National University of Computer and Emerging Sciences

Lahore Campus

Electromagnetic Theory (EE3005)

Sessional-I Exam

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

Date: September 24, 2024

Course Instructor(s)

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

Roll No _____ Section _____ Student Signature _____

Do not write below this line

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 # 01: Demonstrate the use of 3D orthogonal coordinate system and vector analysis tools (curl, divergence, etc.) in problem solving

Q1: The Fig.1 shown ahead is a 3D image drawn using values (mentioned at the top of the figure) from spherical coordinate system (SCS). Using *differential method*, **find**: **[20 marks]**

$0 \le r \le 1,\ 0 \le \theta \le \frac{\pi}{4},\ 0 \le \phi \le \frac{7\pi}{4}$ (solid)

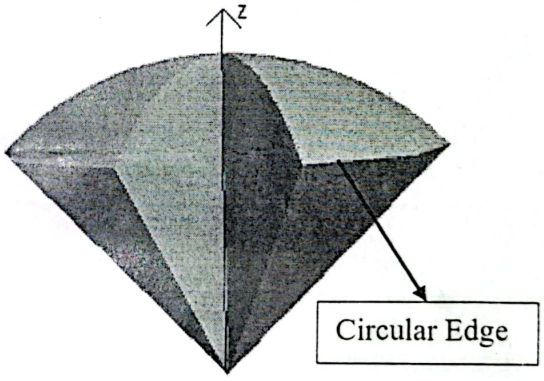

Figure 1. A 3D image with circular edge

(a) the total volume of the image, **[4]**

(b) the total surface area of the image, **[10]**

(c) the length of the circular edge as mentioned in the Fig. 1. **[3]**

(d) Also, convert the point $P\left(r = 1\text{m}, \theta = \frac{\pi}{4}, \phi = \frac{7\pi}{4}\right)$ into RCS. **[3]**

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: A uniform line charge is distributed along the z-axis from $z = 5\text{m}$ to ∞ and from $z = -5\text{m}$ to $-\infty$ as shown in the Fig. 2 with $\rho_L = 20$ [nC/m]. There is no line charge from $z = -5$ *to* 5m.

Formulate the problem for $d\boldsymbol{E}$ in RCS and **compute** the total electric field intensity, $\boldsymbol{E}$, at $(2, 0, 0)$m in CCS.

Hint: Finding symmetry in the problem may reduce the components you need to find.

[20 marks]

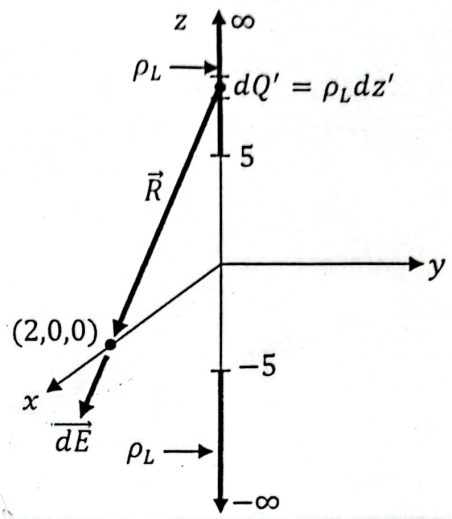

Figure 2. Two semi-infinite line charges on z-axis

Hint:

$$\int \frac{dx}{(a^2+x^2)^{3/2}} = \frac{x}{a^2\sqrt{a^2+x^2}}$$

and

$$\int \frac{x\,dx}{(a^2+x^2)^{3/2}} = \frac{-1}{\sqrt{a^2+x^2}}$$