BRAC UNIVERSITY

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CSE251

Electronic Devices and Circuits

Spring-24

Lab Experiment No- 01

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Section: 03

Group: 04

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Group No: 04

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.

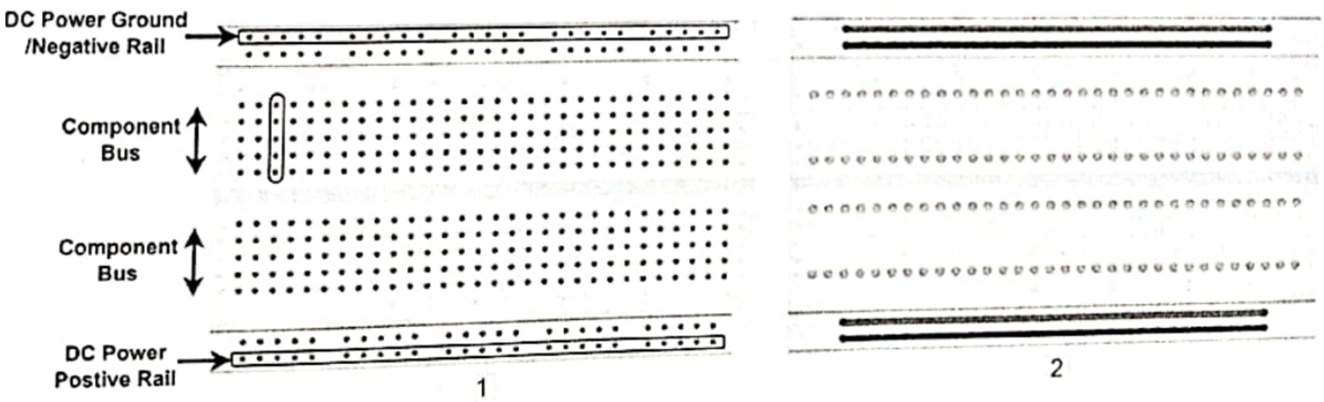


Figure 1: (1) Breadboard (2) Unseen Backside of Breadboard

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).

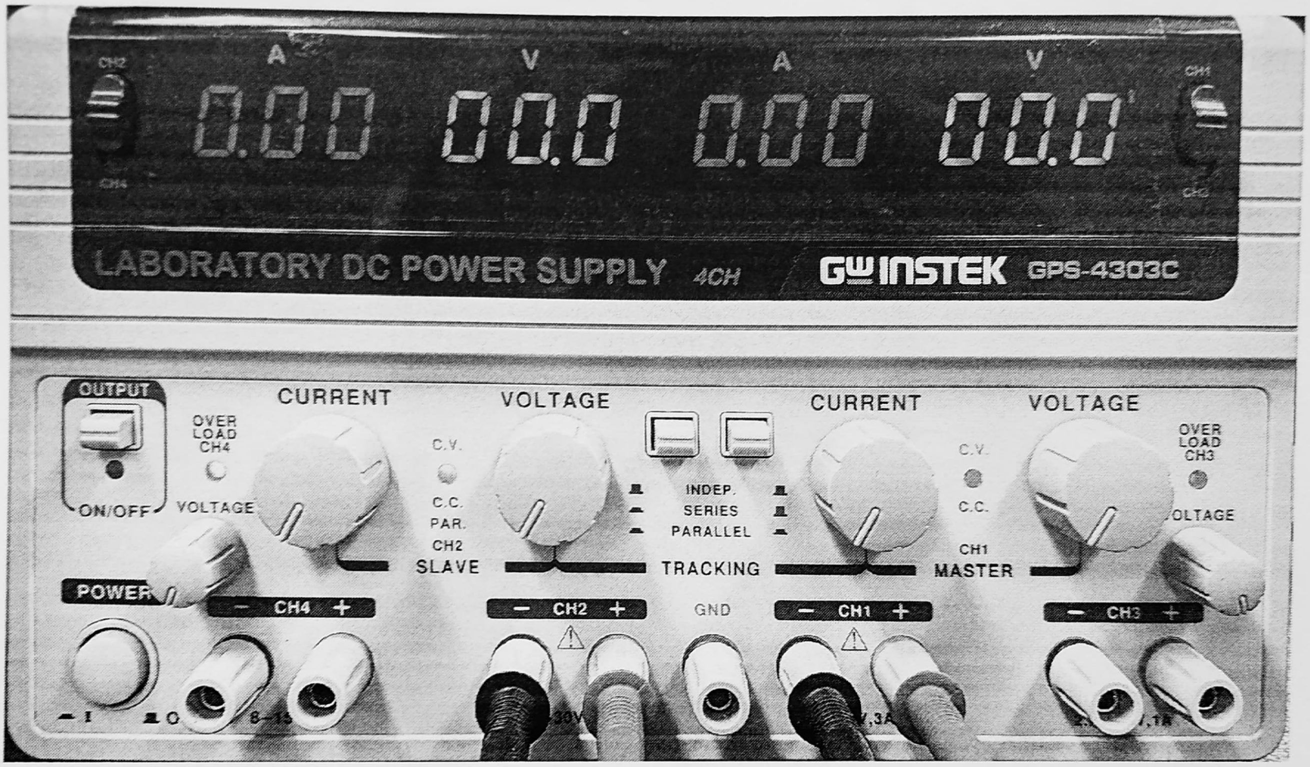


Figure 2: 4-Channel DC Power Supply

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.

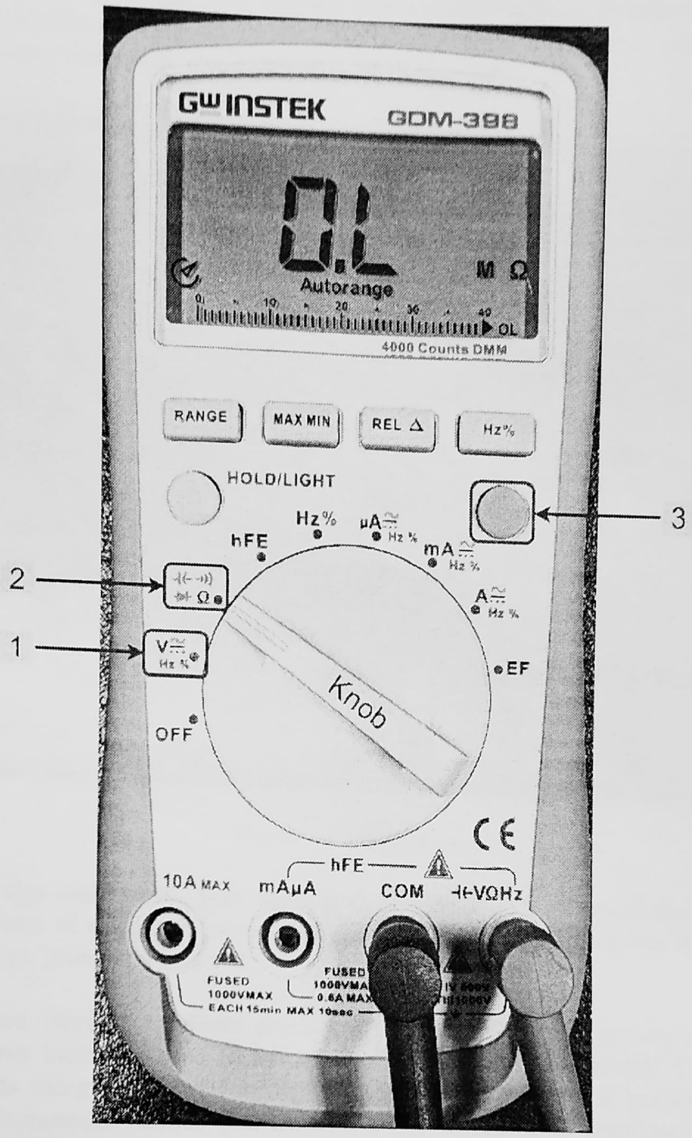


Figure 3: Digital Multimeter

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 ·))) 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

Oscillos

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.

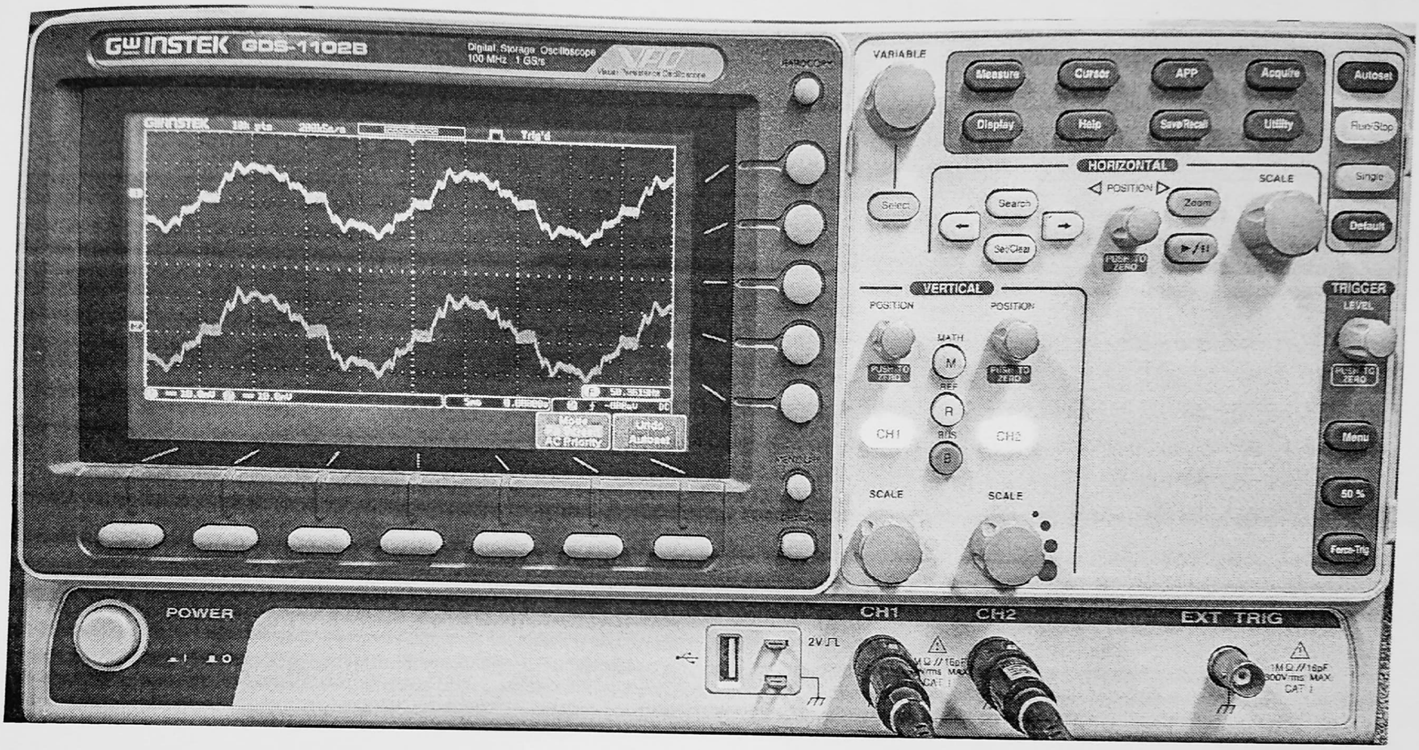


Figure 4: Oscilloscope

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 kΩ resistor since the voltage (in volts) across a 1 kΩ resistor is equivalent to the current (in mA) through that resistor.

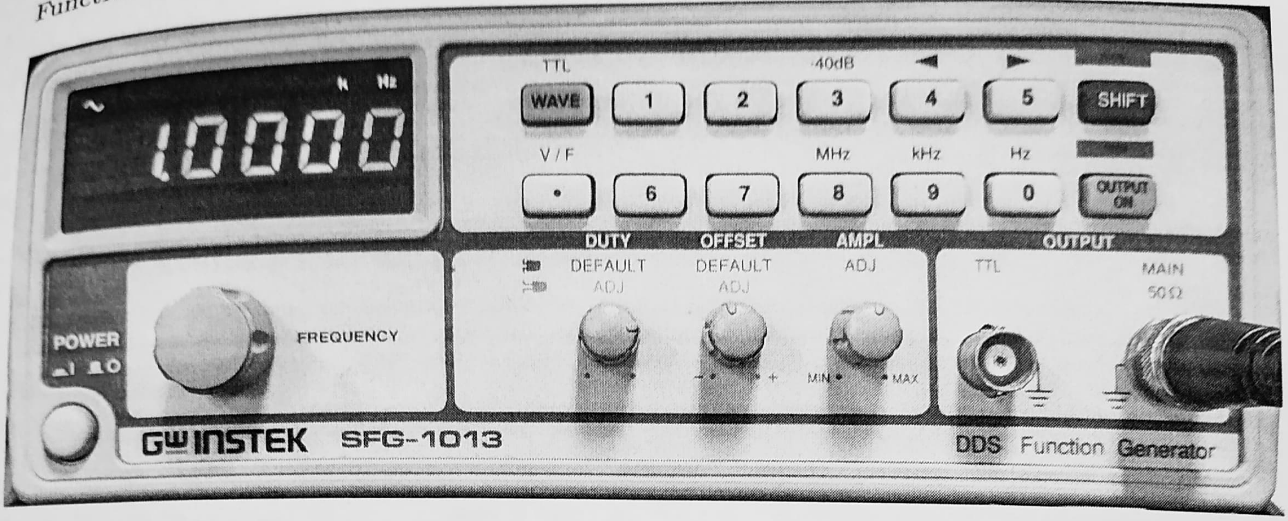


Figure 5: Function Generator

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.

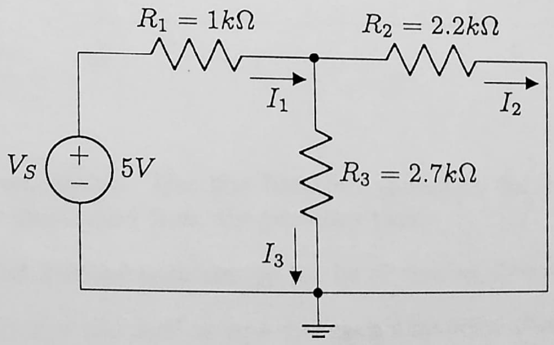


Figure 6: ***Circuit-1***

Procedure

1. Use the DC Power Supply to set $V_S = 5V$ with 0.5A current limit
2. Use the Digital Multimeter to measure the resistances
3. Construct Circuit-1. Now, measure the voltages across the resistances
4. Fill out the table in the Data Sheet section. From the table, observe that KVL and KCL are verified.

Table for Task-01

R_1	R_2	R_3	V_{R_1}	$V_{R_2} = V_{R_3}$	$I_1 = \frac{V_{R_1}}{R_1}$	$I_2 = \frac{V_{R_2}}{R_2}$	$I_3 = \frac{V_{R_3}}{R_3}$	$V_{R_1} + V_{R_2}$	$I_2 + I_3$
1K	2.11 K	2.63 K	2.26	2.68	2.26	1.27	1.01	4.94	2.24

Task-02

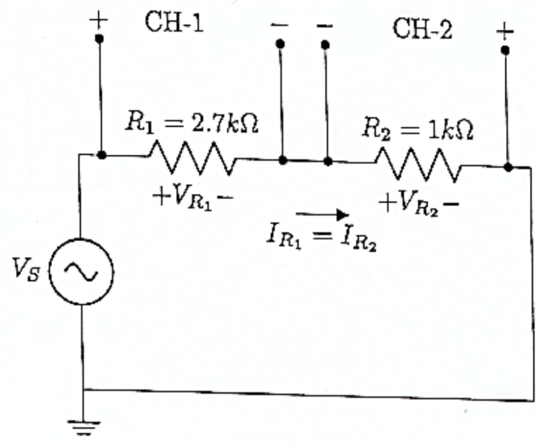
In this task, we will use an AC source and observe the voltage waveforms across resistances.

Procedure

1. Use the circuit of the previous task but replace the V_S with a 4V (p-p) sine wave. Use the Function Generator and the Oscilloscope to do so.
2. Set the frequency of V_S to, f = ***Last 3-digit of the student ID of any group member***
3. Connect the CH1 of the oscilloscope across R_1. Observe the waveform and capture it using a camera.
4. Disconnect CH1 from R_1 and connect it across R_2. Observe the waveform and capture it using a camera.

Task-03

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



Procedure

1. Construct the circuit given above. Use the function generator for the supply voltage V_S. Keep the amplitude and frequency unchanged from the previous task.
2. Connect the CH-1 and CH-2 of the oscilloscope to the circuit as shown in the figure above.
3. We need to invert the CH-2 in the oscilloscope due to it's inverted connection to the circuit. (To do so): Press **CH2** button → Press the **Invert** button (which can be found on the bottom of the display of the oscilloscope) → select the option **On**.
4. Observe the I-V characteristics of the diode 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) 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.
   (c) 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_1}. As, $I_{R1} = I_{R_2} \propto V_{R_1}$, the y-axis represents I_{R1}.

Task-04: Report

1. Cover page [include course code, course title, name, student ID, group, semester, date of performance, date of submission]
2. Attach the signed Data Sheet
3. Attach the captured images
4. Answer the questions in the "Test Your Understanding" section
5. Add a brief Discussion at the end of the report

3/1/24

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

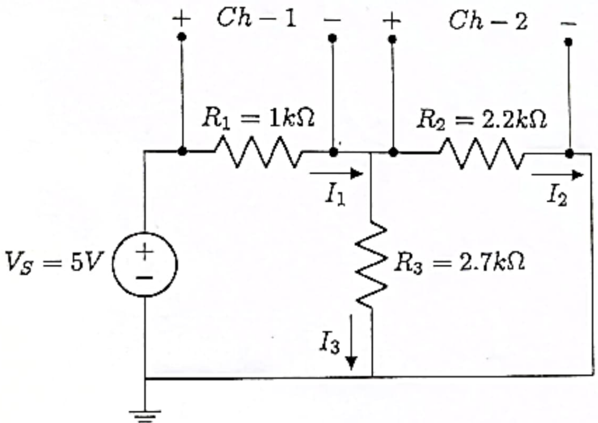


Figure 7: Option-A

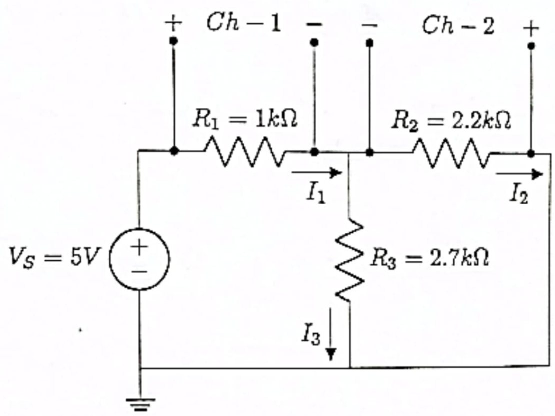


Figure 8: Option-B

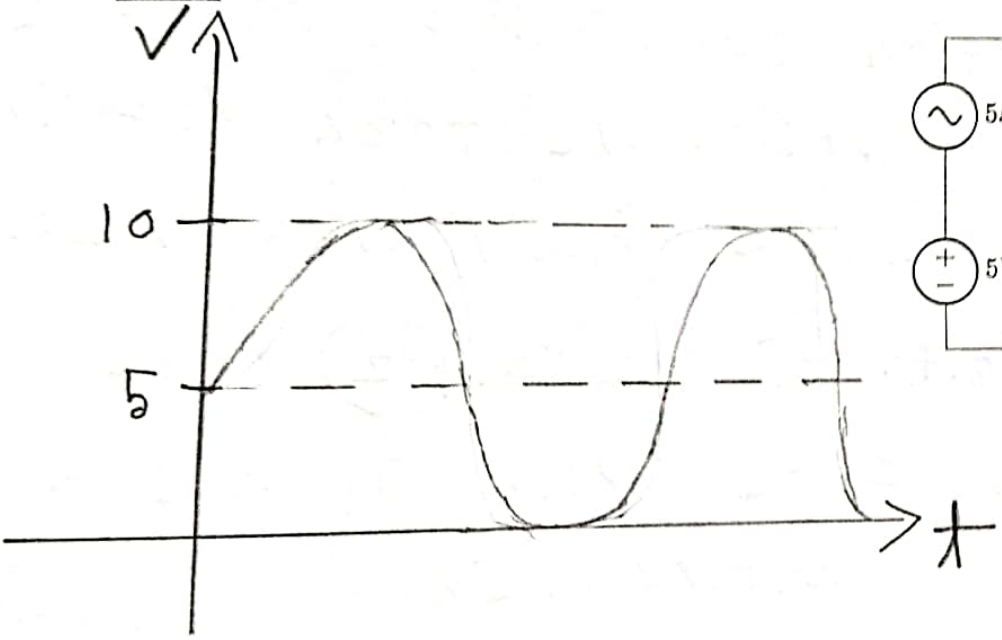
Answer: Option B. Because both negative terminals
of ch-1 & CH-2
is internally sorted/grounded, so if we invert
the waveform of ch-2, then we can get correct result.
Otherwise if the positive terminal and negative
terminal of ch1 and ch2 are connected together
then the positive terminal will be sorted with
ground and we will get incorrect result.

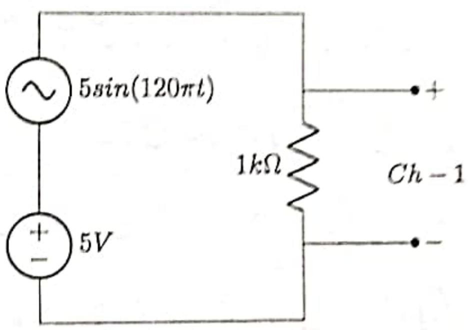
2. We used Ohm's law to measure the current in the circuit instead of using the multimeter as an ammeter. What is the advantage of this method?

Answer: If we use multimeter as an ammeter, we have to disconnect the circuit which is actually inconvinient. Then multimeter has 3 different range for ammeter, if we use wrong range then will damage the multimeter. On the other hand, when we use ohm's law to measure current we get the accurate measurement/result conviniently.

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

Answer:





Discussion:

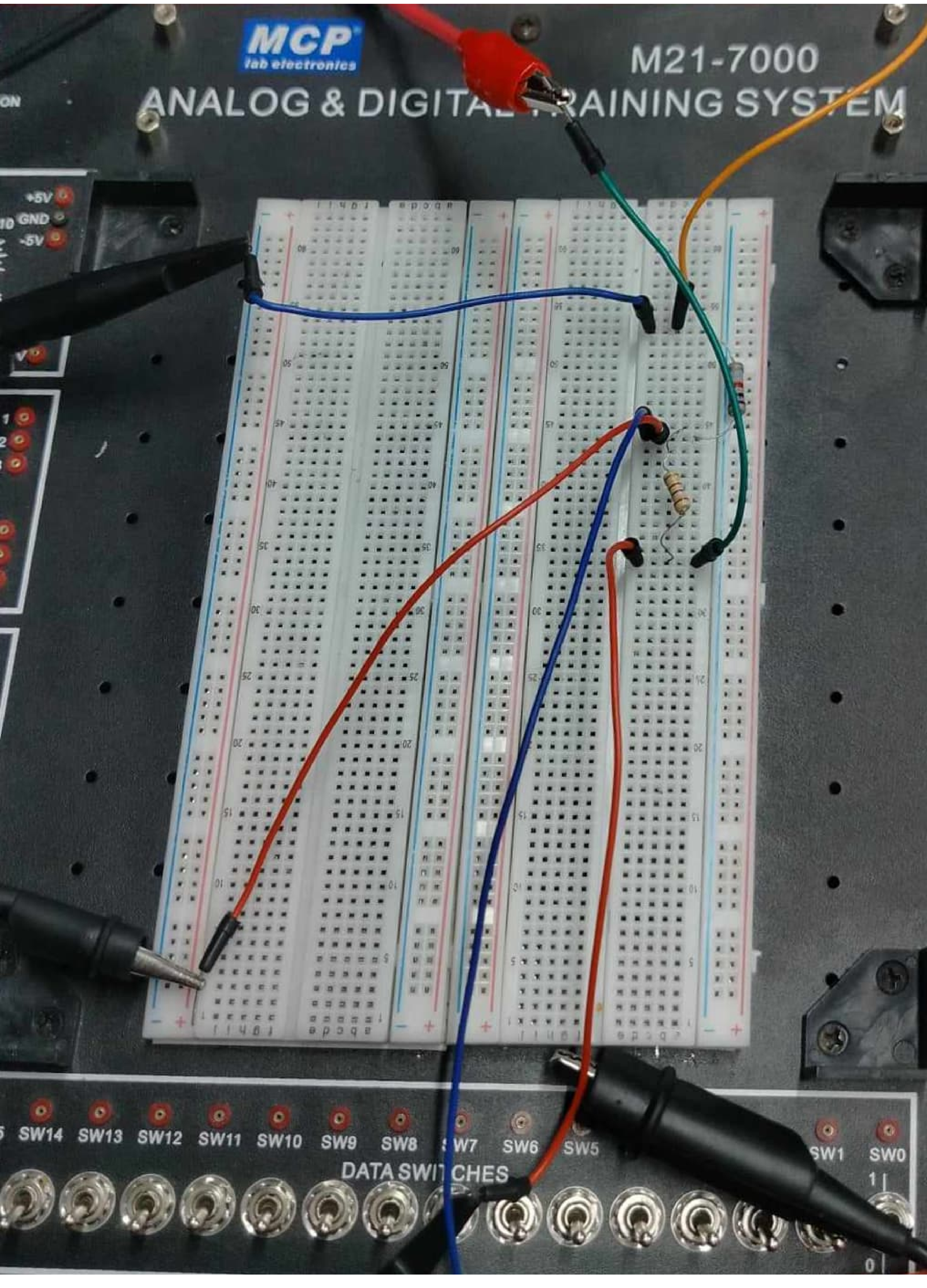
For task-01 we took DC Power supply of $V_S = 5V$ with 0.5A. Then we measured the provided resistance using multimeter and connected according to the circuit-1. After completing circuit we measured the voltages across the resistance using multimeter.

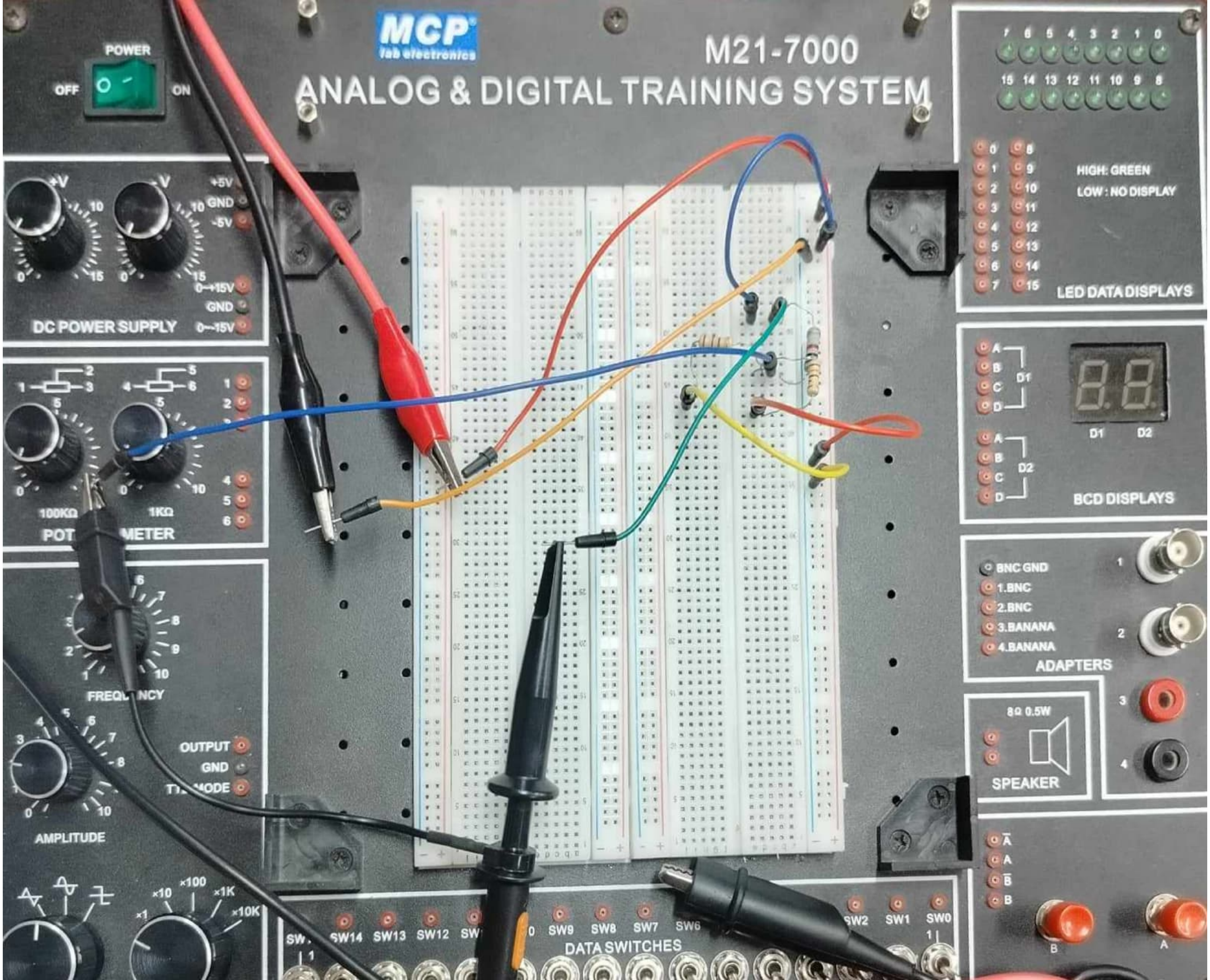
For task-02 we used the same circuit with function generator instead of DC power supply. We took $V_S = 4V(P-P)$ sine wave whose freq was 412. (Last 3 digits of 2230412). Then we connected ch-1 with R_1 and R_2, waveform observed. In task-3, we built a new circuit and used oscilloscope with function generator keeping the amplitude and voltage unchanged. We inverted the ch-2 in the oscilloscope due to its inverted connection. Observed I-V characteristics and captured. For this lab I got to know more about multimeter and its functions, how to use oscilloscope, power supply, function generator and able to clear many confusions.

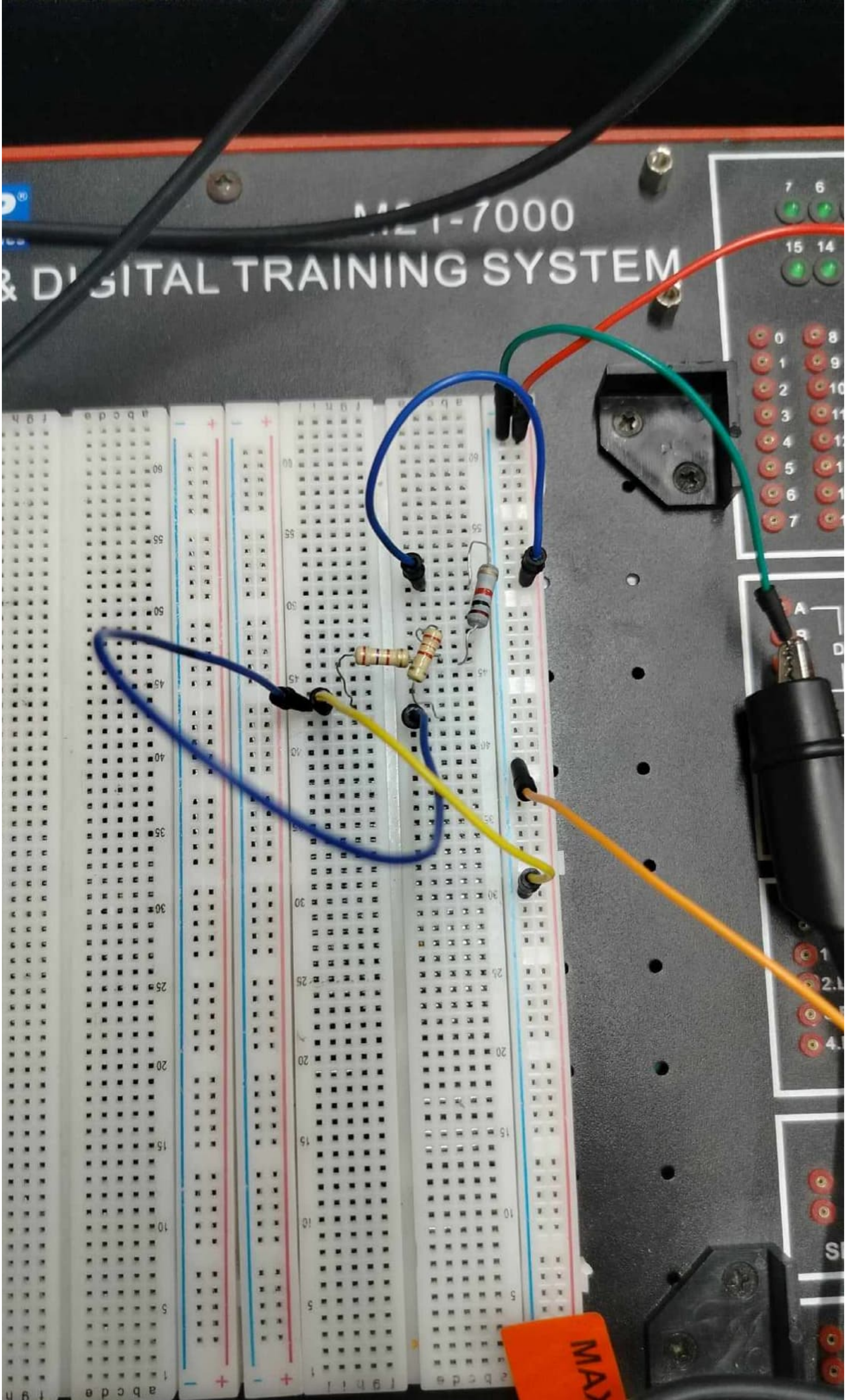

GW INSTEK
10k pts
1MSa/s
Trig'd
Measurement Summary
Pk-Pk 2.16V
Max 1.16V
Min -1.00V
Amplitude 2.16V
High 1.16V
Low -1.00V
Mean 43.7mV
CycleMean 49.9mV
RMS 619mV
CycleRMS 626mV
Area 437uVs
CycleArea 128uVs
RPREShoot ?
FPREShoot ?
Frequency 413.4Hz
Period 2.419ms
+Pulses 12
-Pulses 13
+Edges 8
-Edges 8
Display All
CH1
CH2
Math
Source
CH1
OFF
1ms
Add Measurement
Remove Measurement
Gating
Screen
Display All
CH1
High-Low
Auto
Statistics
Reference Levels


GWINSTEK
10k pts
1MSa/s
Trig'd
Measurement Summary
Pk-Pk 2.04V
Max 1.12V
Min -920mV
Amplitude 1.74V
High 920mV
Low -820mV
Mean 44.0mV
CycleMean 50.7mV
RMS 619mV
CycleRMS 629mV
Area 440uVs
CycleArea 122uVs
ROVShoot 4.60%
FOVShoot 4.60%
RPREShoot 1.15%
FPREShoot 5.75%
Frequency 413.9
Period 2.416
RiseTime 691.8
FallTime 685.3us
+Width 1.220ms
-Width 1.196ms
Dutycycle 50.51%
+Pulses 0
-Pulses 5
+Edges 2
-Edges 3
CH1
CH2
Math
Display All
Source
CH1
OFF
500mV
2.00V
1ms
0.00000s
Add Measurement
Remove Measurement
Gating
Screen
Display All
CH1
High-Low
Auto
Statistics
Reference Levels


GWINSTEK
10k pts
1MSa/s
Trig'd
XY
OFF(YT)
Triggered XY
1.00V
500mV
1ms
0.00000s
Mode
Sample
Reset H Position to 0s
XY
Record Length
10k
Expand
By Center


MCP
lab electronics
M21-7000
ANALOG & DIGITAL TRAINING SYSTEM
+5V
GND
-5V
SW14
SW13
SW12
SW11
SW10
SW9
SW8
SW6
SW5
SW1
SW0
DATA SWITCHES


MCP
lab electronics
M21-7000
ANALOG & DIGITAL TRAINING SYSTEM
POWER
OFF
ON
DC POWER SUPPLY
+V
-V
+5V
GND
-5V
0~+15V
GND
0~-15V
100KΩ
1KΩ
FREQUENCY
AMPLITUDE
OUTPUT
GND
LED DATA DISPLAYS
HIGH: GREEN
LOW : NO DISPLAY
BCD DISPLAYS
D1
D2
BNC GND
1.BNC
2.BNC
3.BANANA
4.BANANA
ADAPTERS
8Ω 0.5W
SPEAKER
DATA SWITCHES
SW14
SW13
SW12
SW9
SW8
SW7
SW6
SW2
SW1
SW0


M21-7000
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