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17/ENG04/070
ELECTRICAL/ELECTRONICS ENGINEERING

ELECTROMAGNETIC WAVES (EEE 318)

4) from $\frac{d^2E_y}{dx^2} = (j\omega\mu\varepsilon - w^2\mu\epsilon)E_y$

where $\rightarrow \frac{d^2E_y}{dx^2} = r^2E_y$

$r = \alpha + jB$

$E_y = \varepsilon_0 e^{-\gamma x} = \varepsilon_0 e^{-\alpha x} e^{-j\beta x}$

$\frac{\partial^2 E_y}{dx^2} = j\omega\mu\gamma E_y = r^2 E_y$

$r = \frac{r^2}{\sqrt{j\omega\mu\gamma}} = \alpha + jB$

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

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

$\alpha = \sqrt{\frac{\omega\mu\delta}{2}}$ & $\beta\sqrt{\frac{\omega\mu\delta}{2}}$

$\therefore E_y = \varepsilon_0 e^{\sqrt{\frac{\omega\mu\delta}{2}}} \times e \cdot \frac{\sqrt{\omega\mu\delta}}{2}$

we have; $E_y = \varepsilon_0 e^{-x/\gamma} e^{-j x/\delta}$

This indicates that the amplitude of the wave decreases exponentially as it generates a conductive medium by a factor $\varepsilon e^{-x/\delta}$

b Skin depth is the depth of penetration of a wave inside a conductor.

$\gamma = \sqrt{2/\omega\mu_\gamma}$ and $\omega = 2\pi f$

$= \sqrt{\frac{2}{2\pi f\mu_\gamma}} = \sqrt{\frac{1}{\pi f\mu_\gamma}}$

$\therefore \gamma = \sqrt{\frac{2}{\omega\mu r}}$ or $\sqrt{\frac{1}{\pi f\mu_r}}$

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

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

$\delta = \frac{1}{\sqrt{\pi f \mu_r}} = \frac{1}{\sqrt{\pi f \mu_r}}$

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

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

$\delta = 2.09 \times 10^{-6}$ M

7) $b = 10mm = 0.01m$, $a = 3mm = 0.003m$.

$\varepsilon_0 = 8.85 \times 10^{-12}$, $\mu_0 = 1.257 \times 10^{-6}$

a) Capacitance per meter

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

$C = \frac{2\pi \times 8.85 \times 10^{-12}}{\log_e \frac{0.01}{0.003}} = \frac{2\pi \times 8.85 \times 10^{-12}}{\log 28.03}$

$\therefore C = 3.84 \times 10^{-4}$ f/m

b) Inductance per meter

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

$= \frac{1.257 \times 10^{-6}}{2\pi} \times \log_e \frac{0.01}{0.03} = \frac{1.257 \times 10^{-6}}{2\pi} \times \log 28.03$

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

c) Characteristics Impedance

$Z_0 = \sqrt{L/C}$

$Z_0 = \sqrt{\frac{2.90 \times 10^{-7}}{3.84 \times 10^{-4}}} = 86.90 \Omega$

d) Phase velocity

$V_P = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.9 \times 10^{-7} \times 3.84 \times 10^{-4}}} = 29.10 \times 10^7 V$

(rsrc 8/8)

the wave decreases
um by a factor $8e^{-7/\delta}$

wave inside a