National University of Computer and Emerging Sciences

Lahore Campus

Electromagnetic Theory (EE3005)

Sessional-II Exam

Total Time (Hrs): 1
Total Marks: 40
Total Questions: 2

Date: November 5, 2024

Course Instructor(s)

1. Mohsin Yousuf (Course Moderator)
2. Dr. Huzaifa Rauf

7629

Roll No _____ Section _____ Student Signature _____

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1. **Attempt all questions and remember to solve parts of the same question together.**
2. **Final answers should be correct up to two decimal places with proper SI units.**
3. **Show all the steps with the help of diagrams and equations.**

CLO # 02: Formulate electrostatic fields and/or its properties governed by Coulomb's / Gauss's law for a given charge distribution in free space and / or dielectrics.

Q1: In a region of free space, the electric flux density **D** is defined by: **[20 marks]**

$$\mathbf{D} = \begin{cases} \rho_0(z+2d)\,\mathbf{a_z} \quad \text{C/m}^2 & \text{for } -2d \le z \le 0, \\ -\rho_0(z-2d)\,\mathbf{a_z} \quad \text{C/m}^2 & \text{for } 0 \le z \le 2d, \\ 0 & \text{elsewhere.} \end{cases}$$

(a) **Define** Maxwell's first equation (both in point and integral form) and **find** the volume charge density ρ_v everywhere. **[5]**

(b) **Determine** the electric flux ψ passing through the surface along $+\boldsymbol{a}_z$, defined by $z = 0, -a \le x \le a, -b \le y \le b$. **[5]**

(c) **Formulate** for the total charge enclosed within the following regions: **[10]**

i) Region 1:

$$-a \le x \le a,$$
$$-b \le y \le b,$$
$$-d \le z \le d$$

call it $Q_{encl,1}$

ii) Region 2:

$$-a \le x \le a,$$
$$-b \le y \le b,$$
$$0 \le z \le 2d$$

call it $Q_{encl,2}$.

CLO # 02: Formulate electrostatic fields and/or its properties governed by Coulomb's / Gauss's law for a given charge distribution in free space and / or dielectrics.

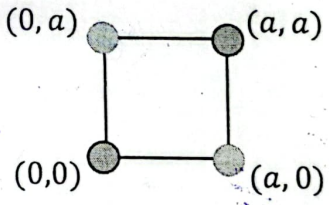
Q2: Answer the following: **[20 marks]**

(a) **Define** electric dipole and dipole moment $\boldsymbol{p}$ with the help of diagram. **[4]**

(b) A dipole of moment $\boldsymbol{p} = 3\boldsymbol{a}_x - 2\boldsymbol{a}_y + \boldsymbol{a}_z$ [n C · m] is located at the origin in free space. **Find** V at $P(r = 3.5\,m, \theta = 30°, \varphi = 60°)$. **[6]**

$$Hint, \qquad V = \frac{\boldsymbol{p} \cdot \boldsymbol{a}_r}{4\pi\varepsilon_0 r^2}$$

(c) Four point-charges $Q_1 = +2q, Q_2 = -q, Q_3 = -q, and\ Q_4 = +2q$ are located at $(0, 0), (a, 0), (0, a)$, and (a, a) respectively in yz-plane. **Formulate** for the potential energy stored in this point charge constellation. **[10]**



$$Hint, \qquad W_E = \frac{1}{2}\sum Q_i V_i$$
