ASSIGNMENT
TDM

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ICE-2

Nakra
Prob 4.3
$$C = \frac{A\epsilon}{3.6\pi d}$$

$$S = \frac{\partial C}{\partial d} = -\frac{A\epsilon}{3.6\pi d^2}$$

given $A = 5\,cm^2$
$d = 1\,mm = 0.1\,cm$

$$S = \frac{5 \times 1}{3.6 \times \pi \times 10^{-2}}$$

$S = -44.2.1\ pF/cm$

Nakra
Prob

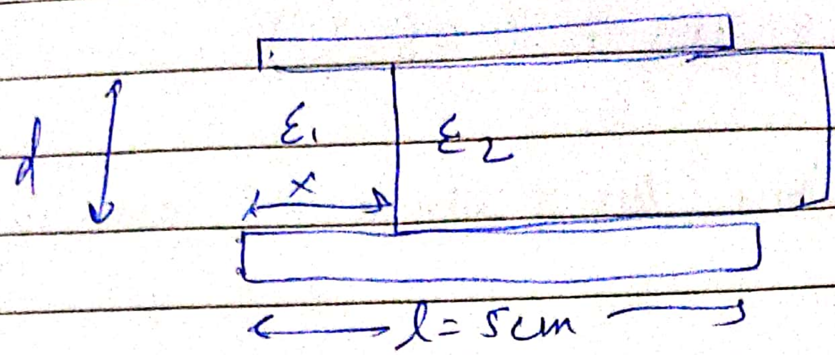
$$C = \frac{A\epsilon}{3.6\pi d}$$

$$S = \frac{\partial C}{\partial d} = -\frac{A\epsilon}{3.6\pi d^2}$$

$A = \frac{\pi}{4}(2)^2 = \pi\,cm^2$ $\quad \epsilon = 1$ for air

$S = -444\,pF/cm$

8.3



$$C_x = \frac{\varepsilon_0 w}{d}\left(\varepsilon_2 l - (\varepsilon_2 - \varepsilon_1)x\right)$$

$$C_x = \frac{8.85 \times 10^{-12} \times 50}{1}\left(4 \times 50 - (4-1)x\right.$$

$$C_0 = 8.85 \times 10^{-12} \times 50 \times 200 \times 10^{-3}$$
$$= \boxed{88.5\,pf}$$

$$C_{25} = 8.85 \times 10^{-12} \times 50\,(4 \times 50 - 3 \times 2.5) \times 10^{-3}$$
$$= \boxed{55.3\,pf}$$

$$C_{50} = 8.85 \times 10^{-12} \times 50\,\left(200 - 3(50)\right) \times 10^{-3}$$
$$= \boxed{22.1\,pf}$$

Q12.4

a) Sensitivity of the thermocouple $= \frac{20.68}{400-0} = 0.0517$ mV/°C

Reference Junction of 0°c ~~and~~ is being used at 25°c

$E_{corr} = 0.0517 \times 25 = 1.293$ mV

b) Indicated emf b/w hot & reference junction at 25°c
$= 8.92$ mV

Difference of temp b/w hot & cold junction

$$= \frac{8.92}{0.0517} = 172.53°C$$

Reference junction temp at 25°c

$172.53 + 25 = 197.53°C$

Exercise

Q12.5 Sensitivity $= \frac{45.14}{1100-0} = 0.041$ mV/°C

the temperature difference b/w hot & cold junction is $840° - 25°c = 815°c$

emf at cold junction ~~or~~ potentiometer
$\boxed{815 \times 0.041 = 33.415 \text{ mV}}$

9.3 $V_{out} = V_{in}\left(\frac{1}{1+\frac{R_4}{R_1}} - \frac{1}{1+\frac{R_3}{R_2}}\right)$

$R_{T\,max} = 1.68\, e^{3050\left[\frac{1}{2.96} - \frac{1}{298}\right]} = 4.288\,k\Omega$

$R_{T\,min} = 1.68\, e^{3050\left(\frac{1}{372} - \frac{1}{298}\right)} = 0.76\,k\Omega$

$V_{out\,max} = 1.037\,V$

$V_{out\,min} = 0.0076\,V$

$V_{ideal} = \left(\frac{V_{max}\, I}{I_{max} - I_{min}} - \frac{V_{max}\, I_{min}}{I_{max} - I_{min}}\right)$

$= 0.24\,V$

$V_{12^\circ C} = 0.225$

~~$\Delta n = 0.225$~~

non linearity $= \frac{0.225 - 0.24}{1.03} \times 100 = 1.456\%$

b) $R_{T\,max} = \frac{1}{1+\frac{R_4}{R_{4max}}} + \frac{1}{1+\frac{R_3}{R_2}} = \frac{2}{3}$

$R_{T\,min} = \frac{1}{1+\frac{R_4}{R_{4min}}} + \frac{1}{1+\frac{R_3}{R_2}}$

c) Range = ~~V_{max}~~ $V_c\ min - V_c\ max$

$= 1.037 \times \frac{1}{1+R_4\ max} - 0.0 \times \frac{1}{1+R_4 min}$

~~0.811~~

$$\boxed{Range = 0 - 0.06V}$$

1.4 $0 = V_c \left(\frac{1}{1+\frac{R_4}{R_{0°C}}} - \frac{1}{1+\frac{R_3}{R_2}} \right)$

$$0.5 = V_s \left(\frac{1}{1+\frac{R_4}{R_{25°C}}} - \frac{1}{1+\frac{R_3}{R_2}} \right)$$

$$1.0 = V_s \left(\frac{1}{1+\frac{R_4}{R_{50°C}}} - \frac{1}{1+\frac{R_3}{R_2}} \right)$$

Using the eq^n in question

$$R_0 = 0.0585\ e^{\left(\frac{3260}{\theta}\right)}$$

$$R_{0°C} = 0.0585\ e^{\left(\frac{3260}{273}\right)} = 8.96 K\Omega$$

$R_{25°c} = 0.0585\, e^{\frac{3260}{298}} = 3.26\, k\Omega$

$R_{50°c} = 0.0585\, e^{\frac{3260}{323}} = 1.40\, k\Omega$

For the thermistor to be approximately linear ~~the o/p~~ at max I/P the O/P should be max and and min I/P the O/P should be min

and from solving the above eqns we get

$$\boxed{\begin{aligned} R_2 &= 1000\,\Omega \\ R_3 &= 265\,\Omega \\ R_4 &= 2370\,\Omega \end{aligned}}$$

~~$V_S = V$~~ and now for min non-linearity we get

$$\boxed{V_S = 243\,V}$$

8.7 a) $\cancel{slope = \frac{27393 - 0}{500 - 0}}$

$\cancel{= 54.786}$

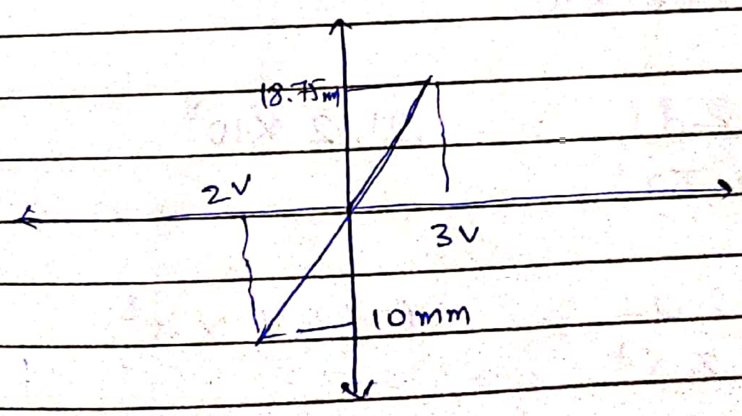
Q3 Sensitivity $= \frac{5}{25} = 0.2\ V/mm.$

a) $V = 0.2 \times 18.75 = 3.75V$

for 18.75 mm $V = 3.75V$

at −10mm $V = -2\ V.$

b)



Q2 Sensitivity (LVDT) $= \frac{6}{0.4} = 15\ V/mm$

Resolution of the voltmeter $= \frac{10}{100} \times \frac{1}{10} = 0.01\ V$

$$\boxed{\frac{1}{2} \times \frac{10^{-3}}{100} \times 0.015 \times 10^{3} = 7.5 \times 10^{-5}}$$

Q1 $R_{core} = \frac{R}{\mu_0 \mu_c r^2} = \frac{4 \times 2}{100 \times 1.2 \times 10^{-6} \times 10^{-2}}$

$= 6.6 \times 10^{8}$

$R_{armature} = \frac{R}{\mu_0 \mu_r s t}$

$= \frac{4}{1.2 \times 10^{-6} \times 100 \times 0.1 \times 0.5}$

$= 0.66 \times 10^{8}$

$R_{gap\,1} = \frac{2 d_1}{\mu_0 \pi r^2} = 21.2 \times 10^{8}$

$R_{gap\,2} = \frac{2 d_2}{\mu_0 \pi r^2} = 0.636 \times 10^{8}$

$R_{T_1} = 28.5 \times 10^{5}$

$R_{T_2} = 7.95 \times 10^{8}$

$$\boxed{L_1 = \frac{n^2}{R T_1} = 0.087\ mH}$$

$$\boxed{L_2 = 0.005\ mH}$$

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8.1 (a) Thermocouple - Iron v constantan
temp range to be measured = 0 - 300°c

a) Slope according to the table

$$\text{Slope} = \frac{27393 - 0}{500} = 54.786$$

at 100°C

$E_{ideal} = 54.786 \times 100$
$= 5478.6$

E_{real} (using table) = 5269

$$|\text{Non linearity}| = \left| \frac{5269 - 5478.6}{27393} \times 100 \right|$$
$= |-0.765\%|$ or 0.765%

at 200°c

$E_{ideal} = 54.786 \times 200$
$= 10957.2$

$E_{real} = 10779$

$$|\text{non linearity}| = \left| \frac{10779 - 10957.2}{27313} \times 100 \right|$$

$$= |-0.650\ \%| = 0.650\%$$

~~b)~~ $\cancel{E_{T,0} = E_{T,20} + E_{20,0}}$

$\cancel{= 12500 + 1000}$

$\cancel{= 13500\ \mu V}$

b) $E_{T,0} = a_1 T + a_2 T^2$ (given)

at $100^\circ C$

$$5269 = a_1(100) + a_2(100)^2 \quad \text{— (1)}$$

$$10779 = a_1(200) + a_2(200)^2 \quad \text{— (2)}$$

solving (1) & (2) we get

$$a_1 = 51.485$$

$$a_2 = 0.086$$

c) $E_{T,0} = E_{T,20} + E_{20,0}$

$= 12500 + 51.485(20) + 0.0$

~~(given)~~

$= 12500 + 1000$

$= 13500$

Also,

$E_{T,0} = T(51.48) + 0.086(T)^2$

Solving the quadratic eq^n and ignoring -ve value we get

$\boxed{T = 250^\circ C}$

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