23-2 Dynamics

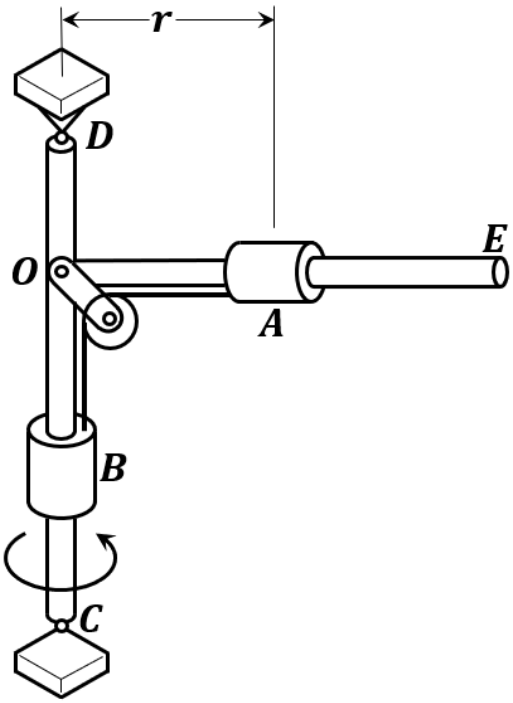
Finam exam

1. Two 4kg collars A and B can slide without friction on a frame, consisting of the horizontal rod OE and the vertical rod CD, which is free to rotate about CD. The two collars are connected by a cord running over a pulley that is attached to the frame and a stop prevents collar B from moving. The frame is rotating at the rate $\dot{\theta} = 16$rad/s and r=0.2m when the stop is removed allowing collar A to move out along rod OE. It is assumed that friction and the mass of the frame are neglected.

(a) Determine the transverse component of the velocity of collar A for the position $r = 0.4$ m. (5 pts)

(b) Determine the acceleration of collar A relative to the rod OE for the position $r = 0.4$ m. (10 pts)

(c) Draw the free body diagram of A and B each, and determine the tension in the cord for the position $r = 0.4$ m. (5 pts)

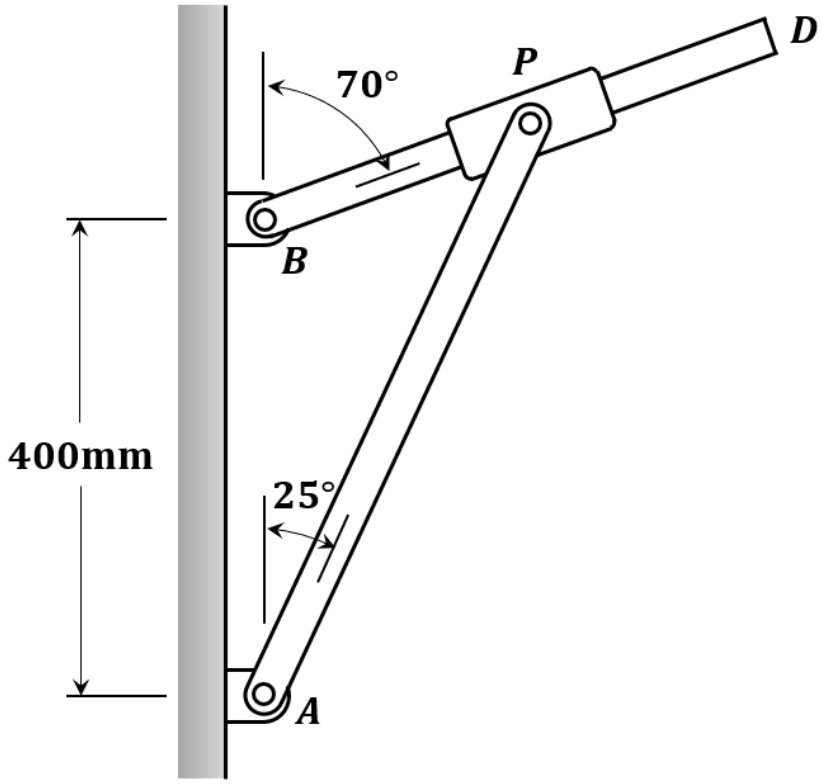


2. At the instant shown, the rod attached at A has an angular velocity of 5 rad/s counterclockwise and and angular acceleration of 2 rad/s^2 clockwise.

(a) Determine the velocity vector of the collar P. (10 pts)

(b) Determine the angular velocity of the rod attached at B and relative velocity of the collar about the rod at B (10 pts).

(c) Determine the angular acceleration of the rod attached at B (10 pts).

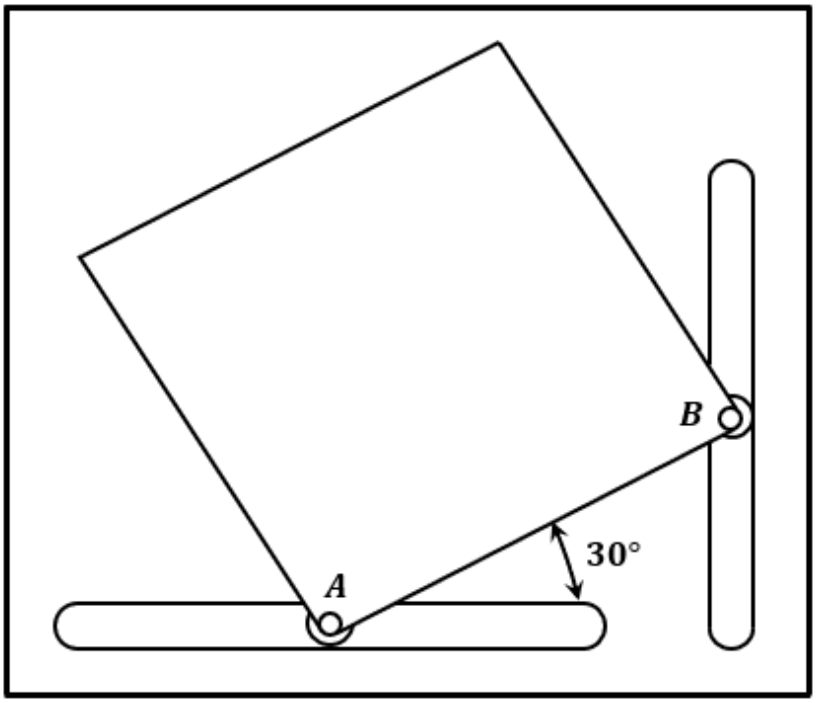


3. The motion of a square plate of side 200mm and mass 4 kg is guided by pins at corners A and B that slide in slots cut in a vertical wall.

a) Draw the free-body diagram of the square plate for translational, rotational and total motion. (6 pts)

b) Determine the angular acceleration of the plate immediately after the plate is released from the rest in the position shown. (14 pts)

c) Determine the reaction at corner A at the same moment. (5 pts)



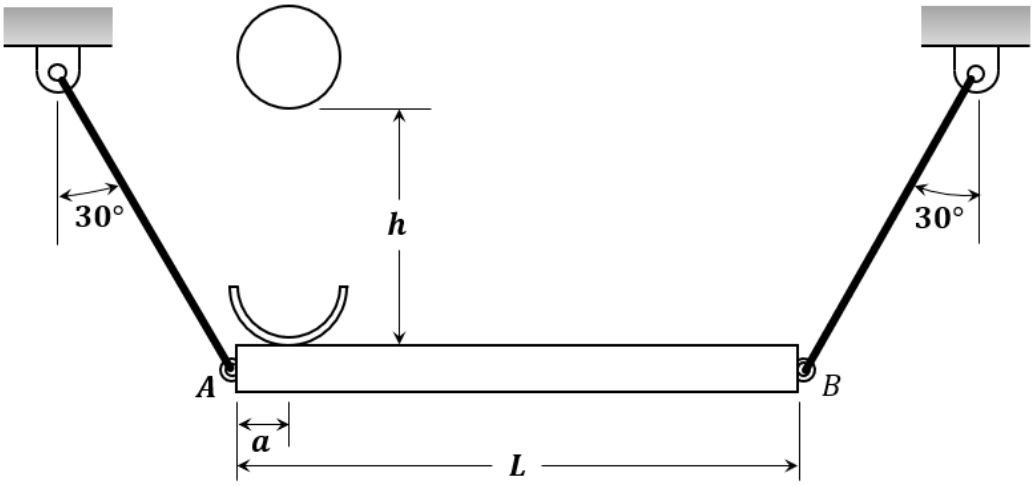
4. A 3-kg solid sphere of radius r= 30 mm is dropped from a height h= 250 mm and lands on a uniform slender plank AB of mass 5 kg and length L= 600 mm which is held by two inextensible cords. It is known that the sphere remains attached the plank at a distance a= 30 mm from the left end. Neglect the thickness of the blank, and it can be assumed that the gravitational force is relatively small to the impact.

a) Draw the free-body diagram of the plank. (5 pts)

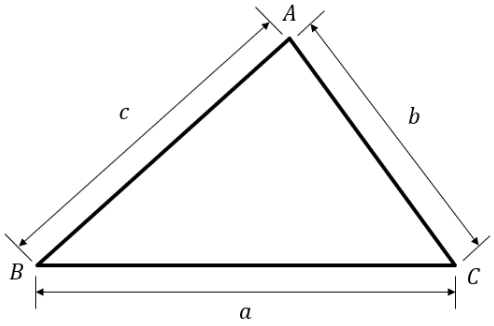
b) Determine the velocity vector of the sphere immediately after the impact. Assume that both cables are taut during the impact. (10 pts)

c) In (b), we assumed that both cables will be taut during the impact. Check whether the both ropes will be taut as we assumed. (10 pts)

(Hint : You can check the tautness of the rope by checking whether the integral of the impact over time is positive)



Appendix



- 사인 법칙

  주어진 삼각형에 대해, 아래의 수식이 성립한다.

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

- 제 2 코사인 법칙

  주어진 삼각형에 대해, 아래의 수식들이 성립한다.

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$b^2 = c^2 + a^2 - 2ca\cos A$$

$$c^2 = a^2 + b^2 - 2ab\cos A$$