first mid-term Examination

Subj:- Power system Instrumentation

Question:-

Q:① (a) Explain in detail the Gaussian error curves.

(b) A 0-150 V voltmeter has a guaranteed accuracy of 1 % of full scale reading. The voltage measured by this instrument is 75 V. Calculate the limiting error in %.

Q:②

(a) Draw and explain the construction and working Principle of hall effect Transducer.

(b) A piezo electric crystal having dimensions of 5mm x 5mm x 1.5 mm and voltage sensitivity of 0.055 V-m/N is used for force measurment. calculate the force if the voltage developed is 100 V.

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Q 1.

(a): Ans. **Gaussian Error Curves :-**

In general, measuring instruments are associated with a number of factors causing random errors. The normal distribution is the most commonly occured. The normal distribution model is employed in decision making process like the determination of the probability.

The law of probability states the normal distribution of deviations from average value of an infinite number of measurment can be expressed by:

$$Y = \frac{h}{\sqrt{\pi}} \exp(-h^2 x^2)$$

where,

x = Magnitude of deviation from mean

h = A constant called Precision index

Y = Number of reading at any deviation

Another more convient form of equation describing Gaussian error curve is given by:

$$Y = \frac{h}{\sigma\sqrt{2\pi}} \exp\left(\frac{-x^2}{2\sigma^2}\right)$$

P.T.O

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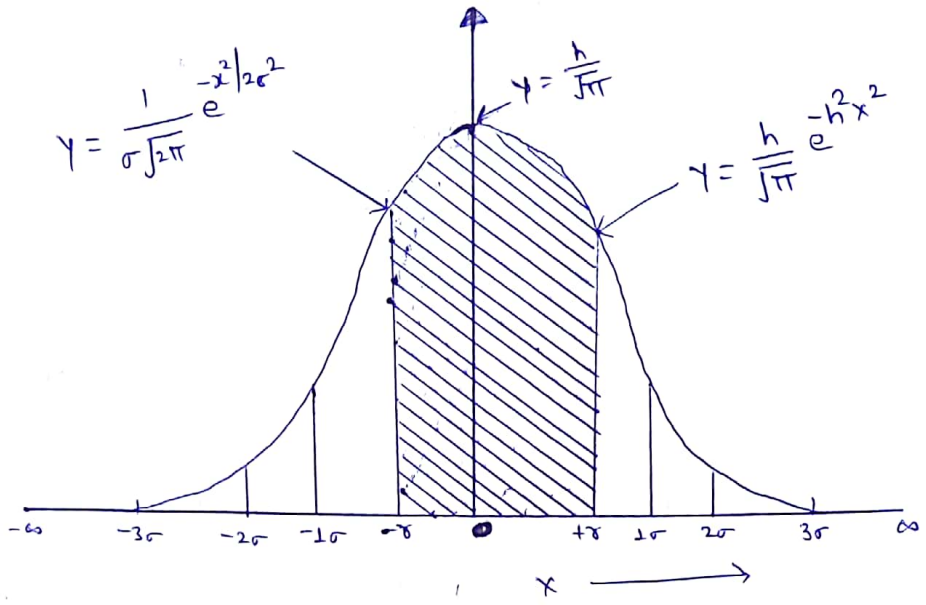

fig: Normal Probability curve or Gaussian curve

This curve shows plotted against x which is called "Normal or Gaussian Probability curve".

→ The assumptions made for the normal law of errors are as follows:

(i) All observations include a large number of small random disturbing effects or random errors.

(ii) These errors can be either (+)ve or (-)ve

(iii) There is an equal Probability of (+)ve and (-)ve random errors.

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(b)

Ans.

The magnitude of Limiting error of instrument is

$$\varepsilon_o = \varepsilon_r . A$$

$$= 0.01 \times 150 = \pm 1.5V$$

The magnitude of the voltage being measured is 75V. Hence, The relative error at this voltage is

$$\varepsilon_r = \frac{\varepsilon_o}{A} = \frac{1.5}{75} = 0.02$$

Therefore, the voltage being measured is between the limits of.

$$A_g = A(1 \pm \varepsilon_r)$$

$$= 75(1 \pm 0.02)V$$

$$= 75 \pm 1.5V.$$

The percentage limit error is

$$\% \varepsilon_r = \frac{\pm 1.5}{75} \times 100 = \pm 2\%.$$

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Q. 2

(a)

Ans.

HALL Effect Transducer :-

- The Hall effect was discovered in 1879 and belongs to one of the galvano-magnetic phenomenon in which the interaction between the magnetic field and moving electrical charges result in the development of forces that alter the motion of the charge.
- If a strip of conducting material carries current in the presence of a transverse magnetic field as shown in fig. an emf is produced between two edges of conductor. The magnitude of the voltage depends upon the current, flux density and a property of conductor i.e called "Hall effect co-efficient".
- The Hall effect is observed in all metals, but it is very much prominent in semiconductor materials.

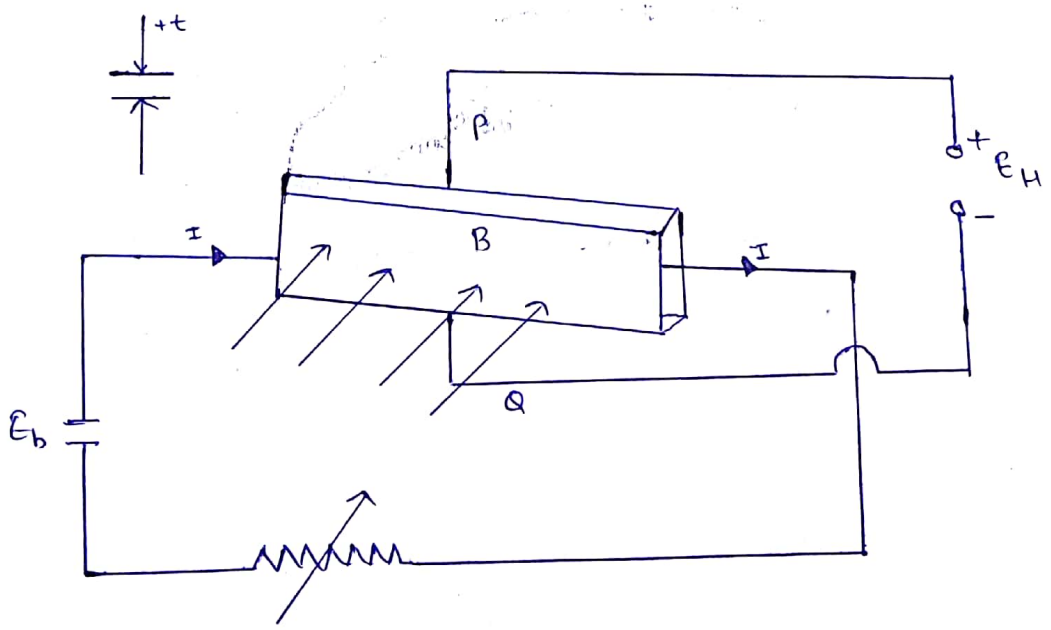

fig: Hall Effect Transducer

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- The magnetic field exerts a force on the electrons moving at a velocity v, with the result that some of them drift towards the edges of the strip.
- The edge surfaces act like charged electrodes and the Potential difference measured between P and Q is known as Hall Potential E_H, which increases with increase of B and I.
- If e is the charge of the electron, then the lorentz force evB and the force due to Hall field are equal to each other. Hence,

$$evB = \frac{eE_H}{b}$$

$$E_H = BbV \quad (\text{volts})$$

where

B = The magnetic Hall density, in T
V = Velocity, in m/s
b = width, in m

- The hall coefficient depends on the number of free charge carries per unit volume. The coefficient for metal and semiconductors is given by

$$k_H = \frac{k(nx_n^2 - px_p^2)}{e(nx_n + px_p)}$$

where k = a Positive constant
n, p = No. of free electrons and holes per m^3
x_n, x_p = mobility of the electrons and holes respect.
e = charge of the electron

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(b)

Ans

⇒ The applied Pressure is

⇒ $P = \frac{E_0}{gt}$

⇒ where $E_0 = 100\ V$,

$= g = 0.055\ V-m/N$

⇒ $t = 1.5 \times 10^{-3}\ m$

⇒ Now force

⇒ $f = PA = 1.2 \times 10^6 \times 5 \times 10^{-6}$

⇒ $\boxed{f = 30\ N}$

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