

ANSWER on Question #75003 – Math – Calculus

A surface wave with frequency

$$\omega = 3 \times 10^{-5} \frac{\text{rad}}{\text{s}}$$

is propagating at a metal-free space boundary.

The plasma frequency of metal is $\omega_{pl} = 9 \times 10^{15} \frac{\text{rad}}{\text{s}}$ and $\epsilon_r = 7$. Estimate k .

If the amplitude of the wave is

$$A = 10^5 \text{ Vm}^{-1}$$

at the surface, what will be its value at the depth of $0.2 \mu\text{m}$ in the metal? Ignore the collision effect.

SOLUTION

$$\omega^2 - \omega_{pl}^2 = c^2 k^2 \rightarrow k = \sqrt{\frac{\omega^2 - \omega_{pl}^2}{c^2}}$$

$$\begin{aligned} k &= \sqrt{\frac{\omega^2 - \omega_{pl}^2}{c^2}} = \sqrt{\frac{(3 \times 10^{-5})^2 - (9 \times 10^{15})^2}{(3 \times 10^8)^2}} = \sqrt{\frac{9 \times 10^{-10} - 81 \times 10^{30}}{9 \times 10^{16}}} \approx \\ &\approx \sqrt{\frac{-81 \times 10^{30}}{9 \times 10^{16}}} = \sqrt{-9 \times 10^{14}} = -3i \times 10^7 \end{aligned}$$

Conclusion,

$$k \approx -3i \times 10^7 \frac{1}{\text{m}}$$