DYNAMICS

Planar Kinetics of a Rigid Body (General Plane Motion)

by:

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General Plane Motion

- Aims
  - To discuss the force and acceleration method of a rigid body undergoing general plane motion.

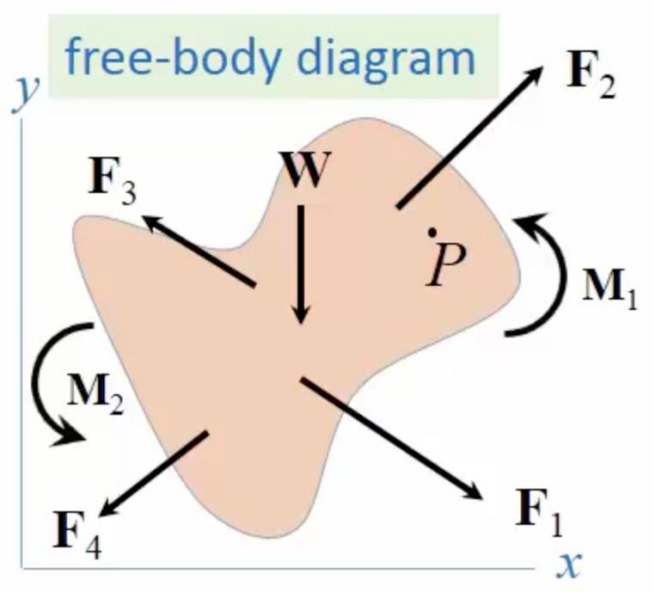
- Expected Outcomes
  - Students are able to determine the forces and moments, acceleration and angular acceleration of a rigid body undergoing general plane motion.

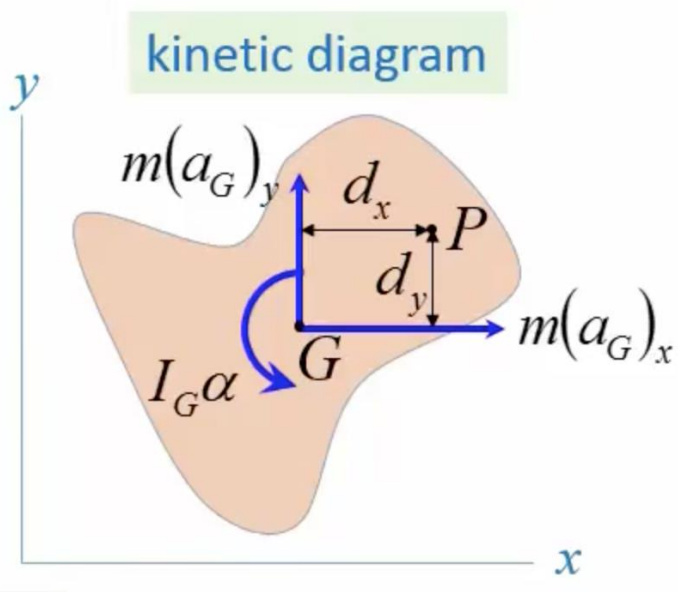
- References
  - Engineering Mechanics: Dynamics 12th Edition, RC Hibbeler, Prentice Hall

Contents

- General Equation of Motion
- Frictional Rolling Problem

General Equation of Motion





$$\sum F_x = m(a_G)_x$$

$$\sum F_y = m(a_G)_y$$

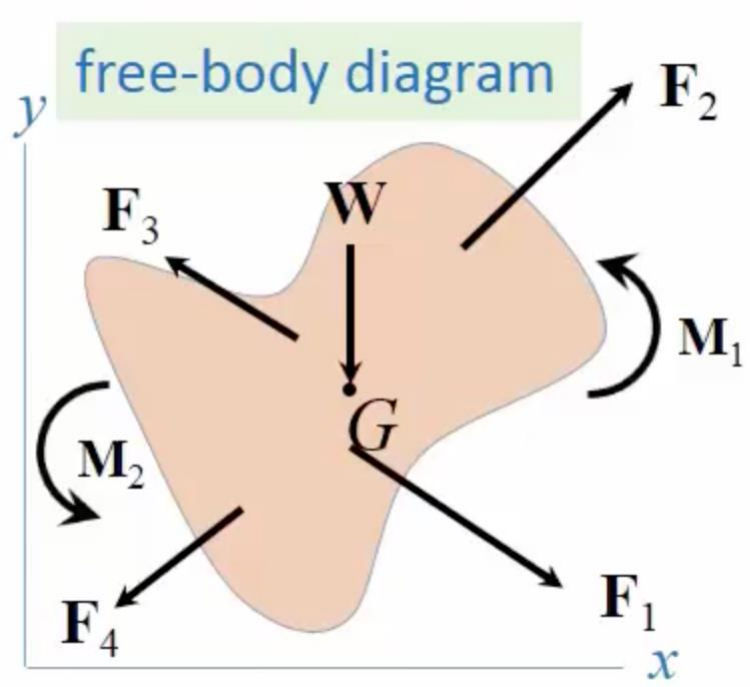
$$\sum M_P = \sum M_{F,P} + \sum M = \sum (\mathcal{M}_k)_P$$

$$\sum (\mathcal{M}_k)_P = m(a_G)_x \cdot d_y - m(a_G)_y \cdot d_x + I_G\alpha$$

Sum of kinetic moment about Point *P*

About Point *P*

General Equation of Motion



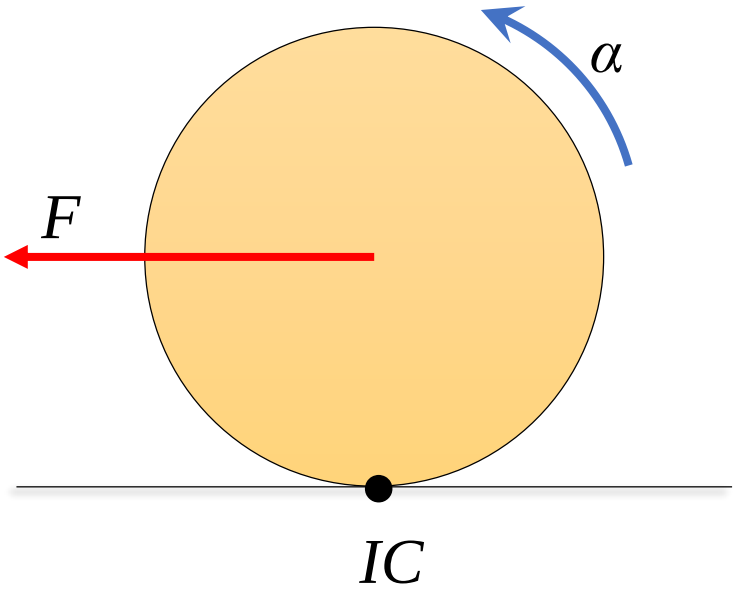
$$\sum F_x = m(a_G)_x$$

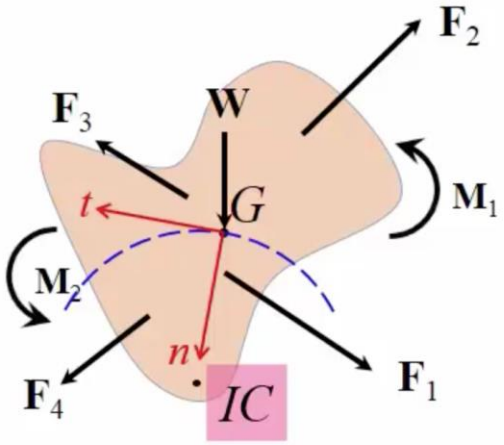
$$\sum F_y = m(a_G)_y$$

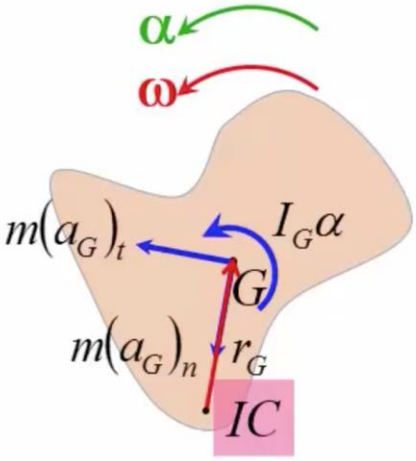
$$\sum M_G = \sum M_{F,G} + \sum M = I_G\alpha$$

About Centre of Gravity *G*

General Equation of Motion







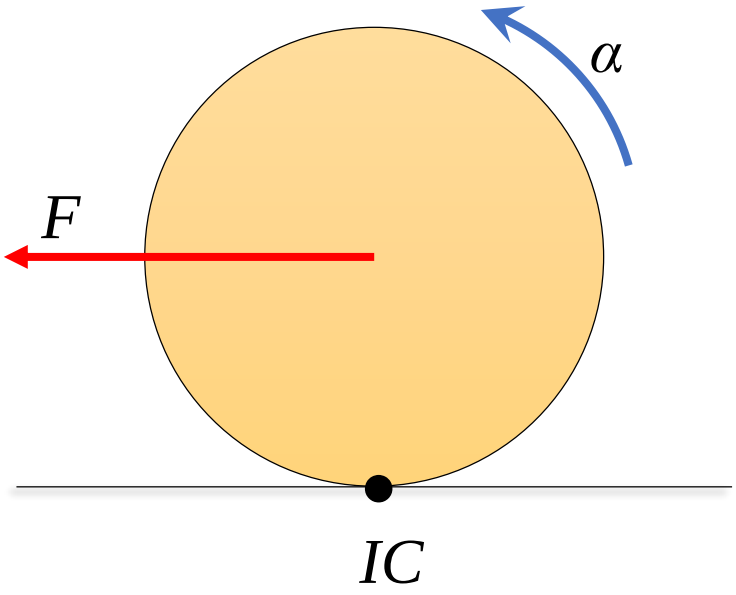
$$\sum F_n = m\omega^2 r_G$$

$$\sum F_t = m\alpha r_G$$

Similar to $\sum M_O = I_O\alpha$ ⟵ $\sum M_{IC} = I_{IC}\alpha$

About the IC

Frictional Rolling Problems



Involving e.g., **wheels**, **disks**, **cylinders**, or **balls** often require an **extra equation** due to the presence of the 'extra unknown' representing the **frictional force**.

No slipping

$$a_G = r\alpha$$

Slipping occur

$$F = \mu_k N$$

Planar Kinetics of a Rigid Body (General Plane Motion)

"I can calculate the motion of heavenly bodies, but not the madness of people."

– *Sir Isaac Newton*