PVP 12

Code: EC4T4

II B.Tech - II Semester – Regular Examinations - JUNE 2014

ELECTROMAGNETIC FIELD THEORY
(ELECTRONICS AND COMMUNICATION ENGINEERING)

Duration: 3 hours Marks: 5x14=70

Answer any FIVE questions. All questions carry equal marks

1. a) Define divergence of a vector field 2 M

   b) State and prove Gauss divergence theorem 6 M

   c) Prove that divergence of curl of a vector field is zero 3 M

   d) Find the unit normal to the surface $x = \frac{z-3y}{5}$ 3 M

2. a) A charge distribution with spherical symmetry has the volume charge density

$$\rho_v = \begin{cases} \rho_0\left(1-\frac{r^2}{a^2}\right) & 0 \le r \le a \\ 0 & r > a \end{cases}$$

   i) Find the electric field intensity in the region $r < a$.

   ii) Find the value of 'r' for which the electric field intensity is maximum. 10 M

   b) Derive Maxwell's second equation (Gauss law of magneto statics) 4 M

3. a) Obtain the continuity equation from law of conservation of charge. 5 M

b) Derive the expression for capacitance of an air filled coaxial capacitor with inner and outer radii 'a' & 'b' respectively. 5 M

c) The space between two large parallel plates separated by a distance 0.2mm is filled with a dielectric of relative permittivity 2. Find the polarization of the dielectric if the plates are connected to a 12V battery. 4 M

4. a) State and explain Biot-Savart's law 3 M

b) Derive Ampere's circuital law in differential form. 3 M

c) Two identical long wires parallel to the z-axes carrying a current I in the positive z- direction are inserted in the XY-plane at (-1, 1) and (-1, -1). A third conductor carrying the same current I is inserted on the x-axes parallel to the z-axes so that magnetic field at the origin (0, 0) is doubled. Find the position of third conductor and direction of current in third conductor. 8 M

5. a) Define magnetic dipole moment of a current loop. Derive the expression for torque on a current loop, if the loop is placed in a magnetic field of flux density $\vec{B}$ 7 M

b) A very long solenoid with $9cm^2$ cross section has an iron core ($\mu_r = 1000$) and 5000 turns per meter. It carries a current of 500mA. Find

i) Its self –inductance per meter.

ii) The energy per meter stored in its field. 7 M

6. a) State and explain Faraday's law. Obtain the differential form of Faraday's law. 5 M

b) A time varying voltage of the form $10\cos(10^5\, t)$ V is applied to a parallel plate capacitor with separation of plates 2cm and plate diameter 20cm. Find the magnetic field between the plates of the capacitor. 6 M

c) The current in a circular coil is increased from 0A to 15A at a uniform rate in 6s, then the coil develops self induced emf of 100V. Find the self inductance of the coil. 3 M

7. a) Define and explain the polarization of an electromagnetic wave. Explain linear, circular, elliptical states of polarization of an electromagnetic wave with neat sketches. 6 M

b) If the magnetic field vector of an electromagnetic wave propagating in a dielectric medium (ϵ, μ) is
$\vec{H} = \sin(\beta_x x)\sin(\beta_y y)\cos\omega t\ \hat{z}$.
Show that $\beta_x^2 + \beta_y^2 = \omega^2\mu\epsilon$ 4 M

c) An electromagnetic uniform plane wave of frequency 300MHz is travelling in vacuum. At some instant and position its electric field vector is $4\hat{x} + 3\hat{y}$ V/m. Find its magnetic field vector at the same instant and position. 4 M

8. a) State and prove Poynting theorem 9 M

b) Define Brewester's angle and derive the expression for Brewester's angle for a parallel plane polarized electromagnetic wave at ideal dielectric – ideal dielectric interface. 5 M