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Experiment-01

Review of Lab Equipment



CSE251 - Electronic Devices and Circuits Lab

Objective

1. To review the basics of lab equipment for comprehensive understanding

Equipment

1. Breadboard
2. Digital Multimeter
3. DC power supply
4. Oscilloscope
5. Function Generator
6. Resistance ($1k\Omega$, $2.2k\Omega$, $2.7k\Omega$)
7. Chords and Wire

Breadboard

A breadboard, also known as a prototyping board, is a device used for building and testing electrical and electronic circuits. It is a reusable platform that allows us to quickly prototype and experiment with different electrical and electronic components without the need for soldering.

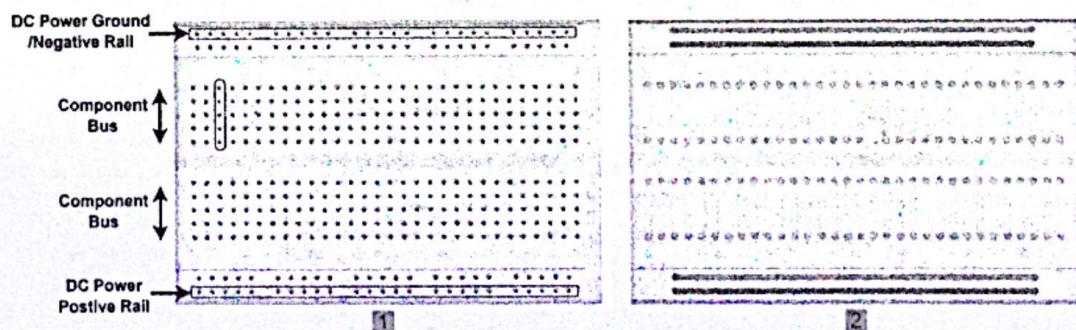


Figure 1: (1) Breadboard (2) Unseen Backside of Breadboard

A typical breadboard consists of a plastic board with a grid of holes and metal clips or sockets that run beneath the holes. The holes are arranged in a pattern that matches the layout of integrated circuits (ICs) and electronic components such as resistors, capacitors, LEDs, and wires. The unseen backside contains interconnections. As a result, component bus is internally short. DC Negative Rail and DC Positive Rail are also internally short.

DC Power Supply

A DC Power Supply is a device that is used to provide a steady and controlled DC voltage to power up a circuit. There are 4 channels in 2 different groups on this device. The display allows us to observe either CH1 or CH3, along with either CH2 or CH4 simultaneously. The buttons on the top-left and top-right corners of the device are used to switch between the channels. Two push buttons are used to operate the two groups in independent, series, or parallel mode (for our lab experiments, we will use them in "independent" mode).

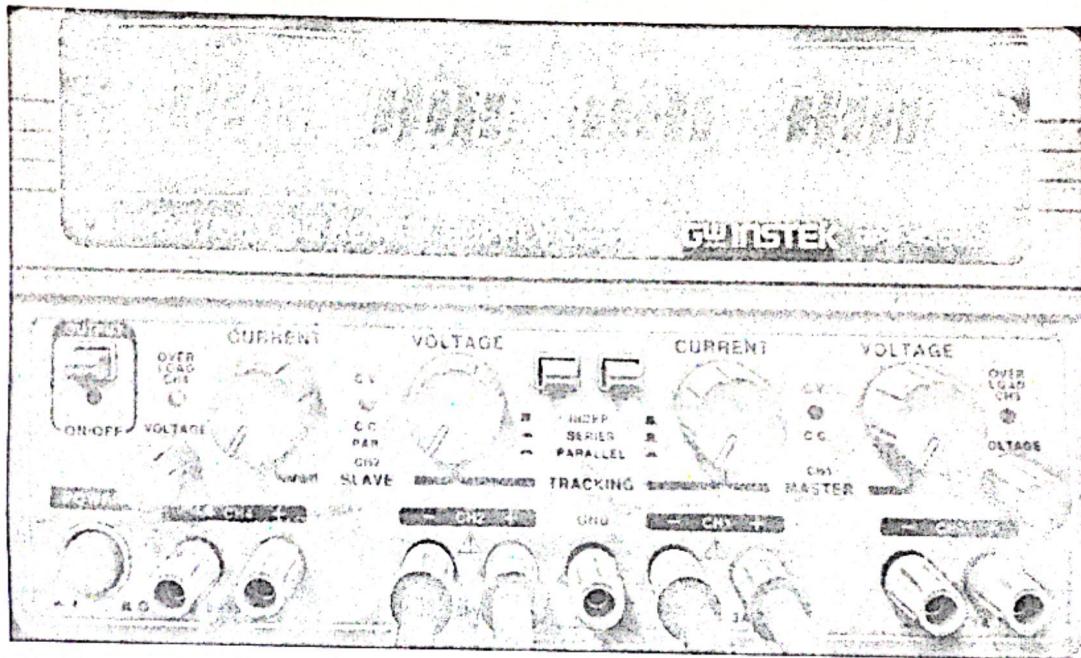


Figure 2: 4-Channel DC Power Supply

To use this device as a voltage source with a desired dc voltage, we need to set the current limit of a channel first. Let's say, we are using CH1. The following steps demonstrate how to use a DC Power Supply:

1. Turn on the device using the power button
2. Check the switches and make sure CH-1 is selected
3. Set the current limit using the current knob (around 0.5 A)
4. Set the desired value of voltage using the voltage knob
5. Once you set the voltage to your desired value push the ***Output*** button left corner of the knob panel. The power will not be supplied to the external circuit until you push the ***Output*** button
6. The ***red wire*** indicates the positive terminal of the power supply and the ***black wire*** indicates the negative terminal of the power supply

Digital Multimeter

A Digital Multimeter is a versatile electronic instrument used to measure various electrical quantities in circuits. It combines several measurement functions into a single device, making it an essential tool. For example, it can measure - voltage, current, resistance, capacitance etc.

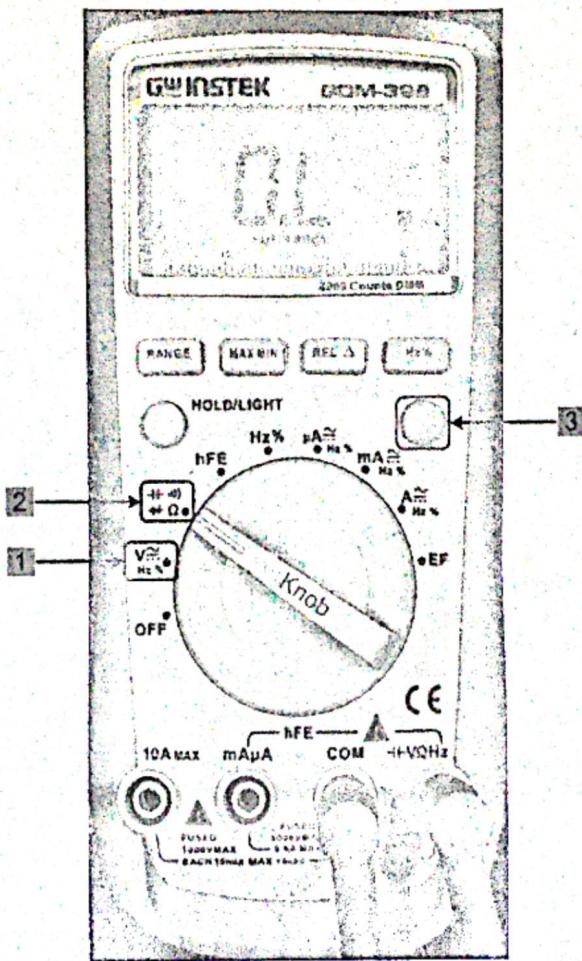


Figure 3: Digital Multimeter

The knob of the multimeter is rotated to change the measuring mode of the device. In position "1", it can measure voltage. In position "2", it can measure the resistance, capacitance etc. There is a *Blue* button indicated by "3" which is used for selecting the required measurement function when there is more than one function at one position of the knob. The red and black wire of the multimeter represents the positive and negative terminal respectively.

For example, voltage can be measured in DC and AC mode. If AC voltage (or current) is to be measured, one must use the multimeter in AC mode. The Blue button on the top-right corner of the multimeter (indicated by "3") is used to switch between DC and AC mode.

It is very important to check the wires before constructing a circuit. Multimeter can be used to test wires. Following steps can be followed To test wires,

1. Set the knob to position "2" as indicated in the figure above
2. Press the *Blue* button to select the Ω mode
3. If the buzzer sounds continuously, the wire is ok. If the buzzer does not sound continuously, then the wire is damaged and should not be used in the circuit

Oscilloscope

Oscilloscope is a device that enables the visualization and analysis of electrical signals with precision and accuracy. It is a versatile instrument to understand the behavior of circuits.

The primary function of an oscilloscope is to display and measure voltage waveforms over time. It provides a graphical representation of electrical signals in the form of waveforms on a screen, allowing users to observe the amplitude, frequency, phase, and other characteristics of the signal.

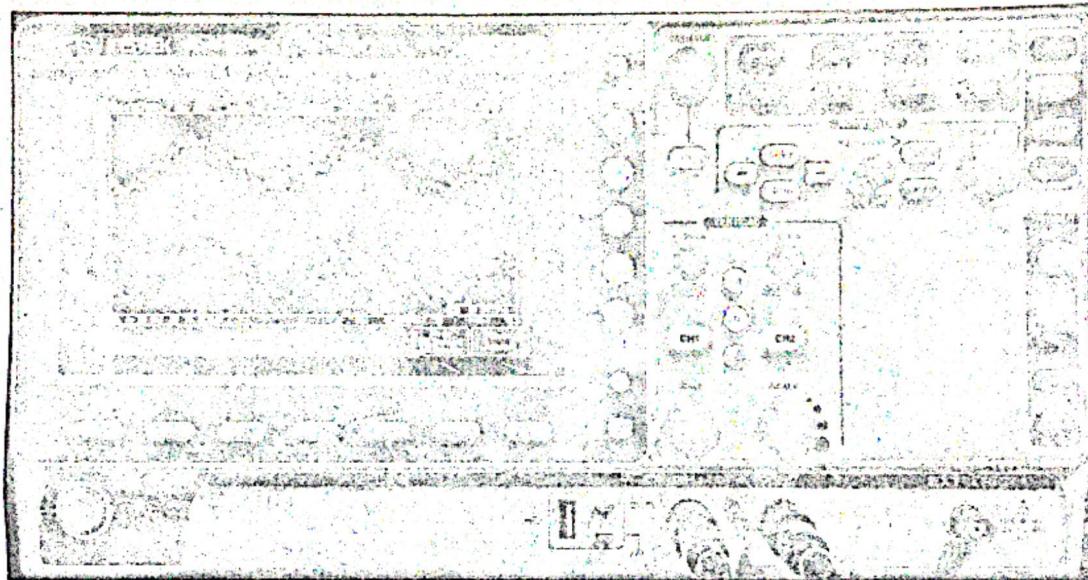


Figure 4: Oscilloscope

There are 2-channels in this oscilloscope that enables us observe 2 voltage waveforms simultaneously. The red and black wire of the probe of a channel represents positive and negative terminal respectively. The negative terminals of the probes are internally shorted.

Vertical **Scale** knobs and Horizontal **Scale** knob are used to adjust the scaling of voltage axis and time axis respectively. **Autoset** button is used to automatically scale the waveform(s). The user can also shift the position of the waveforms using the **Position** knobs both in the vertical and horizontal direction. **Measure** button enables the user to measure various quantities from the waveform(s). Oscilloscope also shows the value of voltage/division and time/division. Using these values, we can manually calculate voltage levels and frequency from the waveform(s). Oscilloscope also generates a 2V (p-p) 1 KHz Square Wave to provide a known and standardized test signal for various applications.

Furthermore, **X-Y mode** can be triggered to observe the I-V characteristic graph of any device. In the "XY" mode, we can plot voltage from CH1 on the x-axis vs voltage from CH2 on the y-axis. This is how we can plot the I-V characteristics of a device. If we connect the voltage, V across the two terminals to CH1 and the measure the current, I on CH2, we can plot the I-V characteristics. However, oscilloscopes can only measure voltages. This can easily be done using a $1\text{ k}\Omega$ resistor since the voltage (in volts) across a $1\text{ k}\Omega$ resistor is equivalent to the current (in mA) through that resistor.

Function Generator

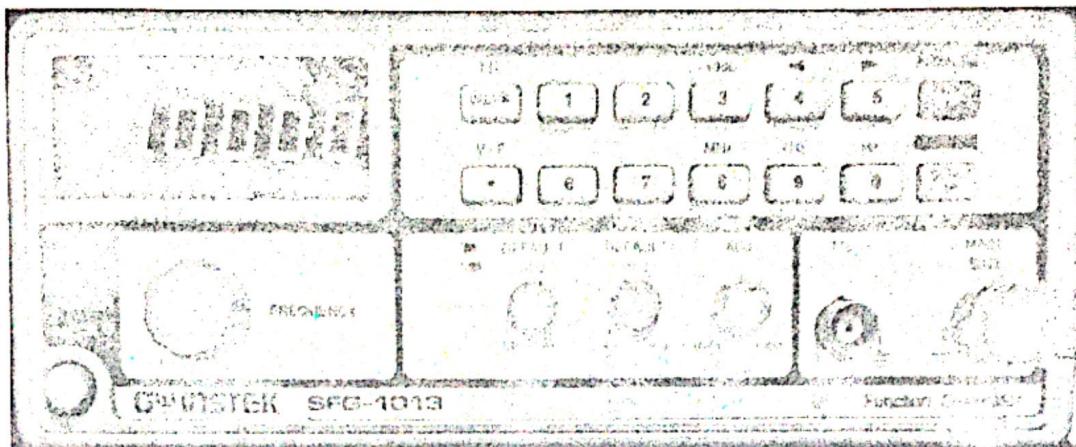


Figure 5: Function Generator

A function generator is a versatile instrument that is used to generate various types of electrical waveforms. It produces signals of different frequencies, amplitudes, and wave shapes, such as sine waves, square waves, triangular waves etc.

To generate a waveform, one needs to set the frequency to the desired value. This can be done by rotating the **Frequency** knob. There are also numerical buttons to set the exact frequency of the signal. For example, to generate a signal of 123 MHz / KHz / Hz,

1. Press the buttons 1, 2, 3 one after another. The display will show 123
2. Press **Shift** → Press 8 (for MHz) or, 9 (for KHz) or, 0 (for Hz) → Press the **Output On** button

The **Wave** button can be used to switch between sine, square and triangular waveform. One can also change the amplitude and DC offset of the signal by rotating the **AMPL** and **OFFSET** knob respectively.

Task-01

In this task, we will verify KVL and KCL.

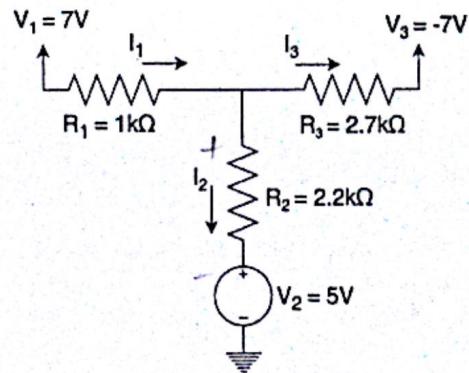


Figure 6: *Circuit-1*

Procedure

1. Use the DC Power Supply to set $V_1 = 7V$ and $V_2 = 5V$ with 0.5A current limit

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2. Use the Trainer Board's Power Supply to set $V_3 = -7V$
3. Use the Digital Multimeter to measure the resistances
4. Construct Circuit-1. Now, measure the voltages across the resistances
5. Fill out the tables. From the 2nd table, observe that KVL and KCL are verified.

Tables for Task-01

R_1	R_2	R_3
0.933	1.144	2.653

V_1	V_2	V_{R_1}	V_{R_2}	V_{R_3}	$I_1 = \frac{V_{R_1}}{R_1}$	$I_2 = \frac{V_{R_2}}{R_2}$	$I_3 = \frac{V_{R_3}}{R_3}$	$V_{R_1} + V_{R_2} + V_2$	$I_2 + I_3$
1.26	5.03	3.49	1.11	10.82	3.514	-0.657	4.08	7.18	3.413

Task-02

In this task, we will observe the I-V characteristics of a resistance, R_1 .

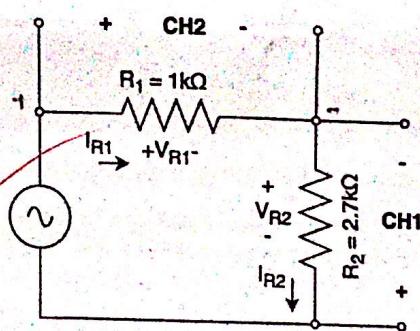


Figure 7: Circuit-2

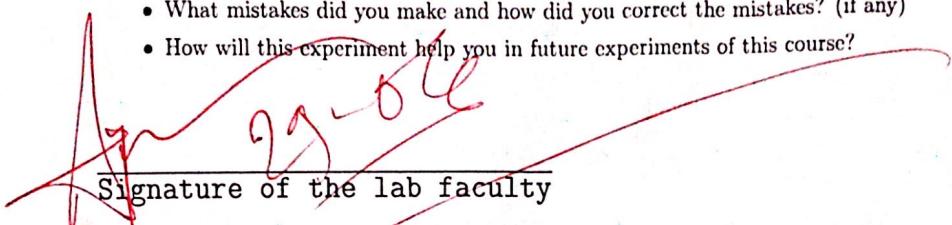
Procedure

1. Construct the circuit given above. Use the function generator for the supply voltage V_s with a 4V (p-p) sine wave. Set the frequency of V_s to, $f = \text{Last 3-digit of the student ID of any group member}$
2. Connect the CH-1 and CH-2 of the oscilloscope to the circuit as shown in the figure above.
3. Observe the I-V characteristics of the resistance R_1 in the XY mode of the oscilloscope and capture the image. To use the XY mode:
 - (a) Press the Autoset button → Push the Position knobs of both channels (i.e. push to zero).
 - (b) We need to invert the CH-1 in the oscilloscope due to its inverted connection to the circuit.
To do so: Press CH-1 button → Press the Invert button (which can be found on the bottom of the display of the oscilloscope) → select the option On.
 - (c) Press the Acquire button → Press the XY button which can be found below the display → Press the Triggered XY button which can be found on the right side of the display.
 - (d) Change the scaling and position of the plot using the Scale knob and Position knob of both channels respectively if you need.

You will see a small screen showing the I-V characteristics graph using the XY mode of the oscilloscope. The XY mode plots the voltage data of CH1 and CH2 in the x-axis and y-axis respectively. So, the x-axis represents V_{R_2} . As, $I_{R1} = I_{R2} \propto V_{R_2}$, the y-axis represents I_{R2} .

Task-03: Report

1. Attach the signed Data Sheet (if any)
2. Attach the captured images (if any)
3. Answer the questions in the "Test Your Understanding" section
4. Add a brief Discussion regarding the experiment. For the Discussion part of the lab report, you should include the answers of the following questions in your own words:
 - What did you learn from this experiment?
 - What challenges did you face and how did you overcome the challenges? (if any)
 - What mistakes did you make and how did you correct the mistakes? (if any)
 - How will this experiment help you in future experiments of this course?


Signature of the lab faculty

Test Your Understanding

1. Which one is the correct way to connect the 2 channels (CH1 and CH2) of the oscilloscope to observe the voltages V_{R_1} and V_{R_2} ? Justify your answer

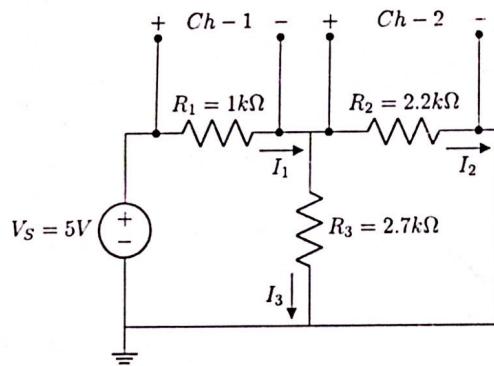


Figure 8: Option-A

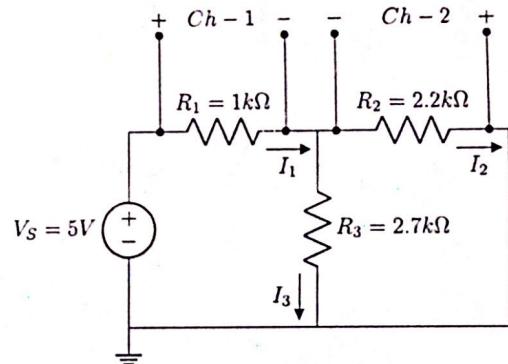


Figure 9: Option-B

Answer:

Option B is correct. Since the grounds of channel one and channel 2 is internally shorted, if we connect one negative on the left side of a node and another negative on the other side, it will have a short circuit. For that reason, we connect both negative in the same node and invert one to see results.

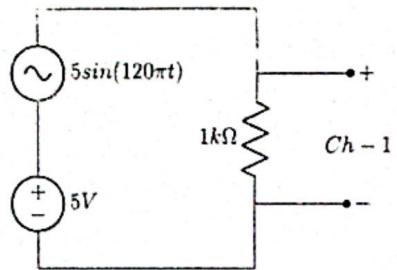
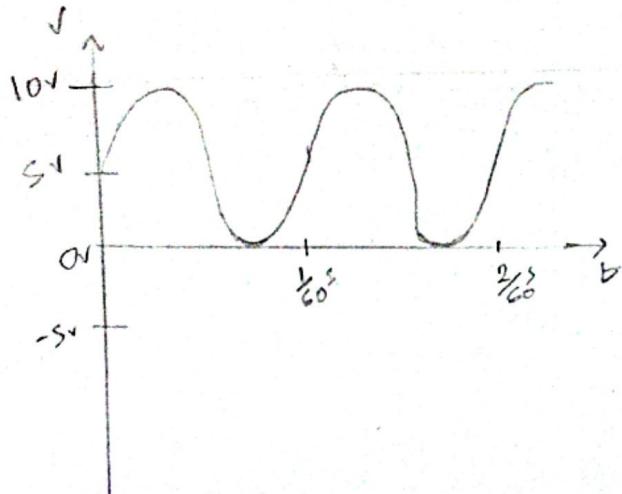
2. We used Ohm's law to measure the current in the circuit instead of using the multimeter as an ammeter.
What is the advantage of this method?

Answer:

Using multimeter as an ammeter would require us to break the circuit to perform checks. Instead we use ohm law to skip the breaking part and calculate voltage to figure out the current

3. For the following circuit, draw the waveform that should be observed in CH1.

Answer:



4) From the experiments, we learned about the fundamentals and uses of breadboard, digital multimeters, DC power supply, oscilloscope, function generator. We faced challenges in determining the positions of the negative of the channels. We learned that these should be connected to a single node and we can invert them to observe current. We also learned how the I-V characteristics of a resistance look like under oscilloscope. In the future, we can use these methods to pursue further complex electric circuit related problem.

