Ref. No.: Ex/EE/5/T/213/2024(S)

**BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)**
**SECOND YEAR**
**FIRST SEMESTER**
**SUPPLEMENTARY EXAM 2024**

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** for neatness. All **symbols** have their usual significance.

1. a) What is the **definition of curl?** Derive the **expression for curl** of a vector field **F**,using **definition of curl**, written as $\nabla \times \mathbf{F}$ where$\nabla$ is the vector differential operator in Cartesian co-ordinates and explain its **physical significance**.

b) Establish $\nabla \times \mathbf{H} = \mathbf{J}$. **10+6=16**

2. a) Establish the **Stoke's Theorem**.

b) What is the **definition of** $\nabla . \mathbf{B} = 0$ and draw the $\nabla . \mathbf{B} = 0$.

c) Establish $\nabla \times \mathbf{E} = -\partial \mathbf{B}/\partial t$ and show the pictorial view of this relation. **6+4+6=16**

3. a) Establish **Boundary Conditions** for magnetic field when it passes through two different magnetic media having permeabilities $\mu_1$ and $\mu_2$ respectively& Show one example for application of this relation.

b) What is plane electromagnetic wave? Using electromagnetic waveequation of Magnetic Field ($\nabla^2 \mathbf{H} = \mu_0 \varepsilon_0 \partial^2 \mathbf{H}/\partial t^2$) in free space, obtain an analytical solution of the wave equation of Magnetic Field (H) considering it as a plane wave and also draw the wave propagation. **8+8=16**

4. a) Explain" Biot-Savart Law".

b) A square loop measuring 1.5 m by 1.5 m carries a 7.5A steady current, where the loop is in the xz plane, using Biot-Savart law compute the B-field and Energy density at a point 0.35 m away **on axis of the loop**( the y-axis) in air material. Derive the formulae used if any. **4+12=16**

**5.** a) Establish $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D}/\partial t$ and show the pictorial view of this relation.What is displacement current?

b) What do you understand by electromagnetic wave polarization? Explain. Also show that the speed of any electromagnetic wave in **free space** is the speed of light $c = 3 \times 10^8$ m/s. **8+8=16**

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**BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING) SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2024**

**SUBJECT: FIELD THEORY**

Time: Three Hours

Full Marks: 100
(50 Marks for each part)

**Use a separate Answer-Script for each part**

Two marks are reserved for neat and well-organized answers

| Question No. | | Part-II | Marks |
|---|---|---|---|

Answer any three questions

1. (a) An electric dipole is formed by two charges +1μC at (0,0,5)m and -1μC at (0,0,3)m. Find the electric field intensity at the point (10,0,4)m. The medium is air. 7

   (b) Prove that the electric flux and equipotentials are always normal to each other. 4

   (c) Discuss about the relationship between electric potential and electric field intensity in differential form. 5

2. (a) Find an expression for the electric field intensity at the point located at a height "h" on the axis of a disc charge from the plane of the disc. The uniform charge density of the disc is $\rho_s$ C/m$^2$ and the permittivity of the medium is $\varepsilon_r$. 8

   (b) State and prove the integral form of Gauss law. 8

3. (a) A metallic sphere of 10cm diameter is charged with 1μC spread uniformly over the surface and is surrounded by a dielectric medium of $\varepsilon_r$= 3. Find the electric field intensity just off the sphere surface and also on the sphere surface. Derive the formulae used. 8

   (b) A single-core lead sheathed cable has a core of 30cm diameter and two layers of different dielectric media of thickness 8cm each. The relative permittivities are 4.0 (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) Discuss in details about the boundary conditions between two different dielectric media. 8

   (b) Explain how the electric field distribution within a single-core metal sheathed cable can be analyzed with the help of conformal transformation. 8

5. (a) For the two-dimensional system with equal nodal distances having linear potential variation between two successive nodes, prove that the potential of any node is the arithmetic mean of the four connected nodes. 8

   (b) Derive the expressions for the electric field intensity components at any point due to an electric dipole. 8