MMAN2300
Engineering Mechanics 2

Part A: Week 7

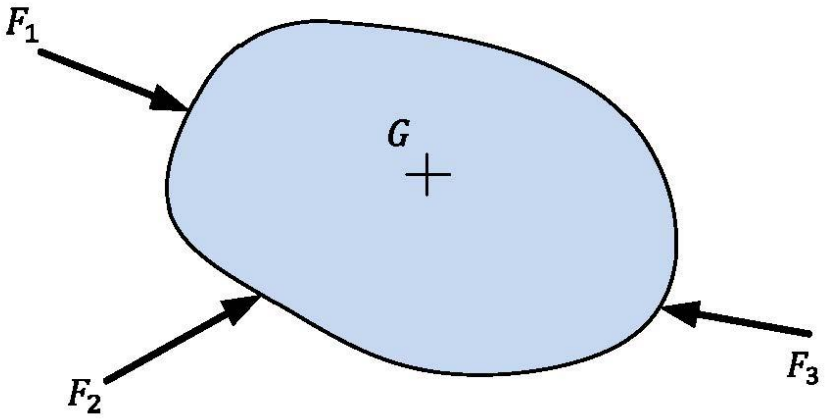
Plane kinetics of rigid bodies: Equations of motion

(Chapter 6 Meriam & Kraige)

Kinetic analysis is the study of the forces and moments acting on a rigid body and the resulting motion produced.

Equations of motion for a rigid body

Consider a rigid body which is acted upon by a number of forces.



G = Centre of mass

In general, the resultant force on the body, $\Sigma \boldsymbol{F}$, will not act through G.

If $\Sigma \boldsymbol{F} \neq 0$, the result will be a linear acceleration $\boldsymbol{a}_G$ of the centre of mass and an angular acceleration $\boldsymbol{\alpha}$ of the rigid body.

Planar equations of motion

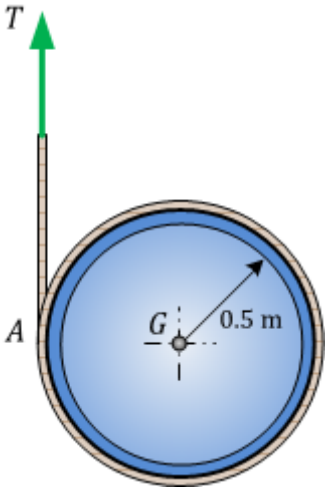
$\Sigma \boldsymbol{F} = m\boldsymbol{a}$, where $\boldsymbol{a}$ is the acceleration of the centre of mass

$\Sigma \boldsymbol{M} = I\boldsymbol{\alpha}$, where $\boldsymbol{\alpha}$ is the angular acceleration of the body

Example 1

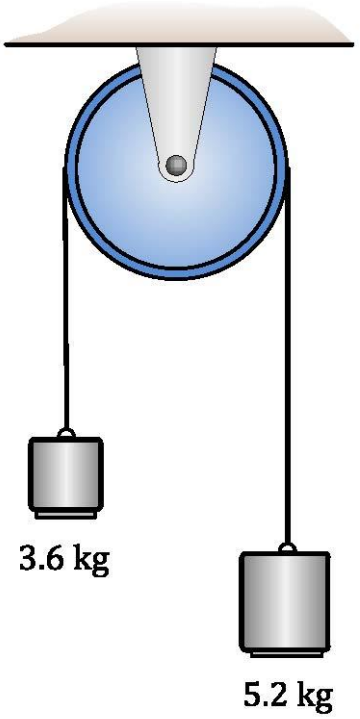
A cord is wrapped around a homogeneous disk of radius r = 0.5 m and mass m = 15 kg. If the cord is pulled upward with a force $\boldsymbol{T}$ of magnitude 180 N, Determine:

(a) the acceleration of the centre of the disk,
(b) the angular acceleration of the disk,
(c) the acceleration of the cord.



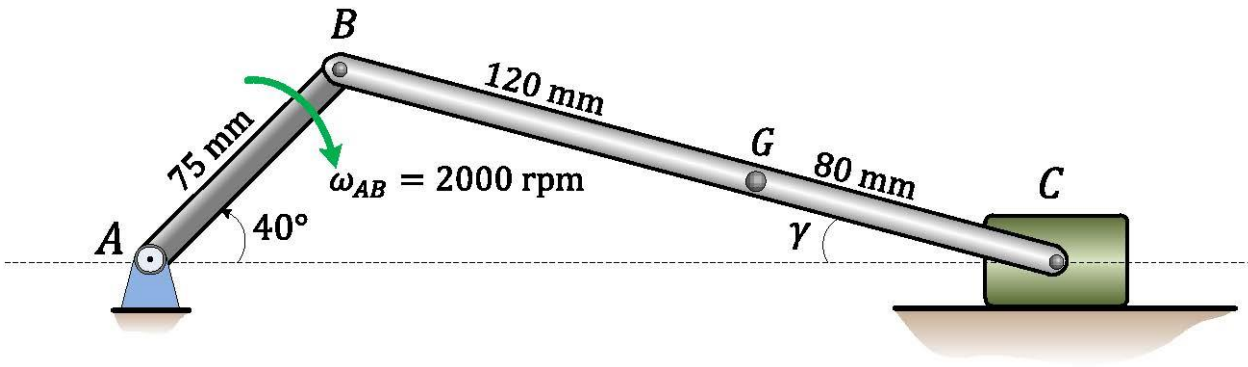
Example 2

The pulley has a moment of inertia of its centre of mass of 0.2144 kgm^2, and a radius of 521 mm. If the cable does not slip on the pulley surface, and the pulley bearing is frictionless, find the angular acceleration α of the pulley.



Example 3

For the slider-crank mechanism below, calculate the forces on the slider pin *C* and the crank *B*.



ω_{AB} = 2000 rpm CW
G is the centre of mass of link *BC*
Mass of slider = 5 kg
Mass of link *BC* = 12 kg
Radius of gyration (*k*) of *BC* = 160 mm ($I_G = mk^2$)