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Code: 13A02401 **R13**

B.Tech II Year II Semester (R13) Supplementary Examinations December/January 2015/2016

ELECTROMAGNETIC FIELDS

(Electrical and Electronics 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) Two positive charges Q Coulomb each are placed at points (0, 0, 0) and (2, 2, 0), while two negative charges are placed at points (0, 2, 0), and (2, 0, 0). What is the electric field at the point (1, 1, 0)?

(b) Two infinite sheets of charge with charge densities $+\sigma$ and $-\sigma\ C/m^2$ are placed parallel to each other with a separating distance of d meters. What is the value of electric field intensity at a point exactly midway between the plane sheets?

(c) What is the energy stored in a capacitor made of two parallel metal plates each of $30\ cm^2$ area separated by $5mm$ in air. $\varepsilon_0 = 8.854\ X\ 10^{-12}$. The capacitor is charged to a potential difference of 500 volt.

(d) What is the significance of 'dielectric strength' of a medium?

(e) A circular coil of diameter 1 m carries a current of 2 A. What is the value of magnetic field intensity at the centre of the coil?

(f) What is magnetic dipole moment?

(g) A long solenoid is bent into a circle and closed on itself, forming a toroid of radius r. A winding of N turns is uniformly wound on the toroid. Radius of the coil is S. The magnetic flux lines are assumed to be entirely confined to the interior of the winding. Give the expression for the self-inductance of the toroid in terms of the given quantities.

(h) Two current carrying loops have self inductances L_1 and L_2. Assuming ideal coupling between the loops, what is the mutual inductance between the loops?

(i) A uniform magnetic field is oriented along X-axis. A coil is made to rotate at a constant speed in this field. What should be the axis of rotation of the coil for the induced e.m.f. in the coil to be maximum and why?

(j) Find the ratio of the amplitudes of conduction current density and displacement current density for the applied field $E = E_{max} Cos\ \omega t$ V/m.

PART – B

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

UNIT – I

2 A spherical volume charge density distribution is given by $\rho = \rho_0 \left(1 - \frac{r^2}{a^2}\right);\ (r \le a)$ and $\rho = 0\ (r > a)$.

(i) Calculate the total charge Q.

(ii) Find the electric field intensity E outside the charge distribution.

(iii) Find the electric field intensity inside.

(iv) Show that the maximum value of E is at $r = 0.745\ a$.

OR

3 (a) Two point charges Q_1 and Q_2 of $+2C$ each are situated at $(-2, 0, 0)m$ and $(+2, 0, 0)m$. At what distance from the point $P(0, 2, 0)\ m$ should a charge of $-1C$ be placed on the Y-axis so that the potential at P would be zero?

(b) The radii of two concentric spheres differ by 4 cm. The capacity of the spherical condenser is $53.33\ pF$. If the outer sphere is earthed, what are the radii of the spheres? Assume air as the dielectric.

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UNIT – II

4 (a) Derive the point form of Ohm's law.

(b) Two parallel conducting plates 3 cm apart and situated in air are connected to a source of constant potential difference of 72 kV. (i) Find the electric field intensity between the plates. Comment on the result given that the dielectric strength of air is 30 kV/cm. (ii) If a mica sheet ($\epsilon_r = 4$)of thickness 1 cm is introduced between the plates, what are the field intensities in air and mica. Comment on the result given that the dielectric strength of mica is 1000 kV/cm.

OR

5 (a) Distinguish between conductors and dielectrics. Give two examples each, of materials commonly used as conductors and dielectrics.

(b) Derive the continuity equation. What is its physical significance?

UNIT – III

6 (a) State and explain Biot-Savart's law.

(b) Develop an expression for the magnetic field at any point on the line through the centre, at a distance h from the centre and perpendicular to the plane of a circular loop of radius a, carrying current I.

OR

7 (a) State and explain Ampere's circuital law.

(b) Derive an expression for the force between two current carrying wires.

UNIT – IV

8 (a) What is 'Vector Magnetic Potential'? Derive Vector Poisson's equations.

(b) If the vector magnetic potential is given by $= 5(x^2 + y^2 + z^2)\boldsymbol{a}_x$, find the magnetic flux density.

OR

9 (a) Derive the expressions for energy stored and energy density in a magnetic field.

(b) Evaluate the inductance of a solenoid of 2500 turns wound uniformly over a length of 0.5 m on a cylindrical paper tube, 4 cm in diameter. The medium is air.

UNIT – V

10 (a) State and prove Poynting theorem.

(b) A plane transverse electromagnetic wave has a power density of 1.2 W/m^2 in a medium with $\varepsilon_r = 3$ and $\mu_r = 1$. Find the amplitudes of electric and magnetic field intensities.

OR

11 (a) Starting from Ampere's circuital law for time invariant fields, develop Maxwell's equation for time varying fields. What is the modification proposed by Maxwell for time varying fields?

(b) The electric field intensity associated with a plane wave travelling in a perfect dielectric medium is given by : $E_x(z,t) = 10\ cos(2\pi \times 10^{-7}t - 0.1\pi z)V/m$.
Determine: (i) The wavelength. (ii) Velocity of propagation of the wave. (iii) Relative permittivity of the medium. (iv) Intrinsic impedance. (v) The expression for magnetic field intensity associated with the wave. Take $\mu = \mu_0$.

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