



Department of Electrical Engineering
Faculty of Engineering & Applied Sciences
Ripah 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

~~Find an LU factorization of system given below. Also determine the values of x .~~

$$A = \begin{bmatrix} \underline{1} & \underline{-2} & \underline{-4} & \underline{-3} \\ \underline{-1} & \underline{1} & \underline{6} & \underline{4} \\ \underline{-4} & \underline{-3} & \underline{9} & \underline{8} \end{bmatrix}, \quad x = \begin{bmatrix} \underline{x_1} \\ \underline{x_2} \\ \underline{x_3} \end{bmatrix}, \quad b = \begin{bmatrix} \underline{-4} \\ \underline{6} \\ \underline{9} \end{bmatrix}.$$

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 ~~Determinant of matrix E given below:~~

$$E = \begin{bmatrix} \underline{0} & \underline{-3} & \underline{1} & \underline{-2} \\ \underline{2} & \underline{-5} & \underline{-1} & \underline{-2} \\ \underline{2} & \underline{-4} & \underline{0} & \underline{1} \\ \underline{0} & \underline{10} & \underline{-6} & \underline{0} \end{bmatrix}.$$

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 $\epsilon_0 = \frac{10^{-9}}{36\pi}$ F/m.
- (d) Recalculate the vector force with the permittivity $\epsilon_0 = 8.854 \times 10^{-12}$ F/m.

~~Find the eigenvalues and eigenvectors for the matrix T given below:-~~

$$\underline{T} = \begin{bmatrix} \underline{5} & \underline{-3} \\ \underline{4} & \underline{-3} \end{bmatrix}.$$

~~Compute A^{10} , where-~~

$$\underline{A} = \begin{bmatrix} \underline{4} & \underline{-3} \\ \underline{2} & \underline{-1} \end{bmatrix}.$$

Q 3 CLO2

10 marks

~~Let $\mathbf{w} = \begin{bmatrix} 3 \\ 0 \\ -5 \end{bmatrix}$, $\mathbf{x} = \begin{bmatrix} 6 \\ 0 \\ 3 \end{bmatrix}$, and $\mathbf{y} = \begin{bmatrix} 6 \\ 0 \\ 3 \end{bmatrix}$~~

You are tasked with analyzing the electric field properties in a region of free space where the electric flux density is given by $\mathbf{D} = 0.3r^2\hat{a}_r$ nC/m². You need to perform the following calculations for a report on the electric field distribution and charge within a spherical region.

- (a) Find ~~a unit vector \mathbf{u} in the direction of \mathbf{y}~~ the electric field \mathbf{E} at point $P(r = 2, \theta = 25^\circ, \phi = 90^\circ)$.
- (b) Determine ~~whether \mathbf{w} , \mathbf{x} and \mathbf{y} are orthogonal vectors. Find the length of \mathbf{x} and \mathbf{y}~~ the total charge within a sphere of radius $r = 3$.
- (c) ~~Find the distance between \mathbf{w} and \mathbf{y}~~ Calculate the total electric flux leaving a sphere of radius $r = 4$.

End of Paper
