NAME / DEPT

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$a = 3mm = 3 \times \frac{1}{100} = 0.03m$

$\varepsilon_0 = 8.85 \times 10^{-12} F/a$, $b = 10mm = 10 \times \frac{1}{100} = 0.01m$

$u_0 = 4\pi \times 10^{-7} H/m$

a $C = \frac{2\pi\varepsilon_0}{\log_e b/a} = \frac{2\pi \times 8.854 \times 10^{-12}}{\log_e 0.01/0.03}$

$\frac{2 \times 22/7 \times 8.854 \times 10^{-12}}{\log_e 0.01/0.003}$

$\frac{44/7 \times 8.854 \times 10^{-12}}{\log_e 3.33}$

$\therefore C = 4.62 \times 10^{-11} F/m$

b $L = \frac{u_0}{2\pi} \log_e \frac{b}{a}$

$L = \frac{4\pi \times 10^{-7}}{2\pi} \times \log_e \frac{0.01}{0.003}$

$L = 2.408 \times 10^{-7} H/m$

c $Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{2.4 \times 10^{-7}}{4.62 \times 10^{-11}}} = \sqrt{0.519 \times 10^{4}}$

$= 0.7204 \times 10^{2} = 72.04\Omega$

d $V_p = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.408 \times 10^{-7} \times 4.62 \times 10^{-11}}}$

$V_p = \frac{1}{\sqrt{11.124 \times 10^{-18}}}$

$V_p = \frac{1}{3.335 \times 10^{-9}} = \frac{1 \times 10^{0}}{3.335 \times 10^{-9}} = 0.299 \times 10^{9}$

2.99×10^{8}

$2.99 \times 10^9 m/s$

4a From the Equation

$$\frac{d^2 E_y}{dx^2} = (I\omega\mu\sigma - \omega^2\mu\varepsilon)E_x = \gamma^2 E_y$$

Where γ is the Propagation Constant
γ has both real and Imaginary Constant
$\gamma = \alpha + \beta b$

$E_y = E_a e^{-\gamma x} = E_a e^{-ax} e^{-jbx}$
Supprosing the $e^{j\omega t}$ term
Where Conducting Ossil:

$$\frac{d^2 E_y}{dx^2} = j\omega\mu\sigma E_x = \gamma^2 E_y$$

$\gamma = \sqrt{j\omega\mu\sigma} = \alpha + j\beta$
for the real and Imaginary Part of γ we have

$\gamma = \sqrt{\frac{\omega\mu\sigma}{2}} + j\sqrt{\frac{\omega\mu\sigma}{2}}$ --- (i)

With $\alpha = \sqrt{\frac{\omega\mu\sigma}{2}}$ and $\beta = \sqrt{\frac{\omega\mu\sigma}{2}}$ --- (ii)

The Eqn

$E_y = E_a e^{-\sqrt{\frac{2\mu\sigma}{2}}\alpha} \cdot e^{-j\sqrt{\frac{\omega\mu\sigma}{2}}x}$

b ~~Skin depth~~ Substitutions

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

$E_y = E_0 e^{-\frac{x}{\delta}} e^{-jx/\delta}$

b

Skin depth is a measure of how closely electric currents flow along the surface of a material

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

Where $\omega = 2\pi f$

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

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

$f = 10\,MHz = 1 \times 10^7\,Hz$

$\sigma = 5.8 \times 10^7\,S/m$

$\mu_r = 1$

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

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

$\mu = \mu_r \times \mu_0$

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

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

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