AKUMA SUNNY . U.
17/ENG04/009
ELECTRICAL /ELECTRONICS

13th April, 2020

~~EEE~~ 316 ASSIGNMENT 1

4(a) from $\frac{d^2 \mathcal{E}_y}{dx^2} = (j\omega\mu\varepsilon - \omega^2\mu\varepsilon)\mathcal{E}_y$

we have $\rightarrow \frac{d^2 \mathcal{E}_y}{dx^2} = \gamma^2 \mathcal{E}_y$

$$\gamma = \alpha + j\beta$$

$$\mathcal{E}_y = \mathcal{E}_0 e^{-\gamma x} = \mathcal{E}_0 e^{-\alpha x} e^{-j\beta x}$$

$$\frac{d^2 \mathcal{E}_y}{dx^2} = j\omega\mu\sigma \mathcal{E}_y = \gamma^2 \mathcal{E}_y$$

$$\gamma^2 = j\omega\mu\sigma$$

$$\gamma = \sqrt{j\omega\mu\sigma} = \alpha + j\beta$$

from $\sqrt{j} = \frac{1+j}{\sqrt{2}}$

$$\therefore \gamma = \sqrt{\frac{\omega\mu\sigma}{2}} + j\sqrt{\frac{\omega\mu\sigma}{2}}$$

$\rightarrow \alpha = \sqrt{\frac{\omega\mu\sigma}{2}}$ and $\beta = \sqrt{\frac{\omega\mu\sigma}{2}}$

$$\therefore \mathcal{E}_y = \mathcal{E}_0 e^{-\sqrt{\frac{\omega\mu\sigma}{2}}x} e^{-j\sqrt{\frac{\omega\mu\sigma}{2}}x}$$

we have $\rightarrow \mathcal{E}_y = \mathcal{E}_0 e^{-x/\delta} e^{-jx/\delta}$

It shows that the amplitude of the wave decreases exponentially as it penetrates a conducting medium by a factor $e^{-x/\delta}$

4(b) Skin depth is defined as the depth of penetration of a wave inside a Conductor

$$\delta = \sqrt{\frac{2}{\omega \mu \sigma}}$$

and $\omega = 2\pi f$

$$= \sqrt{\frac{\cancel{2}}{\cancel{2}\pi f \mu \sigma}} = \sqrt{\frac{1}{\pi f \mu \sigma}}$$

$$\therefore \delta = \sqrt{\frac{2}{\omega \mu \sigma}} \quad \text{or} \quad \sqrt{\frac{1}{\pi f \mu \sigma}}$$

4(c) $f = 10\,MHz \simeq 1 \times 10^{7}\,Hz$

$\sigma = 5.8 \times 10^{7}\,S/m$, $\mu_r = 1$, $\mu_0 = 1.257 \times 10^{-6}$

$$\delta = \sqrt{\frac{1}{\pi f \mu \sigma}} \equiv \frac{1}{\sqrt{\pi f \mu \sigma}}$$

$$\mu = \mu_r \times \mu_0 = 1 \times 1.257 \times 10^{-6}$$

$$= 1.257 \times 10^{-6}$$

$$\delta = \frac{1}{\sqrt{\pi \times 1 \times 10^{7} \times 1.257 \times 10^{-6} \times 5.8 \times 10^{7}}}$$

$$\therefore \delta = 2.09 \times 10^{-5}\,m$$

$b = 10mm = 0.01m$, $a = 3mm = 0.003m$

$\varepsilon_0 = 8.85 \times 10^{-12}$ f/m

$\mu_0 = 1.257 \times 10^{-6}$ H/m

7(a) Capacitance per meter, C

$$c = \frac{2\pi\varepsilon_0}{\log_e b/a}$$

$$C = \frac{2\pi \times 8.85 \times 10^{-12}}{\log_e \frac{0.01}{0.03}}$$

$$= \frac{2\pi \times 8.85 \times 10^{-12}}{\log 28.03}$$

$$\therefore C = 3.84 \times 10^{-11} \text{ f/m}$$

7(b) Inductance per meter, L

$$L = \frac{\mu_0}{2\pi} \log_e b/a$$

$$L = \frac{1.257 \times 10^{-6}}{2\pi} . \log_e \frac{0.01}{0.03}$$

$$L = \frac{1.257 \times 10^{-6}}{2\pi} . \log 28.03$$

$$\therefore L = 2.90 \times 10^{-7} \text{ H/m}$$

7(c) characteristic Impedance, Z_o

$$Z_o = \sqrt{\frac{L}{C}}$$

$$Z_o = \sqrt{\frac{2.90 \times 10^{-7}}{3.84 \times 10^{-11}}}$$

$$Z_o = 86.90\,\Omega$$

7(d) Phase Velocity, V_p

$$V_p = \frac{1}{\sqrt{LC}}$$

$$V_p = \frac{1}{\sqrt{(2.90 \times 10^{-7}) \times (3.84 \times 10^{-11})}}$$

$$V_p = 299664563.4$$

$$= 3 \times 10^{8}$$