Department of Electrical Engineering
Faculty of Engineering & Applied Sciences
Riphah International University
Midterm Examinations, Summer 2024 Semester
B.Sc. Electrical Engineering Program

SAP ID :	_____	**Subject Name :**	Electromagnetic Field
Marks :	30	**Time Allowed :**	120 minutes

Instructions:
1. **All the parts (if any) of each question must be attempted at one place instead of at different places.**
2. **Write Q. No. in the answer book in accordance with Q. No. in the Q. Paper.**
3. **Extra attempt of any question or any part of the attempted question will not be considered.**

Q 1 CLO1 **10 marks**

You are working as an engineer in a telecommunications company, tasked with positioning a new antenna. The antenna's current location is given in Cartesian coordinates as $P(3,4,5)$. To accurately align the antenna with existing infrastructure, you need to convert this location into both cylindrical and spherical coordinates.

(a) Convert the given point $P(3,4,5)$ in Cartesian coordinates to cylindrical coordinates

(b) Convert the same point to spherical coordinates using the equations.

(c) Individually plot the point in the three coordinate systems.

Q 2 CLO1 **10 marks**

You are an electromagnetic field engineer assigned to calculate the interaction between two charged particles in free space for a high-precision experimental setup. Charge $Q_A = -20\,\mu C$ is located at $A(-6,4,7)$, and charge $Q_B = 50\,\mu C$ is at $B(5,8,-2)$. All distances are given in meters.

(a) Calculate the distance R_{AB} between points A and B

(b) Determine the unit vector $\hat{R}_{AB}$ pointing from A to B.

(c) Compute the vector force exerted on Q_A by Q_B using the permittivity $\varepsilon_0 = \frac{10^{-9}}{36\pi}$ F/m.

(d) Recalculate the vector force with the permittivity $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m.

Q 3 CLO2 **10 marks**

You are tasked with analyzing the electric field properties in a region of free space where the electric flux density is given by $\mathbf{D} = 0.3r^2\hat{a}_r\,\text{nC/m}^2$. You need to perform the following calculations for a report on the electric field distribution and charge within a spherical region.

(a) Find the electric field $\mathbf{E}$ at point $P(r = 2, \theta = 25^\circ, \phi = 90^\circ)$.

(b) Determine the total charge within a sphere of radius $r = 3$.

(c) Calculate the total electric flux leaving a sphere of radius $r = 4$.

End of Paper