PYL 100 : Tut. Sheet #3

EM Waves + Applications

1. An em wave propagates (with freq. ω) in a conductor of $\omega_p = 2\omega$, $\epsilon_r = 9$, $\nu = 10^{-3}\omega$. Estimate the distance after which intensity becomes half.
[$(c / 8\sqrt{5}\,\omega) \ln 2$.]

2. A 5 GHz microwave propagates in a lossy dielectric of $\epsilon_r = 80$. It suffers power loss of 0.2 db/meter. Estimate conductivity of the medium.
[Hint : $P = P_0 e^{-2k_i z}$, Power loss in db $= 10 \log_{10}(P_0/P)$.]
Ans: $k_i \simeq 2.3 \times 10^{-2}$, $\sigma = 0.13$ MKS.

3. In a conductor $\vec{J}$ is $\pi/3$ out of phase with $\vec{E}$ of $\omega/2\pi = 0.3$ THz. Estimate electron collision frequency.
[$\nu \simeq 10^{12}\ s^{-1}$.]

4. Plot skin depth ($\delta = k_i^{-1}$) of an em wave in a collisionless plasma as a function of ω/ω_p.

5. Phase velocity of 10 GHz em wave in a plasma is $2c$. Estimate v_{ph} of 17 GHz wave. [Ans. $2c/\sqrt{3}$.].

6. Show that $v_{ph} \cdot v_g = c^2$ in a collisionless plasma. Plot v_g, v_{ph} versus ω/ω_p.

7. A 10 V/m em wave is normally incident on a plasma of $\omega_p/\omega = 1.6$. Estimate the field at a depth of $4c/\omega$.
[4×10^{-2} V/m .]

8. For Earth $\sigma = 1$ MKS, $\epsilon_r = 4$. Plot skin depth as a function of ω for low-freq. waves.