Measurement of Magnetic Field Using Hall Probe Gaussmeter

Objective

I. To measure magnetic field of a bar magnet using Hall Probe Gaussmeter.
II. To draw the 2D contour plot of magnetic field using MATLAB.

Theory

Magnetic field of a bar magnet is measured using a hall probe Gaussmeter. The Gaussmeter uses the Hall Effect principle for field measurement. Figure 1 and 2 illustrate the Hall Effect principle. When current is passed through a thin strip of semiconductor (Hall element) in absence of a magnetic field, no voltage (figure 1) is generated across the output terminals. But with the application of perpendicular magnetic field, Lorentz force is exerted on the current which disturbs the uniformity of the current flow. As a result potential difference is appeared across the output terminals which is perpendicular both to the current and magnetic directions (figure 2). This voltage is known as Hall Voltage (V_H) (equation 1).

$$V_H = \frac{K_H I B}{t} \qquad (1)$$

Where, K_H is the Hall effect co-efficient (Vm/AWb/m^2),
I is the current (A),
B is the magnetic field (Wb/m^2) and
T is the thickness of the thin strip (m).

Thus, this Hall voltage is used to measure the unknown magnetic field (B) to which the Hall element is produced while carrying current (I) through it. In the Gaussmeter the Hall probe tip is made up of semiconducting crystal which is used as Hall Sensor.

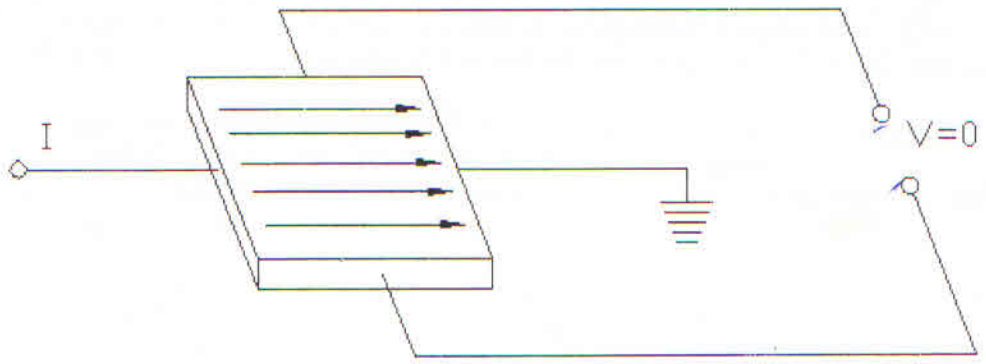


Figure 1 Hall Effect principle in absence of magnetic field

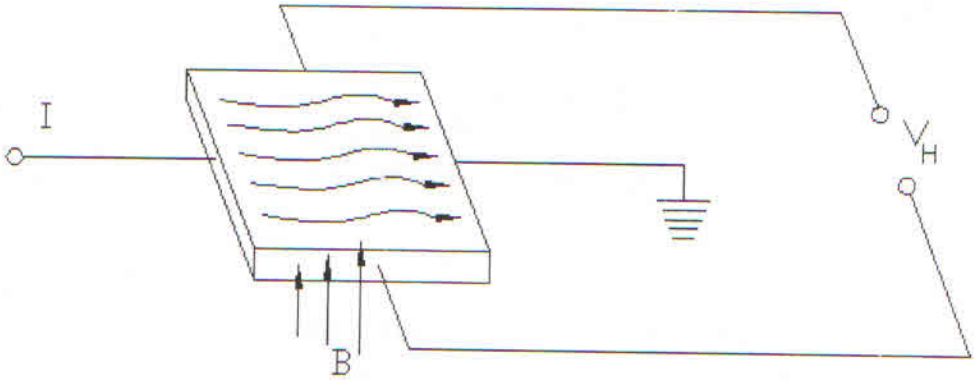
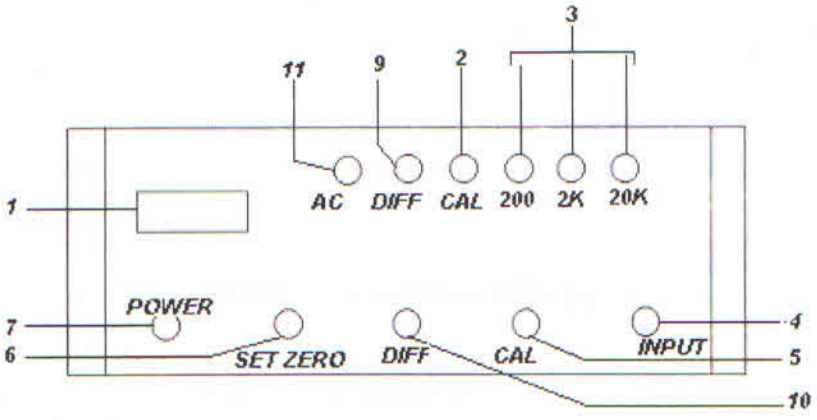


Figure 2 Hall Effect principle in presence of magnetic field

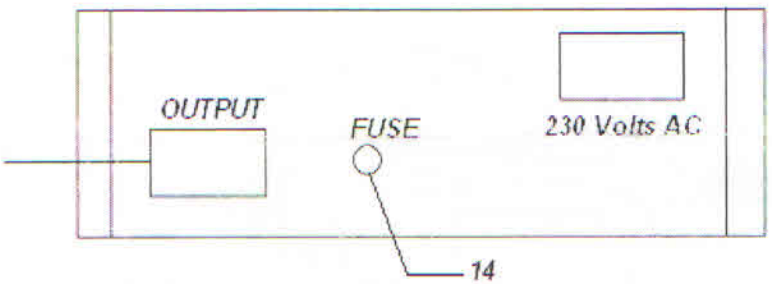
Experimental set up

Place the hall probe of the Gaussmeter above the permanent magnet with the help of a clamp and stand of a *x-y-z* traverse mechanism. Measure the magnetic field (*B*) produced by the permanent magnet by changing the position of the hall probe with the help of the traverse mechanism. Prior to this follow the steps below (refer figure 3a and 3b),

1. Connect the hall probe at the I/p point (4).
2. Connect the power cord at (12) on the backside.
3. Connect the unit to 230 V mains.
4. Make unit 'ON' using (7). The digital display will appear.
5. Press 'CAL' (2). The hall probe is marked with figure (say X). Adjust 'X' on the digital display using 'SET CAL' knob (5).
6. Select the range of the measurements on using one of the selector switches (3). Keep the hall probe in zero magnetic fields and set zero on the readout using 'SET ZERO' knob (6).
7. Keep the tip of the hall probe where the measurement of magnetic fields is intended. The meter directly gives the reading of flux density at that point.
8. For AC field measurements keep the selector switch (11) on the front side and follow the same procedure.



(a) FRONT VIEW



(b) Rear View

Figure 4 Diagram of controls on Digital Gaussmeter DG 900

Results

Take the reading of the digital display of the Hall Probe Gaussmeter in the magnetic field produced by the permanent magnet according table 1 for different z positions.

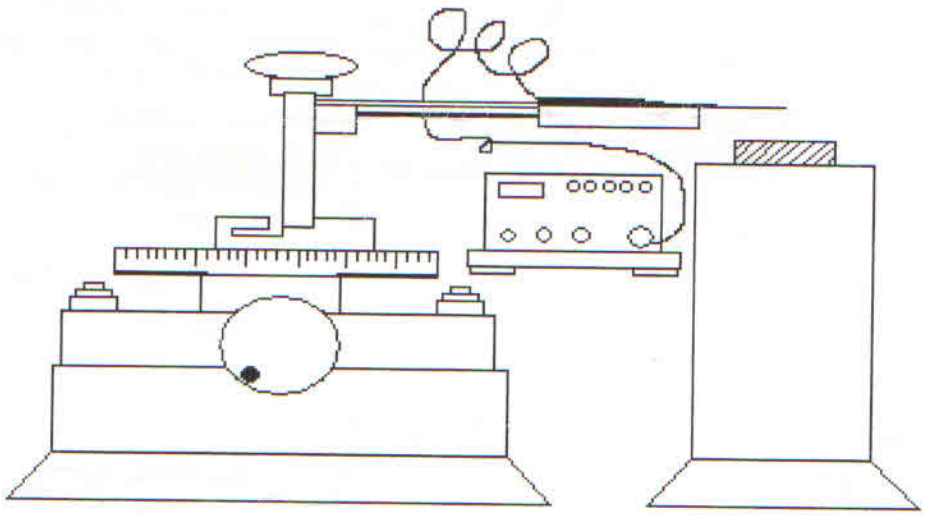
Table 1

$z =$ (mm)

Sl No.	Position along x-axis (mm)	Position along y-axis (mm)	Value of the magnetic field or flux density

Discussions

1. Write down a MATLAB program to draw the 2D contour plot and 2D surface of the magnetic field.
2. Justify the nature of contour plot of magnetic field.
3. Discuss the operation of the Hall Probe of the Gaussmeter.
4. Write the precautions taken during the measurement of magnetic field using Hall Probe
5. Gaussmeter.



Experimental set up:- For Gaussmeter Method