

ROTATIONAL MOTION

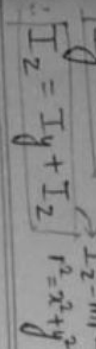
Moment of Inertia (MOI)

$I = MR^2$ kg m²

r → distance between from rotational axis

MOI about?

About $I_x = m \cdot y^2$
 $I_y = m \cdot x^2$
 $I_z = I_y + I_x$



MOI depends on
(i) Mass (M ↑ CM ↑)
(ii) dist.
(iii) Rotational axis
(iv) Mass distribⁿ?

MOI Calculatⁿ?

→ || axis
 $I = I_{cm} + Md^2$

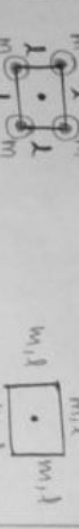
→ ⊥ axis
Applicable to all bodies (2D/3D) only for 2D

point of intersectⁿ Same karta hai

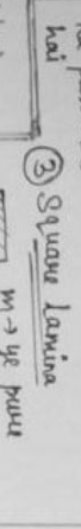
Continuous Mass Distribⁿ (Body)

$dI = \int dm \cdot r^2$

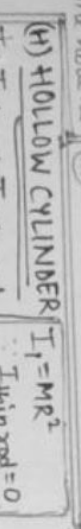
① four particles
m → particle ka part mass hai



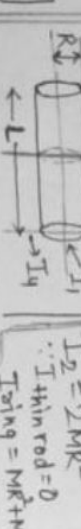
② four thin Rod
m → thin rod ka mass



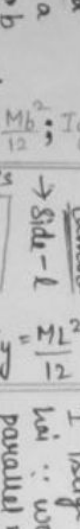
③ Square lamina
m → ye pure lamina ka mass hai



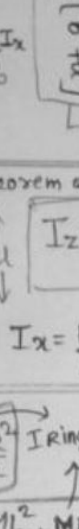
④ Hollow Cylinder
 $I = I_{ring} + I_{thin rod}$



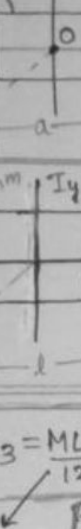
⑤ Rectangular lamina
length → a
breadth → b
Theorem → I axis



⑥ Square lamina
side → l



⑦ Thin rod ka I value 0
I value 0
parallel wo hai axis ka



⑧ Theorem of I axis
 $I_z = \frac{ML^2}{12}$
 $I_x = \frac{ML^2}{12}$
 $I_y = \frac{ML^2}{12}$



TRANSLATORY

→ Displacement → s
→ velo. → v
→ accⁿ → a
→ inertia → mass
 $F = \frac{dp}{dt} = ma$
Linear momentum
 $p = mv$

→ $W = \vec{F} \cdot \vec{s}$
→ $P = \vec{F} \cdot \vec{v}$
→ $W = \Delta K = \frac{1}{2} m (v_f^2 - v_i^2)$

ROTATIONAL

→ angular displacement = θ
→ Ang. velo. → ω
→ " accⁿ → α
→ Moment of Inertia
 $\tau = \frac{dJ}{dt} = I\alpha$
Angular momentum
 J or $L = I\omega$
 $\omega_{rot} = \vec{\omega} \cdot \vec{\theta}$
 $P_{rot} = \vec{r} \cdot \vec{\omega}$
 $\omega_{rot} = \frac{1}{2} I (\omega_f^2 - \omega_i^2)$

Angular Momentum

(i) Only translatory
 $\vec{J} = \vec{R} \times \vec{p} = \vec{R} \times m\vec{v}$
x-y plane

(ii) Only rotatⁿ
 $\vec{J} = I\omega$

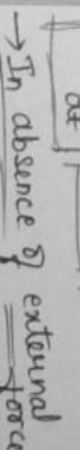
(iii) If rolling
 $\vec{J}_0 = \vec{J}_{trans} + \vec{J}_{rot}$

Angular Momentum Conservatⁿ

Newton → IInd law
 $\vec{F} = \frac{d\vec{p}}{dt}$ (F_{ext} = 0)
in Rot motion
 $\tau = \frac{dJ}{dt}$
In absence of external force (F_{ext} = 0)
 $\tau = 0$
 $J = \text{const.}$

(J_i) system = (J_f) system

Basic Maths



clockwise (CW)
anticlockwise (ACW)

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ROTATIONAL MOTION

Moment of Inertia (MOI)

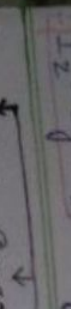
$I = MR^2$ kg m²

→ I distance between from rotational axis

MOI about = ?

About

$I_x = m \cdot y^2$
 $I_y = m \cdot x^2$
 $I_z = I_y + I_x$



① x-y plane
 $I_z = I_x + I_y$

② x-z plane
 $I_y = I_x + I_z$

③ y-z plane
 $I_x = I_y + I_z$

(A) Twin Rod

(i) MOI about axis ⊥ to the length

$I = ML^2/12$

↳ By continuous mass distributed?

(ii) MOI about axis passes through

$I = ML^2/3$

MOI depends on

(i) Mass (M) (CM)

(ii) I dist.

(iii) Rotational axis

(iv) Mass distributed?

MOI Calculat?

$I = I_{CM} + Md^2$

Applicable to all bodies (2D/3D)

Applicable only for 2D

point of interest? Same keta hai

(B) RING

$I = MR^2$

(C) DISC

$I = MR^2/2$

(D) Hollow sphere

$I = 2/3 MR^2$

$I = 2/5 MR^2$

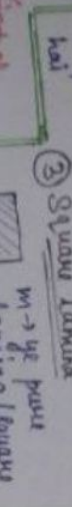
Continuous Mass Distributed (Body)

$dI = dm \cdot r^2$

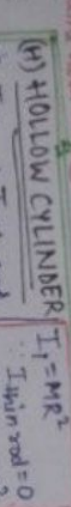
1) four particles



2) four thin rod



3) Square lamina

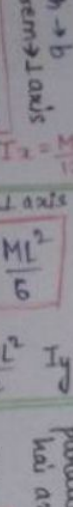


(H) HOLLOW CYLINDER

$I = I_{ring} + I_{thin rod}$

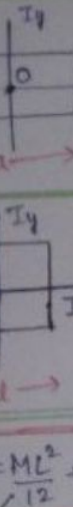
(G) Square lamina

$I_z = M/12 [b^2 + a^2]$



(F) Rectangular lamina

$I_z = M/12 [b^2 + a^2]$



(E) Solid sphere

$I = 2/5 MR^2$

TRANSLATORY

Displacement → s

velo. → v

accⁿ → a

inertia → m·mass

$F = dp/dt = m \cdot a$

Linear momentum

$p = F \cdot t$

$W = F \cdot s$

$W = \Delta K = \frac{1}{2} m [v_2^2 - v_1^2]$

ROTATIONAL

Angular displacement → θ

Ang. velo. → ω

accⁿ → α

Moment of Inertia

$\tau = dJ/dt = I \cdot \alpha$

Angular momentum

$J = I \cdot \omega$

$W_{rot} = \tau \cdot \theta$

$W_{rot} = \frac{1}{2} I (\omega_2^2 - \omega_1^2)$

Angular Momentum

(i) Only translatory

$\vec{J} = \vec{R} \times \vec{p} = \vec{R} \times m\vec{v}$

(ii) Only rotat.

$\vec{J} = I \cdot \omega$

(iii) If rolling

$\vec{J}_0 = \vec{J}_{trans} + \vec{J}_{rot}$

Angular Momentum Conservat?

Newton → IInd law

$\vec{F} = \frac{d\vec{p}}{dt}$ (F_{ext} = 0)

$\tau = \frac{dJ}{dt}$ (τ_{ext} = 0)

$J = \text{const.}$

In absence of external force

(J_i) system = (J_f) system

Basic Maths



Anticlockwise (ACW)

Clockwise (CW)