FIRST PART: CARTESIAN, POLAR AND CYLINDRICAL COORDINATE SYSTEMS

Exercise 01:

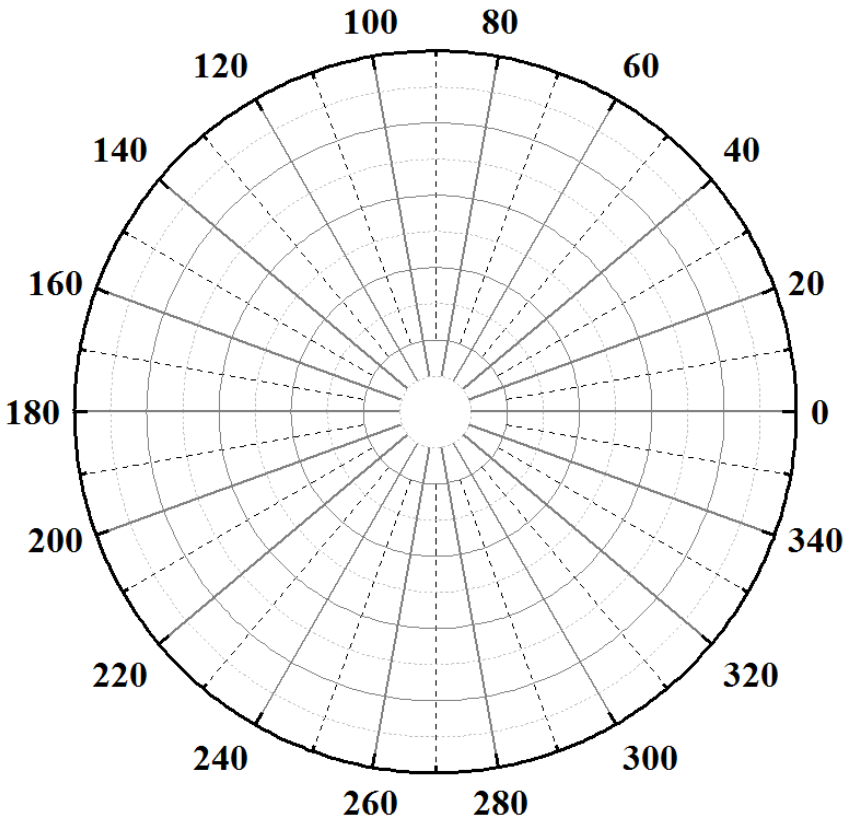
Using $\vec{\imath}$ and $\vec{\jmath}$ as the unit vectors for the Cartesian coordinate system, and $\vec{u}_r$ and $\vec{u}_\theta$ as the unit vectors for the polar coordinate system (where θ is time-dependent),

1) *Write the expressions for the unit vectors $\vec{u}_r$ and $\vec{u}_\theta$ in terms of $\vec{\imath}$ and $\vec{\jmath}$.*
2) *Calculate the derivatives of these unit vectors with respect to both time and θ.*
3) *Express the unit vectors $\vec{\imath}$ and $\vec{\jmath}$ in terms of $\vec{u}_r$ and $\vec{u}_\theta$.*
4) *Compute the derivatives of $\vec{\imath}$ and $\vec{\jmath}$ unit vectors with respect to both time and θ*

Exercise 02:

*In the polar coordinate system with unit vectors $\vec{u}_r$ and $\vec{u}_\theta$, the positions of the moving object **M** at two different moments t_1 and t_2 are given as follows : $M_1\ (3, \pi/6)$ $M_2\ (2, 2\pi/3)$*

1) *Represent the positions of the moving object **M** in the polar coordinate system.*
2) *Provide the expressions for the position vector at t_1 and t_2 moments.*
3) *Determine the expression for the displacement vector from M_1 to M_2.*
4) *Convert the coordinates of the two positions from polar to Cartesian coordinates, and rewrite the previous expressions in Cartesian coordinates.*



Exercise 03:

- *Identify the coordinates of points **A**, **B**, and **C** presented in the following polar coordinate system.*
- *Represent **D**, **E**, and **F** points on the same polar coordinate system.*

  D(5 cm,150^0); E(1 cm,90^0); F(3.5 cm,320^0)
- *From the cylindrical coordinate system shown in the attached diagram, calculate the coordinates for points **K**, **L**, and **M**.*
- *Similarly, Represent **N**, **P**, and **Q** points on the same cylindrical coordinate system **N(4 cm,150^0,2 cm); P(3 cm,60^0, 2 cm); Q(4.5cm,320^0, 9 cm)***