Code No: R059210204 **Set No. 1**

II B.Tech I Semester Regular Examinations, November 2006
ELECTROMAGNETIC FIELDS
(Common to Electrical & Electronic Engineering and Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define the term: "potential difference V(A) - V(B) between points A and B in a static electric field. Give an energy interpretation to the potential difference.
   (b) What are the equipotential surfaces for an infinite straight line of uniform linear charge density? Explain.
   (c) Potential for a certain region is given by $V(x, y, z) = \frac{300}{x} + \sin 0.1y + \log_e xy$ volts; where x and y are in meters. Find the electric field at the point P: (x = 1 m, y = 0.6 m, z = 0). [4+6+6]

2. (a) For a pure dipole pa_z C- m at the origin in free space, find the potential at a point A $\left(rm, \theta, \phi = \frac{\pi}{2}\right)$.
   (b) Use the result of (a) to find the electric field at the point A. (∇V in spherical co ordinates $\frac{\partial v}{\partial r}\, a_r + \frac{1}{r}\frac{\partial v}{\partial \theta} a_\theta + \frac{1}{r \sin\theta}\frac{\partial v}{\partial \phi} a_\phi$).
   (c) What is the electric field at (x=0, y=0, z=5m) due to a pure dipole $1a_z$ μc-m at the origin? [4+6+6]

3. For linear dielectric, show that D $\overline{E}_{total} = \overline{E}_{ext/\in_r}$, , where $\in_r$ is the relative permittivity of the dielectric. E total is the toral electric field, and Eext is the electic field due to charges other than bound charges. [16]

4. (a) State Biot-Savarat's law for the magnetic field $\overline{B}$ due to a steady line current element in free space.
   (b) A solenoid of radius Rm, and N closely wound turns per meter, is in free space with its axis along the (figure 4)Z-axis from the origin to Z =1m. The solenoid is carrying a steady current IA. Find the magnetic field $\overline{B}$ at the origin
   (Hint: In figure, magnetic field $\overline{B}$ and $P = \frac{\mu_0 I r^2}{2(r^2+z^2)^{3/2}} a_z T$). [4+12]

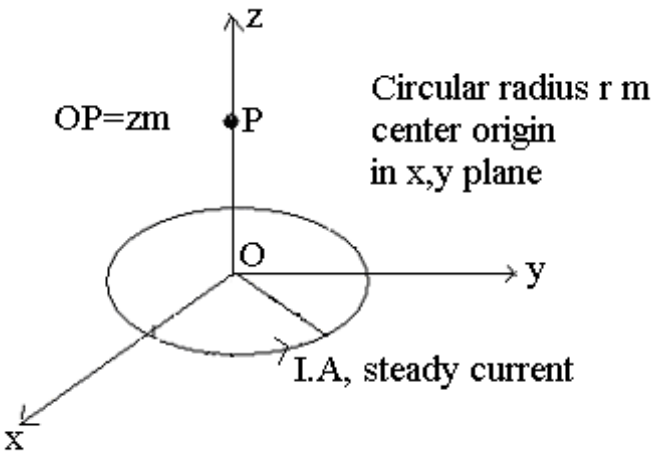

Figure 4

5. (a) How Amperes current law differs from Biot - Savart Law.
   (b) Evaluate the closed line integral of H from (5,4,1) to (5,6,1) to (0,6,1) to (0,4,1) to (5,4,1) using straight line segments, if H= $0.1y^3$ a_x + 0.4_x a_z A/m. [6+10]

6. (a) Justify the statement 'Most of the electrical machines are working on electromagnetic 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. [8+8]

7. (a) Obtain the expression for inductance of a toroid.
   (b) A solenoid of 10 cm in length consists of 1000 turns having the cross section radius of 1 cm. Find the inductance of solenoid. What is the value of current required to maintain a flux of 1 mWb in the toroid. Take $\mu_r = 1500$. [8+8]

8. (a) In a region defined by $\sigma = 10^6$ Siemens/ m and $\varepsilon_r = 4$, at certain frequency the ratio of conduction and displacement current density is unity. Find frequency
   (b) Find the value of K in the following pair of fields in free space, such that they satisfy Maxwell's equation. D = 5xa_x - 2ya_y + Kz a_z mC/m^2 and B = 2 a_y mT. [8+8]

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Code No: R059210204 **Set No. 2**

II B.Tech I Semester Regular Examinations, November 2006
ELECTROMAGNETIC FIELDS
(Common to Electrical & Electronic Engineering and Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) State and explain Coulomb's law for the vector force between two point charges in free space.
   (b) Figure shows two charges at points figure 1 A and B in free space. Find the electric field at point P. Is the result consistent with what may be expected if d>>s?
   (c) Find the flux of the electric field through a spherical surface of radius 5m and center origin, in free space, If there is a charge of $10\mu c$ at the point (0, 0,3m). What are its units? [4+6+6]

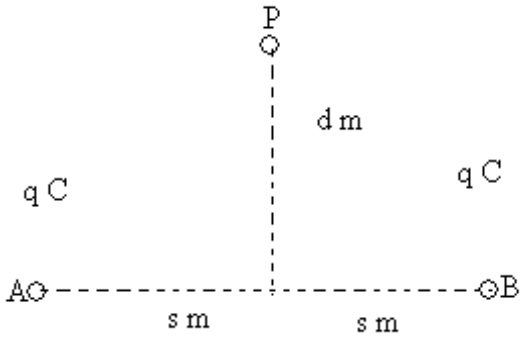

Figure 1

2. (a) For a conducting body in a static electric field of static charges, explain what will be the
      i. net electric field inside the conductor, and
      ii. Volume charge density at any point inside the conductor.
   (b) Derive the expression for the energy stored in a capacitor.
   (c) A parallel plate capacitor with a large plate area is situated in air. With a potential difference of 100 V between the plates, the stored energy 44.21 μ Joule. Per unit area. Find the distance of separation between the plates. [6+4+6]

3. (a) Define polarization. Explain how a dielectric acquires polarization.
   (b) A long straight line of uniform charge density $\lambda c/m$ is surrounded by an insulating medium out to a radius Rm. Find $\overline{D}$: Also find the electric field in the region outside the insulation. Explain why the electric field cannot be found in the insulation region. [8+8]

4. (a) State Biot-Savart's law for the field $\overline{B}$ due to a steady line current in free space.

   (b) Find the magnetic field $\overline{B}$ at the center of the axis of a Solenoid of radius Rm, axial length l m, and (figure 4) N turns per meter closely wound, which is carrying a steady current 1A.
   (Hint: In figure, magnetic field $\overline{B}$ at $P = \frac{\mu_0 I r^2}{2(r^2+z^2)^{3/2}} a_z T$). [4+12]

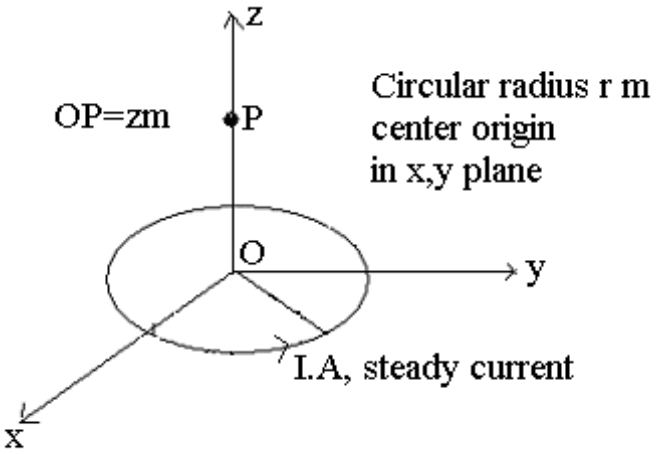

Figure 4

5. A steady current of 10 A is established in a long straight hollow aluminum conductor having inner and outer radius of 1.5 cm and 3 cm respectively. Find the value of B as function of radius. Also define the law used. [16]

6. (a) What is Ampere's force law? Derive the expression.

   (b) Two long parallel wires separated 2 meters apart carry currents of 50 A and 100 A respectively in the same direction. Determine the magnitude and direction of the force between them per unit length. [10+6]

7. (a) Explain the self and mutual inductance. Obtain the expression for same.

   (b) A coil of 1 mH is magnetically coupled to another coil of 500 μH. The coefficient of coupling between two coils is 0.015. Calculate the inductance, if these two coils are connected in series addition and series opposition. [10+6]

8. (a) Explain the nature of current flowing through the capacitor.

   (b) Find J_D in a typical metallic conductor at 60 Hz where $\sigma = 5 * 10^7$ Siemens/m, $\varepsilon = \varepsilon_o$ and J = 10^6sin [117.193.22t - z)]a_x A/m^2. [6+10]

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Code No: R059210204 **Set No. 3**

II B.Tech I Semester Regular Examinations, November 2006
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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) State and explain Coulomb's law for the vector force between two point charges in free space.
   (b) Figure shows two charges at points figure 1 A and B in free space. Find the electric field at point P. Is the result consistent with what may be expected if d>>s?
   (c) Find the flux of the electric field through a spherical surface of radius 5m and center origin, in free space, If there is a charge of $10\mu c$ at the point (0, 0,3m). What are its units? [4+6+6]

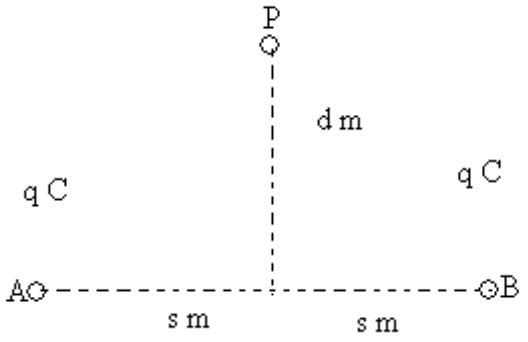

Figure 1

2. (a) i. Define capacitance. Express its units in 2 different ways.
   ii. As per the usual definition, show that a capacitance is always positive.
   iii. Sometimes, capacitance of a single conductor is referred to what does this mean?
   (b) i. Two large parallel conducting plates are separated by a distance dm in air. Find the capacitance per unit area.
   ii. A conducting sheet of thickness sm(s<d) is now introduced between the plates, parallel to them but not touching them. Find the new capacitance per unit area between the outer plates. [6+4+6]

3. (a) Define polarization. Explain how a dielectric acquires polarization.
   (b) A long straight line of uniform charge density $\lambda c/m$ is surrounded by an insulating medium out to a radius Rm. Find $\overline{D}$: Also find the electric field in the region outside the insulation. Explain why the electric field cannot be found in the insulation region. [8+8]

4. (a) i. A steady current element $10^{-}3$ a_zA-m is located at the origin in free space. What is the magnetic field $\overline{B}$ due to this element at the point (0,1m,0) (in rectangular coordinates)
   ii. Where should a point be located for the magnetic field due to this element to be 0?

   (b) A straight length of steady current I A extends from the origin to Z = ℓ m along the Z-axis. Find the magnetic field $\overline{B}$ at a distance of y m from the origin along the y-axis. [6+10]

5. (a) What are the limitations of Amperes current law? How this law can be modified to time varying field.

   (b) A circular loop located on $x^2 + y^2 = 9$, z = 0 carries a direct current of 10 A. along a_φ direction. Determine H at (0, 0, 5) and (0, 0, -5). [8+8]

6. (a) Prove that the force on a closed filamentary circuit in a uniform magnetic field is zero

   (b) If the magnetic field is H = $(0.01/\mu_0)$ a_x A/m, what is a force on a charge of 1 pC moving with a velocity of 10^6 a_y m/s . [8+8]

7. (a) What is vector magnetic potential? What are its properties? How vector magnetic potential and flux density are related?

   (b) A current sheet K = $40a_z$ A/m is located in free space at x = 0.25 m and a second sheet K = $-40a_z$ A/m is at x = -0.25 m, let vector magnetic potential may be zero at P (0.1, 0.2, 0.3), find vector magnetic potential in Cartesian co-ordinates for -0.25< x, y, z < 0.25. [8+8]

8. (a) Explain why conduction current is absent through the capacitor.

   (b) Find the displacement current within a parallel plate capacitor where $\varepsilon = 100\ \varepsilon_o$, A = 0.1 m^2, d= 0.05mm and the capacitor voltage is 100 sin 2000π t Volts. [6+10]

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Code No: R059210204 **Set No. 4**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) State and prove Gauss's law in integral form, considering static charges in free space.
   (b) Given that $\overline{E}(r,\phi,z) = \frac{1}{\varepsilon 0}\left(2r\cos\phi a_\phi - \frac{1}{3r}\sin\phi a_z\right)$ N/C (in cylindrical co ordinates), find the flux of $\overline{E}$ crossing the portion of the z = 0 plane defined by $r \le a$, $0 \le \phi \le \pi/2$ in the + ve z -direction.
   (c) $\nabla V = xa_x + ya_y + za_z$.If (1,1,1)m is at zero volts, find the potential V(x,y,z). [6+6+4]

2. (a) For a conducting body in a static electric field of static charges, explain what will be the
      i. net electric field inside the conductor, and
      ii. the net volume charge density at any point inside the conductor.
   (b) Define capacitance and explain why it is always a positive quantity.
   (c) Obtain the capacitance of an isolated conducting sphere of rad 1 cm.[6+4+6]

3. (a) The potential at a point in free space due to a volume of dielectric with a polarization $\overline{P}(x,y,z)\, c/m^2$ is given by $(A) = \int\limits_{volume\, of\, dielectric} \frac{\overline{P} dT.a_n}{4\pi E_0}$ v where the terms in the integral are shown in figure 3. (Reference point for the potential is assumed to be at infinity) Obtain the expressions for bound surface charge density and bound volume charge density from the integral given.
   (b) A dielectric spherical shell, with center origin, negligible thickness, and radius 50 cm has a permanent polarization of $3a_r$ n C/m^2 on its surface (spherical co ordinates used). Find the potential at the surface, with reference of infinity. [8+8]

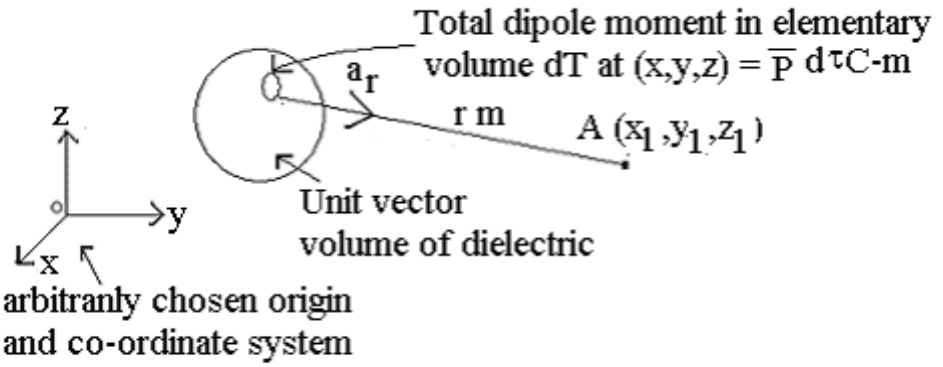

Figure 3

4. (a) Starting from Biot ? Savart's law, obtain the expression for the magnetic field $\overline{B}$ due to a steady surface current in free space.
   (b) Find $\overline{B}$ due to a straight length of ℓ m of steady current I A at a distance of y m from the center of the line current. [6+10]

5. (a) State and explain Amperes circuital current law.
   (b) Given J = 10^3 sin θ a_r A/m^2, find the current passing through spherical shell of r = 0.2 m. [6+10]

6. (a) Prove that the force on a closed filamentary circuit in a uniform magnetic field is zero
   (b) If the magnetic field is H = $(0.01/\mu_0)$ a_x A/m, what is a force on a charge of 1 pC moving with a velocity of 10^6 a_y m/s . [8+8]

7. (a) Explain the Laplace's & Poisson's' equations for steady magnetic field.
   (b) A current sheet K = 2.4 a_z A/m is present at the surface $\rho = 1.2$ in free space. Find H for $\rho > 1.2$. Find scalar magnetic potential at (1.5, 0.6π, 1), if scalar magnetic potential is zero at $\varphi = 0$ and barrier is at $\varphi = \pi$. [8+8]

8. (a) In free space E=E_m sin (ωt - βz) a_x V/m, from Maxwell's equation, find H.
   (b) The circular loop conductor having a radius of 0.15 m is placed in X-Y plane. This loop consists of a resistance of 25 Ohms. If the magnitude of flux density is B = 0.5 sin 10^3 t a_z Tesla, find the current flowing through the loop. [8+8]

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