Code: 9A02404

1

B.Tech II Year II Semester (R09) Regular & Supplementary Examinations, April/May 2013

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 An infinitely large cylinder has a radius and a uniform charge of one micro coulomb per meter. Calculate the potential at a point 10 m away from the cylinder if zero potential point is taken to be at a radial distance of 1m.

2 (a) Explain: (i) Dipole and (ii) Dipole moment.

(b) Find electric potential due to electric dipole.

3 A parallel plate capacitor consists of two square metal plates with 500 mm side and separated by 10 mm. A slab of sulphur (ε_r = 4) 6 mm thick is placed on the lower plate and air gap of 4 mm. Find capacitance of capacitor.

4 (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 plane circular loop of radius 'a' and carrying current 'I' amperes.

5 A steady current of 1000 A is established in a long straight hollow aluminum conductor of inner radius 1 cm and outer radius 2 cm assume uniform resistivity and calculate B as a function of radius r from the axis of the conductor and also derive the formula used.

6 (a) Derive the expression for the magnetic moment of a planar coil.

(b) A magnetic field B = 3.5 x 10^{-2} a_z wb/m^2 exerts a force on a 0.3 m conductor along the x-axis. If the conductor current is 5 A in the -a_z direction what force must be applied to hold the conductor in position. Also derive the formula used.

7 (a) Determine the self inductance of a coaxial cable of inner radius a and outer radius b.

(b) A coaxial cable consists of an inner conductor of radius 1.2 cm and an outer conductor of radius 1.8 cm the two conductors are separated by an insulating medium(μ_r = 4μ_o). If the cable is 3 m long and carries 25 mA current, calculate the energy stored in the medium.

8 Write Maxwell's equations in good conductors for time varying fields and static fields both in differential and integral form.

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1 (a) State and prove Gauss's law in integral form, considering static charges in free space.

(b) $\nabla V = xa_x + ya_y + za_z$. If (2, 2, 2) m is at zero volts, find the potential V(x, y, z).

2 (a) Derive Laplace and Poisson's equation.

(b) Derive the expression for potential and field between two co-axial cylinders.

3 (a) What are boundary conditions for potential?

(b) Derive the boundary conditions for a current density at a conductor boundary.

4 A single phase circuit comprises of two parallel conductors A and B, 1cm radius and 1m apart. The conductors carry + 10 A and – 10 A respectively. Determine the magnetic field intensity at the surface of each conductor and also in the space exactly mid way between A and B. Establish the relations used.

5 (a) Using the amperes circuital law find the magnetic field intensity due to an infinite current sheet of current density J and hence prove that magnetic field intensity at any point in between two infinite surface current sheets carrying current in opposite direction is equal to the sheet current density of each sheet .

(b) Using amperes circuital law, find H and B inside a long straight non magnetic conductor of radius 8 mm carrying a current density of 50 kA/m^2.

6 (a) Device the expression for force on a straight current carrying conductor placed in a magnetic field.

(b) If a point charge of 3 coulombs moves with a velocity of $7a_x + 4a_y – 6a_z$ m/s, find the force exerted (i) if the electric field intensity is $12a_x + 7a_y – 6a_z$ V/m (ii) if the flux density is $6a_x + 5a_y + 7a_z$ wb/m^2.

7 (a) The vector magnetic potential A due to a direct current in a conductor in free space is given by $A = (x^2 + y^2)\, a_z$ micro wb/m^2. Determine the magnetic field produced by the current element at (1, 2, 3).

(b) What is the inductance of a pair of transmission lines separated by 2 m in air and the diameter of each wire is 5 cm the line is 15 m in length?

8 (a) State Poynting's theorem. What is pointing vector?

(b) A copper wire carries a current of 1 A. Determine the displacement current in the wire at 1 MHz. for copper $\epsilon = \epsilon_0$ and $\sigma = 5.8 \times 10^7$.

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3

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1 (a) Explain Gauss's law with example.

(b) Using gauss law find E at any point due to long infinite charge wire.

2 A square cube of a dielectric side dimensions D is centered on the right of a rectangular coordinate system with its sides parallel to the x, y, z coordinate axes. The polarization vector within the dielectric is given by $\mathrm{P} = P_o(xa_x + ya_y + za_z)$. Determine the surface and the volume charge densities and show the total bound charge is zero.

3 Explain the phenomenon of polarization when a dielectric slab is subjected to an electric field with neat diagrams.

4 (a) Derive Biot-Savart law and relate it to amperes law. Show that the divergence magnetic induction is always zero.

(b) If H = $x^2ya_x + 0.1xa_z$ A/m, find the current density.

5 (a) Find the magnetic field intensity due to a hollow conductor of radius R_1 and outer radius R_2.

(b) Derive the boundary conditions at the magnetic interfaces and show that $tan\, {}^{\theta_1}/_{\theta_2} = {}^{\mu r_1}/_{\mu r_2}$.

6 (a) 'A current carrying conductor kept in magnetic field experience a force' justify the statement.

(b) A cylindrical conducting shell of radius ρ = 4 mm and negligible thickness forms the inner conductor of a co-axial line. The outer conductor is a co-axial conducting cylinder of 20 mm radius and negligible thickness. The cylinders carry equal and opposite total currents of 100 A. What is the magnitude of force per unit length acting to split the outer cylinder apart longitudinally?

7 (a) Explain scalar magnetic potential and its limitations.

(b) Compute energy density in free space on account of field having H = 1000 A/mt.

8 (a) Show that in a capacitor the conduction current and displacement current are equal.

(b) A capacitor has a capacitance of 1.5 pF. Find the displacement current at t = 0, if a voltage 5 sin 100(πt) is applied to it.

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4

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1 (a) Define rectangular co-ordinate system.

(b) Electric potential in an electric field is given by v(x, y, z) = $-3x^2yz$. Compute the electric field intensity as a function of x, y and z coordinates. Derive the formula used.

2 Find the magnetic dipole movement of an electron in a circular orbit of radius a normal to the uniform magnetic field of flux density of B_0. Compute its value for a = 10^{-3} m and $B_0 = 5\times10^{-5}\, wb/m^2$.

3 (a) Derive the conditions at a boundary between two dielectrics.

(b) Define capacitance. Obtain the expression for capacitance of concentric spheres.

4 A current filament of 10 A in the + y direction lies along the y-axis, at a current sheet k = 2.0 a_x A/m, is located at z = 4 m. Determine H at the point (2, 2, 2) m.

5 (a) Find the magnetic field intensity H due to a solenoid carrying current I and having length L = 4 m.

(b) Write down Maxwell's second and third equation in point and integral form. Also state the basic laws from which these two equations were derived.

6 (a) Justify the statement 'most of the electrical machines are working on electro-magnetic principles rather than the electrostatic principles'.

(b) A galvanometer has a rectangular coil side of 10 mm × 30 mm pivoted about the center of shorter side. It is mounted in a radial magnetic field so that a constant magnetic field of 0.4 T always acts across the plane of the coil. If the coil has 1000 turns and carries current 2 mA, find the torque exerted on it.

7 (a) Explain the difference between self inductance and mutual inductance.

(b) Calculate the inductance of a solenoid of 200 turns wound tightly on a cylindrical tube of length 60 cm and of diameter 6 cm given that the medium is air. Derive the formula used.

8 Assuming Maxwell's equations show that the quantity given by the expression $\oint(\overline{E}\, X\, \overline{H})\overline{ds}$ is equal to the total power flowing out the volume enclosed by the closed surface surrounding the volume.

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