Electric Circuit Analysis I EEE-121

Lab 6

Name	Mujeeb Munsab
Registration Number	FA21-BSE-070
Department	Software Engineering (B)
Instructor's Name	Prof. Tariq Bashir

Lab 06: Voltmeter and Ammeter Design Using Galvanometer

Part (b)

A) Ammeter Design Using Galvanometer

Pre-Lab

PART: AMMETER DESIGN USING GALVANOMETER

The selected galvanometer can measure currents from 0-300 micro amperes. The internal resistance of different galvanometers is different but it ranges from 130-150 ohms. Suppose we wish to convert the galvanometer into an ammeter with a range of 0 to 10 milli amperes. Galvanometer should give maximum deflection when a current of 10mA flow through it. We know that the galvanometer would give maximum deflection only if the current through it is maximum, i.e., 300 micro amperes.

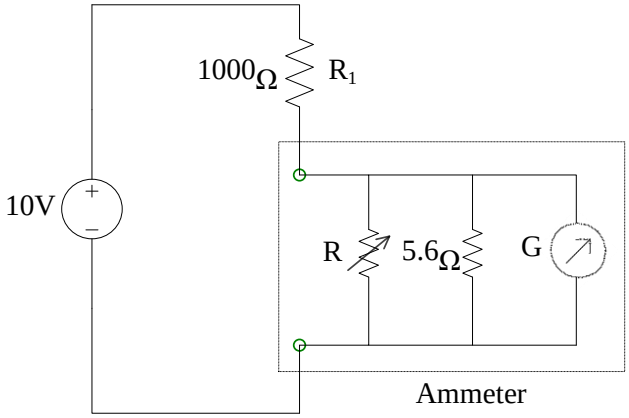

Figure: Ammeter design using galvanometer

If i = 10mA then i_g = 300μA and i_s = 9.7mA (i_s is the current flowing through the shunt resistance R_s). Suppose the internal resistance R_g of the galvanometer is 140Ω then according to Current Divider Rule, current through shunt resistance is:

$$i_s = \left(R_g / (R_g + R_s)\right) \cdot i \tag{5.3}$$

(5.4)

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

$$R_s = \left(140\right)\left(10/9.7\right) - 140$$

$$R = 4.33\Omega$$

The design of the ammeter as explained in the theory section has two constraints: First, actual value of the internal resistance (Rg) of the galvanometer is unknown. Second, if found the actual value of internal resistance (Rg) still it would be really fortuitous if the calculated value of the resistance Rs is actually present in the laboratory. So, we would make a circuit as shown in figure 5.4. A variable resistance R of 1kΩ has to be attachedin parallel with the galvanometer. The value of the variable resistance is slowly varied until maximum deflection of the galvanometer is achieved; thus, our ammeter design is complete and calibrated for 0 to 10 mA measurement. You can verify that the designed ammeter can measure current up to 10 mA by finding the total current flowing through 10V source using the DMM.

e v_l is the voltage and i_l is the current associated with the load resistance R_l.

In Lab

Task: Testing the designed ammeter:

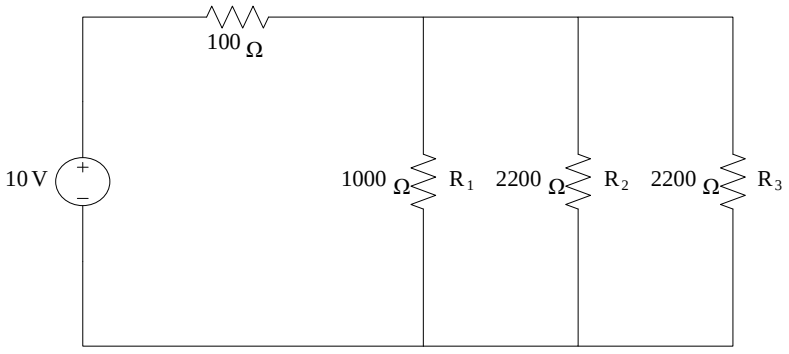

Figure: Test circuit to validate the ammeter design

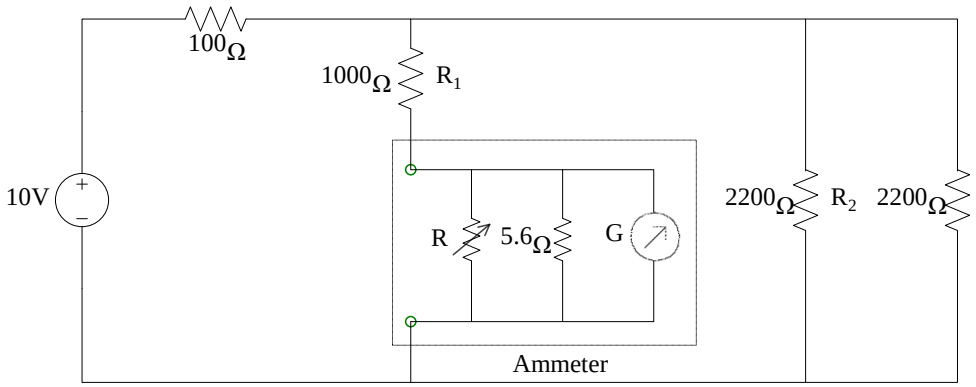

Figure: Measuring current through the resistor R1

Measurement Table 2:

Value of resistance (Ω)	Current measured by the designed ammeter (A)	Current measured by the DMM (A)	% Difference
R_1 = 99.9	0.00817	0.00847	3.54
R_2 = 2173	0.00360	0.00373	3.49
R_3 = 2177	0.00360	0.00372	3.23

Table

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?

   Ans: A short circuit is an electrical circuit that allows a current to travel along an unintended path with no or very low electrical impedance. The opposite of a short circuit is an "open circuit", which is an infinite resistance between two nodes.

   Current passing through an open circuit is zero, while current through the short circuit is infinite. An open circuit posse's infinite resistance, while a short circuit posses zero resistance. The voltage through the short circuit is zero, while voltage through the short circuit in maximum.

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

   Ans: Voltmeter has high resistance because it measures the voltage difference between two different points, but it should not change the amount of current going through the element between those two points. So, it should have high resistance.

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

   Ans: Since Galvanometer is a very sensitive instrument therefore it can't measure heavy currents. In order to measure heavy current, we should convert galvanometer into ammeter so I can measure large currents. convert a Galvanometer into an Ammeter, a very low resistance known as "shunt" resistance is connected in parallel to Galvanometer. Value of shunt is so adjusted that most of the current passes through the shunt.

Critical Analysis / Conclusion

After performing this lab tasks/experiments, we can understand the concept and working of voltmeter (for measuring voltage) and ammeter (for measuring currents) that are designed by using galvanometer (a sensitive device which can measure very small currents accurately) by converting it. We can also verify the values of voltage and current measured by designed voltmeter and ammeter to values of voltage and current measured by digital multimeter to check as mentioned in tables. We can also determine the internal resistance of voltage source. We are able to theoretically solve the circuit shown in circuit diagrams for verify. We can compare the calculated and measured values of voltage and current and find percent error. A small error may occur during observations. The results supported my observations.