

**WORLD COLLEGE OF TECHNOLOGY AND  
MANAGEMENT,  
GURGAON (HARYANA)**



**PHYSICS-II  
PHY-104-F  
LAB MANUAL**

**II SEMESTER  
B. Tech.**

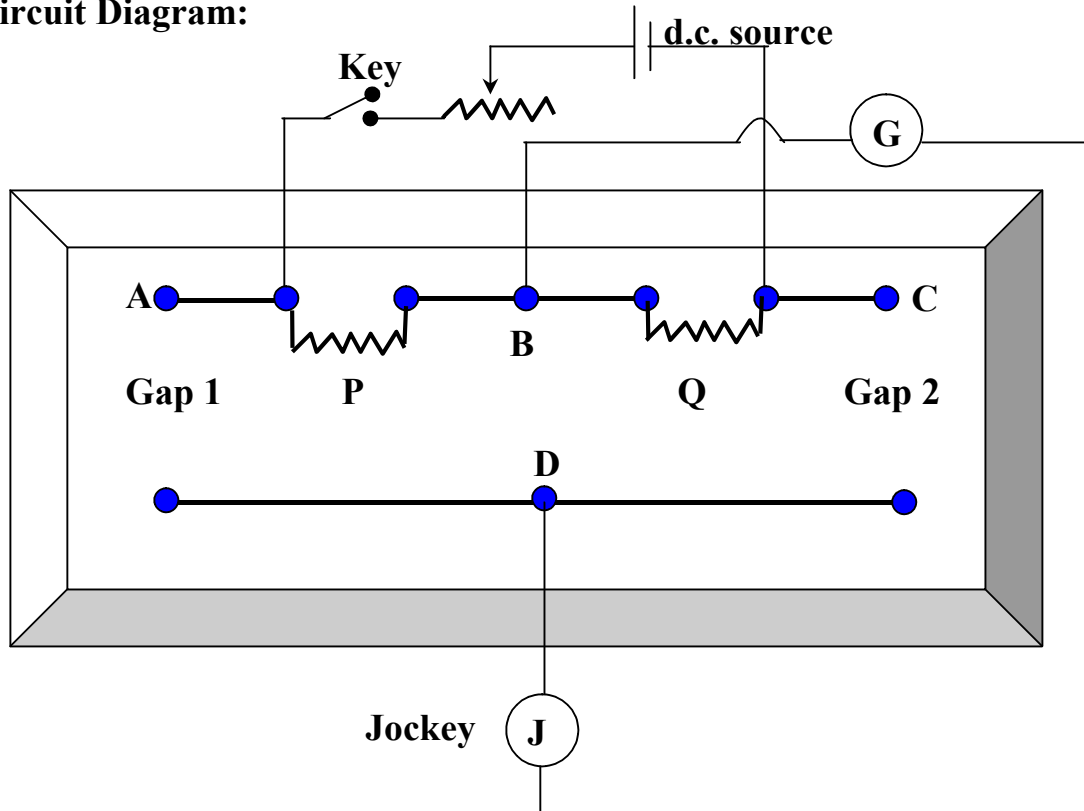
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## Experiment No. 1

**Aim: To find low resistance by Carey Fosters bridge**

1. **Apparatus required:** Given low resistance, dc power supply (2 V), Carey Foster's bridge, galvanometer, one way key.
2. **Formula used:**  $X = \frac{d_2 Y_1 - d_1 Y_2}{d_2 - d_1}$
3. **Circuit Diagram:**



**4. Theory:** Carey Foster's bridge is a modified Wheatstone bridge. Here a potentiometer wire MN is inserted between the R and S arms of the Wheatstone bridge as shown in Fig. below. The ratio arms P & Q are made equal. Gap 1 carries a small resistance (known) and the Gap 2 (fourth arm) carries the unknown resistance. If  $\rho$  be the resistance per unit length of wire,  $r_1$  &  $r_2$  be the end resistances at M & N,  $MD = l_1$  is balancing length as shown in Fig.,

then,  $\frac{P}{Q} = \frac{X + l_1 \rho + r_1}{Y + (100 - l_1) \rho + r_2}$  .. (1) When, X & Y are interchanged, the balance point shifts to a

length  $l_2$ , then,  $\frac{P}{Q} = \frac{Y + l_2 \rho + r_1}{X + (100 - l_2) \rho + r_2}$  .....

Comparing (1) & (2) and adding 1 to both sides, we get,

$$\frac{X + Y + 100\rho + r_1 + r_2}{Y + (100 - l_1)\rho + r_2} = \frac{X + Y + 100\rho + r_1 + r_2}{X + (100 - l_2)\rho + r_2}$$

$$\Rightarrow X + (100 - l_2)\rho + r_2 = Y + (100 - l_1)\rho + r_2 \Rightarrow Y - X = (l_1 - l_2)\rho$$

Where X is unknown resistance,  $(l_1 - l_2)$  is shift in balance point when the positions of X & Y are interchanged. Let  $d_1$  &  $d_2$  are the shifts corresponding to resistances  $Y_1$  &  $Y_2$ , then,

$$X - Y_1 = d_1 \rho, \text{ and, } X - Y_2 = d_2 \rho, \text{ so, } \frac{X - Y_1}{X - Y_2} = \frac{d_1}{d_2} \Rightarrow X = \frac{d_2 Y_1 - d_1 Y_2}{d_2 - d_1}.$$

### 5. Procedure:

- (i). Make connection as shown in Fig.
- (ii). Fix  $P = Q = 1 \Omega$  throughout the experiment.
- (iii). Keep  $X = Y = 0$  by short circuiting by copper plates to get balance point.
- (iv). Repeat step (iii) by interchanging the position of copper plates and determine  $x_0$ .
- (v). Replace trip of gap 1 by unknown resistance X and gap 2 by known resistance Y. Find balance point for  $0.1 \Omega$ , and, then interchange X & Y, and, again find balance point.
- (vi). Repeat this step for  $Y = 0.2, 0.3, 0.4, 0.5 \Omega$ .

### 6. Observations: Determination of electrical zero:

Sr. No.	Resistance introduced in between		Position of Null point (cm)	Value of electrical zero, $x_0$ (cm) ( $x_0 = a - b$ )
	Gap-1	Gap-2		
1	Copper plate	Copper plate (a)		
2	Cu plates interchanged (b)			

### (b). Determination of unknown resistance:

Sr. No.	Y ( $\Omega$ )	Position of balance point with unknown resistance in		Shift $l_1 - l_2$ (cm)	Corrected shift $d = (l_1 - l_2) - x_0$ (cm)	Unknown resistance $X = \frac{d_2 Y_1 - d_1 Y_2}{d_2 - d_1}$ ( $\Omega$ )	Mean X ( $\Omega$ )
		Left gap $l_1$ (cm)	Right gap $l_2$ (cm)				
1							
2							
3							
4							
5							
6							

7. Results: The value of unknown resistance is ..... $\Omega$ .

### 8. Precautions:

- (i). All terminals should be tight.

- (ii). The connecting wires and the copper strip should be thoroughly cleaned with sand paper.
- (iii). The connection should be tight and the plugs of the resistance box should be given twist so that they are tight.
- (iv). The battery key should be taken out when the readings is not being taken in order to avoid heating and the wire.

### VIVA-VOCE

**Q 1. What do you mean by the resistance of a conductor?**

**Ans.** The ratio of the potential difference between the two ends of a conductor to the current flowing in it, is called the resistance of a conductor.

**Q 2. On what factor does it depends?**

**Ans.** Resistance of a conductor is directly proportional to its length( $l$ ), inversely proportional to the area of cross section ( $A$ ). It also depends upon the nature of material and temperature of the conductor.

**Q 3. What is its unit?**

**Ans.** Unit of resistance is ohm.

**Q 4. What is effect of temperature on resistance?**

**Ans.** It increases with the increase in temperature.

**Q 5. What is the effect of increasing the effective length of a Carey Foster's bridge wire?**

**Ans.** It will increase the accuracy of the result because then percentage error in reading the position of the balance point is very much decreased.

**Q 6. What is the minimum difference in resistance that you can measure with this bridge wire?**

**Ans.** It is equal to the resistance of the one millimeter length of the bridge wire.

## Experiment No. 2

### Aim: To measure high resistance by substitution method

**1.Apparatus required:** Given high resistance, dc power supply, galvanometer, high resistance boxes, one way key, two way key, connecting wires.

**2.Formula used:**  $X = \left[ R \frac{G+S}{S} + G \right] \theta_2 / \theta_1 - G$

Where,

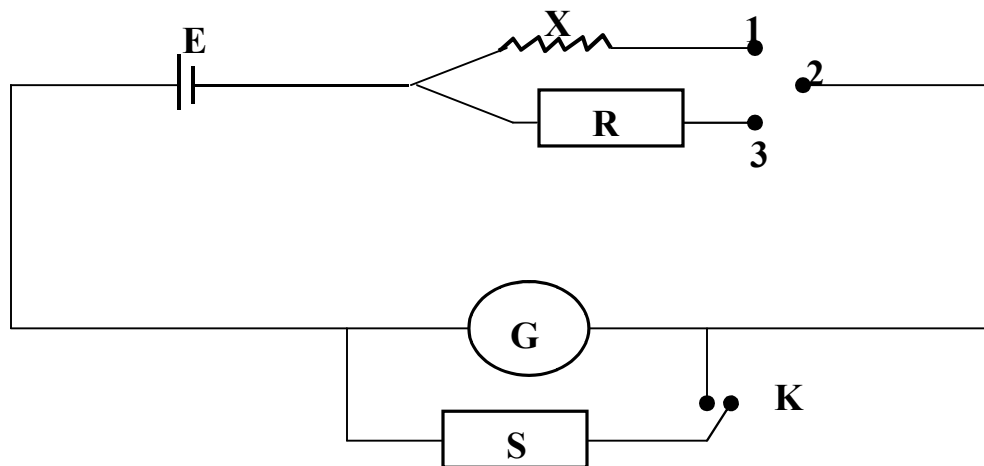
G = Resistance of galvanometer.

S = resistance of Shunt.

R= high resistance.

$\theta_1, \theta_2$  = Deflection with X and R, S.

### 3.Circuit diagram:



**4. Theory:** The connections are made as shown in Fig. below. The key between the terminals 1 and 2 is inserted so as to pass current through the unknown resistance X and the deflection of the galvanometer is noted. The current passing through the galvanometer,  $I_g$ , is given by

$$I_g = \frac{E}{R+G} \dots\dots\dots (1)$$

Here E is the e.m.f. of the battery and G is the galvanometer resistance. The key between 1 & 2 are now removed. Some high resistance, R, from the resistance box is introduced and key between the terminals 3 and 2 is inserted. As  $R \gg X$ , the galvanometer will give larger deflection which may be out of range. Insert the key K and adjust the value of shunt resistance, S, so that deflection in galvanometer is same as it was with X earlier. The current passing through the galvanometer,  $I_g$ , is

$$\text{given by } I_g = \frac{E}{R + \frac{GS}{G+S}} \times \frac{S}{G+S} \Rightarrow I_g = \frac{ES}{R(G+S) + GS} \dots\dots\dots (2)$$

A current flowing through the galvanometer in two cases is equal, so, from (1) and (2), we have,

$$\frac{E}{X+G} = \frac{ES}{R(G+S) + GS} \Rightarrow X = R \frac{G+S}{S}$$

**5. Procedure:** Make the connections as shown in earlier figure.

- (i). Introduce high resistance from R and then insert plug between 2 & 3 of two way key. Adjust R to get full deflection in the galvanometer. Note this deflection 'n' and value of R.
- (ii). Insert plug in key 'K'. Keeping R fixed adjust S so that the deflection in the galvanometer becomes half of the previous deflection, i.e., 'n/2'. Note this deflection and the value of S.
- (iii). Repeat steps (a) & (b) for different R.
- (iv). Remove plug from 2 & 3, and, insert into terminal between 1 & 2 to bring the unknown resistance X in the circuit. Remove plug in key 'K'. Note down the deflection.
- (v). Remove plug from 1 & 2, and, insert into terminal between 2 & 3. Insert plug in key 'K'. Take out a resistance from high resistance box R. Adjust the value of S so that the deflection is exactly the same as in the previous step.
- (vi). Repeat step (e) for different combinations of R & S.

**5. Observation:**

The value of G = 02 K $\Omega$

**Determination of Unknown resistance, X:**

Sr. No.	Deflection with		Resistance inserted, R ( $\Omega$ )	Shunt resistance S ( $\Omega$ )	$X = \left[ R \times \frac{G+S}{S} + G \right] \theta_2 / \theta_1 - G$ K $\Omega$	Mean X (K $\Omega$ )
	(X) $\theta_1$	(R) $\theta_2$				
1						
2						
3						
4						
5						

**6. Result:** The value of X is .....K  $\Omega$

**7. Precautions:**

- (i). A high resistance sensitive galvanometer should be used.
- (ii). Plugs of resistance boxes, keys should be tight.

**VIVA-VOCE****Q 1. What is galvanometer?**

**Ans.** A device used to detect the presence of current in a circuit.

**Q 2. How will you find resistance of a galvanometer?**

**Ans.** (i) Equal deflection method.  
(ii) Half deflection method.

**Q 3. Explain substitution method.**

**Ans.** In this method current is first passed through resistance and deflection in the galvanometer is noted after this unknown resistance is replaced by resistance R and shunt S, the values of R and S are adjusted in such a manner that galvanometer shows same deflection. The value of unknown resistance is given as-

$$X = \frac{R(G+S)}{S}$$

**Q 4. What is the deflection between galvanometer and ammeter.**

**Ans.** The resistance of ammeter is higher than that of galvanometer. Further, galvanometer is used to detect the presence of current in the circuit whereas ammeter is used to measure low current in the circuit.

**Q 5. What is shunt.**

**Ans.** A shunt is a small resistance connected in parallel with galvanometer. It provides a bypass of current through the galvanometer.



### Experiment No. 3

**Aim: To determine the resistance of Weston type galvanometer by Kelvin's method using Post Office box.**

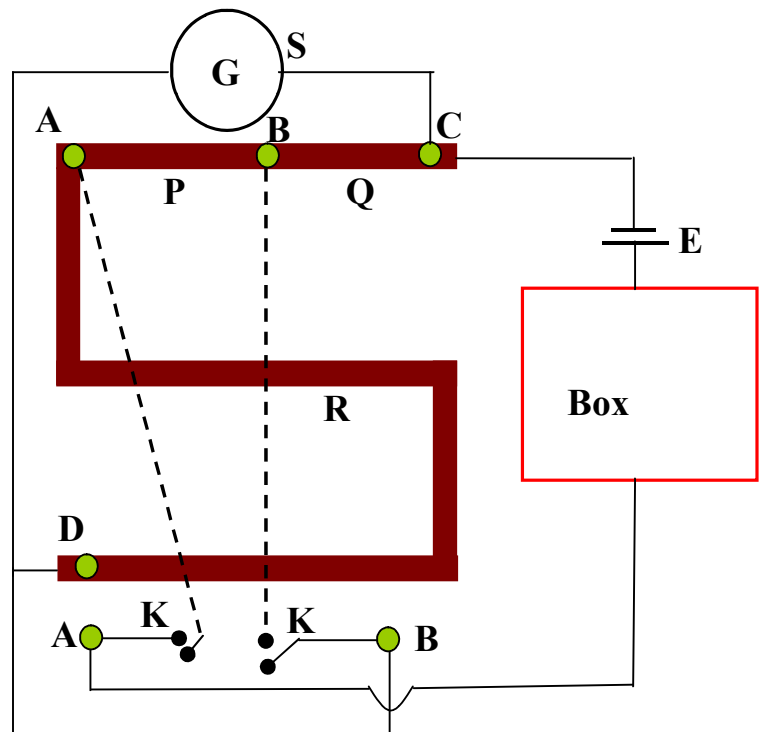
**1. Apparatus required:** Post Office box, galvanometer, power supply (2v), Resistance box, connecting wires.

**2. Theory:** A post office box is a compact form of the Wheatstone's bridge. In the instrument each of the arms AB & BC contains three of 10, 100 and 1000  $\Omega$  respectively as shown in Fig.1. These are called ratio arms. The arm AD is the other ratio arm R. The key K1 is connected to the

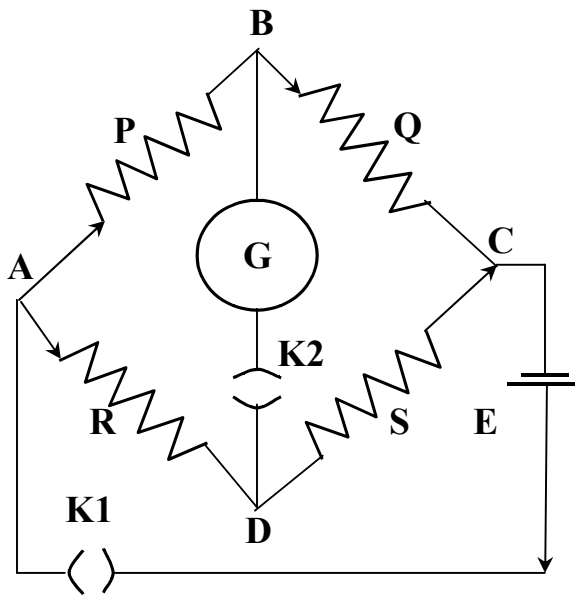
point A and the key K2 to the point B internally as shown by the lines drawn on the ebonite plate. The unknown, S, is connected between C & D, the battery, E, between C & A through the key K1 and the galvanometer, G, between D & B through the key K2. The circuit is now exactly the same as shown in Fig.2. Hence,

$$\frac{P}{Q} = \frac{R}{G} \Rightarrow G = R \cdot \frac{Q}{P}$$

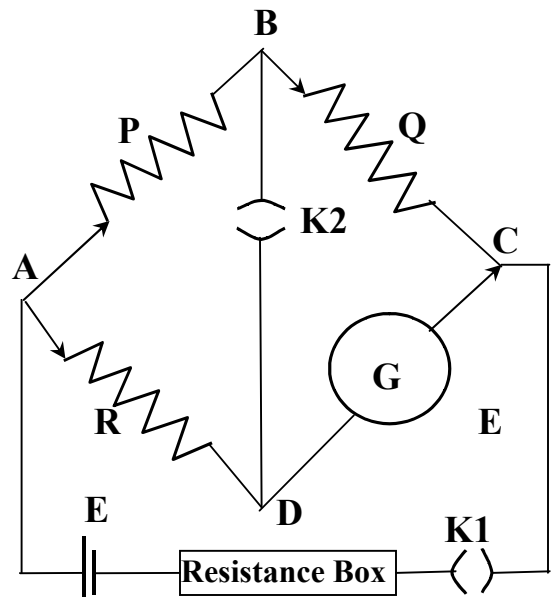
In the Kelvin's method the same galvanometer whose has to be measured, is also used as an indicator for obtaining the balance point. The galvanometer acts as its own indicator for obtaining the balance point a shown in Fig.3.



**Fig.1**



**Fig.2**



**Fig.3**

**3. Procedure:**

- (i). Make connections as in Fig.1.
- (ii). Take resistance from box and keep other plugs tight.
- (iii). Keeping  $R = 0$ , insert  $10 \Omega$  s in arms P & Q. Press tapping key K1 and adjust from resistance box so that deflection is between 10 & 30.
- (iv). Insert  $10 \Omega$  in R, press tapping K1 and note deflection in galvanometer. If deflection decreases on tapping key K2, go on repeating the observation by increasing R in steps so that on pressing K1 first and then tapping K2, the deflection increases. The value of galvanometer lies between last two values of R.
- (v). Keeping  $Q = 10 \Omega$  make  $P = 100 \Omega$ . Starts with 10 times the lower value of R obtained in earlier step and increase it in steps, so that on pressing K1 first and then K2, the deflection increases instead of decreasing. Note last two values of R.
- (vi). Keeping  $Q = 10 \Omega$  make  $P = 1000 \Omega$ . Starts with 10 times the lower value of R obtained in earlier step and increase it in steps, so that on pressing K1 first and then K2, the deflection increases instead of decreasing. Note last two values of R.

**4. Observations:**

Sr. No.	Ratio arms		Values of R ( $\Omega$ ) for which deflection increases instead of decreasing	G ( $\Omega$ ) lies between $G = R \cdot \frac{Q}{P}$
	P ( $\Omega$ )	Q ( $\Omega$ )		

**5. Result:** The resistance of the Galvanometer is .....  $\Omega$ .

**6. Precautions:**

- (i). The ends of the connecting wires should be clean.
- (ii). All the plugs should be properly tight.
- (iii). K1 should be pressed first and thereafter K2.

**VIVA-VOCE****Q 1. What is post office box?**

**Ans.** It is a modified form of wheatstone bridge. It was first used in post office for determining the resistance of telephone wires and thus to find fault in them, so called post office box.

**Q 2. Why it is called post office box?**

**Ans.** Because it is first used in post office to find faults in telegraphic wires.

**Q 3. What do you mean by resistance?**

**Ans.** It is a property of a conductor virtue of which it offers obstruction to the flow of current.

**Q 4. What is the difference between ohmic and non ohmic conductors?**

**Ans.** The conductors which obeys ohms law are called conductors, whereas the conductors which do not obeys ohms law are called non- ohmic conductors. However, the relation  $V=IR$  is followed by both type of conductor.

**Q 5. What is the balanced condition of bridge?**

**Ans.** In balanced condition

$$\frac{P}{Q} = \frac{R}{S}$$

### Experiment No. 4.

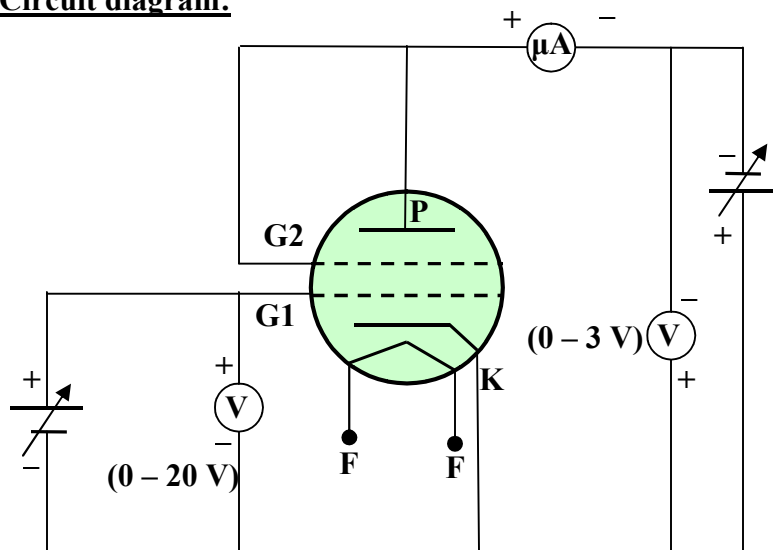
**Aim :** To determine the ionization potential of mercury used inside a Thyatron tube.

**1. Apparatus required:** Thyatron tube, variable power supply, ammeter, voltmeter, connecting wires.

**2. Theory: Ionization potential** is defined as the minimum amount of energy required in (ev) electron – volts to just remove an electron from an atom. Here the ionization potential of mercury can be determined by filling the vapours of mercury in a diode or triode tube. The hot cathode has filled triode is known as Thyatron.

In our experiment when a positive potential is applied to the plate and it is increased slowly, plate current also increases slowly. But when plate potential increases beyond a particular value,

**Circuit diagram:**



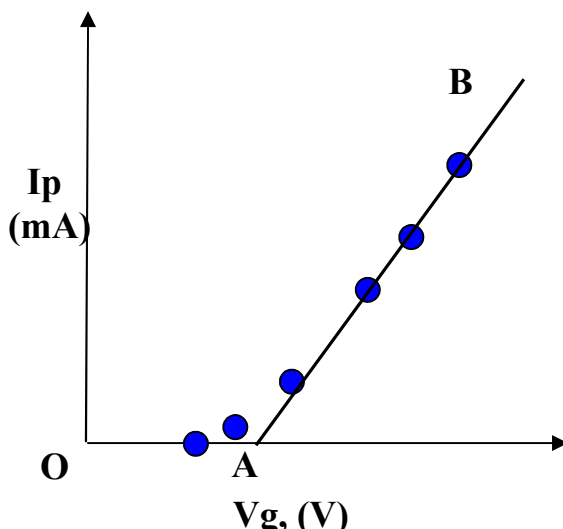
**Fig.1**

plate current increases more rapidly. This is because the electrons arriving at the anode gain enough energy to knock out electrons from the atoms of the gas close to anode. These electrons are also attracted by plate and hence causing increase in plate and current. The positive ions so produced neutralize the space charge which further helps in increasing the kinetic energy of thermal electrons. This value of plate potential at which plate current shows large increase is known as ionization potential

of the gas (vapours). The circuit connections are shown in Fig.1.

### **3. Procedure:**

#### **I. To find observed ionization potential**



(i). Make connections as in Fig.1 and switch on power supply.

(ii). Vary plate voltage,  $V_g = 1 - 20$  V and take reading of plate current,  $I_p$ , for each one.

(iii). Draw graph between  $V_g$  &  $I_p$ .

(vi) Draw a straight line AB between last few points. This line intersects with X-axis at A. OA gives the value of observed ionization potential of mercury.

#### 4.Observations Table:

##### I. Table to find observed ionization potential

S.NO.	Grid voltage, V	Plate current, $\mu\text{A}$
1		
2		
3		
4		
5		

#### 5. Result:

The ionization potential of mercury is \_\_\_\_\_ Volts.

#### 6. Precautions:

- (i). A gas filled tetrode must be used.
- (ii). The connections should be proper before switching on the power supply.

#### VIVA-VOCE

##### Q 1. What do you mean by ionisation potential?

**Ans.** It is the potential required to give an electron just sufficient energy to ionise the atom.

##### Q 2. Of what substance are you finding the ionisation potential?

**Ans.** Of the gas filled in the thyatron valve.

##### Q 3. What is gas in the thyatron valve?

**Ans.** It is inert gas, e.g., Argon. It may be mercury vapour also.

##### Q 4. What is a thyatron valve?

**Ans.** It is the commercial name for a thermionic gas filled triode.

##### Q 5. What is their construction?

**Ans.** In thyatron, filament is indirectly heated, plate is in the form of the disc and the grid is in the form of a cylinder surrounding the plate.

### Experiment No. 5.

**Aim: To draw the V-I characteristic of a solar cell under constant illumination and to determine its fill factor.**

**1. Apparatus required:** Solar cell, d.c.voltmeter, d.c.ammeter, resistance box, one way keys, connecting wires.

**2. formula used:**

(i) Maximum Power =  $V_m \times I_m$

(ii) Ideal power =  $V_{oc} \times I_{sc}$

(iii) Fill Factor =  $\frac{V_m \times I_m}{V_{oc} \times I_{sc}}$

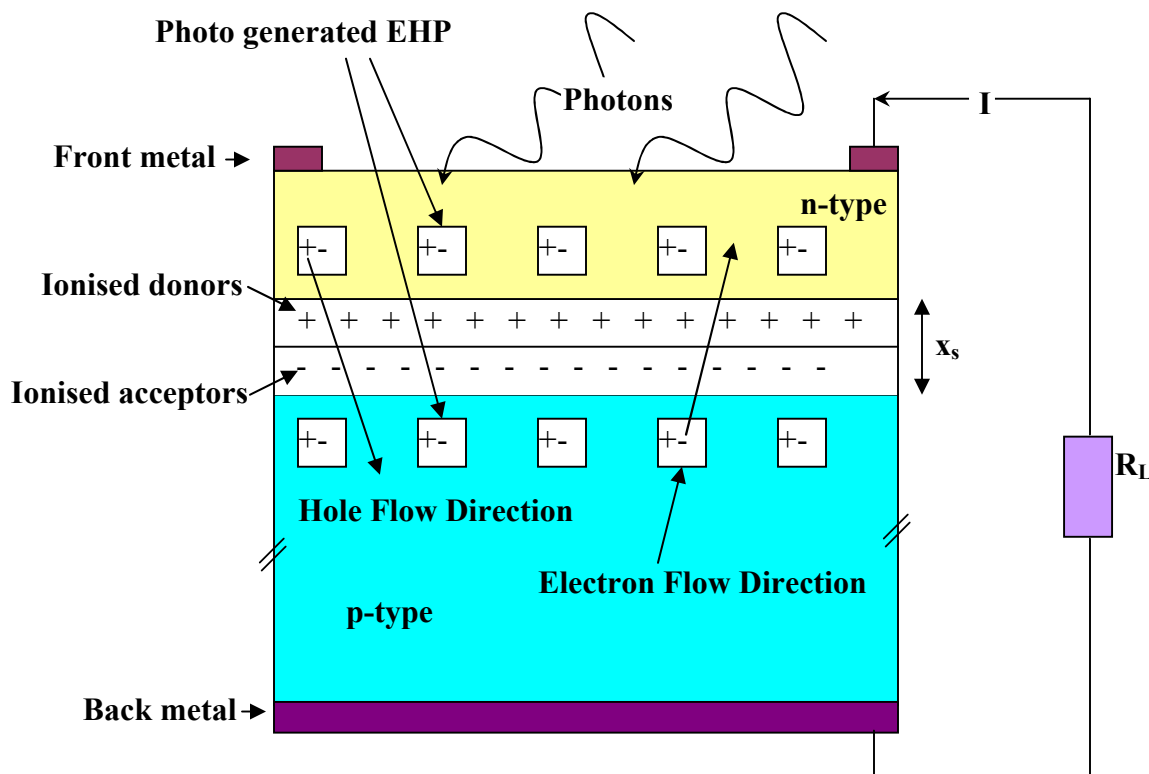
Where,

$V_m$  = Max. Voltage,  $I_m$  = Max. Current,  $V_{oc}$  = Open circuit Voltage,  $I_{sc}$  = Short circuit Current.

**3. Theory:** Solar cell is a device which directly converts light energy to electricity. Becquerel in 1839 discovered this phenomenon of development of a voltage or potential difference under the effect of light (photons). This phenomenon is called Photovoltaic effect. Devices based on this effect are known as **Photovoltaic Cells**. A Solar Cell is a device based on Photovoltaic effect.

#### Construction

The solar cells generally consists of a p-n junction, where onto its base p-region an n-region is



diffused as shown in Fig. above. It can be other way also. The bottom side is totally covered and the front side is partially covered by a metal layers. Metal layers are used to collect all the photo generated carriers generated into the diode materials. Front side is partially covered ( $\approx 5 - 7\%$ ) to allow more light to incident on the front surface to generate more carriers. The diode materials generally used are semiconductor materials like gallium Arsenide (GaAs), Cadmium Telluride

(CdTe), etc. However, most commonly used materials are Silicon, both in single or multi crystalline form. When a solar cell is exposed to sunlight the photons with energy,  $h\nu$ , greater than  $E_g$  of the semiconductor material are absorbed in the cell. In this process a fraction of  $E_g$  of photon energy is utilized in creating EHP and the excess energy,  $h\nu - E_g$ , is dissipated generally in the form of thermal energy given to the crystal. In a pn junction solar cell the incident photons generate EHP in both p and n regions of the junction as shown in Fig. below. The EHP thus produced in the vicinity of the junction and in the space charge region ( $x_s$ ) at the junction is separated by the strong built-in electric field that exists at the junction. This causes the photo generated electrons of the p-side to flow due to diffusion; they reach the junction and crossover to the n-side. Similarly the photo generated holes of the n-side cross over to the p-side. This accumulation of electrons on n-side and holes on p-side of the junction gives rise to a photo voltage.

► The photo voltage attains a maximum value when there is infinitely large load across the cell such that the output current of the cell is zero. This is the maximum photo voltage and is known as the **Open Circuit Voltage ( $V_{oc}$ )**.

If a finite load resistance,  $R_L$ , is connected across the cell, current flows through it and there is a voltage drop also across the load.

► When the load connected across the diode terminals is zero, the current is maximum and is known as **Short Circuit Current,  $I_{sc}$** .

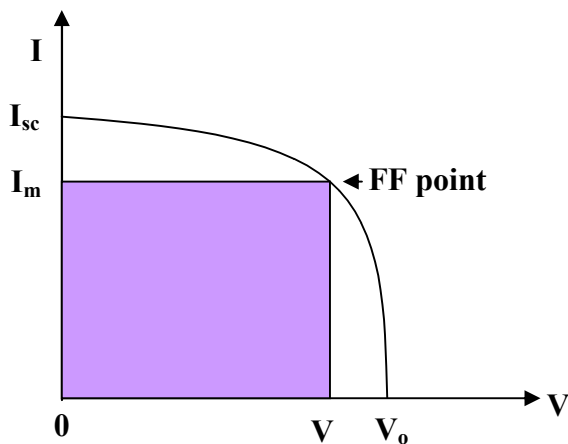
For a finite value of  $R_L$  the current continues to flow in the circuit as long as the solar cell is exposed to sunlight, its magnitude being higher for a higher intensity of light.

The photocurrent,  $I$ , which flows through the solar cell and the load is given by

$$I = I_{sc} - I_d \text{ ----- (1). Here, } I_d = I_0 \left[ e^{\frac{V+IR_s}{nkT}} - 1 \right] - \frac{V + IR_s}{R_{sh}} \text{ ---- (2)}$$

Here, junction voltage,  $V_j = V + IR_s$ , and  $V$  is the voltage developed across the load  $R_L$ ,  $I_d$  and  $I_0$  are the diode and reverse saturation current of the cell respectively,  $n$  is diode ideality factor. Here  $R_s$  and  $R_{sh}$  are the series and shunt resistances of the cell respectively. The ideal values of  $R_s$  and  $R_{sh}$  are zero and infinite respectively. However, in all practical solar cells it is difficult to achieve these values.

Under open circuit condition  $V_{oc}$  can be expressed as  $V_{oc} = \frac{nkT}{q} \ln \left[ \frac{I_{sc}}{I_0} + 1 \right]$  ----- (3)



The condition of maximum power is  $\frac{d(IV)}{dV} = 0$

----- (4). Eqn. (3) in conjunction with Eqn. (1) gives the value of maximum power output,  $P_m$ , under ideal condition (i.e.,  $R_s = 0$  and  $R_{sh} = \alpha$ ) as

$P_m = I_m V_m$  ----- (5). Here,  $I_m$  and  $V_m$  are the values current and voltage of the cell at maximum power point. The curve factor (CF) or Fill Factor (FF) of the illuminated I-V characteristics of the cell is defined as,

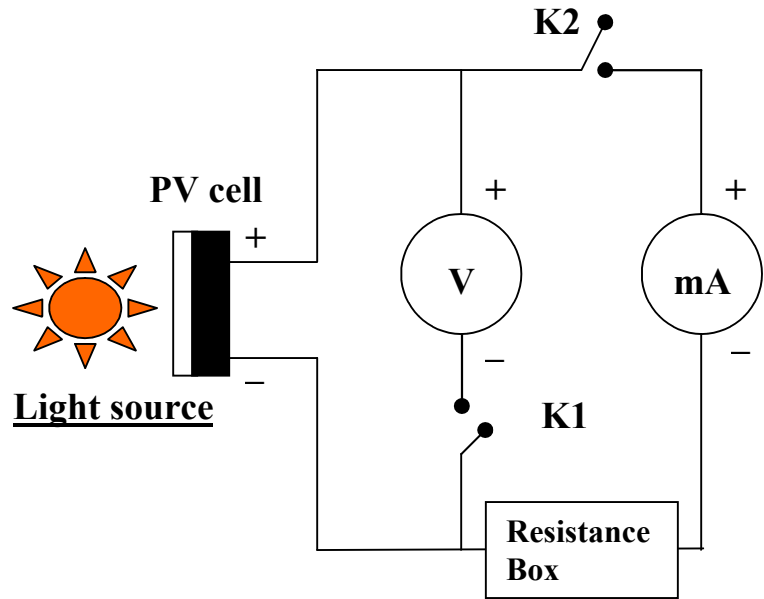
$$FF = \frac{P_m}{I_{sc} V_{oc}} \text{ ----- (6)}$$

FF is a measure of how squarish is the I-V characteristics of the cell. However, FF is always less than 1. Larger the value of FF more squarish is the I-V characteristics of the cell. Increase in  $R_s$  and decrease in  $R_{sh}$  results in degradation of FF. FF basically denotes the maximum power rectangle inside the curve as also clear from the above Fig. An ideal solar cell characteristic curve lays in fourth quadrant due to the flow of the minority carriers only and hence is negative. However, for simplicity we draw it on the first quadrant as shown in Fig. above.

#### 4. Procedure:

- (i). Keep the solar cell under light so that the light falls normally on it.  
 (ii). Make circuit connections as shown in Fig. next.

- (iii). Switch on the light source & close key K1. Note the reading of voltmeter. This is  $V_{oc}$ .  
 (iv). Open K1 & close K2. Make the resistance in resistance box as zero and note the reading in ammeter. This is  $I_{sc}$ .  
 (v). Now close both K1 & K2. Introduce resistance from resistance box in steps and note the voltmeter and ammeter readings for each value of resistances.  
 (vi). Remove K1 & K2 and switch of the light source.



#### 5. Observations:

Open circuit voltage ( $V_{oc}$ ) =                      Volts; Short circuit current ( $I_{sc}$ ) =                      mA

Sr. No.	Resistance ( $\Omega$ )	Readings of		Power output, VI ( $\mu$ W)
		Voltmeter, V (V)	Ammeter, I ( $\mu$ A)	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



## 6. Results :

- (i). Draw the graph between V along X-axis and I along Y-axis.  
 (ii). Mark the point at which power output, obtained from previous table, is maximum. This is the fill factor point.

(iii). **Determination of the fill factor.**

Value of voltage at maximum power output point from the table =  $V_m =$  V.

Value of current at maximum power output point from the table =  $I_m =$  mA.

$$\text{So, Fill factor} = \frac{V_m \times I_m}{V_{oc} \times I_{sc}} =$$

## 7. Precautions:

- (i). The light from source should fall normally on the cell.  
 (ii). Light exposure time should be optimum as over exposure of light will heat the cell, which subsequently degrade the cell performance.

### VIVA-VOCE

#### Q1. Define solar cell.

**Ans.** A solar cell is a device which is basically a P-N junction diode which converts solar energy into electrical energy.

#### Q 2. Define fill factor.

**Ans.** It is the ratio of Maximum useful power to the ideal power.

$$\text{Fill Factor (FF)} = \frac{V_m \times I_m}{V_{oc} \times I_{sc}}$$

#### Q 3. What happened to a photon when it is absorbed by a solar cell?

**Ans.** If the energy of the photon is greater or equal to the band gap energy than it may generate a electron-hole pair. If the energy is less than the band gap energy, it produce excitation.

#### Q 4. What is the conversion efficiency range of a silicon cell?

**Ans.** 10 to 15 %

#### Q 5. What is the range of fill factor for silicon?

**Ans.** 0.65 to 0.80

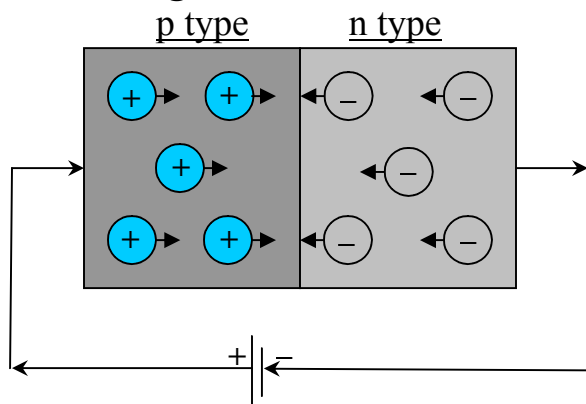
## Experiment No.6.

**Aim : To study the V-I characteristics of a pn diode.**

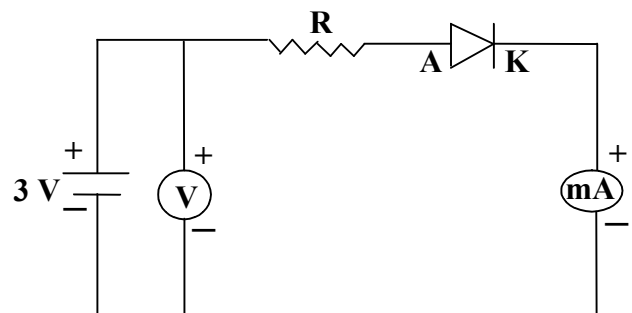
**1. Apparatus required:** A variable voltage supply, semiconductor diode, ammeter, voltmeter, connecting wire.

**2. Theory:** A pn junction is formed by the diffusion of p type impurities at elevated temperatures into the n type silicon substrate for the fabrication of silicon pn diode. In pn diode the electrons from n-side are diffused into p-side and holes from p-side are diffused into n-side. As a result, a region, which is devoid of free charges, is formed near the metallurgical junction of both sides. This is known as depletion layer. When a positive terminal of battery is connected to p-type and negative terminal is connected to n-type, (as shown in Fig.1), the diode is said to be forward biased. In this case hole from p-side tends to cross the junction from p to n and electrons from n side tend to cross the junction from n to p. When a positive terminal of battery is connected to n-type and negative terminal is connected to p-type, (as shown in Fig.2), the diode is said to be reverse biased. In this case holes and electrons move in opposite directions unlike forward biased case.

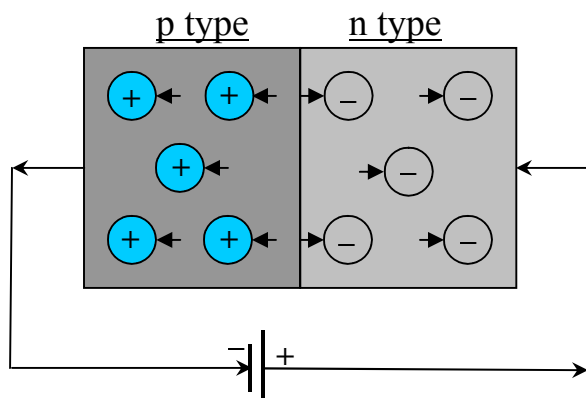
**Circuit Diagram:**



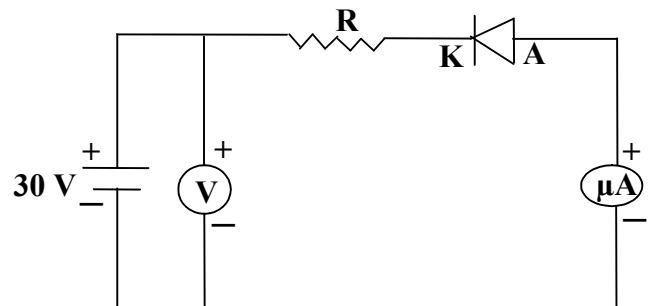
**Forward Bias**



**Fig. 1.**



**Reverse Bias**



**Fig. 2.**

### 3. Procedure:

#### I. Forward Characteristics

(i). Make connection as in Fig.1. (ii). Vary the voltage in small steps and measure the corresponding currents. (iii). Plot a graph between diode voltage and diode forward current.

#### II. Reverse Characteristics

(i). Make connection as in Fig.2. (ii). Vary the voltage in small steps and measure the corresponding currents. (iii). Plot a graph between diode voltage and diode reverse current.

### 4.Observations: Table for V-I characteristics of the diode

Forward Biasing condition			Reverse Biasing condition		
Sr. No.	Diode Voltage (V), Volts	Diode current (I), mA	Sr. No.	Diode Voltage (V), Volt	Diode current (I), $\mu$ A
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		

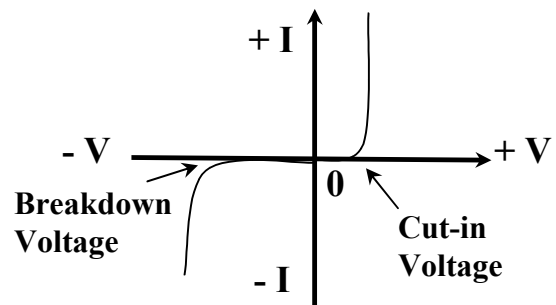
### 5. Calculations:

(i). To obtain dynamic resistance ( $r_d$ ) of diode:

The ideal graph is show in Fig. 3.

Extend the linear portion of the graph (forward)

to obtain cut-in voltage (VC) and  $r_d = \frac{\Delta V}{\Delta I}$ .



### 6. Precautions:

(i). Current should not be passed for a longer time to avoid damage due to over heating.

(ii). Voltage should be below the safety limit of diode.

(iii). Connections should be proper in both the biasing conditions.

**VIVA-VOCE****Q 1. What is semiconductor diode?**

**Ans.** A p-n junction is called semiconductor diode.

**Q 2. Define depletion layer?**

**Ans.** The region having uncompensated acceptor and donor ions is called depletion layer.

**Q 3. What do you mean by forward bias and reversed bias?**

**Ans.** When p-type semiconductor is connected to the positive terminal and n-type semiconductor connected to negative terminal of voltage source, so that zero resistance is offered to the flow of current, is called forward bias. When p-type semiconductor is connected to the negative terminal and n-type semiconductor connected to positive terminal of the voltage source, so that zero current flows in this condition, is called reverse bias.

**Q 4. Define knee voltage?**

**Ans.** The forward voltage at which current through the junction starts increasing rapidly.

**Q 5. Define break down voltage?**

**Ans.** The reverse voltage at which p-n junction breaks down which sudden rise in reverse current.

**Q 6. What is doping?**

**Ans.** Addition of impurity atoms to a pure semiconductor in controlled manner to increase the conductivity is called doping.

### Experiment No. 7.

**Aim: To study the variation of magnetic field and to find the radius of current carrying coil by Stewart & Gee's method.**

**1.Apparatus required:** Tangent galvanometer of Stewart & Gee's type, Battery, Rheostat, a plug key.

**2.Formula Used:**

**(i) Point of inflexoin =  $(\tan\theta)m \times 0.707$**

**(ii) Radius of coil = Sum of distance between two points on X- axis.**

**3. Theory:** This experiment is based on the principle of magnetic effect of current. It consists of circular coil of many turns of thin insulated copper wire. It is fixed with its plane vertical on horizontal bench. A magnetometer compass box is placed inside the coil such that it can slide on the bench in such a way that the center of the needle always lies on the axis of the coil. The distance of the needle from the center of the coil can be read on a graduated scale fixed on the arms of the magnetometer.

**Description of the Apparatus:** Stewart & Gee tangent galvanometer consists of a circular coil of thin copper wire with tapings at 5, 25 and 125 (5,50&100) turns. This coil is fixed vertically at the center of one-meter long horizontal bench. A magnetic compass box can slide from the center to either end of the bench along the axis of the coil. The whole length of bench is graduated in millimeter in order to read the distance of the magnetic needle from the center of the coil. The whole

set-up is shown in Fig. Next. The magnetic field along the axis of a coil at a point is 
$$F = \frac{2\pi n^2 i}{10(x^2 + r^2)^{\frac{3}{2}}}$$

.....(1) Here n is number of turns in the coil, r is the radius of coil, i is the current in ampere flowing in the coil, x is the distance of the point from the center of the coil. If F is made perpendicular to H the earth's magnetic field the deflection of the magnetic needle  $\theta$  is given by  $F = H \tan \theta$ .

.....(2) So, 
$$F = \frac{2\pi n r i^2}{10(x^2 + r^2)^{\frac{3}{2}}} = H \tan \theta \quad \text{.....(3)}$$

**4. Procedure:**

(i). The magnetometer compass box is placed on the sliding bench so that its magnetic needle is at the center of the coil as shown in Fig.1.

(ii). The coil is set in the magnetic meridian by the whole apparatus in the horizontal plane.

(iii). The current is adjusted using rheostat Rh so that the deflection of nearly  $70^\circ$  to  $75^\circ$  is produced in the compass needle placed at the center. Both the ends of the pointer are to be read.

(iv). The direction of the current is reversed and again both the ends of the pointer are read.

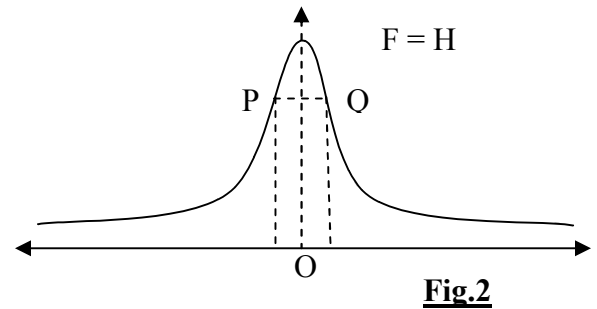
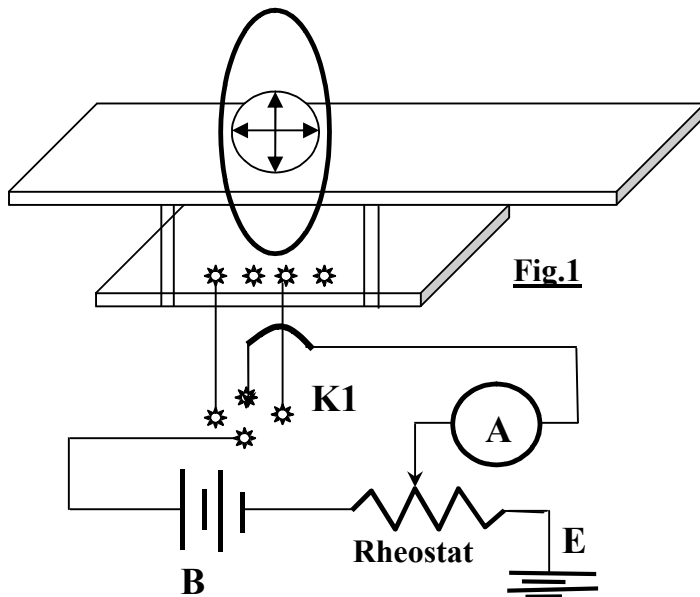
(v). The mean of four reading in step 3 and 4 given the mean deflection at x.

(vi). The compass needle is then shifted through 2 cm each time along the axis of the coil and for each position the mean deflection is noted, i, e... steps 3,4 and 5 are repeated for distance x from the center of the coil 2 cm, 4 cm upto 20 cm.

(vii). Perform the above measurement for the west arm in the similar way. This gives deflections  $\theta_1, \theta_2$  for the west arm.

(viii). Reverse the current and note the deflections of the pointer  $\theta_3, \theta_4$  at the center of the coil. These should be same as  $\theta_1, \theta_2$  for  $x = 0$ . Repeat steps for the reversed current. This gives  $\theta_3$  and  $\theta_4$  for the entire length for the bench.

(ix). The points of inflexion are marked on the curve. The nature of the graph is shown in Fig.2. The distance between the two points gives the radius of the coil.

**Circuit Diagram:****5. Observations: Table for measurement of  $\theta$** 

Sr. No	distance of the needle from the center x, cm	Deflection on east side (arm)				Deflection on west side (arm)							
		Current one way (degree)		Current reverse (degree)		Mean $\theta$ (degree)	tan $\theta$	Current one way (degree)		Current reverse (degree)		Mean $\theta$ (degree)	tan $\theta$
		$\theta_1$	$\theta_2$	$\theta_3$	$\theta_4$			$\theta_1$	$\theta_2$	$\theta_3$	$\theta_4$		
1	0												
2	2												
3	4												
4	6												
5	8												
6	10												

**5. Calculations:**

A graph is plotted taking distance along x-axis and  $\tan\theta$  along y-axis.

Standard value of the radius of coil. = ----- cm.

**6. Result:** (i). The graph between the distance from the center of the coil and  $\tan \theta$  is shown.

(ii). The distance between the points of inflections P & Q is equal to the radius of coil and is of \_\_\_\_\_ cm.

**7. Sources of Error and Precautions:**

1. The coil should be carefully adjusted in the magnetic meridian.
2. All magnetic material should be kept away from the apparatus.

3. The deflection in the coil should be nearly  $75^\circ$ .
5. Both the ends should be read.
6. A smooth curve should be drawn.

### VIVA-VOCE

**Q 1. What is the magnitude of the field at the centre of the coil?**

**Ans.** It is  $H = \frac{2\pi ni}{10 r}$ , where  $r$  is the radius of coil and  $n$  is the number of turns in it. Thus field at the centre increases if we increase no. of turns in the coil.

**Q 2. What is the direction of this field?**

**Ans.** If in the face of the coil, we look at, the current is flowing in clockwise direction then that face of the coil acts as south pole. Thus direction of the field will be away from us.

**Q 3. How does the field vary along the axis of the coil?**

**Ans.** It varies as shown in the graph. The points at which curve changes its direction of curvature are called points of inflexion. The distance between them is equal to the radius of coil.

**Q 4. Is the field uniform at the centre?**

**Ans.** It is uniform only over a very small region at the centre.

**Q 5. How can you get more wide region of uniform field?**

**Ans.** By the use of Helmholtz galvanometer which consists of two exactly similar coils placed coaxially.

**Q 6. Is it true for any direction of current in the two coils?**

**Ans.** Yes, but current should flow in the two coils in the same direction.

### Experiment No. 8.

#### Aim: Determination of energy band gap of a semi-conductor by four probe method.

**1. Apparatus required:** A four point probe arrangement, a semiconductor sample, a constant current generator, heating arrangement, thermometer, voltmeter and ammeter.

**2. Formula used:-** 
$$E_g = \frac{2 \times K \times 2.3026 \times \log_{10} \rho}{\frac{1}{T} \times 10^{-3}} \text{ eV}$$

Where K = Boltzmann contt.

$$= 8.6 \times 10^{-5} \text{ eV/degree.}$$

$\rho$  = Resistivity

$$= \frac{\rho}{f\left(\frac{W}{S}\right)}$$

$$\rho_0 = \frac{2\pi v \times s}{I} = 2 \times 3.14 \times 0.2 \times \frac{v}{I} = \frac{v}{I} \times 1.256 \text{ ohm - cm.}$$

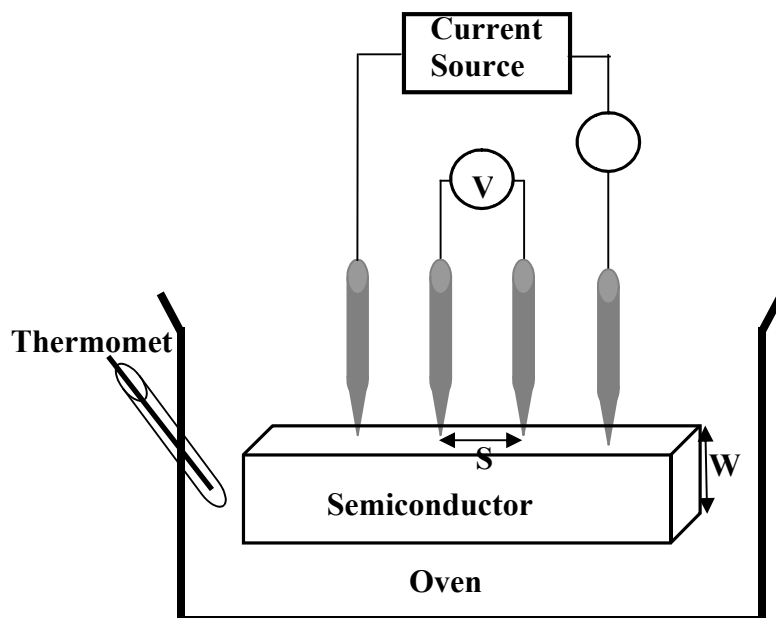
S = distance between twq probes = 2 mm = 0.2 cm.

W = Thickness of crystal = 0.062 cm.

V = voltage

I = Current = 8 mA =  $8 \times 10^{-3}$  A.

**3. Theory:** In this method there are four probes, in which outer two are used for passing current 'I' and the inner two probes are used to measure potential difference 'V' developed between any two points



**Fig.1**

on the semiconductor specimen. If the dimension of the specimen are large compared to spacing between probes, then, the potential between any two points is

$$V = \frac{\rho_0 I}{2\pi S} \Rightarrow \rho_0 = \frac{2\pi S V}{I},$$

where, S is spacing between the probes. For a slice of semiconductor sample some correction factor 'D(W/S)' has to be applied as  $\rho = \frac{\rho_0}{D(W/S)}$ ,

where, W is the width of the slice,  $\rho$  is the resistivity of the sample. D(W/S) can be calculated from the table next for different values of W and S. The variation of resistivity is give



W/S	f(W/S)
0.100	13.863
0.141	9.704
0.200	6.931
0.33	4.159
0.500	2.780
1.000	1.504
1.414	1.223
2.000	1.094
3.333	1.0228
5.000	1.0070
10.000	1.00045

$$\rho = Ce^{\frac{E_g}{2kT}}, \text{ where } C \text{ is a}$$

constant. Taking natural log of both sides,  $\log_e \rho = \log_e C + \frac{E_g}{2kT}$

$$\Rightarrow 2.303 \log_{10} \rho = 2.303 \log_{10} C + \frac{E_g}{2kT}$$

$$\Rightarrow \log_{10} \rho = \log_{10} C + \frac{E_g}{2 \times 2.303 \times kT} \dots\dots\dots (1)$$

So (1) shows that the plot of  $\log_{10} \rho$  versus  $1/T$  will be a straight line. The slope of the curve is

$$\frac{\log_{10} \rho}{1/T} = \frac{E_g}{2 \times 2.303 \times k}$$

$$\text{So, } E_g = 2 \times 2.303 \times k \times \text{slope.} \dots\dots\dots (2).$$

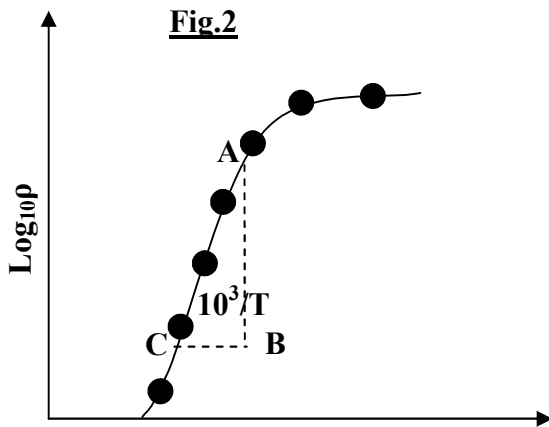
**4. Procedure:** (i). Put the sample on the base plate of four probe arrangement and ensure proper contact for all the four probes.

(ii). Verify the probe connections as shown in Fig.1.

(iii). Set a constant current in constant current source and note its value.

(iv). Increase the temperature of the oven and note the value of voltage for every 2-3°C increase in temperature.

(v). Take 8-10 observations and complete the following table.



**7.Observations:-** (i) Distance between two probes (S) = 2mm. = 0.2cm.

(ii) Width of crystal = 0.062 cm.

(iii) Current (contt.) = 8mA =  $8 \times 10^{-3}$

(iv) resistivity at absolute temp. ( $\rho_0$ )

(v)  $\frac{W}{S} = \frac{0.062}{0.2} = 0.31$

(vi)  $f\left(\frac{W}{S}\right) = f(0.31) = 4.12$

(vii) resistivity ( $\rho$ )

$$= \frac{\rho}{f(W/S)} = \frac{V}{I} \times \frac{1.256}{4.12} = \frac{V \times 1.256}{8 \times 10^{-3} \times 4.12}$$

$$= 38.10 \times V$$

**Table to plot the graph between  $\log_{10} \rho$  vs  $10^3 / T$** 

Sr. No.	T in °C	T in K	Voltage (mV)	$\rho$ (ohm-cm) = $38.10 \times V$	$\log_{10} \rho$	$1/T \times 10^{-3}$
1						
2						
3						
4						
5						
6						
7						
8						

**6. Calculations:**

A graph is plotted between  $\log_{10} \rho$  versus  $10^3 / T$ . The slope of the curve (as shown in Fig.2) is

$$\frac{AB}{BC} = \frac{\log_{10} \rho}{10^3 / T}$$

So the energy band gap of the semiconductor is  $E_g = \frac{2 \times k \times 2.303 \times \log_{10} \rho}{1/T}$

$$= 2 \times 8.6 \times 10^{-5} \times 2.303 \times \frac{AB}{BC} \times 1000 \text{ eV}$$

$$= 0.396 \times \frac{AB}{BC} \text{ eV.}$$

**8. Result:** The energy band gap of the semiconductor is ..... eV.

**9. Precautions:** (i). Resistivity of the sample should be uniform.

(ii). The probing surfaces should be absolutely flat.

(iii). Exert optimum pressure to make electrical contact of probe with the wafer.

(iv). Current should not be large enough to cause heating.

**VIVA-VOCE****Q. 1 What is four probe method?**

**Ans:** In four probes method there is a set of four probes. Outer pair is used for passing current through the semiconductor and the inner pair is used for measuring p.d. by using suitable relationship we can measure the resistivity of given semiconductor.

**Q. 2 What is resistivity?**

**Ans.** The resistance offered by a conductor of unit cross-sectional area and of unit length is called resistivity. It is the property of the material of the conductor (unit: ohm-cm).

**Q. 3 What are the factors that control the resistivity of a semiconductor?**

**Ans.** Temperature and band-gap.

**Q. 4 How does the resistivity of a semiconductor vary with rise in temperature?**

**Ans.** It decreases.

**Q. 5 What is the position of the Fermi-level in n-type and p-type semiconductor?**

**Ans.** In an n-type semiconductor, the concentration of electrons is more so the Fermi-level lies nearer to the conduction band.

In a p-type semiconductor, the concentration of holes is more so the Fermi-level lies nearer to the valence band.

**Q. 6 How do you differentiate among a conductor, an insulator and a semiconductor on the basis of forbidden energy-gap?**

**Ans.** In conductors, the conduction band and the valence band overlap consequently the energy-gap is zero. In semiconductors, there is a small energy-gap (of the order of  $1_eV$ ) between the conduction band and the valence band.

### Experiment no. 9.

**Aim: - To determine the hysteresis loss by C.R.O.**

**1.Apparatus required: -** A step down transformer specimen transformer hysteresis loss of which is to be calculated, capacitor ( $8\mu\text{F}$ ), resistor ( $50\text{ K}\Omega$  potentiometer), A.C. Voltmeter (0-10), A.C. millimeter (0-500mA), Rheostat ( $10\Omega$ ).

**2.Formula used: - Energy loss =  $\frac{0.5N \times S_V \times S_H \text{ Area of loop}}{R \times L}$  joules/ cycle/ unit volume.**

$$\text{Area of loop} = \frac{\text{No. of small squares} \times R \times L}{100\text{cm}^2}$$

Where,

N is the number of turns of sample coil

R is the value of the resistance,

L is the length of specimen in meters,

$V_x$  is the applied voltage to the horizontal X plate.

**3.Theory: -** The flux density B is the ratio of total no of lines of force existing in the magnetic field (in webers) and the area (in  $\text{m}^2$ )

$$B = \text{Total no of lines of force (Wb)} / \text{Area (m}^2\text{)}$$

The permeability ( $\mu$ ) is the ratio of the change in flux density to the change in field intensity.

$$\mu = \text{change in flux density} / \text{change in field intensity} = \frac{\Delta B}{\Delta H}$$

Materials like cobalt, nickel, iron which possess a value of  $\mu$  much greater than unity are called ferromagnetic materials. Materials with  $\mu$  less than unity are called diamagnetic, while materials with  $\mu$  values slightly greater than unity are called paramagnetic. For vacuum, the value of permeability is unity. When an alternating current is allowed to flow through an air core coil the variation of flux density (B) with magnetizing force (H), the flux density increases in phase with the magnetizing force. If H is now decreased 'I' also decreases but following a path AB. Thus 'I' lags behind H becomes zero; 'I' still has a value OB. This amount of magnetization is called the "**Residual Magnetism**" or "**Retentivity**" of the specimen. Thus the retentivity of a specimen is a measure of the intensity of magnetization remaining in the specimen when the magnetizing field is removed. If the magnetizing field H be now increases in the reverse direction, the value of 'I' further decreases, still lagging behind H and become zero when H has a value equal to OC. This value of magnetizing field is called the "**Coercive force**" or "**Coercivity**" of the specimen. Thus coercivity is a measure of the magnetizing field required to destroy the residual magnetism of the specimen.

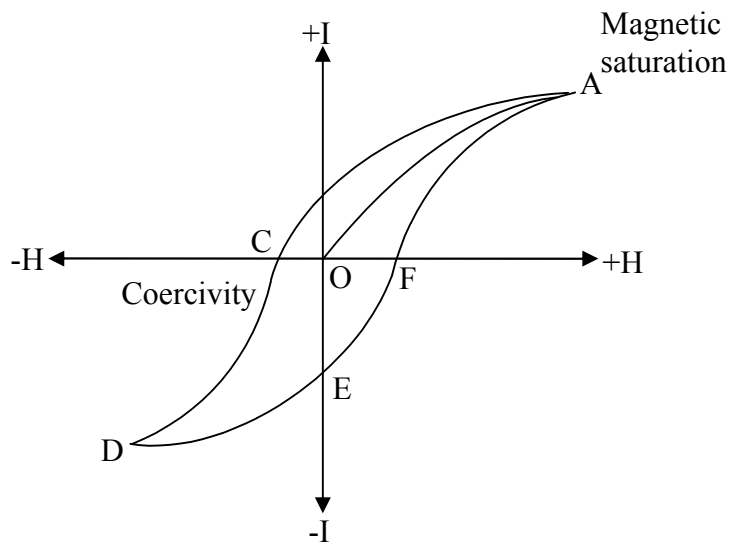
As H is increases beyond OC, the specimen is increasingly magnetized in the negative direction, until the magnetic saturation is reached at D. by taking H back from its negative saturation value, through zero, to its original positive saturation value, a similar curve DEFA is obtained.

It is thus found that the intensity of magnetization 'I' always lags behind the magnetizing field H when H changes. The lagging of 'I' behind H called "**Hysteresis**". The closed curve ABCDEF A which represents a cycle of magnetization if specimen is known as "**Hysteresis Curve**" of the specimen. A graph between magnetic induction B and magnetizing field H is similar in shape with the only difference that B never becomes constant but always increases with H. Hence in the B-H curve, the corners A and D are not straight but slopping.

The magnetic field H

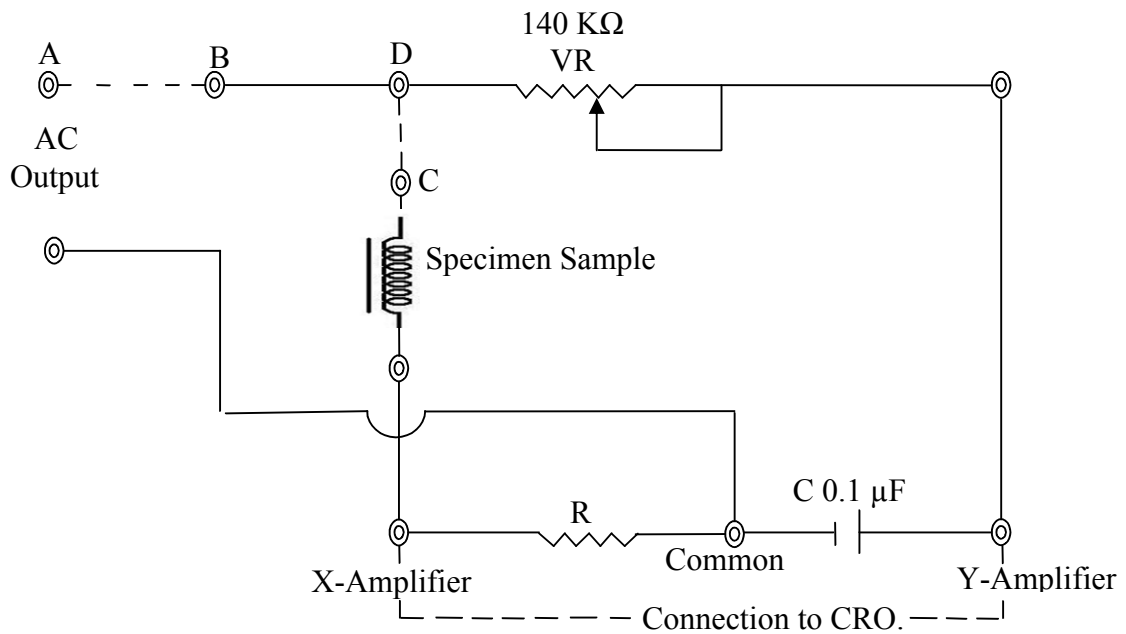
$$H = \frac{N}{RLVx} \text{ ampere turns/meter.}$$

Similarly the flux density decrease with the magnetizing force in face. However for an iron cored coil or a coil consisting of a core of ordinary steel the B-H curve or magnetization curve of the iron core forms a loop called hysteresis loop. Saturable reactor normally uses cores of nickel iron or silicon iron alloys. These materials may be of (a) thin lamination to reduce eddy currents loss. (b) Construction without gap to minimize flux leakage.



**Fig. 1.**

**RETENTIVITY, COERCIVITY AND HYSTERESIS:** Ferromagnetic materials contains large no of regions, called domain. In each domain, all the atomic magnets are fixed in rigid parallelism. Thus each domain has a net magnetization in a particular direction distributed randomly. When a specimen of a ferromagnetic material is placed in a magnetizing field (H), the specimen is magnetized by induction. As the magnetizing field (H) varied, the intensity of magnetization of specimen, "I" changes. The variation in "I" with variation in H is shown in fig. (1). The point O represents unmagnetised specimen and a 0 magnetizing field. As H is increased, "I" also increases but not uniformly. When all the domains are aligned in the field direction, the magnetization of specimen gets saturated at A. any further increase in H result no more increase in "I".

**4.CIRCUIT DIAGRAM:-****Fig. 2.****5.Observations:**

$N$  = No. of turns in the coil = 300

$S_v$  = Vertical sensitivity =-----

$S_h$  = Horizontal sensitivity =-----

$L$  = 3.3cm.

$R$  =-----KΩ

$$\text{Area of the loop} = \frac{\text{No. of small squares}}{100 \text{ cm}^2}$$

**5.Result :**

Energy loss =----- Joules / cycle / cc.

**VIVA-VOCE****Q. 1 What is hysteresis?**

**Ans.** We observe that though the magnetizing field becomes zero yet the intensity of magnetization does not become zero. This lagging of intensity of magnetization behind the magnetizing field is called hysteresis.

**Q. 2 What do you mean by hysteresis loss?**

**Ans.** It has been observed that when we magnetize a magnetic material, certain amount of work is to be done i.e. energy is spent in magnetization. The same work is not recovered when the magnetizing field switched off. Thus this balance of energy left with the specimen, which is lost as heat, is called hysteresis.

**Q.3 Why is the work not totally recovered?**

**Ans.** Because some molecular magnets do not come back in their pre-magnetization orientation. This is due to retentivity.

**Q. 4 What is retentivity?**

**Ans.** The value of intensity of magnetization ( $I$ ) for which the magnetizing field is zero is called retentivity.

**Q. 5 What is corecivity?**

**Ans.** The value of intensity of measures of magnetic field required to make the residual magnetism to zero.

**Q. 6 What is intensity of magnetization?**

**Ans.** It is the magnetic moment per unit volume of the specimen of the material.

### Experiment No. 10.

**Aim: To study Hall Effect by determining the Hall Voltage and Hall Coefficient**

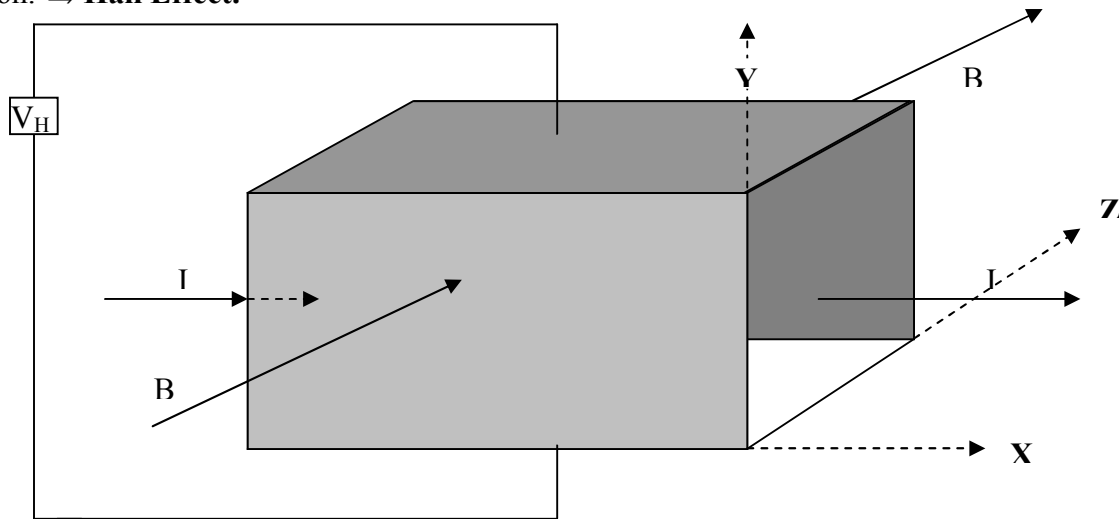
**1.Apparatus required:** Hall probe with Germanium (Ge) crystal, Hall Effect set up, Electromagnet, a constant current source, Gauss meter.

**2.Formula used:-** Hall coefficient  $R_H = \frac{t}{B_y} \times \tan \theta . Cm^3 / coulomb$

Where t = thiknes

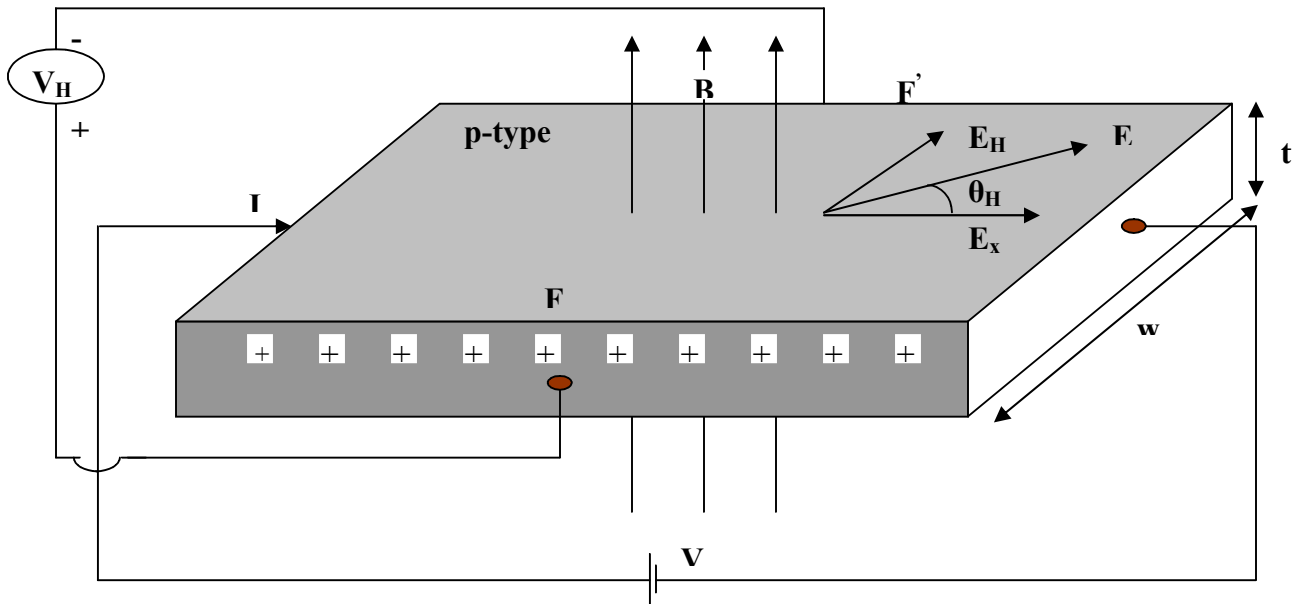
B = Magnatic fld.

**3.Theory:** If a metal or a semiconductor carrying a current is placed in a transverse magnetic field, a potential difference is produced in the direction normal to both the current and magnetic field direction.  $\Rightarrow$  **Hall Effect.**



In the Fig. above, the electric field is applied along X-direction; magnetic field is in Z-direction. Hence, a potential difference due to Hall Effect is developed in the rectangular sample along Y-direction. For a rectangular plate of a p-type semiconductor when a potential difference is applied for the application of electric field at the ends of it a current 'I' flows through it along X-direction as shown in Fig. Hence the current due to charge carrier 'holes' in p-type semiconductor is given by,

$$I = peA \quad \text{----- (1)}$$





Here,  $p$  is concentration of holes in atoms/cc,  $A$  is the cross sectional area of the end face,  $e$  is the charge of a hole. By applying the external electric field, now the potential difference between the front and rear faces  $F$  and  $F'$  is zero, as this plane along  $FF'$  is perpendicular to the plane of electric field. However, on application of  $B$  normal to the crystal surface and to the current flow, a transverse potential difference is produced between  $F$  and  $F'$ . This is called the Hall Voltage,  $V_H$ . If 't' be the thickness of the plate (as in 2<sup>nd</sup> Fig.), then,  $A=wt$ . Hence,  $V_H = \frac{wBI}{pewt} = \frac{BI}{pet}$  ----- (1)

### **Hall Coefficient**

► The Hall Coefficient,  $R_H$ , is defined as the Hall Field per unit magnetic induction per unit current density. Hence,  $R_H = \frac{E_H}{BJ_x} = \frac{V_H/w}{BJ_x} = \frac{BI/pet}{wB(I/wt)} \Rightarrow R_H = \frac{1}{pe}$  ----- (2)

► From (1) and (2),  $V_H = R_H \frac{BI}{t} \Rightarrow R_H = \frac{tV_H}{BI}$  ----- (3)

When the directions of  $B$  and  $I$  are like the directions as shown in Fig. before, the sign of  $V_H$  is positive. However, for an n-type semiconductor  $V_H$  is negative for same directions of  $B$  and  $I$ . So by knowing the polarity of Hall voltage the type of a semiconductor can be known. Knowing the value of  $R_H$  (from (3)), the concentration of charge (majority) carriers can be determined (using (2)).

### **4. Procedure:**

- (i). The specimen is placed in the field (between the poles) of electromagnet.
- (ii). Constant current,  $I_x$ , is passed through the sample along X-axis.
- (iii). The magnetic field ( $B_y$ ), already measured in a Gauss meter, is directed along Y-axis.
- (iv). The Hall voltage ( $V_H$ ) developed in the sample is measured.
- (v). Steps (ii) to (iv) are repeated for different values of  $I_x$ .
- (vi). A straight line graph is plotted between  $I_x$  and  $V_H$ .
- (vii). The slope of this curve,  $\tan \theta = \frac{\Delta V_H}{\Delta I_x}$ , is then calculated.

(viii). The value of  $R_H$  is then calculated by using eqn.(3) as  $R_H = \frac{t}{B_y} \tan \theta$  .

### **5. Observations:**

**Table to plot graph between  $I_x$  and  $V_H$**

$t = 0.55 \text{ mm}, B_y = \text{Gauss.}$

Sr. No.	Applied current, $I_x$ , mA	Hall voltage, $V_H$ , mV	Sr. No.	Applied current, $I_x$ , mA	Hall voltage, $V_H$ , mV
1			8		
2			9		
3			10		
4			11		
5			12		
6			13		
7			14		

**6. Calculations:** From the slope of the graph between  $V_H$  and  $I_x$  we have,

$$\tan \theta = \frac{\Delta V_H}{\Delta I_x} = \quad , \text{ and, Hence, } R_H = \frac{t}{B_y} \tan \theta =$$

**7. Result:**

The value of Hall Coefficient,  $R_H$  , is.....cm<sup>3</sup>/ coulomb.

**8. Precautions:**

- (i). The dimension of the crystal slab should be accurately measured.
- (ii). Measurement of  $V_H$  &  $B_y$  has to be very accurate.

### VIVA-VOCE

**Q-1 What is hall effect?**

**Ans:** If a current carrying conductor (or semiconductor) is placed in a transverse magnetic field a voltage is produced perpendicular to both the direction of the current and the direction of magnetic field. The voltage so developed is called Hall voltage and the phenomenon is called the Hall effect.

**Q-2 What is hall coefficient?**

**Ans:** Hall coefficient is defined as the ratio of hall electric field per unit current density and the transverse magnetic field.

**Q-3 What is the use of hall effect?**

**Ans:** It is used in the determination of Hall coefficient.

**Q-4 On what factors the sign of Hall potentials depends.**

**Ans:** It depends upon the nature of charge carriers. Thus by noting the directions of Hall potential and magnetic field, the nature of the charge carriers may be determined by the use of Flemming's left hand rule.

**Q-5 What is mobility?**

**Ans:** It is the drift velocity of the charge carrier acquired per unit electric field.