## METHODS OF VIBRATION ANALYSIS:-

There are various methods by means of which can derive the equation of motion of a vibration system

1. Energy method
2. Newton's laws.
3. D'Alembert principle.

## ENERGY METHOD:-

According to this method the sum of the energies associated with the system is constant

$\therefore$ Kinetic energy + Potential energy = Constant

$$K.E + P.E = \text{Constant}$$

$$\frac{d}{dt}(K.E + P.E) = 0.$$

Consider the spring-mass system


$$K.E = \frac{1}{2} m\dot{x}^2 \text{ (mass)}$$

$$P.E = \frac{1}{2} kx^2 \text{ (spring)}$$

$$\therefore \frac{d}{dt}\left(\frac{1}{2}m\dot{x}^2 + \frac{1}{2}kx^2\right) = 0$$

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

$$\therefore \boxed{m\ddot{x} + kx = 0}$$

This is the equation of motion.

If the motion is simple harmonic given as

$$x = A\sin\omega t$$

$$\ddot{x} = -A\omega^2 \sin\omega t$$

$$\therefore -mA\omega^2 \sin\omega t + KA\sin\omega t = 0$$

$$\omega = \sqrt{\frac{K}{m}} \text{ rad/sec} \quad \text{angular frequency}$$

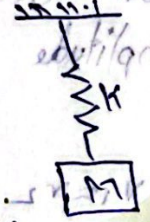
$$f = \frac{\omega}{2\pi} \ (Hz)$$

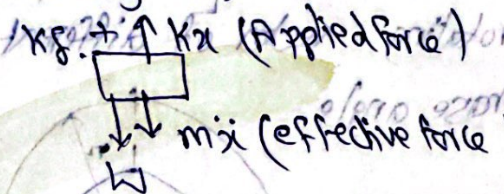
$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}} \ (Hz) \text{ Linear frequency.}$$

**Newton's METHOD:-**

Consider a spring - mass system

Free body diagram




2nd law :- Rate of change of momentum is proportional to the force acting on it.

mass × acceleration = resultant force.

resultant $W - K(\delta + x)$

$m\ddot{x} = W - K(\delta + x)$

$m\ddot{x} = mg - (K\delta + Kx)$

$m\ddot{x} = -Kx$

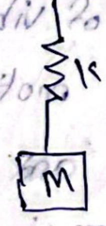
$\boxed{m\ddot{x} + Kx = 0}$


$\therefore \boxed{mg = K\delta}$ weight is balance by spring.

**D'ALEMBERT METHOD:-**

For a body which is not in static equilibrium by the virture of some acceleration it has be brought to static equilibrium by applying on it an inertia force.

This inertia force is equal to mass time acceleration of the body and act through the C.G in the direction opposite to that acceleration.




FBD


$$\boxed{m\ddot{x} + Kx = 0}$$