Code: 9A02404

II B. Tech II Semester (R09) Regular & Supplementary Examinations, April/May 2012

ELECTROMAGNETIC FIELDS

(Electrical & Electronics Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions
All questions carry equal marks
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1 (a) Derive the expression for electric potential due to a dipole.
(b) Show that the family of equipotential for a dipole may be given by $r^2 = d_1 \cos\theta$. Further show that $r = d_2 \sin^2\theta$ represents the line of force of the dipole, where d_1 and d_2 are constants.

2 (a) State and explain Gauss's law.
(b) Derive an expression for potential difference between two co-axial cylindrical conductors of radii 'a' and 'b' (b > a), if the outer surface of the inner cylinder is charged with $Q_8 c/m^2$.

3 (a) Derive the conditions at a boundary between two dielectrics.
(b) State Ohm's law in paint form.

4 A single-phase circuit comprises two parallel conductors A and B, each 1 cm diameter and spaced 1 m apart. The conductors carry current of +100 and -100 Amps. Respectively. Determine the filed intensity at the surface of each conductor and also in space exactly midway between A and B.

5 (a) State and prove Amperes circuital law.
(b) Apply the Amperes circuital law to determine the magnetic field inside and outside a straight solid cylindrical conductor of radius 'a'. The conductor carries a current of I amperes. Sketch the fields.

6 (a) Derive an expression for the force on a differential current element placed in a magnetic field.
(b) Calculate the force on a straight conductor of length 30 cm carrying a current of 5 A in $\mathbf{a_z}$ direction and the magnetic field $\mathbf{B} = 3.5 \times 10^{-3} (\mathbf{a_x} - \mathbf{a_y})$ Tesla where $\mathbf{a_x}$ and $\mathbf{a_y}$ are unit vectors.

7 (a) Prove that in case of two mutually coupled coils $M = K\sqrt{L_1 L_2}$.
(b) A toriod is made up of closed ring wound with 300 turns of insulated copper wire. The cross sectional area of the ring is 5 sq.cm. the mean radius of the ring is 10 cm. relative permeability of iron is 1000. Find self inductance and derive the formula used.

8 Write down the Maxwell's equation in their general integral form. Derive the corresponding equations for fields varying harmonically with time.

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1 (a) State and explain Gauss's law as applied to electrostatic fields in differential form.
(b) Three equal positive charges of Q C each are located at three corners of a square, side 'a' meter. Determine the magnitude and direction of the resulted force experienced by a test charge if placed at the vacant corner of the square.

2 A regular tetrahedron has vertices at P_1 (2, 0, 0), P_2 (-1, $\sqrt{3}$, 0), P_3 (-1, -$\sqrt{3}$, 0) and P_4 (0,0, $2\sqrt{2}$). Charges of 1 mC are located at each of four vertices. If the configuration is located in free space (a) Find the magnitude of force on each charge (b) the angle between any two edges of tetrahedron.

3 A point change of 6 C is located at the origin, a uniform line change density of 180 nc/m lies along the x-axis and a uniform sheet of change equals to 25 nc/m^2 lies in the z = 0 plane. (a) Find $\overline{D}$ at A (0, 0, 4) ; (b) Find $\overline{D}$ at B (1, 2, 4) ; (c) Calculate the total electric flux leaving the surface of a sphere of 4 m radius centered at the origin.

4 (a) Sate and explain Biot-savarts law. Mention the units of the quantities used in the law.
(b) Find the magnetic field intensity at the origin due to a current element $50x10^{-6}U_z$ A-m at the point (4, -7, 0) in free space.

5 (a) Explain the physical significance of a curl.
(b) Discuss Stokes theorem show how Amperes circuital law may be obtained from curl **H** = **J** using stokes law.

6 (a) Obtain the expression for the force experienced by two current carrying conductors. What is the direction of force when they are carrying current in similar direction and opposite direction?
(b) A long linear conductor is coincident with z-axis carries 10 A current. The current flows in a_z direction. If B= ($3a_x$ + $4a_y$) T. find the force per unit length of conductor.

7 A straight long wire is situated parallel to one side of a square coil. Each side of the coil has a length of 5 cm. the distance between straight wire and the centre of the coil is 10 cm. find the mutual inductance of the system. Derive the formula used.

8 (a) State Maxwell's equation in point form, integral form and in words.
(b) If σ = 0 ,ϵ = 2.5 ϵ_o, μ = μ_o determine whether or not the following pair of fields satisfy the Maxwell's equation: **E**=100 sin ($6x10^7$t) sin z $\mathbf{a}_y$, **H** = - 0.1328 cos ($6x10^7$t) cos z $\mathbf{a}_x$

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ELECTROMAGNETIC FIELDS

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1 (a) Determine the inductance of a solenoid carrying N turns on a magnetic core of axial length l meter and cross sectional area of A m^2.

(b) A solenoid of 10 cm in length consists of 1000 turns having the cross section radius of 1 cm. find the inductance of the solenoid. What is the value of current required to maintain a flux of 1 mWb in solenoid. Take μ_r = 1500.

2 (a) Starting from faradays law of electromagnetic induction derive $\nabla x E = -\frac{\partial B}{\partial t}$

(b) A conductor carries a steady current of I amperes. The components of current density vector J are $J_x = 2a_x$ and $J_y = 2a_y$. Find the third component J_z. derive any relation employed.

3 Evaluate both sides of Stoke's theorem for the field $\overline{H} = \frac{y^2 z}{x} a_x + \frac{0.5 y^2 z^2}{x^2} a_z$ A/m and find the current in ay direction crossing the square surface in the plane y = 2 bounded by x = z = 1 and x = z = 2.

4 (a) Define a magnetic dipole and explain how a differential current loop can act as a magnetic dipole.

(b) The rectangular coil shown in figure 3 is in a field $B = 0.05\left(\frac{\overline{a_x} + \overline{a_y}}{\sqrt{2}}\right)$ T .find the torque about z-axis when the coil is in the position shown and carries current of 5 A.

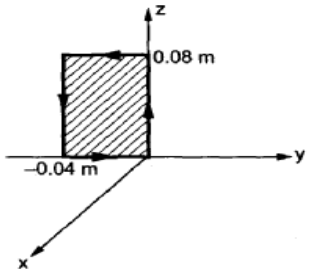

Fig. 3

5 (a) State and prove the conditions at the boundary between two dielectrics.
(b) Determine the resistance of a insulation in length 'L' of co-axial cable as inner and outer radii are 'a' and 'b' respectively

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6 (a) State and explain Coulomb's law indicating clearly the units of quantities in the equation of force.
(b) Calculate the force on a unit positive charge at P(x=2m, y=0) due to the charges Q1 at origin and Q2 at (x=1m, y=0) where Q1 = 1000 pico coulombs Q2 = -2000 pico coulombs.

7 (a) Explain the concept of electric dipole.
(b) Obtain an expression for torque on an electric dipole placed in a uniform electric field.
(c) What is polarization?

8 (a) Derive the boundary conditions at the magnetic interfaces and show that $\tan \theta_1/\theta_2 = \mu_{r1}/\mu_{r2}$.
(b) Write Maxwell's first law and second law with examples.

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Time: 3 hours Max Marks: 70

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1 (a) State and explain Coulomb's law of electrostatic field in vector form.
(b) It is required to hold four equal point charges to each in equilibrium at the corners of a square. Find the point charge, which will do this if placed at the center of the square.

2 (a) A co axial cable with inner and outer conductor radii 'a' and 'b' respectively have the respective voltage V_a and V_b by using laplaces equation, find E at all points.
(b) The construction of a paper capacitor is as follows: Aluminum foil of 100−cm^2 area is placed on both sides of paper of thickness 0.03 mm. If the dielectric constant of paper is given as 3, and its dielectric breakdown strength is 200 kV/cm, what is the rating of the capacitor.

3 A capacitor is composed of two plates separated by a sheet of insulating material 5 mm thick and ε_r = 6. The distance between the plates is increased to allow the insertion of second sheet 8 mm thick and of relative permeability ε_r. If the capacitance of the capacitor so formed is one-half of the original capacitance. Determine the value of ε_r.

4 A current filament carrying 15 A in the a_z direction lies along the entire z –axis. Find H in a rectangular coordinates at (a) $P_a(5,0,4)$ and (b) $P_b(2,-4,4)$.

5 (a) State Amperes law and hence derive the corresponding Maxwell's equation in differential form.
(b) A 'z' directed current distribution is given by **J =** (ρ^2+uρ) for $\rho \le a$. Find **B** at any point $\rho \le$ a using Amperes circuital law.

6 (a) A galvanometer has a rectangular coil suspended in a radial magnetic field so that the magnetic field always acts across the plane of the coil. If the coil is 10 mm by 10 mm side and has the 1000 turns and if the magnet provides a constant flux density of 0.3 tesla, find the torque entered on the coil for a current of 10 mA.
(b) Derive an expression for torque on a closed current loop placed in a magnetic field.

7 Prove that the internal inductance of a non-magnetic cylindrical wire of radius 'a' carrying a uniformly distributed current I is μ0/8 π Henries per mt.

8 (a) Starting form first principle derive Maxwell's equation using Faraday's law and show that div B=0.
(b) For a lossy dielectric σ = 5 S/m and ϵ_r = 1. the electric field intensity is E = 100 sin 10^{10}t. Find J_C, J_D and frequency at which both have equal magnitudes.

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