Sec(4).

Transducer

Transducer: is a device which converts one form of energy into another form.

classification of Transducers:

1) Primary & secondary transducer
2) Active & passive transducer
3) Analog & digital transducer

Primary transducer: A transducer which is directly connected to the measurable quantity.

secondary transducer: A transducer which is not directly connected to the measurable quanti

Active transducer: Not require external power and produce an analoge voltage or current [known as self-generating type transducer].

Passive transducer: require external power.
analoge transducer: converts i/p quantity into an analoge o/p.
Digital transducer: converts i/p quantity into electrical o/p.

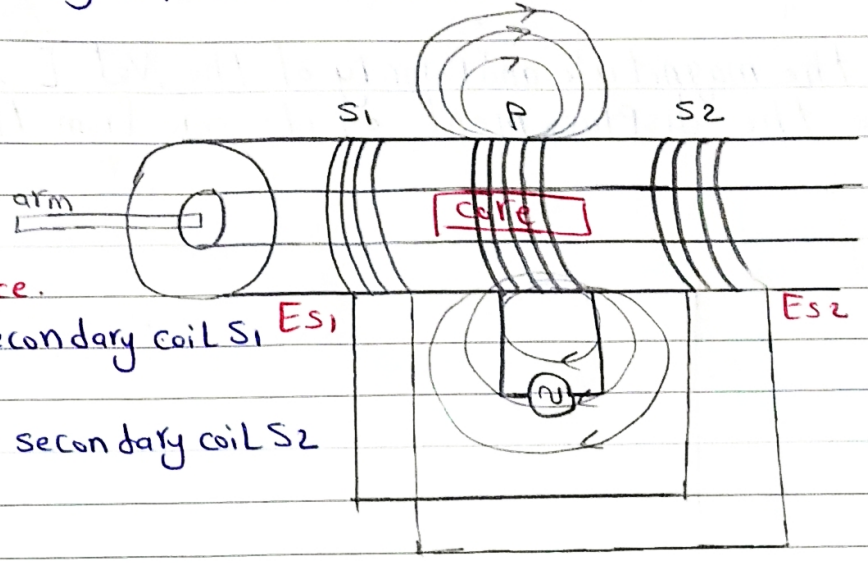
* The transducers used for the measurement of displacement:

1) Potentiometer

sensitivity of potentiometer $S_{pot} = \frac{\text{o/p Voltage}}{\text{i/p displacement}} = \frac{e_o}{x_i}$

LVDT [Linear Variable differential Transducer or Transformer]

- It is a passive Transducer which measures displacement
- used inductive transducer to translate the linear motion into electrical signal.
- Transformer consists of a single primary winding (P) and two secondary windings (S_1 and S_2)
- Two secondary coils having equal number of turns.



$E_o = E_{s1} - E_{s2}$

where

E_o = Net induced E.M.f

E.M.f → electro motive force.

E_{s1} = E.M.f induced at secondary coil S_1

E_{s2} = E.M.f induced at secondary coil S_2

Working of LVDT

1) Ac source connected to primary winding is activiated
2) alternating current start generate in primary coil and alternating magnetic field is produced
3) magnetic field interact with the secondary coils and emf is induced in the two secondary coils.

core at center

$E_{s1} = E_{s2}$

$E_o = E_{s1} - E_s = 0$

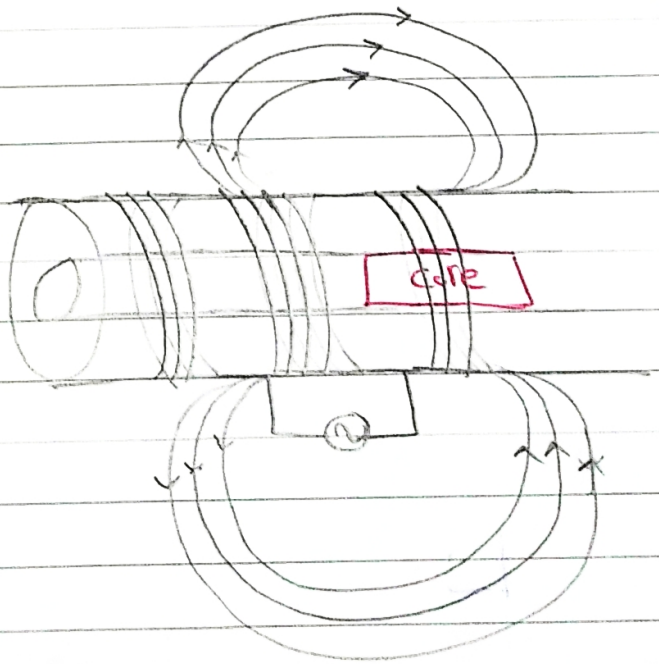
equal emf

This Position is known as null Position.

core at right

$E_{s1} < E_{s2}$

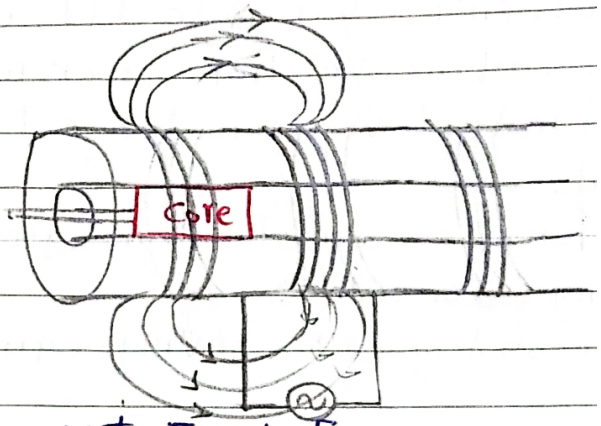
$E_o = E_{s1} - E_{s2} = -ve$



core at left

$E_{S1} > E_{S2}$

$E_o = E_{S1} - E_{S2} = +ve$



LVDT uses the magnitude and Polarity of the Net E.M.F to measure the displacement of its core from the null Position.

3 Hall transducer

Hall effect: if a metal or a semiconductor carries a current (I) placed in an field (B), an electric field (E) is developed which is perpendicular to b the directions of B and I

→ Hall effect transducer works on the principle of Hall effect.

Hall Voltage

$$V_H = \frac{k_H I B}{t}$$

k_H → Hall coefficient $= \frac{1}{ne}$ $V.m/A.Wb.m^{-2}$

n → carrier concentration m^{-3}
e → electron charge C
ne → charge density C/m^3 ρ → ne → charge dene

I → current through the strip (A)

B → magnetic flux density (Wb/m^2)

t → thickness of the strip. (m)

sheet (4) Transducer

1] Spot = 10V/mm & x_i = 2mm find o/p Voltage e_o

Solution

$$Spot = \frac{\text{o/p Voltage}}{\text{displacement}} = \frac{e_o}{x_i}$$

$$e_o = Spot * x_i = 10 * 2 = 20\ V\ \#$$

2] LVDT $E_o = E_{s1} - E_{s2} = 5V$ & $L = \pm 25mm$ find

a) E_o when the core is -18.75 mm away from the center

Solution

sensitivity of LVDT

$$S = \frac{E_o}{L} = \frac{5}{25} = \frac{1}{5}\ V/mm$$

a) $L = -18.75$ mm $\quad S = \frac{1}{5}$ V/mm

$$E_o = S * L = \frac{1}{5} * -18.75 = -3.75\ Volt\ \#$$

b) The o/p Voltage change when the core is moving from ±18.75 mm to -10mm

∵ core moves from $L = \pm 18.75$ mm to -10 mm

for -10 mm

$$E_{o1} = S * L = \frac{1}{5} * -10 = -2\ V\ \#$$

for ±18.75 mm

$$E_{o2} = S * L = \frac{1}{5} * 18.75 = 3.75\ V\ \#$$

∵ Variation of o/p Voltage = 3.75V to -2V #

[3] $E_o = 2mV$ & $L = 0.5\ mm$ & amplification factor = 250
Find the sensitivity of the LVDT and that of the whole setup
if milli Voltmeter scale has 100 divisions, scale can be read to $\frac{1}{5}$ of a division
find resoluation of instrument in mm

Soluation

sensitivity of LVDT = $\frac{E_o}{L} = \frac{2mV}{0.5mm} = \frac{2 * 10^{-3}}{0.5 * 10^{-3}} = 4V = 4 * 10^{-3}\ V/mm$ #

sensitivity of the whole setup instrument = sensitivity of LVDT * amplification fac
$= 4 * 10^{-3} * 250 = 1 V/mm$ #

one scale division $= \frac{5V}{100} = 50\ mV$

minimum Voltage that can be read on the Voltmeter

$= \frac{1}{5} * 50mV = 10mV$

V	mm
1	1
10mV	??

∴ Resoluation of instrument (mm) $= \frac{10 * 10^{-3} * 1mm}{1}$

$= 10^{-2}\ mm$

دى أقل ازاحة يحدث عنها تغير فى قراءة الـ Voltameter

[4] Hall effect transducer $B = 1.5\ wb/m^2$ & $k_H = -52 * 10^{-12}\ V.m/A.wb.m^{-2}$
$t = 2mm$ & $I = 5A$
find V_H

Soluation

$$V_H = \frac{k_H\ I\ B}{t} = \frac{-52 * 10^{-12} * 5 * 1.5}{2 * 10^{-3}} = -195 * 10^{-9}\ V$$

$= -0.195 * 10^{-6}\ V$

$= -0.195\ \mu V$ #