Engineering Mechanics

Introduction

- Engineering mechanics involves the study of both statics and dynamics.
- Statics is concerned with the equilibrium bodies at rest.
- Dynamics is concerned with analysis of bodies in motion.

Dynamics

Kinematics

- It deals with study of the geometry of motion. It is used to relate the displacement, velocity, acceleration and time without reference to the cause of motion.

Kinetics

- It deals with study of the relation existing between the forces acting on the body, the mass of the body and the motion of the body.

Module 2: Kinematics of Particles and Rigid Bodies

2.1 Kinematics of Particle

Particle

- A body with negligible dimensions is described as a particle. Physically a body can be considered as a particle.

Rigid body

- A body comprising infinite number of particles , whose relative positions remain unchanged under the action of the force is called rigid body.

Types of motion

- Rectilinear motion
- Curvilinear motion

Position

- The location of a particle along a straight line w.r.t. reference point or datum represents the position of the particle.

Distance

- Distance is the actual path length covered by a moving particle or a body in a given interval of time.

Displacement

- It is the shortest distance between initial position and final position of the particle.

Average speed and velocity

- Average speed = $V_{avg} = \frac{\Delta s}{\Delta t}$
- Average velocity = $\bar{V} = \frac{\Delta \bar{x}}{\Delta t}$

Instantaneous speed and velocity

- Instantaneous speed = $\lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$
- Instantaneous velocity = $\lim_{\Delta t \to 0} \frac{\Delta \bar{x}}{\Delta t} = \frac{d\bar{x}}{dt}$

Average and Instantaneous acceleration

- Average acceleration = $\bar{a}_{avg} = \frac{\Delta \bar{v}}{\Delta t}$
- Instantaneous acceleration = $\bar{a} = \lim_{\Delta t \to 0} \frac{\Delta \bar{v}}{\Delta t} = \frac{d\bar{v}}{dt}$

Uniform motion or constant velocity motion in 1 - dimension

- When particle undergoes same amount of displacement in equal intervals of time, then the particle is said to be moving with uniform velocity or constant velocity.
- s = vt or x = vt or y = vt

Uniform acceleration motion

$$V = u + at \quad \ldots\ldots\ldots\ldots (1)$$

$$V^2 = u^2 + 2as \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$S = ut + \frac{1}{2}at^2 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

$$S = S_0 + ut + \frac{1}{2}at^2 \quad \ldots\ldots\ldots\ldots (4)$$

Variable acceleration motion

1) $V = \frac{ds}{dt} or \frac{dx}{dt} or \frac{dy}{dt}$ $\therefore ds\ or\ dx\ or\ dy = Vdt$

2) $a = \frac{dv}{dt}$ $\therefore dv = adt$

3) $a = v\frac{dv}{ds}\ \ or\ v\frac{dv}{dx}\ \ or\ \ v\frac{dv}{dy}$ $\therefore vdv = ads\ \ or\ \ adx\ \ or\ \ ady$