OGBONNA VICTOR CHIBUZO
17/ENG04/048
Electrical/Electronics Engineering
EEE 316

Question 7

$a = 3mm = (3 \times 10^{-3})m = 0.003m$

$b = 10mm = (10 \times 10^{-3})m = 0.01m$

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

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

(a) Capacitance per meter, C

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

$$C = \frac{2\pi \times 8.85 \times 10^{-12}}{\log_e \frac{0.01}{0.003}}$$

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

$$C = 3.84 \times 10^{-11}\ F/m$$

(b) Inductance per meter (L) = ?

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

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

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

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

(c) Characteristic impedance $(Z_0) = ?$

$$Z_0 = \sqrt{\frac{L}{C}}$$

$$Z_0 = \sqrt{\frac{2.90 \times 10^{-7}}{3.84 \times 10^{-11}}}$$

$$Z_0 = 86.90\Omega$$

(d)

Phase velocity

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

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

$$V_p = 299664563.4$$
$$= 29.10 \times 10^{7} V$$

Question 4

(a) From, $\frac{\partial^2 E_y}{\partial x^2} = (j\omega\mu\sigma - \omega^2\mu\varepsilon)E_y$

$$\Rightarrow \frac{\partial^2 E_y}{\partial x^2} = \gamma^2 E_y$$

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

$$E_y = E_0 e^{-\gamma x} = \mathcal{E}_0 e^{-\alpha x} e^{-j\beta x}$$

$$\frac{\partial^2 E_y}{\partial x^2} = j\omega\mu\sigma E_y = \gamma^2 E_y$$

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

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

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

$\Rightarrow$ we have; $\gamma = \sqrt{\frac{\omega\mu\sigma}{2}} + j\sqrt{\frac{\omega\mu\sigma}{2}}$

$\rightarrow \alpha \equiv \sqrt{\frac{\omega\mu\sigma}{2}}$ & $\beta \equiv \sqrt{\frac{\omega\mu\sigma}{2}}$

$\Rightarrow E_y = E_o e^{-\sqrt{\frac{\omega\mu\sigma}{2}}x} e^{-j\sqrt{\frac{\omega\mu\sigma}{2}}x}$

we now have; $\Rightarrow E_y = E_o e^{-\frac{x}{\delta}} e^{-j\frac{x}{\delta}}$ //

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

(b) Skin depth "δ" is defined as the depth of penetration of a wave inside a conductor

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

& $\omega = 2\pi f$

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

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

(c) $f = 10MHz = 1\times10^7 Hz$

$\sigma = 5.8\times10^7 S/m$, $\mu_r = 1$, $\mu_o = 1.257\times10^{-6}$

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

$\mu = \mu_r \times \mu_o$

$= 1\times1.257\times10^{-6}$

$= 1.257\times10^{-6}$

$$\delta = \frac{1}{\sqrt{\pi\times1\times10^7\times1.257\times10^{-6}\times5.8\times10^7}}$$

$$\delta = 2.09\times10^{-5} m //$$