted and verified before connecting it to a circuit?

Task 3

Display the output waveforms of function generator (Sine Wave, Square Wave) on an oscilloscope.

Task 4

Connect the two signals to Channel 1 (CH1**)** and Channel 2 (CH2) of the oscilloscope.

- Display the both waveforms simultaneously.
- Describe how to adjust their vertical positions and scales for a clear and accurate comparison.

Task 5

During a continuity test of a resistor, the multimeter buzzer does not sound. State the possible reasons.

Task 6

Compare series and parallel configurations of DC power supplies.

Task 7

Discuss the commonly used connectors in electrical engineering along with their usage and figures.

2.8 Lab Report