Note Title

Example 1: Capacitive Transducer..

A Capacitive transducer as the one shown in Fig 1.

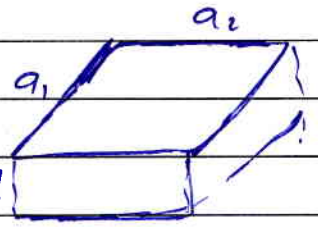


Fig 1. Capacitive transducer

if this capacitor has $\epsilon = 1 \times 10^{-6}$ and $a_1 = a_2 = 1$ cm. if this capacitor is connected to 50 Hz Frequency, Find its impedance. Assume $d = 0.1$ cm

Solution..

Given data: $\epsilon = 1 \times 10^{-6}$, $A = 1\text{cm} \times 1\text{cm} = 1\text{cm}^2$ $d = 0.1$ cm
$f = 50$ Hz

$$C = 0.225\epsilon \frac{A}{d} = (0.225)(1 \times 10^{-6}) \left(\frac{1}{0.1}\right) = 2.25 \times 10^{-6} \text{ F}$$

$$Z = \frac{1}{2\pi f C} = \frac{1}{2\pi (50)(2.25 \times 10^{-6})} = 1.145 \text{ K}\Omega$$

Note Title

Example 2: Piezoelectric Transducer

A piezoelectric transducer has the following data:

1. Voltage Sensitivity = 0.005 VN/m
2. thickness = 1 mm
3. output voltage = 0.5 Volt

Find the Pressure measured by this device.

Solution

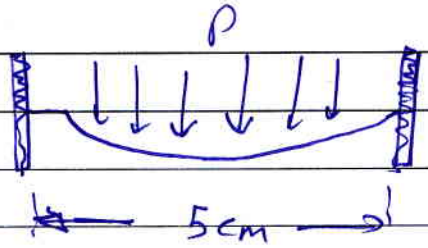
$$E = g\,t\,P \Rightarrow P = \frac{E}{g\,t} = \frac{0.5}{(0.005)(1\times10^{-3})} = 0.1\ \text{MPa} = 100\ \text{kPa}.$$

Note Title

Example 3: Diaphram and Bellows Gage

A diaphram as the one shown in the Fig2 if this diaphram is made from material with Possions ratio (μ) = 0.25 and modulas of elasticity E = 50 GPa. The Pressure applied to the diaphram equal 100 kPa, find the maximum deflection for this diaphram

Assume diaphram thickness equal 1mm



Solution:-

$$y_{max} = \frac{3P}{16Et^3} a^4 \left[1 - \mu^2\right]$$

$$\Rightarrow y_{max} = \frac{(3)(100\times10^3)}{(16)(50\times10^9)(0.001)^3} (0.05)^4 \left(1 - 0.25^2\right)$$

$$= 2.2 \times 10^{-3}\ m = 2.2\ mm.$$

Note Title

Example 4: RTD

a) A RTD (First order) used to measure a Hot liquid Temp., if the linear temp. Coefficient is 0.5 and the Resistance of the device equal 5 Ω at temp = 20 C°, When this device was Used to measure the liquid temp, the Resistance Reads 6.5 Ω.
Find the liquid temp.

Solution $R_0 = 5\ \Omega$ $T_0 = 20\ C^\circ$ $\alpha = 0.5$

$$R = R_0 [1 + \alpha (T - T_0)]$$

$$6.5 = 5 [1 + 0.5 (T - 20)]$$

$$6.5 = 5 + 2.5T - 50 \Rightarrow T = 20.6\ C^\circ$$

b) For same fluid in (a), if 2nd order RTD is used when $a = 0.5$, $b = 0.1$, $R_0 = 10\ \Omega$, $R = 25\ \Omega$
Find the T?

Solution:-

$$R = R_0 (1 + aT + bT^2) \Rightarrow 25 = 10(1 + 0.5T + 0.1T^2)$$

$$\Rightarrow 0.1T^2 + 0.5T - 15 = 0 \Rightarrow T = 10, -15\ C^\circ$$

Exercise
Find the Sensitivity for Both Cases.

Note Title

Example 5: Thermistor:-

A Thermistor has Coefficient (β) equal 4000 k, if this thermistor used to measure some body temp. and the Resistance at this Temp. was 15 Ω. IF the diree show the following information: @ T=25 C°, Resistone equal 10 Ω Find the Temp.

Solution

$R = 15\ \Omega$, $R_o = 10\ \Omega$ $\quad T_o = 25 + 273 = 298\ K$

$$R = R_o \exp\left[\beta\left[\frac{1}{T} - \frac{1}{T_o}\right]\right] \Rightarrow \frac{15}{10} = 10 \exp\left[\frac{4000}{T} - \frac{4000}{298}\right]$$

Take Ln for Both sides

$$\ln\frac{15}{10} = \frac{4000}{T} - 13.423$$

$$\Rightarrow \frac{4000}{T} = \ln 1.5 + 13.423 = 13.828$$

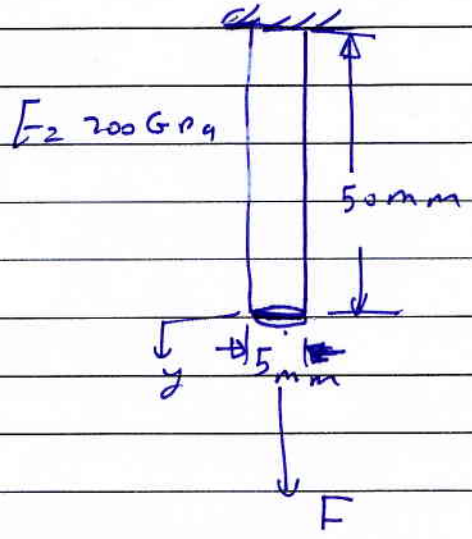
$$\Rightarrow T = \frac{4000}{13.828} = 289.3\ K = 16.3\ C°$$

Exercise: Calcute the Sensitivity for this device

Note Title

Example 6:- Force measurments

Consider the flowing Rod: if the Force cause the Rod to displce 2mm, find the F value of this force.



Solution:-

$$F = \frac{AE}{L} y \quad ; \quad A = \frac{\pi}{4} d^2$$

$$\Rightarrow F = \frac{(\pi/4)(0.005)^2 (200 \times 10^9)}{50 \times 10^{-3}} * 2 \times 10^{-3}$$

$$\Rightarrow F = 157000 \, N = 157 \, KN.$$