Ref. No.: Ex/EE/PC/B/T/226/2022

B.E. Electrical Engineering - Second Year - Second Semester-2022

FIELD THEORY

Time:3 hours Full Marks:100

(50 marks for each part)

Use separate Answer-script for each part

PART-I

Answer any three questions. Two marks are for neatness. All symbols have their usual significance.

1. a) What is the fundamental definition of curl of a vector field? 8+8=16
   Derive the expression for curl of a vector field **M**, written as $\nabla \times \mathbf{M}$ where, ∇ is the vector differential operator in Cartesian co-ordinates. What is the physical significance of Curl?
   b) Establish the boundary relation for magnetic field when it passes through two different magnetic media having permeabilities μ_1 and μ_2. Show one example for application of boundary relation for magnetic field.
2. a) What do you understand by Magnetic Vector Potential? Deduce Biot-Savart Law. 8+8=16
   b) A thin ring of rectangular loop having sides of 4cm by 8cm and the ring carries 50A , find **H** at a point on the axis positioned at a height of 10cm on the axis of the loop. Derive the formulae used if any.
3. a) Establish $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D}/\partial t$ and show the pictorial view of this relation. 8+8=16
   What is displacement current?
   b) Derive $\nabla \times \mathbf{E} = -\partial \mathbf{B}/\partial t$ and show the pictorial view of this relation.
4. a) Derive electromagnetic wave equations from Maxwell's equations. Using E.M. wave equation in free space, obtain an analytical solution of the wave equation of Electric Field (E) considering it as a plane wave and also draw the wave propagation.
   b) Describe electromagnetic wave polarizations. 10+6=16
5. Write short notes on any four: 4×4=16
   a) $\nabla . \mathbf{J} = 0$; b) $\nabla . \mathbf{B} = 0$; c) **EM Plane wave Propagation;**
   d) $\nabla \times \mathbf{H} = \mathbf{J}$; e) Stoke's Theorem and f) Poynting Vector.

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B.E. ELECTRICAL ENGINEERING SECOND YEAR SECOND SEMESTER - 2022

SUBJECT: FIELD THEORY

Time: Three Hours | Full Marks: 100 (50 Marks for each part)

Use a separate Answer-Script for each part

Two marks for neat and well-organized answers

Question No.	Part-II	Marks

Answer any three questions

1. (a) What is potential gradient? How is it related to the electric field intensity? Calculate electric field intensity at a point 'P' (1,0,4)m due to $Q_1 = +0.24$ μC at point '1' (2,4,2)m and $Q_2 = -0.8$ μC at point '2' (4,1,0)m — 2+2+5

   (b) Consider a ring charge of radius 10cm and uniform charge density of +0.8nC/m and also a disc charge of radius 20cm and uniform charge density σ C/m^2. Both the two charges are placed in the x-y plane with their centre at the origin. If the electric field intensity at a point of height 25cm lying on the z-axis is same due the ring and disc charges individually, then find the magnitude of σ. Relative permittivity of the medium is 2.7. — 7

2. (a) State and prove the integral form of Gauss Law with proper explanation. — 2+6

   (b) Show that electric field intensity on the conductor surface is half of the electric field intensity just off the conductor surface. Also, deduce an expression for the mechanical pressure on the conductor surface. — 6+2

3. (a) What do you mean by 'field utilization factor'? Calculate the field utilization factor of a cylindrical coaxial cable insulation. — 2+6

   (b) A single-core lead sheathed cable has a core of 20cm diameter and two layers of different dielectric media of thickness 8cm each. The relative permittivities are 4.5 (inner dielectric) and 2.4 (outer dielectric). Calculate the maximum and minimum electric field intensities and their locations within the cable when the potential difference between the core and the sheath is 33kV. — 8

4. (a) For the two-dimensional system with equal nodal distances shown in Fig.1, write the FDM equations for the unknown node potentials. Derive the formula used. 4+4

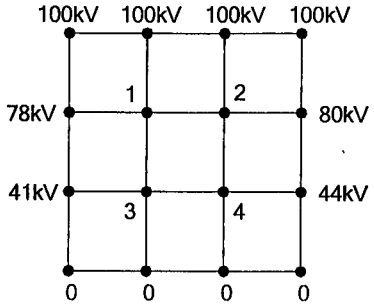

Fig.1

(b) A point charge of 1mC is placed at (0, 0, 1)m. An infinitely long conducting plane is there at z=0. Find the electric potential and the electric stresses at the point (3, 4, 1)m. The medium is air. 8

5. (a) State Uniqueness Theorem for an insulating material. Prove the theorem for calculation of electric potential. 2+6

(b) What is electric dipole? Calculate the electric field intensity components at any point due to an electric dipole. 1+7