University of Tlemcen
Faculty of Sciences
Department of Mathematic

Academic Year: 2024/2025
1st Year LMD-M and MI

SW N°4 of Mechanics

Relative Motion

EXERCISE 1

In the **Oxy** plane, we consider a system of moving axes **(OXY)** with the same **origin O** and such that Ox makes a variable angle θ with OX. A point M moving **along axis OX** is marked by **OM=r**. We call relative motion of M, its motion with respect to (OXY), and absolute motion with respect to (Oxy).

Calculate in the moving frame of reference (polar coordinates)
1- Relative velocity and acceleration of M.
2- The velocity and training acceleration of M.
3- Coriolis acceleration.
4- Deduce its absolute velocity and acceleration.

EXERCISE 2

In the (Oxy) plane, consider a system of moving axes (OXY), rotating with a **constant angular** velocity **ω around (OZ).** A moving point M moves along axis (OX) with **constant acceleration γ** and **no initial velocity**. We call relative motion of M its motion with respect to (OXY), and absolute motion with respect to (Oxy).

At time t=0, axes (Ox) and (OX) are coincident and M is in OA.

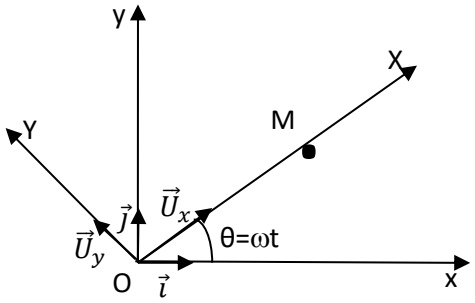
Calculate in the moving reference frame :

1- The velocity and relative acceleration of M.

2- Entrainment velocity and acceleration.

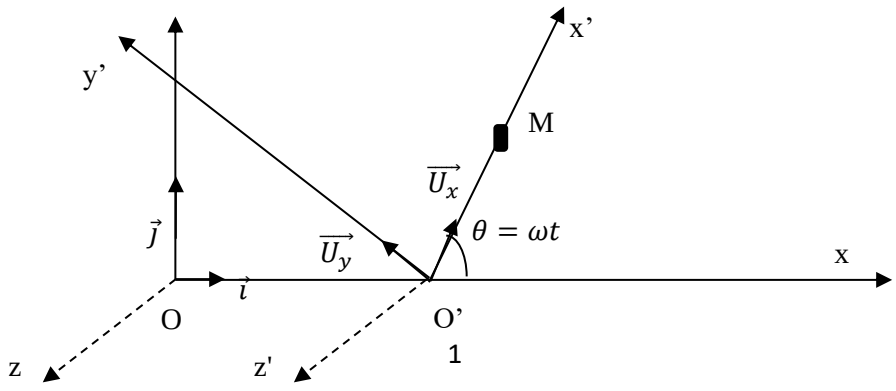
3- Coriolis acceleration.

4- Deduce its absolute velocity and acceleration.



EXERCISE 3

Consider the reference frame R(Oxyz) where point O' moves **along the axis (Ox)** with **constant velocity v**. O' is linked to the reference frame (O'x'y'z'), which rotates **around (Oz)** with **constant angular velocity ω**. A moving point M **moves along the axis O'x'** such that **$|O'M|=t^2$**.



At time t=0, the axes (Ox) and (O'x') are coincident and M is at O.

1. Calculate the relative velocity $\overrightarrow{v_r}$ and the training velocity $\overrightarrow{v_e}$, deduce the absolute velocity $\overrightarrow{v_a}$.

2. Calculate the relative acceleration $\overrightarrow{a_r}$, the training acceleration $\overrightarrow{a_e}$ and the Coriolis acceleration $\overrightarrow{a_c}$, deduce the absolute acceleration $\overrightarrow{a_a}$.

EXERCISE 4

Consider the reference frame R(Oxyz) where point **O' moves along axis (Oy)** with constant **acceleration γ**. We link to O' the reference frame (O'XYZ) which **rotates around (Oz)** with a **constant angular velocity ω**. The coordinates of a moving body M in the moving frame of reference **are $x'=t^2$ and $y'=t$**.

At time t=0, the axis (O'X) coincides with (Ox).

Calculate in the moving frame of reference:

1- Velocity $\overrightarrow{v_r}$ and $\overrightarrow{v_e}$, deduce the absolute velocity $\overrightarrow{v_a}$.

2- Relative acceleration $\overrightarrow{a_r}$, training acceleration $\overrightarrow{a_e}$ and Coriolis acceleration $\overrightarrow{a_c}$, deduce the absolute acceleration $\overrightarrow{a_a}$.

SUPPLEMENTARY EXERCISE

Consider a fixed reference frame (Oxyz) and a moving reference frame (OX'Y'Z') which rotates **around (Oz)** with a **constant angular velocity ω**.

A moving point M **(OM=r)** moves **along the axis (OX')** according to the law

$\boldsymbol{r = r_0\,(\cos \omega t + \sin \omega t)}$ with r_0= constant.

Determine in the **moving reference frame** (OX'Y'Z'):

1- The velocity $\overrightarrow{v_r}$ and the entrainment velocity $\overrightarrow{v_e}$, deduce the absolute velocity $\overrightarrow{v_a}$.

2- Relative acceleration $\overrightarrow{a_r}$, drag acceleration $\overrightarrow{a_e}$ and Coriolis acceleration $\overrightarrow{a_c}$, deduce absolute acceleration $\overrightarrow{a_a}$.