University of Tlemcen
Faculty of Sciences
Department of Mathematic

Academic Year: 2023/2024
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.

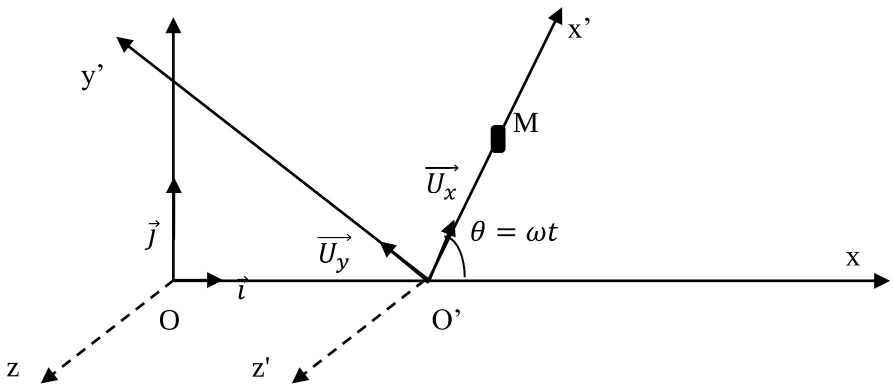
EXERCISE 2

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|=t²**.

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 3

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 $\vec{v_r}$ and $\vec{v_e}$, deduce the absolute velocity $\vec{v_a}$.

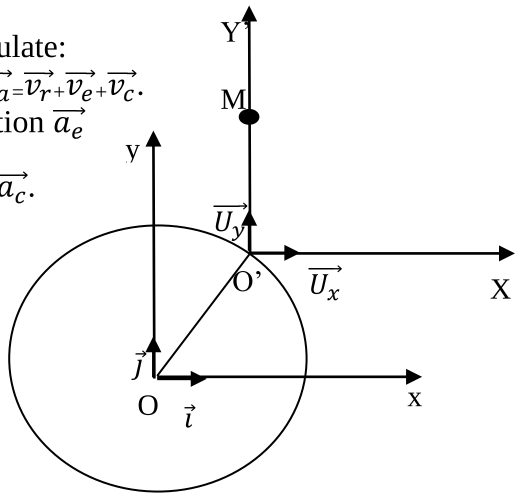
2- Relative acceleration $\vec{a_r}$, training acceleration $\vec{a_e}$ and Coriolis acceleration $\vec{a_c}$, deduce the absolute acceleration $\vec{a_a}$.

EXERCISE 4

In the plane (Oxy) of a reference frame (Oxyz), a point O', to which the reference frame (O'XYZ) is linked, describes a circle of **center O and radius r**, and rotates **with a constant angular velocity ω**. A point M moves **along the axis (O'Y) parallel to Oy** with constant **acceleration γ** (at time t=0, M is merged with M_0 (r,0,0) and its initial velocity is positive).

1- Calculate in the (Oxyz) reference frame the position vector $\overrightarrow{OM}$, the absolute velocity $\vec{v_a}$ and the absolute acceleration $\vec{a_a}$.
2- Knowing that O'X//Ox, O'Y//Oy and O'Z//Oz, calculate:
   a- Relative speed and drive speed, check that $\vec{v_a}=\vec{v_r}+\vec{v_e}+\vec{v_c}$.
   b- A relative acceleration $\vec{a_r}$, training acceleration $\vec{a_e}$

and the Coriolis acceleration $\vec{a_c}$, check that $\vec{a_a}=\vec{a_r}+\vec{a_e}+\vec{a_c}$.



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 $\vec{v_r}$ and the entrainment velocity $\vec{v_e}$, deduce the absolute velocity $\vec{v_a}$.

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