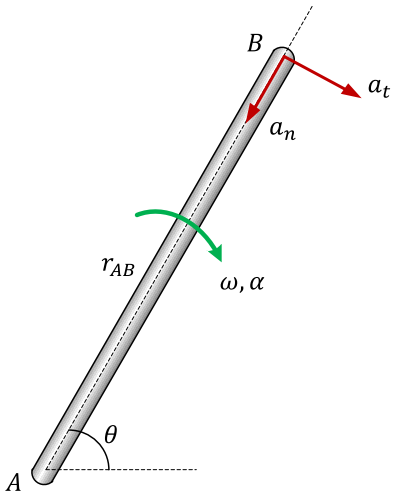
MMAN2300
Engineering Mechanics 2

Part A: Week 5

Acceleration analysis (review)

(Chapter 5/6-5/7 Meriam & Kraige)

1. Acceleration analysis of rigid bodies (Review)



The motion of a rigid body can be considered as a combination of translation and rotation about a point on the body.

Relative velocity equation:

$\boldsymbol{v}_B = \boldsymbol{v}_A + \boldsymbol{v}_{B/A}$

where $\boldsymbol{v}_{B/A} = \omega\overline{AB}\boldsymbol{e}_t = \boldsymbol{\omega} \times \boldsymbol{r}_{AB}$

Relative acceleration equation:

$\boldsymbol{a}_B = \boldsymbol{a}_A + \boldsymbol{a}_{B/A}$

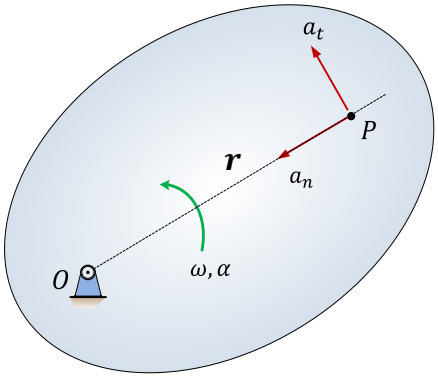
$\boldsymbol{a}_A$ = Acceleration of point *A*
$\boldsymbol{a}_B$ = Acceleration of point *B*
$\boldsymbol{a}_{B/A}$= Acceleration of point *B* relative to *A* due to rotation of the rigid body about point *A*

$$\boldsymbol{a}_{B/A} = (\boldsymbol{a}_{B/A})_n \boldsymbol{e}_n + (\boldsymbol{a}_{B/A})_t \boldsymbol{e}_t = \omega^2\overline{AB}\boldsymbol{e}_n + \alpha\overline{AB}\boldsymbol{e}_t = \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \boldsymbol{r}_{AB}) + \boldsymbol{\alpha} \times \boldsymbol{r}_{AB}$$

- Rotation about a fixed axis

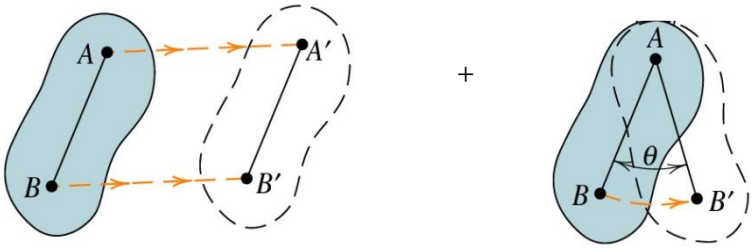
$$\boldsymbol{a}_P = \boldsymbol{a}_O + \boldsymbol{a}_{P/O}$$

$$= \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \boldsymbol{r}) + \boldsymbol{\alpha} \times \boldsymbol{r}$$



- General plane motion

Combination of translation and rotation



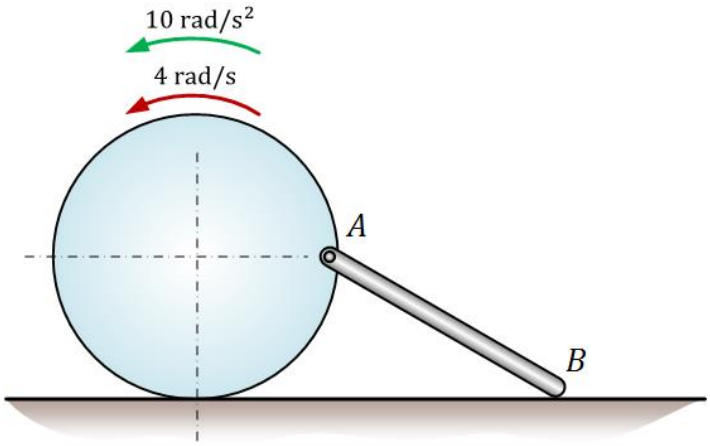
Translation Rotation

$$\boldsymbol{a}_B = \boldsymbol{a}_A + \boldsymbol{a}_{B/A} \quad \text{and} \quad \boldsymbol{a}_{B/A} = (\boldsymbol{a}_{B/A})_n \boldsymbol{e}_n + (\boldsymbol{a}_{B/A})_t \boldsymbol{e}_t = \omega^2\overline{AB}\boldsymbol{e}_n + \alpha\overline{AB}\boldsymbol{e}_t$$

Example 1

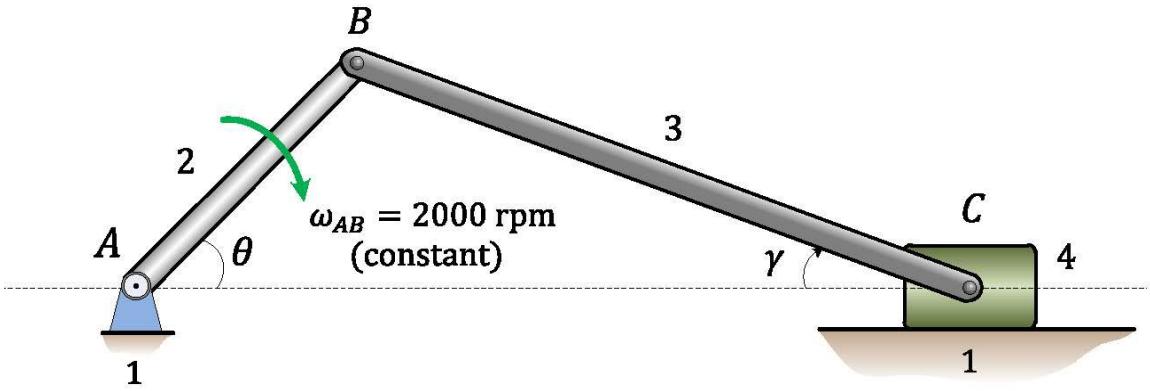
The 1-m-diameter disk rolls, and point *B* of the 1-m-long bar slides, on the plane surface. Determine:

(a) the angular velocity of the bar and the velocity of point *B*, and
(b) the angular acceleration of the bar and the acceleration of point *B*.



Example 2

Slider crank mechanism



AB = 75 mm

BC = 200 mm

Find: (a) the angular velocity of link *BC* and the velocity of slider *C*,

(b) the angular acceleration of link *BC* and acceleration of slide *C*.