UNIT-2 Part-I (Waves & Oscillations)

Waves:- A wave motion is a disturbance of some kind which moves from one place to another by means of a medium.

Oscillation:- Oscillation is an effect expressible as a quantity that repeatidly & regularly fluctuate above and below some mean position.

I) **Transverse wave:-** Wave motion in which particle of medium vibrate about their mean position at right angle to the direction of propagation.
Eg- Light Waves.

II) **Longitudinal waves:-** Wave motion in which wave vibrate about their mean position along the same line as propagation of wave.
Eg. Sound waves

Simple Harmonic Motion:- If the acceleration of a particle in a periodic motion is always directly proportional to its displacement from its equilibrium position.

Types of SHM:-

I) Linear ~~Harmonic~~ Simple Harmonic Motion:-
If the displacement of a particle executing SHM is linear is said to be linear simple harmonic motion.
Example - Simple Pendulum.

Angular Simple Harmonic Motion:-

If the Displacement of a Particle Executing SHM is angular. Example - compound Pendulum.

Essential Conditions for SHM:-

1) If f be the linear acceleration and x be the displacement from Equilibrium Position.

The essential condition is -

$$\boxed{f \propto -x}$$

2) If α be the angular Momentum θ be the angular displacement then essential condition is -

$$\boxed{\alpha = -\theta}$$

Time Period:- The smallest time interval during which oscillation repeat itself is called time Period, denoted by T. Its Unit is seconds.

Frequency:- Number of oscillation that a body complete in one second is called frequency of Periodic Motion.

It is reciprocal of time period T and is given by -

$$\boxed{n = \frac{1}{T}}$$

Unit - Hertz represented by Hz.

Amplitude:- Maximum displacement of a body from its Mean Position.

Phase :- It is a physical quantity that express the instaneous position and direction of motion of an oscillating system.

Differential Equation of SHM & its solution:-

Let us consider a particle of mass m executing SHM along a straight line with x as displacement from the mean position at any time t. Then from the basic condition of SHM restoring force F will be proportional to displacement and will be directed opposite to it.

Therefore

$$F \propto -x$$

$$\boxed{F = -Kx} \quad —(1)$$

K is proportionality constant known as force constant

If $a = \frac{d^2x}{dt^2}$ be the Acceleration at any instant of time

From (1)

$$F = -Kx$$

$$ma = -Kx$$

$$m\frac{d^2x}{dt^2} = -Kx$$

$$\frac{d^2x}{dt^2} = -\frac{K}{m}x \quad —(2)$$

Substituting $\frac{K}{m} = \omega^2$

$$\frac{d^2x}{dt^2} = -\omega^2 x \Rightarrow \boxed{\frac{d^2x}{dt^2} + \omega^2 x = 0} \quad —(3)$$

Equation (1) & (2) are known as differential Equation of SHM.