EE236 : Electronic Devices Lab
Lab 8 [Tuesday Batch]

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1 Aim of The Experiment

1. To study the Hall Effect by varying the distance between the hall sensor and the magnet, and recording the output voltage.

2. To determine the strength of the bar magnet and calculate the doping concentration of the hall element.

2 Output Voltage vs Distance Plot

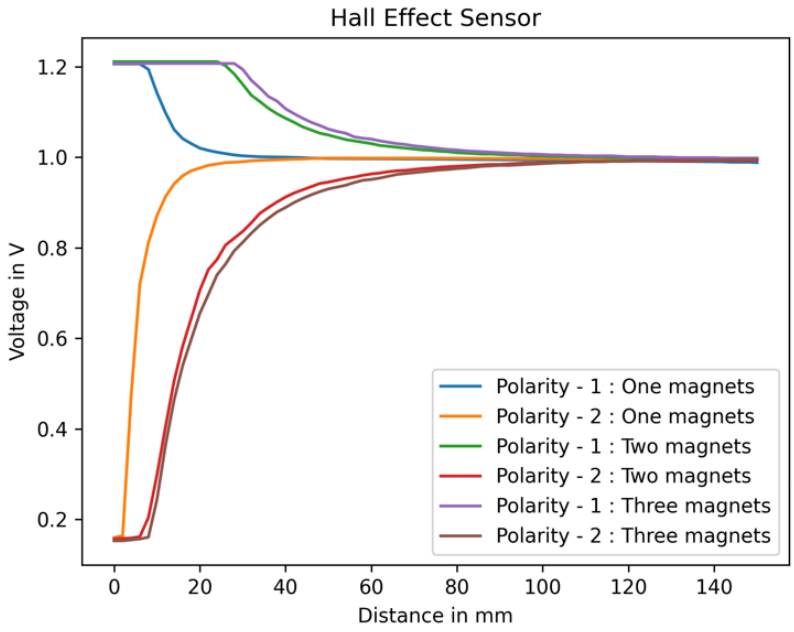

Figure 1: Output Voltage v/s Distance

3 Formulae

3.1 Strength of Bar Magnet

- Longitudinal electric field:

$$E_{\text{long}} = \frac{V_{\text{in}}}{a}$$

  where $a = 0.53\,\text{mm}$, $V_{\text{in}} = 8\,\text{V}$.

- Lateral electric field due to Hall effect:

$$E_{\text{lat}} = \frac{|V_{\text{out},0} - V_{\text{out,max}}|}{a}$$

- Magnetic field strength B:

$$E_{\text{lat}} = 3 \cdot B \cdot \mu \cdot E_{\text{long}}$$

3.2 Doping Concentration

- Hall coefficient R_H:

$$R_H = \frac{V_{\text{out,max}} \cdot t}{I_{\text{in}} \cdot B}$$

  where $t = 0.053\,\text{mm}$.

- Doping concentration N:

$$N = \frac{1}{R_H \cdot e}, \quad e = 1.6 \times 10^{-19}\,\text{C}$$

4 Magnetic Field Strength Calculation

4.1 Given Data

$V_{\text{out, max}} = 1.206\,\text{V}$
$V_{\text{out, 0}} = 1.0\,\text{V}$
$\mu = 0.8\,\text{m}^2/\text{Vs}$
$V_{\text{in}} = 8\,\text{V}$
$a = 0.53\,\text{mm} = 0.53 \times 10^{-3}\,\text{m}$

4.2 Formulas and Calculations

1. **Lateral Electric Field**:

$$E_{\text{lat}} = \frac{|V_{\text{out, 0}} - V_{\text{out, max}}|}{a}$$

$$E_{\text{lat}} = \frac{|1.0 - 1.206|}{0.53 \times 10^{-3}} = 388.679\,\text{V/m}$$

2. **Longitudinal Electric Field**:

$$E_{\text{long}} = \frac{V_{\text{in}}}{a}$$

$$E_{\text{long}} = \frac{8}{0.53 \times 10^{-3}} = 15,094.34\,\text{V/m}$$

3. **Magnetic Field Strength**:

$$E_{\text{lat}} = 3 \cdot B \cdot \mu \cdot E_{\text{long}}$$

$$B = \frac{E_{\text{lat}}}{3 \cdot \mu \cdot E_{\text{long}}}$$

$$B = \frac{388.679}{3 \cdot 0.8 \cdot 15,094.34} = \frac{388.679}{36,226.41} \approx 0.0107\,\text{T}$$

5 Doping Concentration Calculation

5.1 Given Data

$I_{\text{in}} = 3\,\text{mA} = 3 \times 10^{-3}\,\text{A}$
$t = 0.053\,\text{mm} = 0.053 \times 10^{-3}\,\text{m}$
$V_{\text{out, max}} = 1.206\,\text{V}$
$B = 0.0107\,\text{T}$
$e = 1.6 \times 10^{-19}\,\text{C}$

5.2 Formulae and Calculations

1. **Hall Coefficient (R_H)**:

$$R_H = \frac{V_{\text{out, max}} \cdot t}{I_{\text{in}} \cdot B}$$

Substituting the known values:

$$R_H = \frac{1.206 \times 0.053 \times 10^{-3}}{3 \times 10^{-3} \times 0.0107} = 0.002131\,\text{m}^3/\text{C}$$

2. **Doping Concentration(N)**:

$$N = \frac{1}{R_H \cdot e}$$

$$N = \frac{1}{0.002131 \times 1.6 \times 10^{-19}} = 3.14 \times 10^{18}\,\text{m}^{-3}$$

3. **Convert to cm^{-3}:**

$$1\,\text{m}^{-3} = 10^{-6}\,\text{cm}^{-3}$$

$$N = 3.14 \times 10^{18}\,\text{m}^{-3} = 3.14 \times 10^{12}\,\text{cm}^{-3}$$

6 Experiment Completion Status

Completed the experiment in time and submitted the taken readings on moodle.