College of Engineering, Pune
END SEMESTER EXAM
Year (T. Y. B.Tech)
(ET-311) - (Electromagnetic Waves)

Day & Date: Tuesday, 30/04/13 **Max. Marks:** 50
Timing: 2.00pm to 5.00pm **Duration:** 3 Hrs.

Instructions:
1. Figures to the right indicate full marks.
2. Assume Suitable data wherever necessary.
3. Draw neat figure wherever required.

Q.1 a] Explain the application of transmission line as Resonant Circuit. [4]

b] A load impedance $(60 - j25)\ \Omega$ is to be matched to 50Ω using single stub matching. Find the length and location of stub. [4]

OR

b] A line is terminated in a normalized admittance 0.2- j0.5. Find the location of the voltage maximum from the load end. Also find the reflection coefficient, normalized admittance, and normalized impedance at a distance of $0.12\ \lambda$ from the load. [4]

c] Identify the load impedances in the following cases [2]
- i) Partial standing wave and the voltage drops towards the generator at the load point.
- ii) Fully standing wave and the voltage rises on the line as we move from load towards generator.
- iii) Fully standing wave and the voltage is maximum at the load point.
- iv) No standing wave.

Q.2 a] What is electric scalar potential? Derive the relationship between electric field and electric scalar potential and hence show that ideal conductor is equi-potential body. [4]

b] A medium has infinite conductivity for $z \leq 0$, and $\varepsilon_r = 5$, $\mu_r = 20$ and $\sigma = 0$ for $z > 0$. If the electric field for $z > 0$ is given by $\mathbf{E} = 10 \cos(3 \times 10^8 t - 10x)\mathbf{z}$. Find the surface charge density and surface current density at location (2, 3, 0) at t = 0.5nsec. [4]

OR

b] A uniform plane wave travelling in a medium having dielectric constant 9, has peak electric field of 10 V/m. The frequency of the wave is 1 GHz. Find the wavelength and peak magnetic field of the wave. If at some location (z = 0) and some instant (t = 0), the electric field is 5 V/m, find the magnitudes of the electric and magnetic fields at z = 2m and t = 50 msec. Assume the wave to be moving in +z direction. [4]

c] A material has dielectric constant 25 and conductivity 2 X 10^6 mho/m. What is the frequency above which the material cannot behave like good conductor? If a plane wave of 10MHz is incident on the material, effectively upto what depth can the wave penetrate the material, and what will be the wavelength of the wave inside the material? [2]

Q.3 a] What is Poynting vector? Derive the expression for Poynting vector and give its significance. [4]

b] A circularly polarized plane wave is incident on a thick glass slab at an angle of incidence of 45^0. Find the state of polarization of the reflected and transmitted waves. The frequency of the wave is 10^{14} Hz and the refractive index of glass is 1.5. [6]

OR

b] What is TIR? When does it occur? Write reflection and transmission coefficient for it and justify following for it. [6]

i) TIR can take place only if wave travels from denser to rarer medium.
ii) Wave undergoes a phase change during TIR.
iii) At TIR the fields do not vanish in the second medium.

Q.4 a] Derive the field expression for TM wave in a rectangular waveguide and write important observations from them. [5]

b] Find the cut off frequencies of TM_3 and TE_4 modes of an air filled parallel plane waveguide of height 20cm. How many TE and TM modes will propagate in the waveguide at 6 GHz? [3]

c] A hollow rectangular waveguide has dimensions 6cm X 4cm. The frequency of impressed signal is 5GHz. Calculate for TE_{10} mode [2]

i) Cut-off wavelength
ii) Phase constant

Q.5 a] What is Hertz dipole? Discuss different fields generated by it. [4]

b] Calculate the power radiated by $\lambda/50$ Hertz dipole in free space if it carries a uniform current I= 10 cos wt amperes. What is its radiation resistance? [2]

c] The field radiation pattern of an antenna is given by [4]

$$F(\theta) = \frac{sin(10cos\theta)}{sin(2cos\theta)} \qquad 0 \leq \theta \leq \pi$$

Find the directions of the nulls, direction of maximum radiation and HPBW of the antenna.

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