Code No: R21029 **R10** SET - 1

II B. Tech I Semester Regular Examinations, March – 2014
ELECTROMAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) State and explain Coulomb's law.
   b) Derive an expression for electric field intensity at a distance 'h' along the Z-axis due to an infinite sheet of charge placed in the Z=0 plane. (7M+8M)

2. a) For a physical dipole in the z-direction, located at the origin in free space, find the potential at a point $(r, \theta, \varphi = \frac{\pi}{2})$ (in spherical co ordinates).
   b) Discuss about the behavior of conductors in an electric field. (7M+8M)

3. a) Establish the electrostatic boundary conditions for the tangential components of electric field and electric displacement at the boundary of two linear dielectrics.
   b) Derive an expression for capacitance between two concentric spherical shells. (7M+8M)

4. a) A filamentary current of 15A is directed in from infinity to the origin on the positive x axis, and then back out to infinity along the position y axis. Use the Biot-Savarts law to find $\overline{H}$ at P (0, 0, 1)?
   b) Derive the expression for magnetic flux density at a point due to an infinitely long current carrying conductor. (7M+8M)

5. a) State and explain Amperes current law and derive the same in point differential form.
   b) A circular loop located on $x^2 + y^2 = 9$, z = 0 carries a direct current of 19 A along a_φ direction. Determine H at (0, 0, 6) and (0, 0, -6). (7M+8M)

6. a) State and explain Lorentz's force equation?
   b) Filamentary currents of -25 a_z and 25 a_z Amp are located in the x = 0 plane in free space at y = -1 and y = 1 m respectively. A third filamentary current of 10^{-3} a_z A is located at x = k, y = 0. Find the vector force on a 1 m length of 1 mA filament. (7M+8M)

7. a) Derive the expression for energy density in a magnetic field.
   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 $\mu_r = 1500$. (7M+8M)

8. a) Starting from Faraday's law of electromagnetic induction, derive $\nabla \times E = -\frac{\partial \vec{B}}{\partial t}$.
   b) A parallel plate capacitor with plate area of $5cm^2$ and plate separation of 3mm has a voltage of 50 *sin* 10^3t V applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$. (7M+8M)
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Code No: R21029 **R10** SET - 2

II B. Tech I Semester Regular Examinations, March – 2014
ELECTROMAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
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1. a) State and prove Gauss law. What are its limitations?
   b) Derive an expression for electric field intensity at a distance h on the z-axis due to a line charge placed along the x-axis which is extending from negative infinity to positive infinity. (7M+8M)

2. a) Derive Poisson's and Laplace equations from fundamentals.
   b) Show that the torque on a physical dipole $\overline{P}$ in a uniform electric filed $\overline{E}$ is given by $\overline{P} \times \overline{E}$. Extend this result to a pure dipole. (7M+8M)

3. a) Using the concept of energy density in an electric field, find the total energy stored in a parallel plate system. Hence find its capacitance.
   b) Define and explain the conduction and the convection current densities. (7M+8M)

4. a) Derive the expression for magnetic field intensity at the center of a circular wire.
   b) Find the expression for the magnetic flux density, 'B' at a distance 'h' above the centre of a square loop of wire 'b' meters of each side. The loop carries a current of one ampere. (7M+8M)

5. a) Show that $\nabla \times \vec{H} = \vec{J}$.
   b) A square loop 8 cm on a side has 600 turns that are closely and tightly wound and carries a current of 100 A. Determine the magnetic flux density at the centre of the loop. (7M+8M)

6. a) Derive the expression for torque exerted on a current-carrying loop by a magnetic field.
   b) Find the maximum torque on an 85 turns, rectangular coil with dimension (0.2×0.3)m, carrying a current of 5 Amps in a field $B = 6.5T$. (7M+8M)

7. a) Obtain the expression for inductance of a toroid.
   b) A very long solenoid with 6 cm^2 cross section has an iron core $\mu_r = 1000$ and 400 turns/meter. If it carries a current of 500 mA, find: i) its self inductance per meter ii) the energy per meter stored in its field. (7M+8M)

8. a) Derive the expression for displacement current and explain its significance.
   b) Derive the Maxwell's equations in point and integral form for time varying fields? (7M+8M)
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Code No: R21029 **R10** SET - 3

II B. Tech I Semester Regular Examinations, March – 2014
ELECTROMAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Explain the terms i) Electric Potential ii) Electric Field Intensity
   b) Explain the properties of potential function.
   c) Derive an expression for the electric field intensity at an arbitrary point due to a system of point charges in a given space. (5M+5M+5M)

2. a) In spherical coordinates V=0 for r=0.1 and V=100 for r=2 m. Find the potential function. Use Laplace's equation.
   b) Determine the solution of Laplace's equation in one variable form. (7M+8M)

3. a) Derive the continuity equation in point form and explain it.
   b) Prove that the derivative of the energy stored in an electrostatic field with respect to volume is ½ D.E, where D and E are electric flux density and electric field intensity respectively. (7M+8M)

4. a) Show that the Maxwell's second equation $\nabla \bullet B = 0$.
   b) A circuit carrying a direct current of 10A forms a regular hexagon inscribed in a circle of radius of 1.5 m. Calculate the magnetic flux density at the centre of the hexagon. Assume the medium to be free space. (7M+8M)

5. a) What are the limitations of Amperes current law? How this law can be modified to time varying field.
   b) A current sheet $K_1 = \frac{8}{\mu_0}\vec{a}_y$ A/m, at x=0 separates region 1, x < 0 and μ_{r1}=3, from region 2, x > 0 and μr2=1. Given $H_1 = \frac{10}{\mu_0}(\vec{a}_y + \vec{a}_z)$ A/m. Find H_2. (7M+8M)

6. a) Two infinitely long parallel conductors are separated by a distance 'd'. Find the force per unit length exerted by one of the conductor on the other if the currents in the two conductors are I_1 and I_2.
   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. (7M+8M)

7. a) Derive the expression for inductance of a solenoid.
   b) Derive the expression for energy density in a magnetic field. (7M+8M)

8. a) State and explain Poynting theorem.
   b) Find the frequency at which conduction current density and displacement current density are equal in a medium with $\sigma = 2x10^{-4}$ mho/m and ϵ_R=81. (7M+8M)
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Code No: R21029 **R10** SET - 4

II B. Tech I Semester Regular Examinations, March – 2014
ELECTROMAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
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1. a) Prove that the electric field intensity is the negative gradient of potential.
   b) A very thin , finite, and uniformly charged line of length 10m carries a charge of 10 μC/m. Calculate the electric field intensity in a plane bisecting the line at ρ = 5 m. (7M+8M)

2. a) Show that the electric field intensity due to an electric dipole represents a conservative field.
   b) Let $V_1(r,\theta,\phi) = \frac{6}{r}$ and $V_2(r,\theta,\phi) = 3$. (i) State whether V_1 and V_2 satisfy Laplace's equation. (ii) Evaluate V_1 and V_2 at r=2. (7M+8M)

3. a) Derive Ohm's law in point form.
   b) A parallel plate capacitor consists of two square metal plates of side 600 mm and separated by a 12 mm slab of Teflon with ε_r = 3 and 5 mm thickness is placed on the lower plate leaving an air gap of 4mm thick between it and upper plate. If 200 V is applied across the capacitor, find D, E, and V in Teflon and air. (7M+8M)

4. a) State and explain Biot-Savart's law.
   b) A long solenoid has a radius of 3 mm and a length of 2 cm. If the number of turns per unit length is 400 and the current is 10 A, calculate the magnetic flux density at i) the Centre and ii) the ends of the solenoid. (7M+8M)

5. a) A current sheet $K_1 = 11\vec{a}_z$ A/m lies in the x=4 m plane and second sheet $K_2 = -7\vec{a}_z$ A/m is at x=-5m. Find $\overline{H}$ in all regions.
   b) Derive the expression for magnetic flux density at a point due to an infinitely long current carrying conductor. (7M+8M)

6. a) With the help of basic definitions, prove that T = m x B.
   b) Two infinitely long parallel filaments each carry 50A in the a_z direction. If the filaments lie in the plane y = 0 and x = 5 mm, find the vector force per meter length on the filament passing through the origin. (7M+8M)

7. a) Derive an expression for mutual inductance between a straight long wire and a square loop wire in the same plane.
   b) Obtain an expression for the self-inductance of a toroid of a circular cross-section, with N closely spaced turns. (7M+8M)

8. a) Show that power loss in a conductor is given as product of voltage and current using Poynting theorem.
   b) Explain the terms: i) Motional EMF ii) Static EMF (7M+8M)
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