BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2019

(3rd Year, 1st Semester)

FIELD THEORY

Time: Three Hours | Full Marks: 100

(50 marks for each part)

Use a separate Answer-script for each Part

PART-I

Answer ***any three*** questions

Two marks are reserved for neat and well organized answer script

1. a) A circular disc of charge of radius 1m having a uniform charge density $\rho_s = +1 nC/m^2$ lies in the z = 0 plane, with center at the origin. There is also a point charge of -4 nC at the origin. Find the magnitude and polarity of uniform charge density of a circular ring of charge of radius 1m lying in the z = 0 plane, with center at the origin, which would produce the same electric field intensity at the point (0,0,6)m as that due to the combined effect of the disc and point charges. Medium is air. {CO1} 8

   b) The potential field in a space containing a dielectric medium of $\varepsilon_r=3$ is given by $\phi = (-7xy + 3yz - 4zx)$ V. Find the polarity and magnitude of the point charge located in that space at (1,1,1) m such that the x-component of electric flux density at (1,2,2) m will be zero. {CO1} 8

2. a) Discuss the integral as well as differential form of relationships between electric field intensity and electric potential. {CO2} 8

   b) State and prove the Uniqueness Theorem. {CO2} 8

3. a) Justify the following statement with reason: "The field intensity just off the conductor surface is twice the field intensity on the conductor surface". {CO3} 8

   b) Discuss the boundary conditions for electric field in two different dielectric media. {CO3} 8

4. a) Derive the FDM equations for the unknown node potentials with equal nodal distances in two-dimensional system having homogeneous medium. {CO3} 8

   b) Calculate the unknown node voltages using FDM as shown in Fig. 1. Consider air as the medium. {CO3} 8

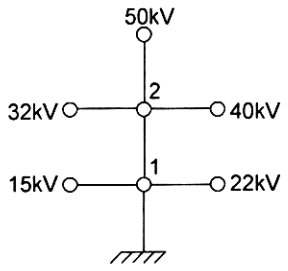

Fig. 1

5. a) From the basic concept of orthogonal curvilinear coordinate system derive an expression for Laplace's equation in cylindrical coordinate system. {CO3} 8

b) An electric dipole is formed by a point charge of +0.5μC at (0,0,0.2)mm and another point charge of -0.5μC at (0,0,0.1)mm. Find the electric field intensity in vector form at the point (10,0,10)cm. The medium is air. Deduce the formulae used. {CO4} 8

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Ref.No. Ex/EE/T/315/2019

B.E. ELECTRICAL ENGINEERING EXAMINATION, 2019

(3-RD YEAR, 1-ST SEMESTER)

FIELD THEORY

Time:3 hours Full Marks:100

(50 marks for each part)

Use separate Answer-script for each part

PART-II

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

1. a) What is the fundamental definition of curl of a vector field?
Derive the expression for curl of a vector field **C**, written as $\nabla \times \mathbf{C}$ where ∇ is the vector differential operator in Cartesian coordinate. What is the physical significance of the curl of a vector field?

   b) Derive an expression of Self-Inductance per unit length of a two wire transmission line of solid conductors having radius 'R_1' unit at a 'D' unit distance apart .

8+8=16

2. a) What is significance of $\nabla.\mathbf{J} = 0$ and show the pictorial view of this relation.
   b) Explain $\nabla.\mathbf{J} = -\partial\rho/\partial t$, where ρ is volume charge density.
   c) Using Magnetic Vector Potential (**A**) derive Biot- Savart Law. **4+4+8=16**

3. a) Establish $\nabla \times \mathbf{E} = -\partial\mathbf{B}/\partial t$ and show the pictorial view of this relation.
   b) Using Biot- Savart Law compute **H** (A/m) at the height 2m **on z-axis** from a square current loop of 2m side carrying 100A in clockwise direction while loop is **placed on x-y plane** keeping one corner at (0,0,0) and derive the formulae used if any.

6+10=16

4. a) Using Maxwell's equations derive Electromagnetic (E.M.) Wave 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 find wave velocity.
   b) What do you mean by linear polarization of Electromagnetic Waves? Also draw the wave propagation.

10+6=16

5. Write short notes on any two: **8+8=16**
   a) Boundary Condition for magnetic field when it passes through two different magnetic media having permeabilities μ_1 and μ_2 respectively.

   b) $\nabla \times \mathbf{H} = \mathbf{J} + \partial\mathbf{D}/\partial t$ and displacement current.

   c) "Poynting Theorem" and Poynting vector.