Course: **Mechanical System Design (MSD)**

L-T-P: 3-1-3

Class: 8thSemester, Mechanical Engineering

Lectures: Monday, Tuesday, Thursday and Saturday

Labs: Monday

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UNIT 03: Design of Flywheel

Before we start with the design of flywheel, it is important to understand the following concepts.

- D'Alembert's Principle
- Inertia Force and Couple
- Dynamic Equivalence
- Dynamic Force Analysis of Slider Crank Mechanism
- Engine Force Analysis
- Turning Moment Diagram

D’Alembert’s Principle

- The vector sum of all external forces and inertia forces acting upon a rigid body is zero. The vector sum of all external moments and the inertia torque, acting upon the rigid body is also separately zero.
- In short, sum of forces in any direction and sum of their moments about any point must be zero.

Inertia Force and Couple

Inertia: Tendency to resist change either from state of rest or of uniform motion

Let ‘R’ be the resultant of all the external forces acting on the body, then this ‘R’ will be equal to the product of mass of the body and the linear acceleration of C.G. of the body. The force opposing this ‘R’ is the inertia force (equal in magnitude and opposite in direction).

(Inertia force is an Imaginary force equal and opposite force causing acceleration)

If the body opposes angular acceleration (α) in addition to inertia force R, at its C.G., there exists an inertia couple I_g x α, Where I_g= MI (Moment of Inertia) about CG. The sense of this couple opposes α. i.e., inertia force and inertia couple are equal in magnitude to accelerating force and couple respectively but, they act in opposite direction.

Inertia Force, F_i = m x f

= mass of the body x linear acceleration of the CG of the body

Inertia Couple, C_i = I x α

= mass moment of Inertia of the rigid body about an axis perpendicular to the plane of motion x Angular acceleration

Dynamic equivalence

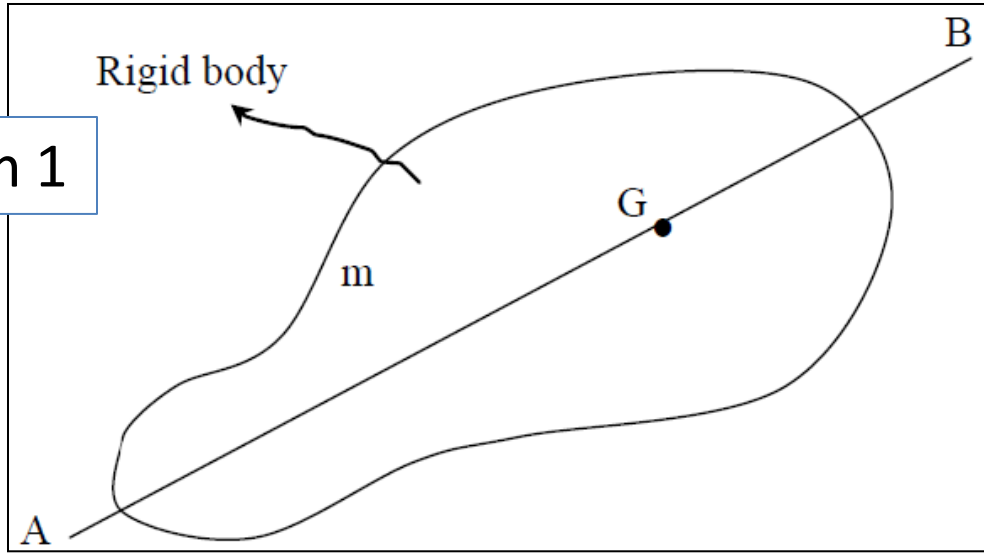
Two systems are said to be dynamically equivalent to one another, if by application of equal forces, equal linear and angular accelerations are produced in the two systems.

Following conditions must be satisfied for two dynamically equivalent system

i. The masses of the two systems must be same.
ii. The CGs of the two systems must coincide.
iii. The moments of inertia of the two systems about same point must be equal, Ex: about an axis through CG

Dynamically equivalent system

System 1

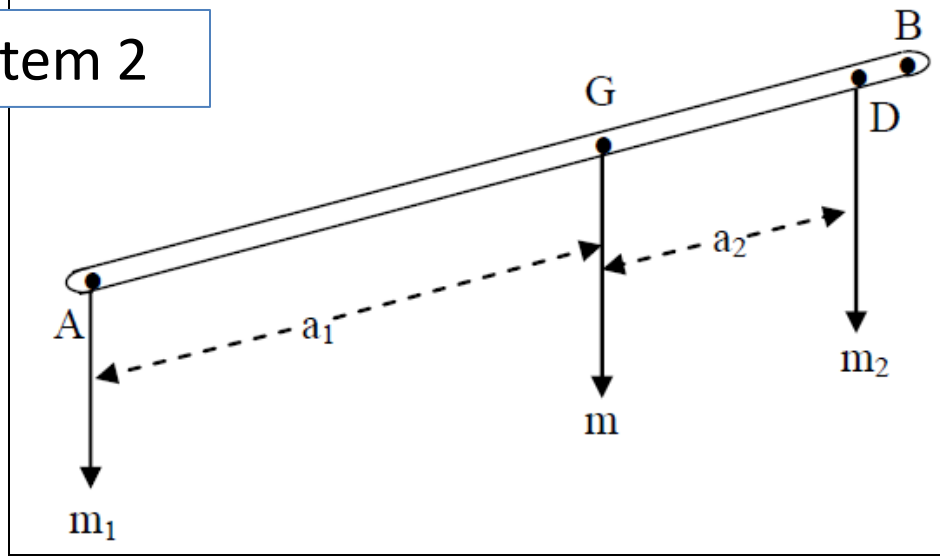


G = c.g.

m = mass of the rigid body

k_g = radius of gyration about an axis through G and perpendicular to the plane

System 2



m_1, m_2 – masses of dynamically equivalent system at a_1 & a_2 from G (respectively)

Q. Work out the conditions of dynamically equivalent system.