MECH230 - Fall 2024
Recommended Problems - Set 04

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Constraints Constraints result in constraint forces. Watch this video explaining the difference in the normal force acting on a particle moving on a curve vs. a particle moving on a surface.

For pulley-chord systems,

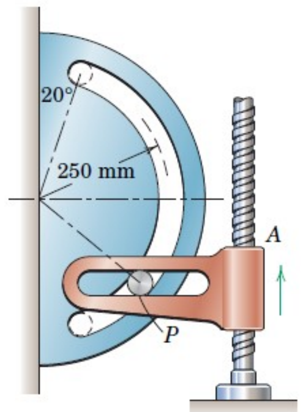
1. choose a datum,
2. define the distance of each connected body from the datum, and
3. write a chord equation for each separate chord.

Each chord equation and its derivatives provide additional information to solve the problem.

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 2/099] In this problem, rather than determining the $n-$ and $t-$ components of the acceleration of pin P, determine its $\mathbf{e}_r$ and $\mathbf{e}_\theta$ components where the origin is taken to be at the center of the circular slot.

2/99 In the design of a timing mechanism, the motion of pin P in the fixed circular slot is controlled by the guide A, which is being elevated by its lead screw. Guide A starts from rest with pin P at the lowest point in the circular slot, and accelerates upward at a constant rate until it reaches a speed of 175 mm/s at the halfway point of its vertical displacement. The guide then decelerates at a constant rate and comes to a stop with pin P at the uppermost point in the circular slot. Determine the n- and t-components of acceleration of pin P once the pin has traveled 30° around the slot from the starting position.



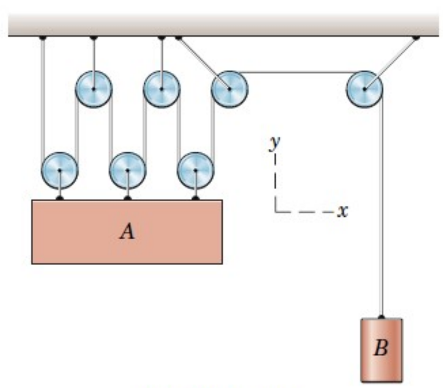
PROBLEM 2/99

2/100 An earth satellite which moves in the elliptical equa-

2. [MKB 02-172] The relative velocity notation signifies

$$\mathbf{v}_{B/A} = \mathbf{v}_B - \mathbf{v}_A = 3.5\mathbf{E}_y \quad \text{m/s}.$$

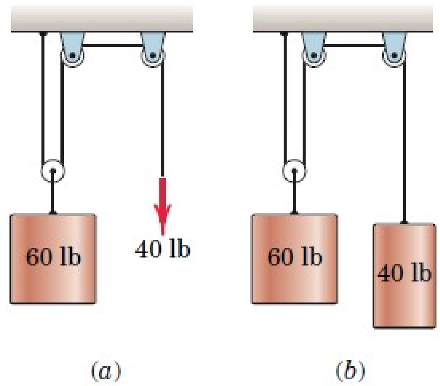
2/172 At the instant represented, $\mathbf{v}_{B/A} = 3.5\mathbf{j}$ m/s. Determine the velocity of each body at this instant. Assume that the upper surface of A remains horizontal.



PROBLEM 2/172

3. [MKB 03-021] Take $\mathbf{E}_y$ to point vertically upwards. Draw the free body diagram of each of the massless pulleys to determine the forces acting on the 60 lb cylinders in terms of the tension in the rope.

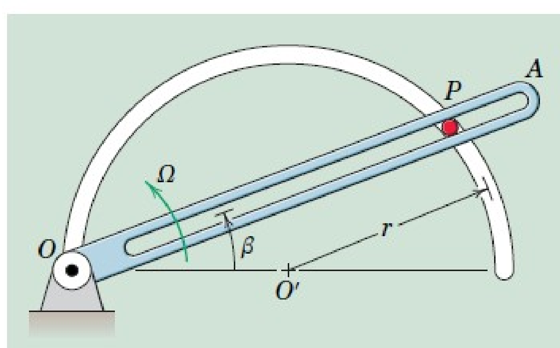
3/21 **SS** Determine the vertical acceleration of the 60-lb cylinder for each of the two cases. Neglect friction and the mass of the pulleys.



PROBLEM 3/21

4. [03-056] In this problem, you need to follow the 4 steps. Set up two polar coordinate systems having origins O and O' with respective basis vectors $\{\mathbf{e}_r, \mathbf{e}_\theta\}$ and $\{\mathbf{e}'_r, \mathbf{e}'_\theta\}$. Write the position vectors of the particle P in each basis. As you solve this problem, remember that the absolute velocity and acceleration of a particle are the same regardless of the basis they are expressed in.

3/56 A 0.2-kg particle P is constrained to move along the vertical-plane circular slot of radius $r = 0.5$ m and is confined to the slot of arm OA, which rotates about a horizontal axis through O with a constant angular rate $\Omega = 3$ rad/s. For the instant when $\beta = 20°$, determine the force N exerted on the particle by the circular constraint and the force R exerted on it by the slotted arm.



PROBLEM 3/56