antenna if it is located under seawater ($\varepsilon = 81\varepsilon_0$, $\mu = \mu_0$, $\sigma = 4$ S/m). (9×2=18)

[This question paper contains 8 printed pages.]

Your Roll No..............

Sr. No. of Question Paper : 8613 **J**

Unique Paper Code : 2942822402

Name of the Paper : Electromagnetic Theory (EMT)

Name of the Course : B. Tech. (ECE)

Semester : IV

Duration : 3 Hours Maximum Marks :90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.

2. Attempt **five** questions in all, including **question no. 1**, which **is compulsory**.

3. Non – programmable scientific calculator is allowed.

4. All questions carry equal marks.

1 (a) Given that B = $p^2 \sin \varphi\, a_p + (z - 1) \cos \varphi\, a_\varphi + z^2 a_Z$, find B.ax at (4, Π/4, -1).

(b) Define polarization. Derive Poisson's and Laplace equation.

(c) A dipole antenna ($l = \lambda/8$) operating at 400 MHz is used to send a message to a satellite in space. Find the radiation resistance of the antenna.

(d) A 200 MHz uniform plane wave moving through free space usually impacts a substantial material with $\varepsilon_r = 4$, $\mu_r = 9$, and $\sigma = 0$. Determine the transmission and reflection coefficients of the

in the TE_{10} mode, (9× 2 = 18)

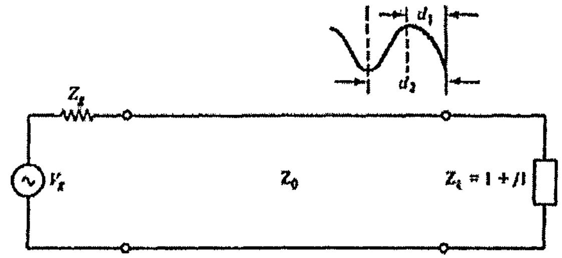
$$\mathcal{P}_{ave} = \frac{\omega\mu\beta a^2}{2\pi^2} H_0^2 \sin^2\left(\frac{\pi x}{a}\right) \mathbf{a}_z$$

6. (a) The radiation intensity of an antenna is given by Calculate the directivity of the antenna.

$$U(\theta, \phi) = \begin{cases} 4\sin^2\theta \sin\phi/2, & 0 < \phi < \pi, 0 < \theta < \pi \\ 0, & \text{otherwise} \end{cases}$$

Calculate the directivity of the antenna.

(b) An antenna engineer is asked to design a $\lambda/2$ dipole antenna to operate at 450 MHz. (a) Calculate the length of the antenna if it is located in free space (b) Determine the length of the illustrated in the figure below. (9× 2 = 18)



5. (a) In an air-filled rectangular waveguide, a TE mode operating at 6 GHz has

$$E_y = 5 \sin\left(\frac{2\pi x}{a}\right) \cos\left(\frac{\pi y}{b}\right) \sin(\omega t - 12z) \text{ V/m}$$

Determine (a) the mode of operation, (b) the cutoff frequency, (c) the intrinsic impedance, and (d) H_x.

(b) The average power density is given by

$$\mathcal{P}_{ave} = \frac{1}{2} \text{Re}[\mathbf{E}_s \times \mathbf{H}_s^*]$$

Show that for a rectangular waveguide operating

interface.

(e) A lossy transmission line with characteristic impedance of 75 + j60 Ω is connected to a 100 Ω load. If attenuation is 1.2 Np/m and the phase constant is 2.4 rad/m, find the input impedance for l = 0.5 m.

(f) A K-band waveguide (1.06 cm × 0.53 cm) is filled with a dielectric material with ε_r = 6.8. If it operates in the dominant TE_{10} mode at 6 GHz, determine the waveguide's cutoff frequency and phase velocity. (9× 2 = 18)

2. (a) Find the Laplacian of the following scalar fields and compute the value at the specified point.

$$V = \rho^2 z(\cos\phi + \sin\phi), (5, \pi/6, -2)$$
$$W = e^{-r} \sin\theta \cos\phi, (1, \pi/3, \pi/6)$$

Show that the vector field $D = (5\rho + 1)\sin\varphi a_z$ is solenoidal.

(b) An infinitely long filamentary wire carries a current of 2 A along the z-axis in the +z-direction. Calculate the following:

(i) Magnetic flux density B at (-3, 4, 7)

(ii) The flux through the square loop described by $2 \leq p \leq 6$, $0 \leq z \leq 4$, $\varphi = 90°$.

(9×2 = 18)

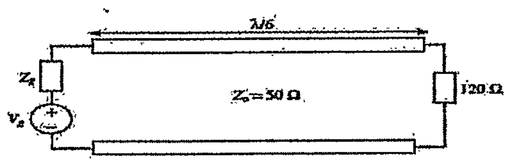
3. (a) Discuss different type of medium. Derive the expression for the attenuation constant, phase constant and intrinsic impedance for a uniform

plane wave in a lossy dielectric.

(b) Briefly explain about the wave incident normally on perfect conductor. Derive the reflection coefficient and the transmission coefficient.

(9 × 2 = 18)

4. (a) Refer to the lossless transmission line depicted in the following Figure. Find the reflection coefficient and standing wave ratio. (b) Determine Z_{in} at the generator.



(b) Given the normalized load impedance $z_l = 1 + j1$ and the operating wavelength, $\lambda = 5$ cm, calculate the first V_{max} and V_{min} from the load, as well as the VSWR (p), utilizing the Smith chart as