Code: 13A04403 **R13**

B.Tech II Year II Semester (R13) Regular & Supplementary Examinations May/June 2016

ELECTROMAGNETIC THEORY & TRANSMISSION LINES

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) A vector filed is described by $\vec{F} = 500\,\hat{a}_x + 750\hat{a}_y$. A plane surface in the region of the field is defined by $2x + 4y + 6z = 12$. Find the scalar component of the vector field normal to the surface.

(b) Explain the importance of the term "Relaxation time" pertaining to different materials.

(c) A circular loop consists of 25 turns of very fine wire. The average radius of the loop is 20 cm and it carries a current of 1.6 A. Find the magnetic flux density at the centre of the loop along axial direction.

(d) Given the magnetic vector potential $\vec{A} = -0.25\rho^2\hat{a}_z\ Wb/m$, What would be the total magnetic flux crossing the surface $\phi = \frac{\pi}{2}, 1 \le \rho \le 2\ m, 0 \le z \le 5\ m$?

(e) What is Lorentz force equation on a charged particle moving in free space where static electromagnetic fields are present?

(f) The xy –plane serves as the interface between two different media. Medium $1(z < 0)$ is filled with a material whose relative permeability is 6, medium $2(z > 0)$ is filled with a material whose relative permeability is 4. If the interface carries a current of $(1/\mu_0)\hat{a}_y\,mA/m$, magnetic flux density $\overrightarrow{B_2} = 5\hat{a}_x + 8\hat{a}_z\ mWb/m^2$, find $\overrightarrow{B_1}$.

(g) With reference to the propagation of EM waves in two different media, prove that average reflected power density equals to average incident power density times square of the reflection coefficient (magnitude only).

(h) In a lossless dielectric medium for which the intrinsic impedance is half of that of free space and its relative permeability is unity. If the magnetic field intensity with unity amplitude has y-directed component, calculate the relative permittivity of the medium.

(i) Show that "a distortion-less line is one in which the attenuation constant is independent of operating frequency while the phase constant is linearly dependent on frequency".

(j) What is microstrip transmission line? Give the expression for effective relative permittivity of the line.

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 (a) Derive the expression for electric field intensity at any point far from an electric dipole which is located at origin. Sketch the field pattern.

(b) Two uniform line charges 8 nC/m each are located at x = 1, z = 2 and at x = -1, y = 2 in free space respectively. If the potential at the origin is 100 V, find the potential at a point P (4, 1, 3).

OR

3 (a) If $\vec{J} = \left(\frac{100}{\rho^2}\right)\hat{a}_\rho\ A/m^2$, Obtain the time rate of increase in the volume charge density and the total current passing through surface defined by $\rho = 2, 0 \le z \le 1, 0 \le \phi \le 2\pi$.

(b) Consider two concentric spherical conductors with inner sphere radius 'a' and the out sphere of radius 'b' are separated by a dielectric medium. The electric potential on the inner conductor 'V' volts with respect to the outer conductor which is connected to ground. Prove that the capacitance between the spherical conductors is $C = 4\pi\varepsilon/\left[\left(\frac{1}{a}\right) - \left(\frac{1}{b}\right)\right]$.

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UNIT – II

4 (a) State Ampere's circuital law. Use this law to find the magnetic field intensity at all the regions of a coaxial cable with current 'I' in the inner conductor flowing along positive z-direction and same current is flowing in the outer conductor along negative z-direction. Assume appropriate dimensions of the cable.

(b) A thin ring of radius 5 cm is placed on plane z = 1 cm so that its center is at (0, 0, 1) cm. If the ring carries 50 mA along $\hat{a}_{\phi,}$ find the magnetic field intensity at (0, 0, -1) cm.

OR

5 (a) Evaluate both sides of Stokes theorem for the field $\vec{H} = 6xy\,\hat{a}_x - 3y^2\hat{a}_y\;A/m$ and the rectangular path around the region, $2 \le x \le 5, -1 \le y \le 1, z = 0$.

(b) Explain the self-inductance associated with magnetic fields & prove that maximum energy stored in magnetic field is proportional to the self-inductance.

UNIT – III

6 What are the boundary conditions of electromagnetic fields at the interface of two media? Derive them for all possible cases of different media.

OR

7 Derive the four Maxwell's equations from the fundamental laws for time varying fields. Give the physical significance of each of them & express all the equations in the phasor form.

UNIT – IV

8 Deduce suitable expressions for transmission and reflection coefficients when a plane wave is obliquely incident on the interface of two media. Consider parallel polarization only. What happens to the coefficients mentioned above when the incident angle is zero? Write your comments.

OR

9 (a) Establish the expressions for attenuation constant and phase shift constant of lossy dielectric medium from complex propagation constant.

(b) A plane wave propagating through a medium with $\varepsilon_r = 8, \mu_r = 2$ has the electric field intensity $\vec{E} = 0.5\exp(-0.00z)\sin(10^8 t - \beta z)\,\hat{a}_x V/m$. Determine wave velocity, wave impedance and the magnetic field intensity.

UNIT – V

10 (a) From the fundamentals of transmission line theory, derive the expression for input impedance of transmission line.

(b) An antenna with an impedance of 40 +j30 ohms is to be matched to 100 ohm lossless transmission line using short circuited stub. Determine the required stub admittance, stub length and the distance between the stub and the antenna. Assume that the signal frequency is 900 Mz.

OR

11 (a) What are the applications of transmission lines of different lengths at radio frequencies? Explain them in detail.

(b) A 60 ohm transmission line operating at 20 MHz is10 m long. If the input impedance is 90 +j150Ω, calculate load impedance, SWR and complex reflection coefficient.

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