ROHININ COLLEGE OF ENGINEERING AND TECHNOLOGY
Approved by AICTE & Affliated to anna university
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DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF THE SUBJECT: ENGINEERING MECHANICS

SUBJECT CODE : ME3351

REGULATION 2021

UNIT V: DYNAMICS OF PARTICLES

DYNAMIC OF PARTICLES

Dynamics

It is the branch of science which deals with the study of a body in motion.

Dynamic is further classified into two branches 1. Kinematics 2. Kinetics

Kinematics:

Kinematics is the study of motion of a moving body without considering the force.

Kinetics:

Kinetics is the study of motion of a moving body with considering external force.

Types of plane motion:

1. Rectilinear motion
2. Curvilinear motion

Rectilinear motion:

The motion of particle along a straight line.

Ex: A car moving straight road.

Ex: A stone vertically downward.

Curvilinear motion:

The motion of a particle along a curved path

Characteristic of Kinematics:

1. Displacement: ‘s’

   The displacement of a moving particle is the change in its position, during which the particle remains in motion. It is denoted by ‘s’

2. Speed:

   It is distance travelled by the particle (or) body along the path per unit time.

$$\text{Speed} = \frac{\textbf{Distance dravelled}}{\textbf{time taken}}$$

3. Velocity ‘v’

   It is the rate of change displacement.

$$\text{Velocity} = \frac{\text{Distance travelled in a particular direction}}{\text{Time taken}} \qquad m/s$$

4. Acceleration ‘a’

   It is the rate of change of velocity acceleration

$$a = \frac{\textbf{change of velocity}}{\textbf{time taken}}$$

$$a = \frac{\textbf{final velocity} \sim \textbf{Intial velocity}}{\textbf{time taken}}$$

Negative acceleration is called retardation [When final velocity $<$ Initial velocity]

5. Average velocity

$$\text{Average velocity} = \frac{\textbf{Change in position}}{\textbf{Change in time}} = \frac{\Delta x}{\Delta t}$$

6. $\frac{\text{Average speed}}{\text{Average speed}} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$

Mathematically Expression for Velocity and Acceleration:

Let s=Distance travelled by a particle in a straight line

t=time taken by the particle travelled this distance

Velocity= $\frac{ds}{dt}$

Acceleration= $\frac{dv}{dt} = \frac{d}{dt}(\frac{d}{dt}) = d^2s/dt^2$

Types of Rectilinear Motion:

1. Uniform acceleration
2. Variable acceleration

Rectilinear motion with uniform acceleration:

Eqn of motion in a straight line:

Consider the particle moving the uniform acceleration is a straight line.

Let u = Initial velocity (m/s)

v = final velocity (m/s)

s=Distance travelled (m)

t=time taken by the particle by the change from the u to v

a=acceleration of particle m/s^2

change o velocity=final velocity−Intial velocity

=v−u

Acceleration= $\frac{\text{change of velocity}}{\text{time taken}}$

a= $\frac{v-u}{t}$

a t = v−u

v=u+at----------> (1)

Average velocity$= \frac{\text{Initial velocity+final velocity}}{2}$

$= \frac{u+v}{2}$

Distance traveled by the particle in +sec

s=Average velocity ×time

s=$(\frac{u+v}{2})$t---------- >(2)

velocity= $\frac{\text{distance}}{\text{time}}$

v=$\frac{s}{t}$

$s = v\,t$

$s = \frac{u+v}{2} \times t$

$2\,s = u + v + t$

$2s/t = u + v$

$u + v = \frac{2s}{t}$ v= u+at

u+$u + at = \frac{2s}{t}$

$s = \frac{(2ut + at)t}{2}$

$s = \frac{2ut + at^2}{2}$

$s = \frac{2ut + at^2}{2}$

$s = \frac{2ut}{2} \neq \frac{at^2}{2}$

$s = ut + {}^1/_2\,at$

s= $ut + {}^{1}/_{2}\, at^2$

from (1) v= $u + at$ t= $\frac{v-u}{a}$

$$s = u\left(\frac{v-u}{a}\right) + \frac{1}{2}\, a \times \left(\frac{v-u}{a}\right)2$$

$$s = \frac{uv - u^2}{a} + \frac{1}{2}\, a\, \left(\frac{v-u}{a^2}\right)$$

$$s = \frac{uv}{a} - \frac{u^2}{a} + \frac{1}{2}\, \frac{v^2 + u^2 - 2vu}{a}$$

$$s = \frac{uv}{a} - \frac{u^2}{a} + \frac{v^2}{2a} + \frac{u^2}{2a} - \frac{2uv}{2a}$$

$$s = \frac{1}{2a}[uv \times 2 - u^2 \times 2 + v^2 + u^2 - 2uv]$$

s=$\frac{1}{2a}$[2uv − 2u² + v² + u² − 2uv]

$$s = \frac{1}{2a}[v^2 - u^2]$$

$2\, as = v^2 - u^2$

v² =u²+2a