Transducer & Measurement

Assignment -2

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Example 4.3

Capacitance of crystal $= 10^{-9}$ F
Capacitance of cable $= 3 \times 10^{-10}$ F
Capacitance constant of crystals $= 4 \times 10^{-6}$ C/m

$R = 10^6 \Omega$
$C = 10^{-9} + 3 \times 10^{-10} + 10^{-10}$
$= 1.4 \times 10^{-9}$ F
$\tau = RC = 1.4 \times 10^{-3}$
$K_i = 4 \times 10^{-6}$ C/cm
$K = K_i / C = 2857$ V/cm

K is the voltage sensitivity constant

$$\left| \frac{e_o}{K_i} \right| = \frac{K\tau\omega}{\sqrt{1 + (\tau\omega)^2}}$$

Substituting the values of K, τ and ω for $K_i = 10^{-4}$ cm

$$\boxed{e_o = 0.248 \text{ V}}$$

Q 8.6) $N(\theta) = 4.0 + 1.5 \cos(22\theta)$ milliweber

$E = b_m \omega_r \sin(m\omega_r t)$ $\omega_r = 1000$

Comparing the given eq^n

$N(\theta) = a + b\cos(m\theta)$

$|\vec{E}| = bm\omega r = 1.5 \times 22 \times 1000$

$= 33,000$ milliweber

$= 33$ webber.

$1000 rpm = \frac{2\pi}{60} \times 1000 = \frac{200\pi}{6}$

Amplitude $= 1.5 \times 22 \times \frac{200\pi}{6} \times 10^{-3}$

$= 3.454 V$

Frequency $= 22 \times \frac{200\pi}{6 \times 2\pi} = 366.66 Hz$

for 10000 rpm

Amp = 34.54

Frequency = 3666.66 Hz.

Q12.11

$d = 150 mm$

$E_0 = 60 mV$

$B = 5000$ V-S/cm^2

$\varphi = ?$

As we know

$$E_0 = \frac{4B}{\pi d} \varphi \times 10^{-8} \text{ vol}$$

$$\Rightarrow \varphi = \frac{E_0 \times \pi \times d \times 10^8}{4B}$$

$$\varphi = (60 \times \pi \times 150 \times 10^{-2} \times 10^{+8}) / 5000$$

$$\varphi = 5.654 \times 10^6 \text{ cm}^3 s^{-1}$$

Q4.9 Capacitance of crystal $= 5\times10^{-9}F$
Capacitance of cable $= 5\times10^{-10}F$

Charge $= 4\times10^{-10}$ colomb produced due to a force of 10N
for 20N it is 8×10^{-10} coulomb.

$R = 1M\Omega$

Capacitance $= 5\times10^{-10}F$

$\omega = 200\times2\pi = 1256.6$

$A = 20N$

Total Capacitance $= 5\times10^{-9} + 5\times10^{-10} + 5\times10^{-10}$
$= 6.0\times10^{-9}F$

$\tau = RC = 6\times10^{-3}$ sec $\quad \omega = 200\times2\pi = 1256.6$ rad s^{-1}

as we know

$CV = q$; $V = q/c$

$$V = \frac{8\times10^{-10}}{6\times10^{-9}} = 0.133V = 133.33mV$$

$$\frac{V_i}{V_0} = \frac{\tau\omega}{\sqrt{1+\tau^2\omega^2}} \times \frac{1}{\sqrt{\left(1-\frac{\omega^2}{\omega_n^2}\right)+4\xi^2\frac{\omega^2}{\omega_n^2}}}$$

$$\Rightarrow \frac{V_i}{V_0} = 1.0087\times1$$

$$\Rightarrow \frac{133.3}{V_0} = 1.0087 \Rightarrow \boxed{V_0 = 132.150\,mV}$$

$$\boxed{O/P = V_0\times0.2 = 26.438\ \text{cm}}$$

Nakra

Q4.10

$$C = \frac{\varepsilon_0 \varepsilon A}{3.6\pi t} = \frac{8.85\times10^{-12}\times5\times\pi\times10^{-2}}{3.6\times\pi\times10^{-3}}$$

$$= 1.229\times10^{-10}\,F$$

Total capacitance $= 1.229\times10^{-10}\,F + 2\times10^{-11}\,F + 5\times10^{-11}\,F$

$$\Rightarrow 19.29\times10^{-11}\,F$$

$$K = \frac{K_L}{C} = \frac{10^{-5}}{1.929\times10^{-10}} = 51840.33\ V/cm$$

$$\left|\frac{e_0}{x_i}\right| = \frac{K\tau\omega}{\sqrt{1+(\omega\tau)^2}}$$ (gain formulae) $\tau = RC$ time constant

As gain is 50 coeff $= 0.5/50 = 0.01$

$$\tau = RC = 20\times10^6\times83.907\times10^{-12} = 1.678\times10^{-3}\ sec$$

$$x_i = 0.01\left(\sqrt{\frac{1+(\tau\omega)^2}{(\tau\omega)K^2}}\right)$$

$\omega = 200\pi = 628.318$; $\tau\omega = 1.054$

$$\boxed{x_i = 2.659\times10^{-7}}$$

as we know

$$\frac{P}{x_i} = \frac{EA}{t}$$

$$P = \frac{EAx_i}{t} = \frac{8\times10^{10}\times\pi\times10^{-4}\times2.659\times10^{-7}}{10^{-3}}$$

$$\boxed{P = 350.6\ N}$$