Resonance:

When the frequency of external excitation is equal to the natural frequency of a vibrating body, the amplitude of vibration becomes excessively large. This concept is known as resonance.

Mechanical systems:

The systems consisting of mass, stiffness and damping are known as mechanical system.

Continuous and Discrete System:

Most of the mechanical systems include elastic members which have infinite number of degree of freedom. such system are called continuous systems. Continuous systems are also known as distributed systems. Cantilever, simply supported beam..etc.

systems with finite number of degrees of freedom are called discrete or lumped systems.

PARTS OF A VIBRATING SYSTEM:-

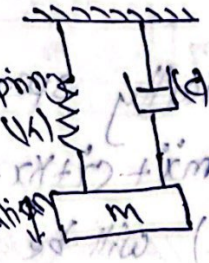
A vibratory system basically consist of three elements, namely the mass (m) the spring (k) and Damper(c) In a vibrating body there is exchange of energy from one form to another. Energy is stored by mass in the form of kinetic energy ($\frac{1}{2}m\dot{x}^2$) in the spring in the form of potential energy ($\frac{1}{2}kx^2$) and dissipated in the damper in the form of heat energy which opposes the motion of the system.

Energy enters the system with the application of external force known as excitation.

The excitation disturbs the mass from its mean position and mass goes up and down from the mean position.

Then the kinetic energy is converted into potential energy and potential energy is converted into kinetic energy. This sequence goes on Repeating and System continues to vibrate. At the same time damping force cx acts on the mass and opposes its motion.

Thus some energy is dissipated in each cycle of Vibration due to damping. The free vibrations die out and system remains at its static equilibrium position. A basic vibratory system is



The equation of motion of such a vibratory system (static equilibrium) can be written as.

$$m\ddot{x} + c\dot{x} + kx = 0$$

$c\dot{x}$ = Damping force (Unit) $\Rightarrow \frac{N.sec}{m}$ $\quad F = c\dot{x}$

$N = N\frac{sec}{m} \times \frac{m}{sec}$

kx = Spring force

$m\ddot{x}$ = inertia force.

TYPES OF VIBRATION:

1. Free and Forced Vibration
2. Linear and Non-linear vibration
3. Damped and Undamped Vibration
4. Deterministic and Random Vibration
5. Longitudinal, Transverse and Torsional Vibrations
6. Transient Vibration.

1. Free and Forced Vibration

After disturbing the system the external excitation is removed, then the system vibrates on its own. This type of vibration is free vibration.

The vibration which is under the influence of external force is called forced vibration. Ex: Machine tools, electric bells

② Linear and Non-linear Vibration.

In a vibratory system mass, spring, and damper behave in a linear manner, the vibrations caused are know as linear in nature. The linear vibrations are governed by linear differential equations. They follow the law of superposition.

Law of superposition in mathematically speaking, if a_1 and a_2 are the solution of $m\ddot{x}+c\dot{x}+kx=F_1(t)$ and $m\ddot{x}+c\dot{x}+kx=F_2(t)$ then (a_1+a_2) will be solution of the equ. $m\ddot{x}+c\dot{x}+kx=F_1(t)+F_2(t)$.

On the other hand, if any of the basic components of a vibratory system behaves non-linearly, the vibration is called non-linear vibration.

Some times, Linear vibration becomes non-linear for very large amplitude of vibration. It does not follow the Law of superposition.

③ Damped and Undamped Vibration

The vibratory system has a damper, the motion of the system will be opposed by it and the energy of the system will be dissipated in friction. This type of vibration is called damped vibration.

Then the contrary, the system having no damper is known as undamped vibration.

④ Deterministic and Random Vibration.

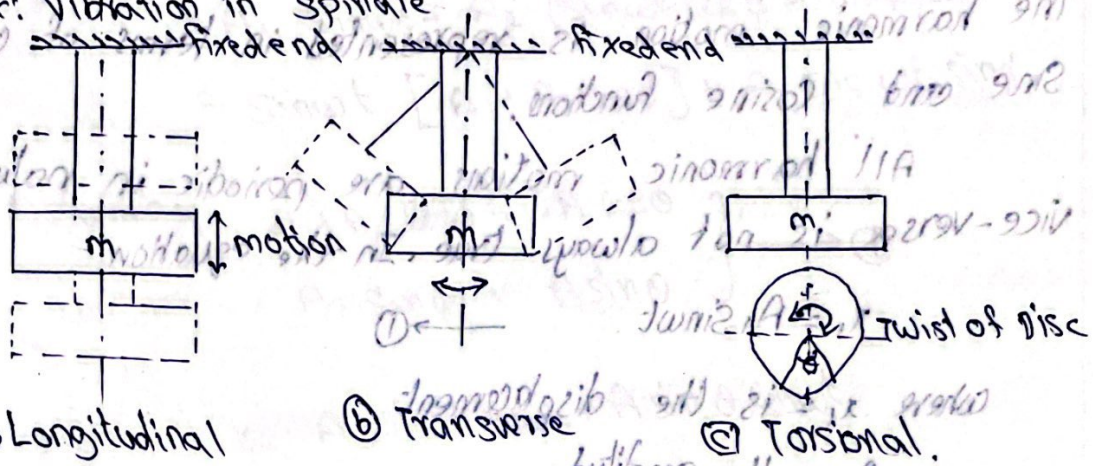
If in the vibratory system the amount of external excitation is known in magnitude, it causes deterministic vibration. Contrary to it the

non-deterministic vibration are known as Random vibration.

⑤ Longitudinal, Transverse and Torsional Vibrations.

ⓐ A body of mass (m) carried on one end of a weightless spindle, the other end being fixed, if the mass (m) moves up and down parallel to the spindle axis, it is said to execute longitudinal vibration.

Ex: Vibration in spindle



ⓐ Longitudinal ⓑ Transverse ⓒ Torsional.

ⓑ When the particles of the body or shaft move approximately perpendicular to the axis of the shaft, the vibration is known as transverse.

ⓒ If the spindle gets alternately twisted and untwisted on account of vibratory motion of the suspended disc it is called torsional vibration.

⑥ Transient Vibration:-

In ideal systems the free vibration continue indefinitely as there is no damping. The amplitude of vibration decays continuously because of damping (in a real system) and vanishes ultimately. Such vibration in a real system is called transient vibration.