EE-102

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2K19/A14/35

Electrical Assignment 01

1 $T = 20°C = 293K$

i) $l = 10m$, $A = 1\ mm^2$.

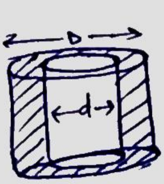
$$R = \rho \frac{l}{A} = \frac{1.72 \times 10^{-8} \times 10}{10^{-6}} = 1.72 \times 10^{-1}\ \Omega.$$

ii) $l = 200\ mm$, $A = 25\ mm^2$

$$R = \rho \frac{l}{A} = \frac{1.72 \times 10^{-8} \times 200 \times 10^{-3}}{25 \times 10^{-6}} = 0.138\ \Omega.$$

2 inner diameter (d)
outer diameter (D)

$$R = \rho \frac{l}{A}$$



$$dR = \frac{\rho\, dx}{2\pi x l}$$

$$\int_0^R dR = \int_{d/2}^{D/2} \frac{\rho\, dx}{2\pi x l}$$

$$R = \frac{\rho}{2\pi l} \ln x \Big]_{d/2}^{D/2} = \frac{\rho}{2\pi l} \ln\left(\frac{D}{d}\right).$$

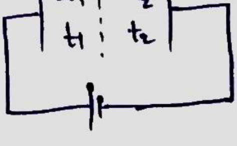
Given $D = 10\ cm$
$d = 9\ cm$
$l = 2m$
$\rho = 1.72 \times 10^{-5}\ \Omega m$

$$R = \frac{1.72 \times 10^{-5}}{2\pi \times 2} \ln\left(\frac{10}{9}\right).$$

$$= 23.14\ \mu\Omega.$$

3 Given,

$\varepsilon_{r_1} = 3$, $t_1 = 0.5\ mm$
$\varepsilon_{r_2} = 4$, $t_2 = 1\ mm$



let $C_1 = \epsilon_{r_1}, t_1$ $\quad C_1 = \frac{\epsilon_0 A \epsilon_{r_1}}{d}$, $\quad C_2 = \frac{\epsilon_0 A \epsilon_{r_2}}{d}$

$C_2 = \epsilon_{r_2}, t_2$

Equivalent capacitance $\Rightarrow \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$

$$= \frac{t_1}{3\epsilon_0 A} + \frac{t_2}{4\epsilon_0 A} \qquad C_{eq} = \frac{12\epsilon_0 A}{5\times 10^{-3}}.$$

Charge, $Q = C_{eq} V$ $= \frac{12\epsilon_0 A}{5\times 10^{-3}} \times 100 \Rightarrow \underline{24\epsilon_0 A \times 10^4\, C}$.

Now charge on $C_1 = C_2 = Q_0$

$$\Delta V \text{ across } C_1 = \frac{Q_0}{C} = \frac{24\times \epsilon_0 A \times 10^{34}}{\epsilon_0 A \times 3} \times 0.5\times 10^{-3}$$

$\underline{\Delta V = 40V}$.

voltage at foil $= 100 - 40$

$= \boxed{60\,V}$

$\boxed{5}$ $\quad Q = CV \qquad V = Ed = Q/C$

$$\frac{V}{d} = 50,000\ V/cm = \frac{Q}{cd}$$

$$Q = 8.55\times 10^{-12} \times 40\times 10^{-12} \times 50,000 \times 226\times 1$$

$$\boxed{Q = 8\mu C}$$

Resistance $= R$,

$R = \frac{\rho l}{\pi d^2} \times 4 \qquad x = \text{volume} = \frac{\pi d^2}{4} l$

$$\frac{x}{l} = \frac{\pi d^2}{V}$$

$$R = \frac{\rho l^2}{x} \Rightarrow l = \sqrt{\frac{Rx}{\rho}} \quad —①$$

$$R = \frac{4\rho}{\pi d^2}\sqrt{\frac{Rx}{\rho}} \qquad d^2 = \frac{4}{\pi}\sqrt{\frac{\rho x}{R}}$$

$$d = 2\left(\frac{\rho x}{\pi^2 R}\right)^{1/4} .$$

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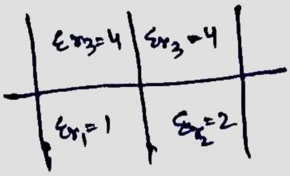
$\varepsilon_{r_1} = 1 \qquad t_1 = 10 \text{ cm} \qquad A_1 = A_2 = 2\times 10^{-2} \text{ m}^2$

$\varepsilon_{r_2} = 2 \qquad t_2 = 10 \text{ cm}$

$\varepsilon_{r_3} = 4 \qquad t_3 = 20 \text{ cm} \qquad A_3 = 2\times 10^{-2} \text{ m}^2$



$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_{12}} = \frac{t_1}{\varepsilon_0 A} + \frac{t_2}{2\varepsilon_0 A}$$

$$C_{12} = 2C_1 - C_2 = \frac{8.85\times 10^{-12}\times 2\times 10^{-2}}{10^{-1}} \times \frac{2}{3}$$

$$C_3 = \frac{8.85\times 10^{-12}\times 2\times 10^{-2}}{2\times 10^{-1}} \times 4 = 8.85\times 4\times 10^{-13} \text{ F}.$$

$$C_4 = C_3 + C_{12} = \left(2\times 17.7 + \tfrac{2}{3}\times 17.7\right)\times 10^{-13}$$

$$= \frac{8}{3}\times 17.7\times 10^{-13} = \boxed{4.72\times 10^{-12} \text{ F}}$$

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$C = 50\times 10^{-6}$ F , steady state current $= 10^{-2}$ A .

$$i = \frac{dq}{dt} = \frac{d(cv)}{dt} = C\frac{dv}{dt} = 10^{-2}$$

$$\int_0^v dv = \frac{10^{-2}}{C}\int_0^t dt$$

$$v = \frac{10^{-2}\times 10^{2}}{50\times 10^{-6}\times 10^{2}} \cdot t = \boxed{2\times 10^{-2}\, t}$$

$$\int_0^Q dq = \int_0^V cv = c\int_0^V 2\times10^{-2}\,dt$$

$$\boxed{Q = 0.1\ C}$$

Capacitor voltage at $t = 10(v)$

$$V = 200t = \boxed{2000V}$$

$$\text{Stored Energy} = \frac{Q^2}{2C} = \frac{(0.1)^2}{2\times50\times10^{-6}} = \boxed{100J}$$

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$D = 1\ cm$, $N = 1000$

$d = 1\ m$, $2r = 0.5\ mm$

$$L = \mu_0 n^2 A l$$

$$= 4\pi\times10^{-7}(1000)^2\times\pi\left(\frac{1}{2}\times10^{-2}\right)^2\times1$$

$$= \underline{0.0987\ mH}$$

Total length of wire $= N\times2\pi\times R$

$$R = \frac{\rho\times N\times2\pi\times D/2}{\pi r^2} = \frac{1.72\times10^{-8}\times2\pi\times10^{-2}}{2\pi\times\left(\frac{0.5}{2}\times10^{-3}\right)^2}$$

$$= \boxed{2.7\ \Omega}$$

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circuit turns $= 1000$

cross sectn $= 20\ m^2$

current $i_1 = 4A$, flux density, $\phi_1 = 1\ wb/m^2$

$i_2 = 9A$ $\qquad \phi_2 = 1.4\ wb/m^2$.

time $= 0.05\ sec$

$$V = L\frac{di}{dt} = -\frac{d\phi}{dt}, \quad L = \frac{d\phi}{dt}\frac{1}{di/dt} = \frac{(0.4)20}{0.05}$$

$$\Rightarrow \boxed{0.16\ H}$$

$$V = L\frac{di}{dt} = \boxed{16V}$$