

Code No: 113BY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech II Year I Semester Examinations, November/December - 2017

ELECTROMAGNETIC FIELDS

(Electrical and Electronics Engineering)

Time: 3 Hours

Max. Marks: 75

Note: This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A.

Part B consists of 5 Units. Answer any one full question from each unit.

Each question carries 10 marks and may have a, b, c as sub questions.

PART- A**(25 Marks)**

- 1.a) What are the properties of potential function? [2]
- b) What are the limitations of Coulomb's law? [3]
- c) Define dipole and dipole moment. [2]
- d) What is the capacitance of a parallel plate capacitor when the stored energy is $5 \mu\text{J}$ and the voltage across the plates is 5 V ? [3]
- e) What are the limitations of Ampere's circuital law? [2]
- f) State Biot-Savart's law. [3]
- g) What is the significance of Lorentz force equation in magnetic fields? [2]
- h) A solenoid with air core has 2000 turns and a length of 500 mm. Core radius is 40 mm. Find its inductance. [3]
- i) Write the Maxwell's equations in integral form for time varying fields. [2]
- j) What is meant by statically induced e.m.f? [3]

PART-B**(50 Marks)**

- 2.a) Derive the expression for electric field intensity due to line charge.
- b) Four concentrated charges $Q_1 = 0.3 \mu\text{C}$, $Q_2 = 0.2 \mu\text{C}$, $Q_3 = -0.3 \mu\text{C}$, $Q_4 = 0.2 \mu\text{C}$ are located at the vertices of a plane rectangle. The length of rectangle is 5 cm and breadth of the rectangle is 2 cm. Find the magnitude and direction of resultant force on Q_1 . [5+5]

OR

- 3.a) Explain the Laplace and Poisson's equations for electrostatic fields.
- b) Using Gauss law, derive an expression for electric field intensity at any point inside and outside of a sphere of radius 'a' due to a uniform spherical charge distribution of volume charge density of ' ρ '. [5+5]
- 4.a) Derive the expression for energy stored and energy density in static electric field.
- b) A parallel plate capacitor consists of two square metal plates of side 500 mm and separated by a 10 mm slab of Teflon with $\epsilon_r = 2$ and 6 mm thickness is placed on the lower plate leaving an air gap of 4mm thick between it and upper plate. If 100 V is applied across the capacitor, find D, in Teflon and air. [5+5]

OR

- 5.a) State and prove the conditions on the tangential and normal components of electric flux density and electric field intensity, at the boundary between the dielectrics.
- b) A square parallel plate capacitor 200 mm on side with a plate spacing of 25 mm is filled with a dielectric slab ($\epsilon_r = 240$ of the same dimensions if 100 V is applied to the capacitor) Find: (i) the polarization P in the dielectric and (ii) the energy stored by the capacitor. [5+5]

- 6.a) State Biot-Savart's law for magnetic field B due to a steady line current in free space.
- b) Derive an expression for magnetic field intensity due to infinite sheet of current. [5+5]

OR

- 7.a) 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.
- b) Derive an expression for the magnetic field strength at the center of a square loop of side 'a' meters and N turns. [5+5]

- 8.a) Derive point form of Ampere's circuital law.
- b) 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 . [5+5]

OR

- 9.a) Derive the expression for inductance of a solenoid.
- b) A single-phase circuit comprises two parallel conductors A and B, each 1 cm diameter and spaced 1 meter apart. The conductors carry currents of +100 and -100 amperes respectively. Determine the magnetic field intensity at the surface of each conductor and also exactly midway between A and B. [5+5]

- 10.a) A conductor with cross sectional area of 10 cm^2 carries a conduction current of $0.2 \sin(109t) \text{ mA}$. Given that $\sigma = 2.5 \times 10^6 \text{ S/m}$ and $\epsilon_r = 6$, calculate the magnitude of the displacement current density.
- b) Derive the Maxwell's equations in point and integral form for time varying fields. [5+5]

OR

- 11.a) Explain the concept of displacement current and obtain an expression for the displacement current density.
- b) Derive Maxwell's fourth equation, $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$. [5+5]

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