Ref No.: **Ex/ME/5/T/112/2019**

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)
FIRST YEAR FIRST SEMESTER – 2019
Subject: ENGINEERING MECHANICS - III

Time : Three Hours **Full Marks : 100**

(Answer any Five Questions)

1. (a) A cylindrical cantilever rod ABC of length 'l' carries a load 'P' at its free end. For the first half length AB, the bar has a diameter 'D' and for the remaining length the diameter is '$D/2$'. Using Castigliano's theorem, show that deflection at the free end is given by $\frac{184}{3}\frac{Pl^3}{\pi D^4 E}$. (10)

(b) Find the deflection at the center of a simply supported beam of span 'l' carrying a uniformly distributed load of 'w' per unit run over the whole span. Use Castigliano's theorem and assume uniform flexural rigidity. (10)

2. (a) Derive the expression for the crippling load of a long column when

(*i*) its both ends are fixed. (6)

(*ii*) its one end is fixed and other end is free. (6)

(b) Determine the crippling load for a *T*-section of dimensions 10cmX10cmX2cm and of length 5m when it is used as a strut with both its ends fixed. Take, E=2.0X10^{5}N/mm^2. (8)

3. (a) What is meant by statically indeterminate beams. (2)

(b) A cantilever of length 2m carries a point load of 20kN at the free end and another load of 20kN at its center. If E=10^5 N/mm^2 and I=10^8 mm^4, determine the slope and deflection of the cantilever at its free end using the moment-area method. (9)

(c) The prismatic rods *AD* and *DB* are welded together (**Fig. 3**) to form the cantilever beam *ADB*. Knowing that the flexural rigidity is *EI* in portion *AD* of the beam and 2*EI* in portion *DB*, determine, for the loading shown, the slope and deflection at end *A*. (9)

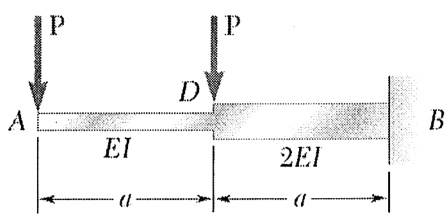

Fig. 3

4. (a) Explain the significance of instantaneous center. (4)

(b) The ends of the 0.4-m slender bar (**Fig. 4a**) remain in contact with their respective support surfaces. If end B has a velocity $v_B = 0.5m/s$ in the direction shown, determine the angular velocity of the bar and the velocity of end A using instantaneous center approach. (6)

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(c) Using vector notation, determine the angular acceleration of link AB and the linear acceleration of A for $\theta=90^0$ if $\dot{\theta} = 0$ and $\ddot{\theta} = 3rad/s^2$ at this position (**Fig. 4b**). (10)

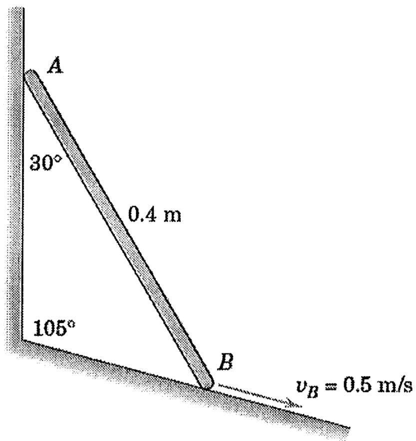


Fig. 4a

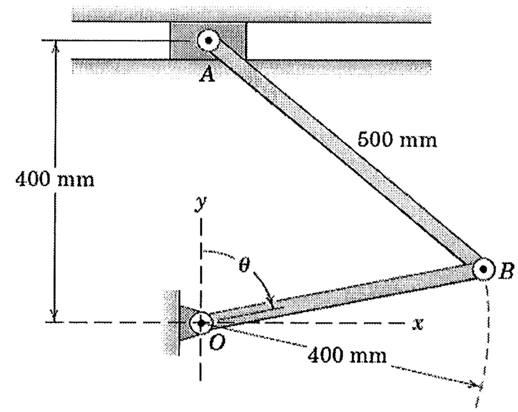


Fig. 4b

5. (a) In the four-bar linkage (**Fig. 5**), control link OA has a counterclockwise angular velocity of ω_0=10rad/s, during a short interval of motion. When link CB passes through the vertical position shown, point A has coordinates x=-60mm and y=80mm. Determine the angular velocities of AB and BC. (10)

(b) For the same four-bar linkage (**Fig. 5**), if OA has a constant counterclockwise angular velocity of ω_0=10rad/s, calculate the angular acceleration of the link AB and BC for the position of A as shown (x=-60mm and y=80mm). Link BC is vertical for this position. (10)

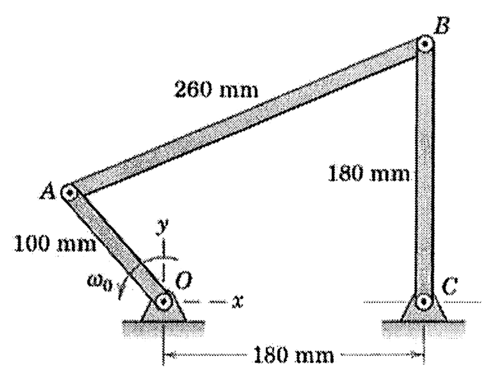
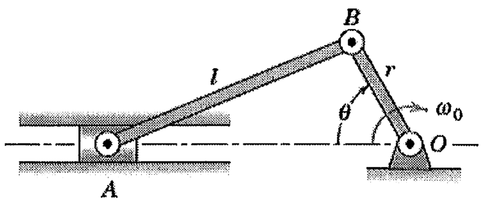


Fig. 5

6. (a) One of the most common mechanisms is the slider-crank (**Fig. 6a**). Express the angular velocity ω_{AB} and angular acceleration α_{AB} of the connecting rod AB in terms of the crank angle θ for a given constant crank speed ω_0. Take ω_{AB} and α_{AB} *to* be positive counterclockwise. (10)

(b) At the instant represented, the velocity of point A of the 1.2-m bar is 3m/s to the right. Determine the speed v_B of point B and the angular velocity ω of the bar. The diameter of the small end wheels may be neglected (**Fig. 6b**). (10)



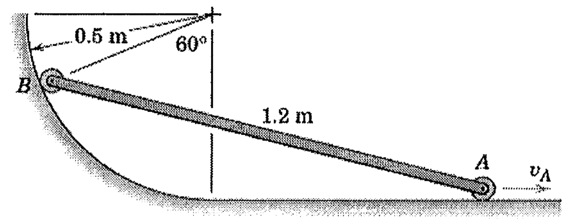


Fig. 6a **Fig. 6b**

7.(a) The flywheel (**Fig. 7a**) turns clockwise with a constant speed of 600rev/min. The connecting link *AB* slides through the pivoted collar at *C*. Calculate the angular velocity ω of *AB* for the instant when $\theta=60^0$. (10)

(b) Determine the acceleration of the shaft *B* for $\theta=60^0$ if the crank *OA* has an angular acceleration $\ddot{\theta}=8\text{rad/s}^2$ and an angular velocity $\dot{\theta}=4\text{rad/s}$ at this position. The spring maintains contact between the roller and the surface of the plunger (**Fig. 7b**). (10)

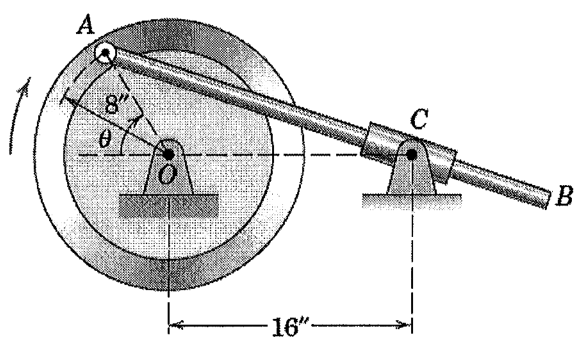


Fig. 7a

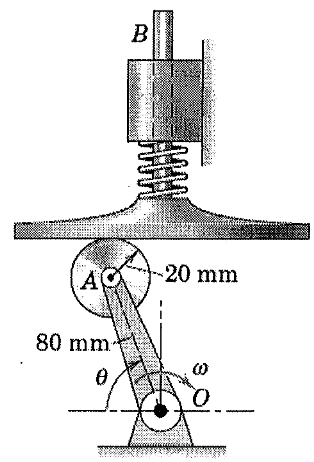


Fig. 7b