Code: 13A04403

R13

B.Tech II Year II Semester (R13) Regular Examinations May/June 2015

ELECTROMAGNETIC THEORY & TRANSMISSION LINES

(Electronics and Communication Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

Smith chart may be permitted in the examination hall

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

(a) Establish the relation between the electric field intensity and electric potential.

(b) In a dielectric material, component of electric field intensity $E_x = 5V/m,$ and the polarization $\vec{P} = 0.1\pi(3\hat{a}_x - \hat{a}_y + 4\hat{a}_z\ nC/m^2$ are given. Find the electric susceptibility of the material.

(c) State Ampere's circuital law and give one application of it in detail.

(d) Given the magnetic vector potential $\vec{A} = x^2\, y\hat{a}_x + y^2 x\hat{a}_y - 4xyz\hat{a}_z$ Wb/m, determine the magnetic flux through a surface define by $0 \le x \le 1, -1 \le y \le 4, z = 1$.

(e) Express all Maxwell's equations in phasor form for time varying EM fields.

(f) List out the boundary conditions of electromagnetic fields at the interface of two different media with suitable sketches.

(g) Get the expression for phase shift constant $'\beta'$ from the wave equation in a lossy dielectric medium.

(h) In free space, measurements field intensity $\vec{H} = 0.2\cos(\omega t - \beta x)\hat{a}_z\ A/m$. Find the total power passing through a circular disk of radius 5 cm on plane x = 1.

(i) State and explain lossless and distortion less transmission lines.

(j) Slotted line measurements yield a VSWR of 5, 15 cm spacing between successive voltage maxima and the first maximum at a distance of 7.5 cm in front of the load. Determine the frequency of the signal and value of the reflection coefficient.

PART – B

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

UNIT – I

2 (a) State and explain the Gauss's law. Apply the Gauss's law to find the electric field intensity at any of interest due to uniformly charged sphere of radius 'a' and with uniform charge distribution ρ_0 C/m^3.

(b) In free space the electric flux density $\vec{D} = 2y^2\hat{a}_z + 4yx\hat{a}_y - \hat{a}_z\, mC/m^2$. Find the total charge stored in the region $1 < x < 2, 1 < y < 2, -1 < z < 4$.

OR

3 (a) A circular disk of radius 'a' is uniformly charged with ρ_s C/m^2. The disk lies on z = 0 plane with its axis along the z-axis. Derive the expression for the electric field intensity at a point (0, 0, h).

(b) An electric dipole of 100 $\hat{a}_z$ pC-m is located at the origin. Find electric potential and the electric field at a point (1, π/3, π/2).

UNIT – II

4 (a) Obtain the expression for magnetic field intensity at any point in free space due to a long current carrying conductor using Biot-Savart's law.

(b) A rectangular loop of wire in free space joins points A(1,0,1) to B(3,0,1) to C(3,0,4) to D(1,0,4) to A. The wire carries a current of 6 mA, flowing in the $\hat{a}_z$ direction from B to C. A filamentary current of 15 A flows along the entire z-axis in the $\hat{a}_z$ direction. Find the total force on the loop.

OR

5 (a) State and explain the importance of Stokes' theorem with regard to EM fields.

(b) Derive the expression for energy stored in magneto-static field.

(c) Planes z = 0 and z = 4 carry current $\vec{K} = -10\hat{a}_x\ A/m$ and $\vec{K} = 10\hat{a}_x A/m$ respectively. Determine $\vec{H}$ at (1,1,1).

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UNIT – III

6 (a) Explain about inconsistency of Ampere's law.

(b) In free space, $\vec{E} = 20\cos(\omega t - 50x)\,\hat{a}_y V/m$. Calculate displacement current density, frequency of the wave and magnetic field intensity.

(c) Establish the relationship between electric and magnetic field intensities in terms of retarded potentials for time varying fields from the fundamental laws.

OR

7 (a) Derive all Maxwell's equations for time varying EM fields from the basic laws.

(b) The xy-plane serves as the interface between two different media. Medium 1 (z<0) is filled with a material whose $\mu_r = 6$, and medium 2 (z>0) is filled with a material whose $\mu_r = 4$. If the interface carries linear current density of $(1/\mu_0)\hat{a}_y\ mA/m$, and $\vec{B}_2 = 5\hat{a}_x + 8\hat{a}_z\ mWb/m^2$, find $\vec{H}_1$.

UNIT – IV

8 (a) When a uniform wave is incident normally on an interface between two media derive the expression for transmission coefficient.

(b) The electric field component of a uniform plane wave travelling in seawater ($\sigma = 4S/m$, ε_r =81, μ_r = 1) is $\vec{E} = 8e^{-0.1z}\cos(\omega t - 0.3z)\,\hat{a}_x V/m$. Determine the average power density.

OR

9 (a) Discuss about the propagation of uniform plane waves in good conductors and deduce the expression for intrinsic impendence and skin depth.

(b) In free space (z≤ 0), a plane wave with $H = 10\cos(10^8 t - \beta z)\,a_x\ mA/m$ is incident normally on a lossless medium ($\varepsilon_r = 2$, $\mu_r = 8$) in region $z \geq 0$. Determine the reflected and transmitted electromagnetic waves.

UNIT – V

10 (a) Discuss about the properties of transmission lines of various lengths. Give their corresponding LC equivalents at RF frequencies.

(b) A series RC combination having an impedance of (450 – j600) Ω at 10 MHz is connected to a 300 ohm line. With the aid of Smith chart, calculate the position and length of a short circuited stub designed to match this load to the line.

OR

11 (a) Derive the expression for characteristic impedance of a transmission line.

(b) A telephone line has the following parameters: R =40 Ω/m, G = 100 mS/m, L = 0.2 μH/m, C = 0.5 nF/m. If the line is operated at 10 MHz, calculate the characteristic impedance and velocity of the signal.

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