MECH230 - Fall 2024
Recommended Problems - Set 17

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RB Kinetics Recall that for a rigid body the BoLM is

$$\mathbf{F} = m\mathbf{a}_C, \tag{1}$$

and the BoAM can be written in three equivalent forms

$$\mathbf{M}^O = \dot{\mathbf{H}}^O \quad \text{about a fixed point } O, \tag{2}$$

$$\mathbf{M}^C = \dot{\mathbf{H}}^C \quad \text{about the center of mass } C, \tag{3}$$

$$\mathbf{M}^P = \dot{\mathbf{H}}^P + (\mathbf{v}_P - \mathbf{v}_C) \times \mathbf{G} = \dot{\mathbf{H}}^C + (\mathbf{r}_C - \mathbf{r}_P) \times m\mathbf{a}_C \quad \text{about any material point } P \text{ on the body.} \tag{4}$$

The calculate the right-hand side of the BoAM for the case $\boldsymbol{\omega} = \dot{\theta}\mathbf{E}_z$, we have

$$\dot{\mathbf{H}}^O = (I^O_{xz}\dot{\omega} - I^O_{yz}\omega^2)\mathbf{e}_x + (I^O_{yz}\dot{\omega} + I^O_{xz}\omega^2)\mathbf{e}_y + I^O_{zz}\dot{\omega}\mathbf{E}_z, \tag{5}$$

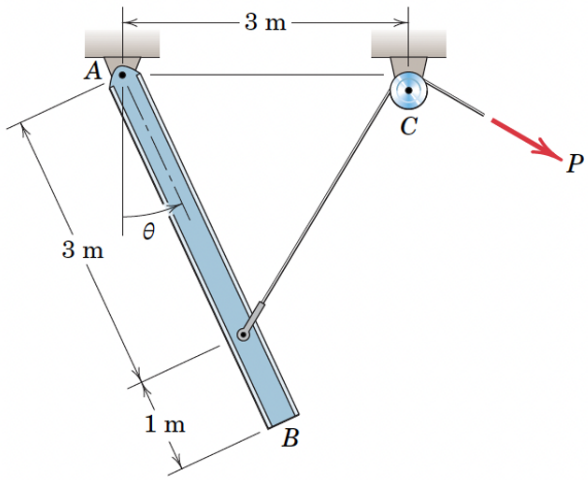
$$\dot{\mathbf{H}}^C = (I^C_{xz}\dot{\omega} - I^C_{yz}\omega^2)\mathbf{e}_x + (I^C_{yz}\dot{\omega} + I^C_{xz}\omega^2)\mathbf{e}_y + I^C_{zz}\dot{\omega}\mathbf{E}_z, \tag{6}$$

$$\dot{\mathbf{H}}^P = (I^P_{xz}\dot{\omega} - I^P_{yz}\omega^2)\mathbf{e}_x + (I^P_{yz}\dot{\omega} + I^P_{xz}\omega^2)\mathbf{e}_y + I^P_{zz}\dot{\omega}\mathbf{E}_z + \frac{d}{dt}\left((\mathbf{r}_C - \mathbf{r}_P) \times m\mathbf{v}_P\right). \tag{7}$$

These problems are taken from J. L. Meriam, L. G. Kraige, and J. N. Bolton (MKB), Engineering Mechanics: Dynamics, Ninth Edition, Wiley, New York, 2018.

1. [MKB 06-029]

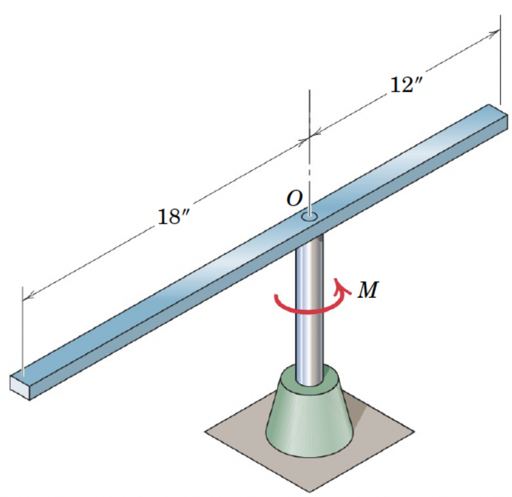
6/29 The uniform 100-kg beam is freely hinged about its upper end A and is initially at rest in the vertical position with $\theta = 0$. Determine the initial angular acceleration α of the beam and the magnitude F_A of the force supported by the pin at A due to the application of the force $P = 300$ N on the attached cable.



PROBLEM 6/29

2. [MKB 06-035]

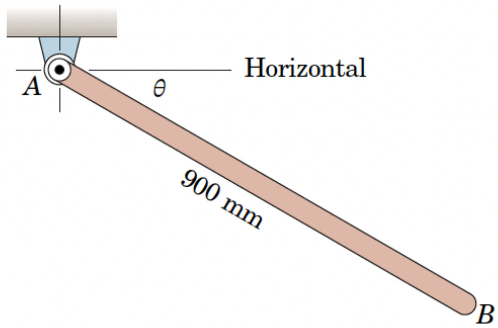
6/35 The 30-in. slender bar weighs 20 lb and is mounted on a vertical shaft at O. If a torque $M = 100$ lb-in. is applied to the bar through its shaft, calculate the horizontal force R on the bearing as the bar starts to rotate.



PROBLEM 6/35

3. [06-037]

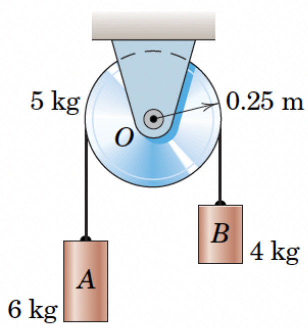
6/37 The uniform slender bar AB has a mass of 8 kg and swings in a vertical plane about the pivot at A. If $\dot{\theta} = 2$ rad/s when $\theta = 30°$, compute the force supported by the pin at A at that instant.



PROBLEM 6/37

4. [06-039]

6/39 Determine the angular acceleration of the uniform disk if (*a*) the rotational inertia of the disk is ignored and (*b*) the inertia of the disk is considered. The system is released from rest, the cord does not slip on the disk, and bearing friction at O may be neglected.



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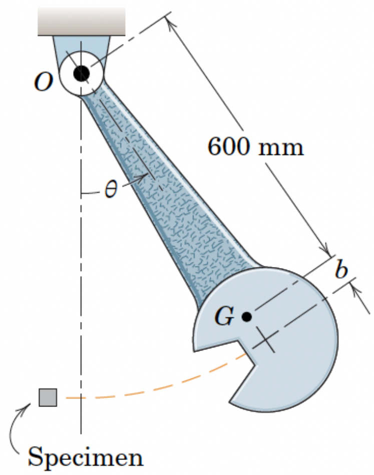
5. [06-051]

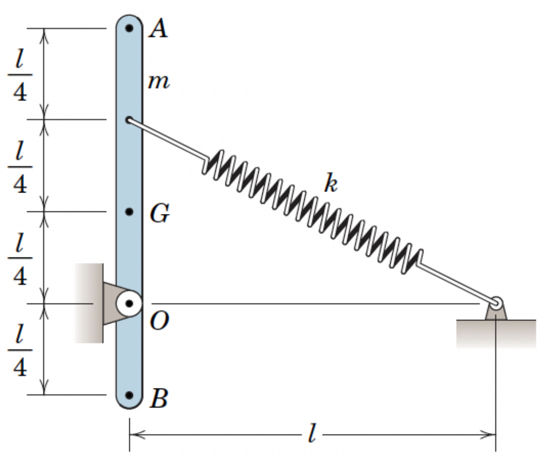
6/51 A device for impact testing consists of a 34-kg pendulum with mass center at G and with radius of gyration about O of 620 mm. The distance b for the pendulum is selected so that the force on the bearing at O has the least possible value during impact with the specimen at the bottom of the swing. Determine b and calculate the magnitude of the total force R on the bearing O an instant after release from rest at $\theta = 60°$.



PROBLEM 6/51

6. [06-054]

6/54 The spring is uncompressed when the uniform slender bar is in the vertical position shown. Determine the initial angular acceleration α of the bar when it is released from rest in a position where the bar has been rotated 30° clockwise from the position shown. Neglect any sag of the spring, whose mass is negligible.



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