Electric Circuits Analysis

Lab Report # 5

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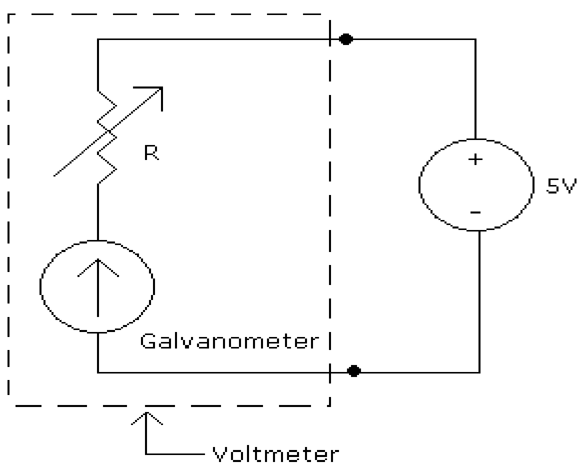
Voltmeter and Ammeter Design Using Galvanometer

PRE LAB

A galvanometer is a sensitive device which can measure very small currents accurately. By slight alterations a galvanometer can be converted into a voltmeter or an ammeter with a reasonably larger range. galvanometers can measure only small amounts of current (300 micro amperes) so the range of voltage which they can measure is very small. By connecting a very large resistance in series with the galvanometer we can make its total resistance significantly large. This would increase the range of measurable voltage and would decrease the loading effect of the galvanometer as well.

PART A: VOLTMETER DESIGN

We will convert our galvanometer into a voltmeter with a range of -5 to 5 volts. It should give maximum deflection when a voltage of 5V is applied across its terminals. We know that it would give maximum deflection only if the current through it is maximum, i.e. 300 microamperes.



Voltmeter design using galvanometer

V= iR+ iRm
R=(v- iR)/ i

PART B: AMMETER DESIGN USING GALVANOMETER

A galvanometer is converted into an ammeter by **connecting a low resistance in parallel with the galvanometer**. This low resistance is called shunt resistance S. The scale is now calibrated in ampere and the range of ammeter depends on the values of the shunt resistance. The internal resistance of different galvanometers is different but it ranges from 130-150 ohms.

$$i_s = \left(R_g / (R_g + R_s)\right) \cdot i$$

$$R_s = R_g\left(i / i_s\right) - R_g$$

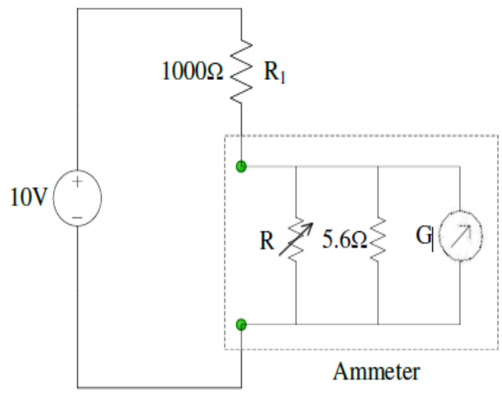


Figure 2: Ammeter design using galvanometer

Part C: Determine the Internal Resistance of a Voltage Source

Any linear electric or electronic circuit or device which generates a voltage may be represented as an ideal voltage source in series with some impedance. This impedance is termed the **internal resistance** of the source. it can be calculated from current and voltage data measured from a test circuit containing the source and a load resistance.

V1=(Rv+ Rl) il

Ry=(vl/IL)-Rl

Where *vl* is the voltage and *il* is the current associated with the load resistance *Rl*.

<u>IN LAB</u>

Task (1): Testing the designed voltmeter

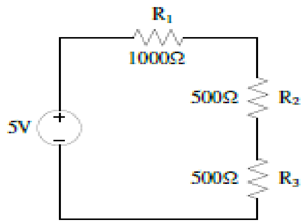


Figure 3: Test circuit to validate the voltmeter design

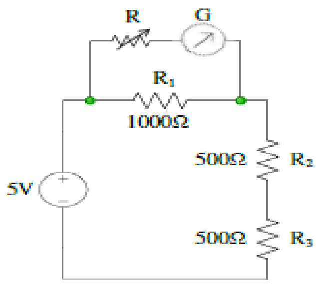
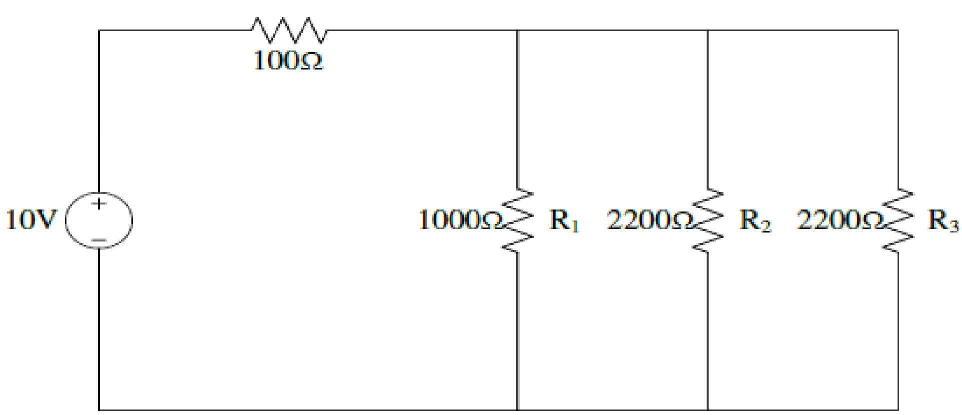


Figure 4: Measuring voltage across the resistor R1

Measurement Table 1

Value of resistance (Ω)	**V measured by the designed voltmeter (V)**	**V measured by the DMM (V)**	**% difference**
1kohm	2.2	2.4	8.33%
500ohm	1.2	1.4	14%
500ohm	1.2	1.3	7.7%

Task (2): Testing the designed ammeter:



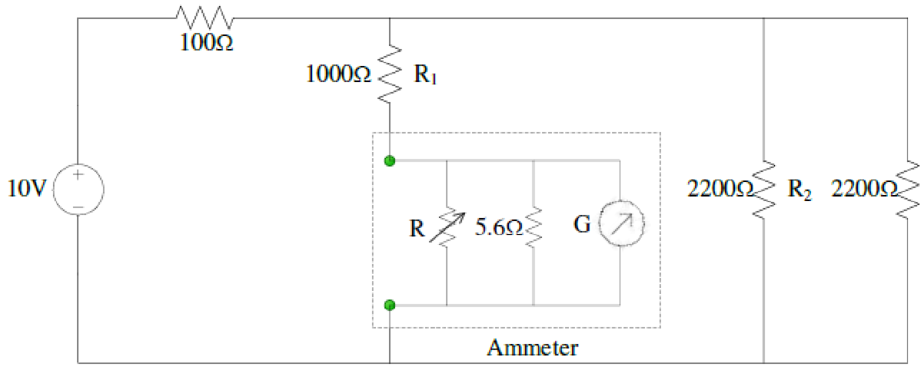


Fig. **Measuring current through the resistor R1**

Measurement Table 2:

Value of resistance (Ω)	Current measured by the designed ammeter (A)	Current measured by the DMM (A)	% difference
1kohm	1.1	1.2	8.3%
2.2kohm	0.5	0.6	16.7%
2.2kohm	0.6	0.8	25%

Task (3): Measuring internal resistance of voltage source

Measurement Table 3:

Value of the test resistance R_x (Ω)	Measured value of the current through R_x, i_x (A)	Measured value of the voltage across R_x, v_x(V)
0 (short circuit)	0.06	0
100	0.03	3
220	0.02	4.15
470	0.01	5
1k	0.005	5.3
3.3k	0.002	5.6
4.7k	0.0012	5.7
10k	0.0005	5.8

33k	**0.0002**	**5.88**
100M	**0.0001**	**5.9**
infinity	**0**	**5.99**

Post Lab

Questions:

1. **What do you mean by short and open circuit? What are the values of voltages and currents in open and short circuits?**

Open Circuit:

In open circuit there is break in flow of current due to breaking connection of wire. An electrical circuit in which the continuity is broken so that current does not flow. In open circuit I=0, V=maximum.

Short Circuit:

When there is no break or no resistance in wire so that there will be maximum current flow in wire and hence no potential difference between terminal of source. In short, I=maximum, V=0.

2. **Why high resistance is a desirable attribute of voltmeter?**

A voltmeter measures the voltage difference between two different paths, but it should not change the amount of current going through the element between those two points. it has very high resistance, so it does not draw current through it.

3. **What is the basic motivation behind converting galvanometer into ammeter?**

To measure heavy or large amount of Current we need to convert galvanometer into ammeter for this a low resistance known as shunt is connected in parallel to galvanometer. Value of shunt is so adjusted that large amount of current passes through shunt resistor and we can measure heavy current without any deflection.

Critical Analysis / Conclusion

In this lab we convert a galvanometer into ammeter and voltmeter and checked the voltmeter and ammeter by measuring currents and voltages in circuits. by doing this method we extract the results from voltmeter and ammeter and compare it with the values extract from DMM.