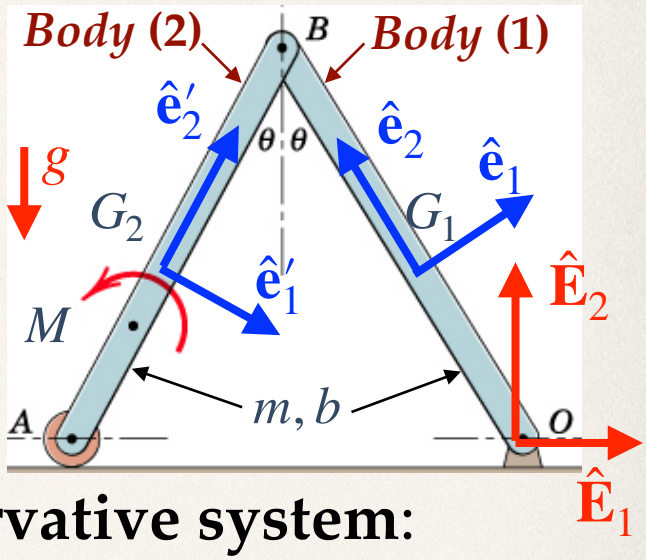
Lecture 16

Rigid body kinetics: Example of power balance

29 September - 5 October, 2021

Example 1

System is released from rest when $\theta = \theta_0$ with . M = const. Roller A is small. Find $\mathbf{v}^A$ when roller A reaches O.



I. **FBD $\Longrightarrow$ 2D conservative system:**

$$E_K + \sum_{n=1}^{N} \sum_{i} U_{in} + \sum_{n=1}^{N} \sum_{j} V_{jn} = \text{const}.$$

II. **Potential energies:**

$$V_{12} = -M\theta,\ U_{11} = U_{12} = -mgb\cos\theta/2$$

III. **KE of 2D rigid body:** $E_k = mv_G^2/2 + I_3^G\omega^2/2$

IV. **Kinematic analysis:** $\boldsymbol{\omega}^{OB} = -\boldsymbol{\omega}^{AB} = \dot{\theta}\hat{\mathbf{E}}_3$,

$\mathbf{v}^A = -2b\dot{\theta}\hat{\mathbf{E}}_1$, $\mathbf{v}^{G_1} = -b\dot{\theta}\hat{\mathbf{e}}_1/2$, $\mathbf{v}^{G_2} = -b\dot{\theta}\hat{\mathbf{e}}_1 - b\dot{\theta}\hat{\mathbf{e}}_1'/2$

V. **KE:** $E_k^{(1)} = mv_A^2/24$, $E_k^{(2)} = 7mv_A^2/24$

VI. **Ans.** $v_A|_{\theta=0^\circ} = \sqrt{3\{M\theta_0/m - gb(1-\cos\theta_0)\}}$

"Someday when you have a kid of your own and you feel the urge to arbitrarily say no just because you can, you'll understand."

Someday, may be, you will have students of your own!