Code No: R2021025 **R20** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, December-2023
ELECTRO MAGNETIC FIELDS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) Determine the electric field intensity due to infinite line charge, at a point perpendicular to its plane and at a given distance from the line charge from first principles. [7M]

b) Find the electric field at distance 'z' above the center of a flat circular disc of radius 'r', which carries a uniform surface charge. [7M]

Or

2 a) Define the potential difference and absolute potential. Give the relation between potential and field intensity. [7M]

b) A point charge of 3×10^{-3}C is located at $P_1(3, -2, -4)$m and a negative charge of 5×10^{-6}C is located at $P_2(1, -4, 3)$m. Find (i) vector force on negative charge (ii) Magnitude force on point P_1. [7M]

UNIT-II

3 a) Derive the boundary conditions of the normal and tangential components of electric field at the inter face of two media with different dielectrics. [7M]

b) Explain about Ohm's law in point form. [7M]

Or

4 a) Derive an expression for the capacitance of a parallel plate capacitor having two dielectric media. [7M]

b) An electric dipole located at the origin in free space has a moment $p = 3a_x - 2a_y + a_z$n C-m. Find V at : i) P(2,3,4) ii) r=2.5, θ=300 , φ=400 . [7M]

UNIT-III

5 a) State Ampere's circuital law and explain any two applications of Ampere's circuital law. [7M]

b) Derive the Maxwell's third equation and explain its importance. [7M]

Or

6 a) Write a shot notes on the following: [7M]
i. Lorentz force equation.
ii. Magnetic dipole and dipole moment.

b) A square loop 10 cm on a side has 500 turns that are closely and tightly wound and carries a current of 120 A. Determine the magnetic flux density at the centre of the loop. [7M]

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UNIT-IV

7 a) Derive an expression for force per meter length between two straight long parallel wires situated in space, separated by a distance 'd' m carrying a steady current of I amp. in the opposite direction. [7M]

b) An iron ring with a cross sectional area of 1.5 cm square and mean circumference of 20 cm is wound with 300 turns wire carrying a current of 0.5A. The relative permeability of ring is 3500. Calculate the flux established in the ring. [7M]

Or

8 a) Derive the expression for co-efficient of coupling in terms of mutual and self inductance. [7M]

b) A toroidal coil of 400 turns is wound on a steel ring of 20cm mean diameter and $2\times10^{-2}m^2$ cross-sectional area. An excitation of 8000 Am^{-1} produces a flux density of 2 tesla. Calculate the inductance of the coil. If a 15mm long gap is cut in the ring, calculate the current required to maintain the flux density at 2tesla. Also calculate the inductance under these new conditions. Neglect all leakage and fringing. [7M]

UNIT-V

9 a) Explain differential and integral forms of Maxwell's equation and also mention them for fields varying harmonically with time. [7M]

b) Explain poynting theorem and poynting vector with help of schematic diagrams. [7M]

Or

10 a) Preliminary from Faraday's law of electromagnetic induction, derive $\nabla \times E = -\frac{\partial B}{\partial t}$. [7M]

b) From $\vec{E} = E_m \sin(\omega t + \beta z) a_y$, find $\vec{D}$, $\vec{B}$, and $\vec{H}$ given in free space. [7M]

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UNIT-I

1 a) Derive the Relationship between electric field and electric potential. [7M]

b) Find the total charge Q with in the sphere of radius r=4 m if its volume charge density is $\rho_v = \frac{10}{rsin\theta} {}^{C}/_{m^3}$. [7M]

Or

2 a) Obtain the expression for electric field intensity and potential due to an electric dipole. [7M]

b) Derive the expression for the electric field intensity due to a line charge. [7M]

UNIT-II

3 a) State and derive the expression for Equation of continuity. [7M]

b) Derive the condition that exists of the boundary between two perfect dielectrics separated by a sharp boundary. [7M]

Or

4 a) Using Laplace equations, obtain the expression to the capacity of a parallel plate condenser. [7M]

b) A dielectric sphere of ε_r = 5.1 and of radius 10 cm has a point charge 2.2 μC placed at its centre. Calculate the surface density of polarization charge on the surface of the sphere. [7M]

UNIT-III

5 a) Derive the expressions for magnetic field intensity due to finite and infinite line. [7M]

b) A filamentary current of 25A is directed in from infinity to the origin on the positive x axis and then back out to infinity along the positive y axis. Use the Biot-Savart's law of find H at P (0, 0, 1). [7M]

Or

6 a) Derive the expressions for magnetic field intensity due to toroidal coil and circular coil. [7M]

b) Using Biot-Savart's law, find the magnetic field intensity on the axis of a circular loop with radius R and carrying a steady current I. [7M]

UNIT-IV

7 a) Drive the expression for mutual inductance between a straight long wire and a square loop wire in the same place. [7M]

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b) Find the mutual inductance between two toroidal windings which are closely wound on iron core of relative permeability 300. The mean radius of the core is 7cm and radius of its cross-section is 3cm. The winding has 400 and 600 turns for windings 1and 2 respectively. [7M]

Or

8 a) Derive the expression for energy density in a magnetic field. [7M]

b) Derive formula for self-inductance of a solenoid. Use this formula and find self inductance of a solenoid having 400 turns, mean diameter equal to 80 cm and length equal to 5 cm. Assume medium to be air. [7M]

UNIT-V

9 a) Derive the Maxwell's four equations for time varying fields. [7M]

b) In a material for which σ = 3.5 s/m and $\in_r$ = 1, the electric field intensity is E = 25 Sin125t (V/m). Find the conduction and displacement current densities, and the frequency at which they have equal magnitudes. [7M]

Or

10 a) Generalize Ampere's law for time varying fields. [7M]

b) Write Maxwell's equation for static fields and explain how they are modified for time varying electric and magnetic fields. [7M]

Code No: R2021025 **R20** SET - 3

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UNIT-I

1 a) Derive Laplace's and Poisson's equation. [7M]

b) Calculate the force on a unit positive charge at P(x=6m, y=0) due to the charges Q1 at origin and Q2 at (x=3m, y=0) where Q1 = 2500 Pico coulombs Q2 = -5200 Pico coulombs. [7M]

Or

2 a) State and explain Maxwell's first law. [7M]

b) A circular disc of 10 cm radius is charged uniformly with a total charge 10^{-10} C. Find the electric field at a point 30 cm away from the disc along the axis. [7M]

UNIT-II

3 a) Derive an expression for capacitance of concentric spheres. [7M]

b) Derive the expression for the energy stored in the charged condenser. [7M]

Or

4 a) Explain and derive the polarization of dielectric materials. [7M]

b) The capacitance of the conductor formed by the two parallel metal sheets, each 150cm^2, in area separated by a dielectric 5mm thick is, 3 micro farad, a potential of 50KV is applied to it. Find (i) Electric flux (ii) Potential gradient in kV/m (iii) The relative permittivity of materials (iv) Electric flux density. [7M]

UNIT-III

5 a) Derive the expression for torque developed in a rectangular closed circuit carrying current I Amp uniform field. [7M]

b) Derive the equation to show that curl of magnetic field intensity is equal to current density. [7M]

Or

6 a) Apply Biot-Savart's law to derive the expression for Magnetic Field Intensity due to circular loop placed on xy plane with radius 'r'. [7M]

b) In the region 0 < r < 0.5m, in cylindrical co-ordinates, the current density is $J = 3.5e^{-2r}\hat{a}_z(^A/_{m^2})$ and J = 0 elsewhere. Use Amperes law to find H. [7M]

UNIT-IV

7 a) Explain the concept self and mutual inductances. [7M]

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b) Two parallel current carrying conductors separated by a distance of 4m carries current of 10A and 15A in opposite directions. Find the force on each conductor. Find the field intensity at mid-point between the two conductors. [7M]

Or

8 a) Derive the expressions for the self inductances of a solenoid and a toroid. [7M]

b) Show that the force between two parallel conductors carrying current in the same direction is attractive. [7M]

UNIT-V

9 a) Write Maxwell's equations for time varying fields along with the statements. [7M]

b) Explain the concept of displacement current and obtain an expression for the displacement current density. [7M]

Or

10 a) State and explain Faraday's laws of electromagnetic induction with suitable examples. [7M]

b) Explain the following [7M]
(i) Conduction Current.
(ii) Displacement current.

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UNIT-I

1 a) Derive the expression for electric field intensity due to an infinite length of line charge using Gauss law. [7M]

b) Obtain the solution of Laplace equation in one variable and list out the limitations. [7M]

Or

2 a) Derive the potential due to (i) point charge (ii) volume charge [7M]

b) A uniform line charge L = 25 NC/m lies on the x = 3m and y = 4m in free space. Find the electric field intensity at a point (2,3,15)m. [7M]

UNIT-II

3 a) Derive the boundary conditions electric fields in conductors and free spaces. [7M]

b) Differentiate the convection current density and conduction current density. [7M]

Or

4 a) Derive the expression for energy stored in static energy filed. [7M]

b) A homogeneous dielectric (ε_r= 2.5) fills region 1(x<0) while region 2(x>0) is free space. If $\vec{D}_1 = 12a_x - 10a_y + 4a_z \ {}^{nC}/_{m^2}$, find $\vec{D}_2$. [7M]

UNIT-III

5 a) State Ampere's circuital law and explain any two applications of Ampere's Circuital law. [7M]

b) A charged particle has mass 3 kg and charge 4 C. it starts at point (1, -2, 0) with velocity ($6a_x + 5a_z$) m/s in an electric field $15a_x + 10a_y$ V/m. At time t = 1s, determine: [7M]
   i) The acceleration of the particle
   ii) Its velocity.

Or

6 a) Obtain the expression for magnetic field intensity due to infinite long straight carrying a steady current I. [7M]

b) Find the magnetic field intensity at the centre of square loop of side 5m carrying 10A of current. [7M]

UNIT-IV

7 a) Derive the expression for the force between two finite current carrying loops. [7M]

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b) A toroid with cross section of radius 1.5cm has a silicon steel core of mean length 30cm and an air gap of length 0.5mm. Assume the air-gap area is 10% greater than the adjacent core and find the mmf required to establish an air-gap flux of 2.75 mWb. [7M]

Or

8 a) Define Scalar Magnetic potential and explain with its limitations. [7M]

b) Derive the expression for energy stored and density in a magnetic field. [7M]

UNIT-V

9 a) State and explain Faraday's laws of electromagnetic induction with its integral and point forms. [7M]

b) A 40 cm × 30 cm loop rotates at 150 rad/s in a magnetic field 0.07 Wb/m^2 normal to the axis of rotation. If the loop has 80 turns, determine the induced voltage in the loop. [7M]

Or

10 a) State the Poynting Theorem and derive the necessary expressions. [7M]

b) Derive the expressions for statically and dynamically induced EMFs. [7M]