Code: 07A31001 **SS**

B.Tech II Year I Semester (R09) Supplementary Examinations December 2015

ELECTROMAGNETIC WAVES & TRANSMISSION LINES

(Electronics & Instrumentation Engineering)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) State and prove Gauss's law. Give three applications of Gauss's law with suitable examples.

(b) Given that electric flux density $D = z\,\rho\,cos^2\phi\,a_z\,C/m^2$, use Gauss's law to calculate the charge density at $(1, \pi/4, 3)$ and the total charge enclosed by the cylinder of radius of 1 m with $-2 \le z \le 2$.

2 (a) Determine magnetic field intensity H at any point in free space due to any straight filamentary conductor of finite length directed along z – axis.

(b) A circular loop located on $x^2 + y^2 = 9$, z = 0 carries a direct current of 10 A along a_ϕ. Determine magnetic field intensity H at (0, 0, 4) and (0, 0, -4).

3 (a) What are the boundary conditions of the magnetic field? Explain.

(b) Medium 1 (z < 0) is filled with a material whose relative permeability is six, and medium 2 (z > 0) is filled with a material whose relative permeability is 4. If the interface carries current of $a_y/\mu_0\ mA/m$, and $B_2 = 5a_x + 8a_z\ m\ Wb/m^2$, find H_1 and B_1.

4 (a) Prove that for a good conductor, the intrinsic impedance of a plane wave $\eta = (1 + j)/(\sigma\delta)$.

(b) A lossy dielectric has an intrinsic impedance of 200 ohms magnitude and phase of 30° at a particular frequency. If at that frequency, the plane wave propagating through the dielectric has the magnetic field component $H = 10\exp(-ax)\cos(\omega t - 0.5x)\,a_y\,A/m$, find E and skin depth.

5 (a) State and prove the Poynting's theorem with regard to EM wave propagation.

(b) A uniform plane wave in air with $H = 4\sin(\omega t - 5x)\,a_y\,A/m$ is normally incident on a plastic region with parameters $\varepsilon = 4\varepsilon_0,\ \mu = \mu_0,\ \sigma = 0$. Obtain the total electric field in air and calculate the time average power density in the plastic region.

6 (a) Obtain expressions for the cut-off frequency and phase velocity in the rectangular waveguide starting from the field expressions of TE modes.

(b) A rectangular air-filled waveguide has a cross section of 80 x 40 mm. Find cut-off wavelength for dominant mode. How many modes are passed at 2.5 times cut-off frequency?

7 (a) Derive the expression for characteristic impedance of a transmission line in terms of primary constants of the line.

(b) A telephone line has R = 30 ohms/km, L = 100 mH/km, C = 20 μF/km, and G = 0. At frequency of 1 kHz, determine the characteristic impedance of the line, the propagation constant and the phase velocity.

8 (a) Show that a lossy transmission line of length $'l'$ has an input impedance of $Z_0\,tanh\gamma l$ when it is shorted and $Z_0\,coth\gamma l$ when it is open at the load end.

(b) A quarter-wave lossless 100 ohm line is terminated by a load of 210 ohms. If the voltage at the receiving end is 80 V, what is the voltage at the sending end?

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