Mid-Sem-2018

EE301 Total Marks: 30

Date: 12/09/2018 Duration: 2 hours

Instructions:

- Please read the questions carefully and mention the assumptions clearly while solving questions.
- Mention the quantities with the appropriate SI (standard) units. Units also have marks.

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1. An antenna generates an electric field intensity in the positive y direction. The amplitude of the generated wave having E_0 =100 V/m, at a wavelength of 12 m and incident on a perfectly conducting wall with an angle 90^o w.r.to the wall. ***9 marks***

(a) Calculate the location of the antenna in relation to a perfectly conducting wall such that a standing wave is generated with three positive maxima in the electric field between the wall and antenna, and the antenna is at the location of the fourth positive peak. Assume propagation in free space.
(b) Find the position(s) with respect to the perfectly conducting wall where we can place another perfectly conducting surface/wall, such that it will not affect the wave behavior.
(c) If propagation occurs in a low-loss medium, $\varepsilon_1=4\varepsilon_0$ [F/m], $\mu_1=\mu_0$ [H/m], $\sigma_1=10^{-5}$ S/m, calculate the amplitude of the electric field intensity at the location of the first positive maximum to the right of the antenna.

2. One of the main concerns in exposure to microwave radiation is heating effects in the body. The US radiation safety code specifies that the total amount of radiation should not exceed 10 mW/cm^2 of skin for 6 hours. Suppose an average person is exposed to this radiation at a frequency of 10 GHz. The effective area of the skin is 1.5 m^2, and the body properties are σ = 0.01 S/m, $\mu = \mu_0$ [H/m], and $\varepsilon = 24\varepsilon_0$ [F/m], at the given frequency. Calculate the total power absorbed by the body and the total energy absorbed during maximum exposure. ***3 marks***

3. A very thin conducting layer carries a surface current density J_0 [A/m] as shown in Fig 1. The frequency is f and the current is directed in the positive z direction. The layer is immersed in seawater, which has permittivity ε, permeability μ_0, and conductivity σ. If the layer is at x = 0, calculate the electric and magnetic fields at x = x0. Given: J_0= 1 A/m, f =100 MHz, σ = 4 S/m, ε_0=8.854 * 10^{-12} F/m, ε_r = 80, $\mu_0 = 4\pi$ *10^{-7} H/m, x_0 = 1 m. ***9 marks***

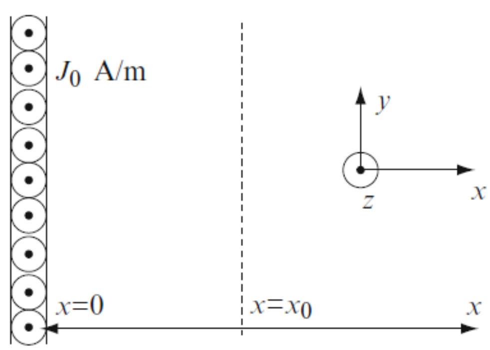

Fig. 1

4. Two dielectrics meet at an interface (Fig. 2) at x =0. A sinusoidal electric field intensity of peak value 5 V/m and frequency 1 kHz exists in dielectric (1). For $x < 0$, $\varepsilon = 2\varepsilon_0$ [F/m], and $\mu=\mu_0$ [H/m]. For $x > 0$, $\varepsilon = 3\varepsilon_0$, and $\mu = 2\mu_0$. If the electric field intensity vector is incident at 30 from the normal.

6 marks

(a) Find the magnitudes of E and D on each side of the interface. Assume no current or charge densities exist at the interface.

(b) Find the Polarization of the wave on each side of the interface.

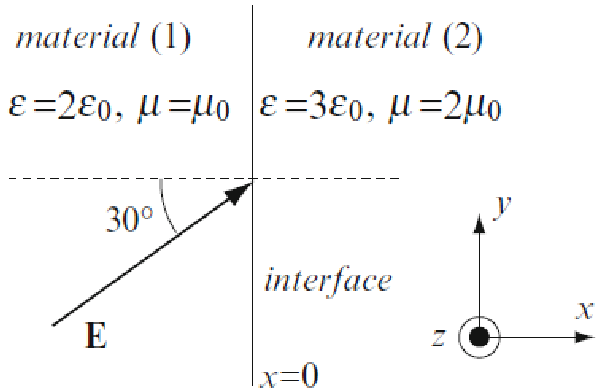

Fig. 2

5. The parameters of a certain transmission line operating at $\omega = 6\times10^8$ rad/s are $L = 0.35\mu$H/m, $C = 40$ pF/m, $G = 75\ \mu$S/m, and $R = 17\ ohm$/m. Find γ, v_p, λ, and Z_0. At what distance power reduced by 20dB.

3 marks