Palestine Technical University- Kadoorie (PTUK)

Mechanical Engineering Department

12210244: Dynamics

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This is an explanation of the Dynamics course

offered at Palestine Technical University - Kadoorie

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Textbook:

Engineering Mechanics: Dynamics, 7th Edition

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Chapter Five: Plane Kinematics of Rigid Bodies

Section Seven: Motion Relative to Rotating Axes

5 Chapter Five: Plane Kinematics of Rigid Bodies

5.7 Motion Relative to Rotating Axes

$$\vec{r}_A = \vec{r}_B + \vec{r} \quad \Rightarrow \quad \vec{r}_A = \vec{r}_B + (x\hat{i} + y\hat{j})$$

$$\vec{v}_A = \vec{v}_B + \vec{\omega} \times \vec{r} + \vec{v}_{rel} \quad \Rightarrow \quad \vec{v}_A = \vec{v}_B + \vec{\omega} \times \vec{r} + (\dot{x}\hat{i} + \dot{y}\hat{j})$$

$$\vec{a}_A = \vec{a}_B + \vec{\omega} \times (\vec{\omega} \times \vec{r}) + \vec{\alpha} \times \vec{r} + 2\vec{\omega} \times \vec{v}_{rel} + \vec{a}_{rel}$$

$$\vec{a}_A = \vec{a}_B + \vec{\omega} \times (\vec{\omega} \times \vec{r}) + \vec{\alpha} \times \vec{r} + 2\vec{\omega} \times \vec{v}_{rel} + (\ddot{x}\hat{i} + \ddot{y}\hat{j})$$

$$\vec{a}_{cor} = 2\vec{\omega} \times \vec{v}_{rel}$$

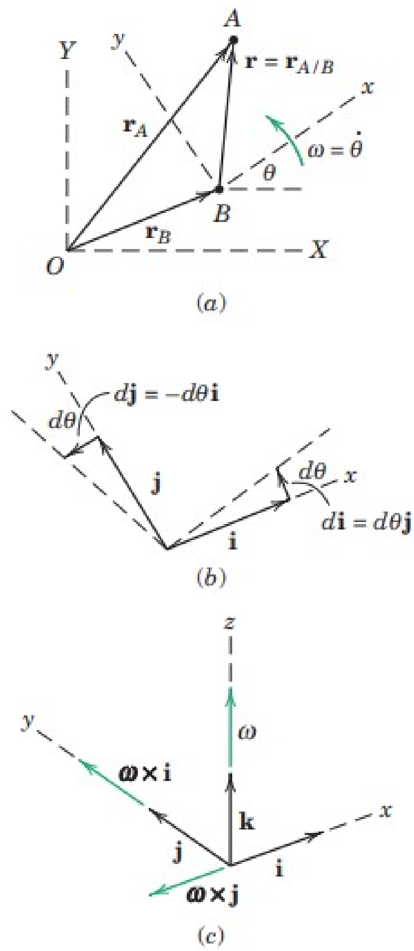


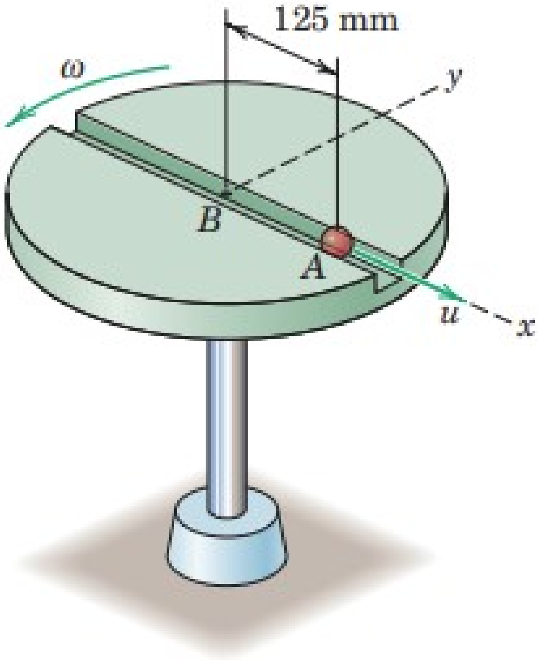
Figure 5/10

End of Section 5.6

Example 1:

The disk rotates with angular speed $\omega = 2\ rad/sec$ The small ball A is moving along the radial slot with speed $u = 100\ mm/sec$ relative to the disk. Determine the absolute velocity of the ball and state the angle β between this velocity vector and the positive x-axis.

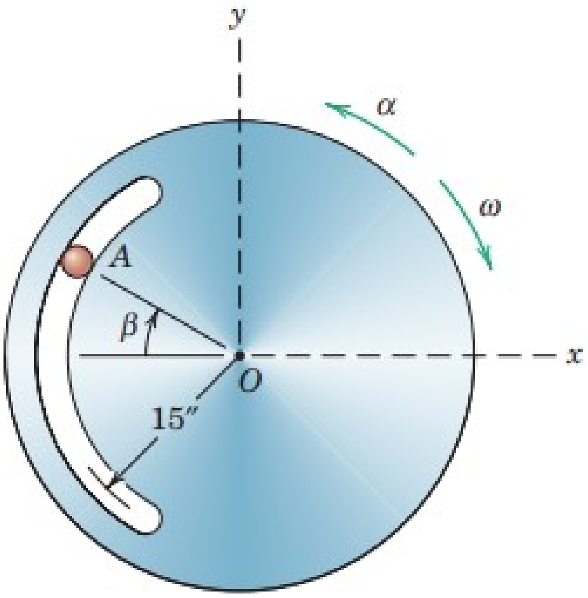
$ans.$ $\vec{v}_A = 0.1\hat{i} + 0.25\hat{j}\ m/sec$ $\beta = 68.2°$



Ans.

Example 2:

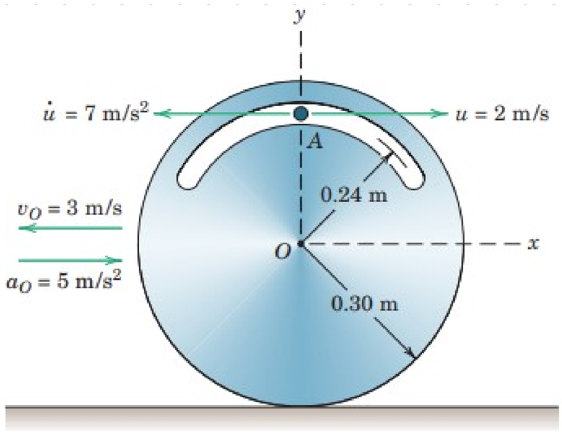
The disk rotates about a fixed axis through O with angular velocity $\omega = \ 5rad/sec$ and angular acceleration $\alpha = \ 3rad/sec^2$ in the directions shown at a certain instant. The small sphere A moves in the circular slot, and at the same instant, $\beta = 30°$, $\dot{\beta} = 2\ rad/sec$ and $\ddot{\beta} = -4\ rad/sec$ Determine the absolute velocity and acceleration of A at this instant
$ans.$ $v_A = 4.38\hat{i} + 7.58\hat{j}\ ft/sec$ $a_A = 48.7\hat{i} - 38.2\hat{j}\ ft/sec^2$



Ans.

Example 3:

The disk rolls without slipping on the horizontal surface, and at the instant represented, the center O has the velocity and acceleration shown in the figure. For this instant, the particle A has the indicated speed u and time rate of change of speed $\dot{u}$, both relative to the disk. Determine the absolute velocity and acceleration of particle A.
$v_A = -3.4\hat{i}\ m/sec$ $\quad a_A = 2\hat{i} - 0.667\hat{j}\ m/sec^2$

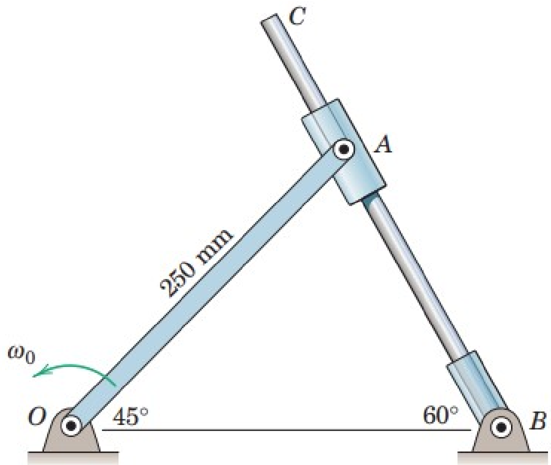


Ans.

Example 4:

Bar OA has a counterclockwise angular velocity $\omega_O = 2\ rad/sec$. Rod BC slides freely through the pivoted collar attached to OA. Determine the angular velocity ω_{BC} of rod BC and the velocity of collar A relative to rod BC

ans. $\omega_{BC} = 0.634\ rad/sec\ CCW$ $v_{rel} = 0.438\ m/sec$ $\theta = 120°$



Ans.