PYL-100

MINOR - II

21/03/2015

Max. Marks : 25

Attempt all questions. The required physical constants are given at the end of the question paper.

1. A plane electromagnetic wave is incident on a conductor.

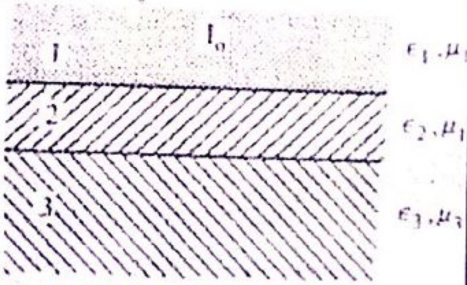
(a) For this EM wave in conductor ($\tau(=\varepsilon/\sigma)$ small, σ large), show that the free charge dissipates with characteristic time τ. (2)

(b) Write the Maxwell's equation inside the conductor (½+ ½+1)

(c) The dielectric constant and permeability of this conductor are of the same value as of free space (i.e., ε_0, μ_0) and a plane EM wave $\bar{E}(\bar{r},t) = \bar{E}_0 \exp[i(\bar{k}\cdot\bar{r}-\omega t)$ is incident normally on this conductor. Frequency and conductivity of the conductor are such that within the conductor the conduction current and displacement current are equal. What is the expression for σ (in terms of ω & ε_0) in this conductor? Justify your answer. (3)

(d) If under the above condition in (c) the complex index of refraction can be written as $n = (1/c)\ \sqrt{[\{\varepsilon_0 - (4\pi\sigma/\omega)\, i\}\mu_0]}$. Arrive at an expression of reflection coefficient for this problem. (3)

2. Given the 3 media shown, an incident plane EM wave of Intensity I_0 enters normal to the interface from medium 1. (5)



(a) Find the intensity of the wave transmitted into medium 3. Medium 3 extends indefinitely downward.

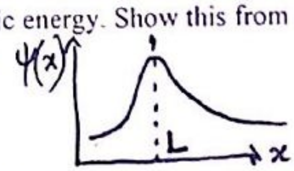
(b) Find the intensity of the wave in medium 1 which returns in the direction opposite to the incoming wave.

Kindly use ONLY the parameters (for the media) given / shown in the problem for arriving at your answer MARKS WILL NOT BE GIVEN IF YOU EXPRESS YOUR ANSWER IN ANY OTHER PARAMETRS NOT SHOWN / USED IN THIS PARTICULAR PROBLEM

3. (a)The signal from a TV station contains pulses of full width ~ 10^{-6} sec. Is it feasible to transmit TV signals in AM broadcasting band, answer with reasoning? The AM band-width is 0.5×10^6 Hz to 1.5×10^6 Hz (2)

(b) A particle confined in a box cannot have ZERO kinetic energy. Show this from uncertainty principle (2)

(c) Suppose we have a wave function that looks like this- (3)



How will you represent dψ/dx graphically? Show specifically what will happen at x=L. What will be $d^2\psi/dx^2$ at x=L

4. In magnetic materials there exist spin waves of frequency $\omega = Ak^2$, where A is a constant and k is the wave-vector (magnitude of propagation vector) of a given spin wave. Find the phase velocity v_p and group velocity v_g for these waves as a function of ω (NO MARKS WILL BE GIVEN IF THE RESULTS ARE EXPRESSED OTHERWISE). (3)

What is the physical interpretation of this result?

Physical Constants :

$k_B = 1.38 \times 10^{-23}$ J/K

$m^* = 9.1 \times 10^{-31}$ Kg

$h = 6.6 \times 10^{-34}$ Js

$N_A = 6.023 \times 10^{23}$ mole^{-1}

1 eV $= 1.6 \times 10^{-19}$ J