Unit no:-07 Oscillations

Date: Day:

RESTORING FORCE:- The force which brings the system back to its stable equilibrium condition.
$\vec{F} = -k\vec{x}$
EQUAL & OPPOSITE TO APPLIED FORCE

Instantaneous displacement: (x) Shortest distance.

FREE OSCILLATIONS:- Due to natural frequency without interference of external force.

FORCED OSCILLATIONS Due to interference of external force.

REASONANCE The increase in amplitude of oscillation of a system exposed to periodic force whose frequency is equal to natural frequency of system.
•- ENERGY ABSORPTION IS MAXIMUM

Oscillatory motion:- To & fro motion of a body about a MEAN Position. **Periodic motion** (The oscillatory motion that repeats itself after equal intervals of time).

EXAMPLES:- mass spring system, motion of a bob of simple pendulum.

TIME PERIOD:- The time required by a body to complete one vibration. Represented by T. SI unit second.

FREQUENCY:- No. of of vibration per second. $f = 1/T$ or $fT = 1$

ANGULAR FREQUENCY:- The no. of revolution per second of a body. $\omega = \theta/T \Rightarrow \omega = 2\pi/T \Rightarrow \omega = 2\pi f$

Simple Harmonic Motion:- The type of oscillatory motion in which acceleration of a body at any instant is directly displacement from mean position and is always directed toward mean position.

Simple Pendulum:-
$T = 2\pi\sqrt{l/g}$, $\omega = \sqrt{g/l}$
$f = \frac{1}{2\pi}\sqrt{g/l}$ (If T = constant)
$\Rightarrow l \propto g$

Velocity
$V = V_0 \cos\theta$
$V = V_0\sqrt{1 - \frac{x^2}{x_0^2}}$
$V = \omega\sqrt{x_0^2 - x^2}$

Vmax
$x = x_0$
$V_0 = x_0\omega$
$V_0 = x_0\frac{2\pi}{T}$
$V_0 = 2\pi f x_0$

Acceleration
$a = -a_0 \sin\theta$
$a = -\omega^2 x$
$a = \left(\frac{2\pi}{T}\right)^2 x$

a max
$x = x_0$
$a = -\omega^2 x_0$

Motion of mass attached to spring. Acceleration $\Rightarrow a = -\frac{k}{m}x$
Angular frequency $\Rightarrow \omega = \sqrt{k/m}$
Time period $\Rightarrow T = 2\pi\sqrt{m/k}$
frequency $\Rightarrow f = \frac{1}{2\pi}\sqrt{k/m}$
Spring constant $K = F/x$
SI Unit (Nm^{-1}) Dimension $[MT^{-2}]$

Energy Cons. in SHM:- $P.E = \frac{1}{2}kx^2$
$K.E = \frac{1}{2}k(x_0^2 - x^2)$
Total energy = P.E + K.E = constant

	Mean	Extreme
K.E	Maxi	Mini
P.E	Mini	Maxi

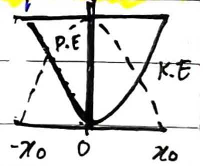
Phase:- The angle $\theta = \omega t$ which specifies the displacement x as well as direction of motion of point oscillation with SHM. $x = x_0\cos\theta = x_0\cos\omega t$ OR $x = x_0\cos(\omega t + \phi)$
Where $\theta = (\omega t + \phi)$ is phase angle * ϕ also called starting or initial phase of an oscillator. * ϕ Also represent phase difference. In Phase angle 0° | Out of Phase angle 180°

VIBRATION One complete round trip of a vibrating body about its mean position.

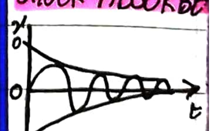
Amplitude (x_0) Maximum displacement

Conditions for SHM
•- System have inertia.
•- system should have restoring force
•- $a \propto -x$
•- System should be frictionless.

Graphical Representation



DAMPED OSCILLATION Amplitude decrease. DUE to energy dissipation.
SHOCK ABSORBER



UNDAMPED OSCILLATION Amplitude remains same with time