

Module : Physics 3  
 2<sup>nd</sup> year 2024/2025

**Set n<sup>o</sup>0**  
**Reminders and generalities**

**Exercise 1:**

Write the following complex numbers in the form  $Z = Ae^{j\varphi}$  ; where  $j^2 = -1$

- 1)  $1 + 2j$  ;  $1 - j$  ;  $j$   
 2)  $(1 + 2j)(1 - j)$       3)  $\frac{1-j}{1+2j}$

**Exercise 2:**

Solve the following differential equations:

- 1-  $\ddot{x} + 9x = 0$       2-  $\ddot{x} - 9x = 0$   
 3-  $\ddot{\theta} - 3\dot{\theta} + 2\theta = 0$   
 4-  $\ddot{q} - 8\dot{q} + 16q = 0$   
 5-  $\ddot{v} - 3\dot{v} + \frac{5}{2}v = A(t)$

**Exercise 3:**

Calculate the average values of the following sinusoidal functions over a time period  $T$ :

- 1-  $A\cos(\omega t + \varphi)$ ,  $A\sin(\omega t + \varphi)$   
 2-  $A^2\cos^2(\omega t + \varphi)$ ,  $A^2\sin^2(\omega t + \varphi)$   
 3-  $[A_1\cos(\omega t)] \cdot [A_2\sin(\omega t)]$

**Exercise 4:**

A machine is subjected to the motion  $x(t) = A \sin(50t + \varphi)$  mm. The initial conditions are  $x(0) = 3$ mm and  $\dot{x}(0) = 1$  m/s.

- 1- Find the constants  $A$  and  $\varphi$ .  
 2- Express the motion in the form  $x(t) = A_1\cos(50t) + A_2\sin(50t)$ .

**Exercise 5:**

Find the sum of the two harmonic motions in each case (using two methods for one of the cases):

- 1-  $x_1(t) = 3 \sin(2t + \frac{\pi}{4})$  ,  $x_2(t) = 6 \sin(2t + \frac{\pi}{3})$   
 2-  $x_1(t) = 10 \cos(3t)$  ,  $x_2(t) = 5 \sin(12t)$   
 3-  $x_1(t) = 2 \sin(25t)$  ,  $x_2(t) = 2 \sin(24t)$

Plot the resulting curve for the third case. What is this physical phenomenon called?

(Use any program of your choice to plot the graph.)

**Exercise 6:**

The resultant of two harmonic motions, as displayed by an oscilloscope, is shown in the figure below. Find the amplitudes and frequencies of the two motions.



**Exercise 7:**

Consider the two harmonic motions:  $x_1(t) = \frac{1}{2} \cos\left(\frac{\pi}{2} t\right)$  and  $x_2(t) = \sin(\pi t)$

1. Is the sum  $x_1(t) + x_2(t)$  a periodic motion? If so, what is its period?  
 2. Is the resultant a harmonic motion?