UNIT-2

Transducers

① A resistance strain gauge with a gauge factor of 2 is cemented to a steel member, which is subjected to a strain of 1×10^{-6}. If the original resistance value of the gauge is 130 Ω, calculate the change in resistance.

Sol:-
$$K = \frac{\Delta R / R}{\Delta l / l}$$

$$\therefore \Delta R = K R \Delta l / l$$

$$\Delta R = 2\times130\times1\times10^{-6}$$

$$\boxed{\Delta R = 260\,\mu\Omega}$$

② ~~The circuit~~ A variable reluctance type inductive transducer has a coil of inductance of 2500 μH when the target made of ferromagnetic material is 1 mm away from the core. calculate the value of inductance when a displacement of 0.04 mm is applied to the target in a direction moving it towards the core.

Sol:- Give inductance with gap length of 1 mm is $L = 2500\,\mu H$

Step1:- Length of air gap when a displacement is applied to the target

$$= 1.00 - 0.04$$

$$= 0.96\,mm$$

Step2:- Now inductance is inversely proportional to the length of air gap

$\therefore L$ with gap length of 0.96 mm

$$= L + \Delta L = 2500\,\mu H \times \frac{1}{0.96\,mm} =$$

$$= 2604\,\mu H$$

Step3: ∴, change in inductance

$$\Delta L = 2604\mu H - 2500\mu H$$

$$\boxed{\Delta L = 104\mu H}$$

③ An ac LVDT has the following data.
i/p = 6.3V, o/p = 5.2V, range ±0.5in. Determine

i) calculate the o/p vol vs core position for a core movement going from ±0.45in to −0.30in.

ii) The o/p voltage when the core is −0.25in. from the centre

Sol: i) 0.5in. core displacement produces 5.2V, ∴ a 0.45in. core movement produces $(0.45 \times 5.2)/0.5$

$$= \underline{4.68V.}$$

Il'y a −0.30in. core movement produces

$$(-0.30 \times -5.2)/(-0.5)$$

$$= \underline{-3.12V}$$

(ii) −0.25in. core movement produces

$$(-0.25 \times -5.2)/(-0.5)$$

$$= \underline{-2.6V}$$

④ A platinum resistance thermometer has a resistance of 180Ω at 20°C. Calculate its resistance at 60°C ($\alpha_{20} = 0.00392$)

Sol: Given $\boxed{R = R_0(1 - \alpha\Delta T)}$

$$R = 180[1 - 0.00392(60°c - 20°c)]$$

$$R = 180[1 - 0.00392 \times 40°c)]$$

$$= 180[1 - 0.1568]$$

$$= 180 \times 0.8432 \Rightarrow R = 151.78\Omega$$

5. A platinum resistance thermometer has a resistance of ~~100Ω~~ 100Ω at 25°C. find its resistance at 50°C. The resistance tempera-ture coefficient of platinum is 0.00392 Ω/Ω°C.
If the thermometer has a resistance of 200Ω, calculate the value of temperature

Sol:- step 1:-

$$R = R_0(1+\alpha_0 \Delta T)$$

$$R = 100(1+[(0.00392)\times(50-25)°C])$$

$$= 100(1+[(0.00392\times 25)°C])$$

$$= 109.8\,\Omega$$

step 2:- Suppose t_2 is the unknown temperature then

$$200 = 100(1+[(0.00392)\times(t_2-25)°C])$$

$$2 = (1+[(0.00392)\times(t_2-25)°C])$$

$$2-1 = [(0.00392)\times(t_2-25)°C)$$

$$(t_2-25)°C = \frac{1}{0.00392}$$

$$\boxed{\therefore t_2 = 280°C}$$

6. A thermistor has a resistance temperature coefficient of -5% over a temperature range of 25°C to 50°C. If the resistance of thermisto is 100Ω at 25°C, what is the resistance at 35°C?

Sol:-

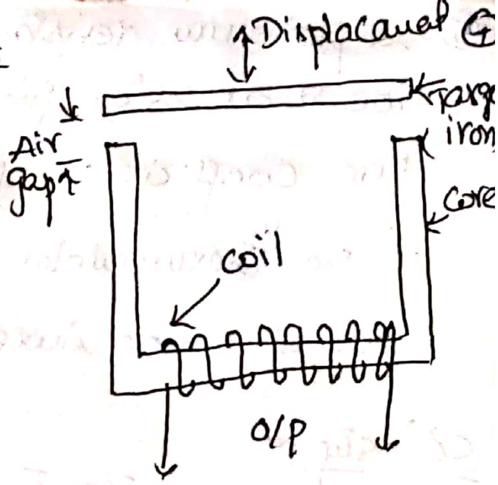
$$R = R_0(1+\alpha_0 \Delta T)$$

$$R_{35} = R_{25}(1+\alpha(35-25))$$

$$= 100[1-0.05(35-25)]$$

$$= 50\,\Omega$$

⑦ A variable reluctance type proximity inductive transducer in which the coil has inductance of 2mH when the target made of ferromagnetic material is 1mm away.



& i) calculate the value of inductance when a displacement of 0.02mm is applied to the target in a direction moving it towards the core.

ii) show that the change in inductance is linearly proportional to the displacement. Neglect the reluctance of the iron parts.

Sol:. Inductance with air gap length of 1.00mm, L = 2mH

i) value of inductance when a displacement of 0.02mm is applied

Length of air gap when a displacement of 0.02 mm is applied towards the core

$= 1.00 - 0.02$

$= 0.98mm$

Now, the inductance is inversely proportional to the length of air gap as the reluctance of flux paths through iron are neglected. Since the gap length decreases the inductance increases by ΔL

$\therefore L + \Delta L = 2 \times \frac{1}{0.98}$

$= 2.04mH$

$\Delta L = 2.04 - 2$

$= 0.04mH.$

ii) ΔL α displacement:

The ratio of change in inductance to the original inductance.

$= \frac{\Delta L}{L} = \frac{0.04}{2} = 0.02$

Also, the ratio of displacement to original gap length

$= 0.02/1 = 0.02.$

⑧ In a linear vol differential transformer (LVDT) the o/p vol is ~~~~ 1.8V at max. displacement. At a certain load the deviation from linearity is max & it is ± 0.0045 V from a straight line through the origin. Find the linearity at the given load. ⑤

Sol:- Given

The o/p voltage of LVDT at max. displacement $= 1.8V$

The deviation from a straight line through the origin $= \pm 0.0045V$

$$\% \text{ linearity} = \pm \frac{0.0045}{1.8} \times 100$$

$$= \pm 0.25\%.$$

⑨ The o/p of a LVDT is connected to a 4V voltmeter through an amplifier whose amplification factor is 500. A o/p of 1.8mV appears across the terminals of LVDT when the core moves through a distance of 0.6mm. If the millivoltmeter scale has 100 divisions ~~when~~ & the scale can be read to $\frac{1}{4}$ of a division, calculate:

(i) The sensitivity of LVDT

(ii) The resolution of the instrument in mm.

Sol:- (i) The sensitivity of LVDT $= \frac{\text{O/P vol}}{\text{Displacement}}$

$$= \frac{1.8}{0.6}$$

$$= 3mV/mm$$

(ii)

sensitivity of measurement = amplification factor x sensitivity of LVDT

$$= 500 \times 3$$

$$\boxed{= 1500mV/mm}$$

1 scale division $= \frac{4}{100}V = \boxed{40mV}$

Min. voltage that can be read on the voltmeter

$$\boxed{= \frac{1}{4} \times 40 = 10mV}$$

∴ Resolution of the instrument $\rightarrow 10 \times \left(\frac{1}{1500}\right) = 0.0067$ mm