AE 688 Dynamics And Vibration
Assignment No. 3

1. The circular disk rotates with a constant angular velocity ω = 40 rad/s about its axis, which is inclined in the $y-z$ plane at the angle $\theta = \tan^{-1}\left(\frac{3}{4}\right)$. Determine the vector expressions for the velocity and acceleration of point P, whose position vector at the instant shown is **r =** 375**i** + 400**j** - 300**k** mm. (Check the magnitudes of your results from the scalar values $v = r\omega$ and $a_n = r\omega^2$.)

Ans. **v** = -20**i** + 12**j** - 9**k** m/s
a = -600**i** - 640**j** + 480**k** m/s^2

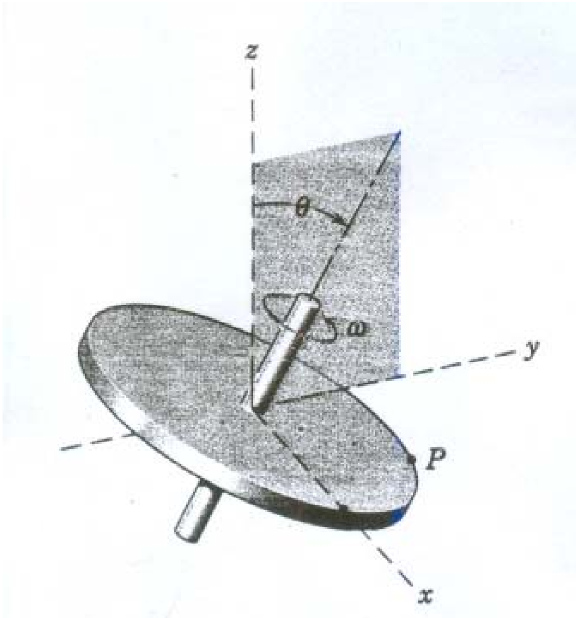


Figure 1

2. A V-belt speed-reduction drive is shown where pulley A drives the two integral pulleys B which in turn drive pulley C. If A starts from rest at time $t = 0$ and is given a constant angular acceleration α_1, derive expressions for the angular velocity of C and the magnitude of the acceleration of a point P on the belt, both at time t.

Ans. $\omega_c = \left(\frac{r_1}{r_2}\right)^2 \alpha_1 t$, $a_P = \frac{r_1^2}{r_2}\alpha_1 \sqrt{1+\left(\frac{r_1}{r_2}\right)^4 \alpha_1^2 t^4}$

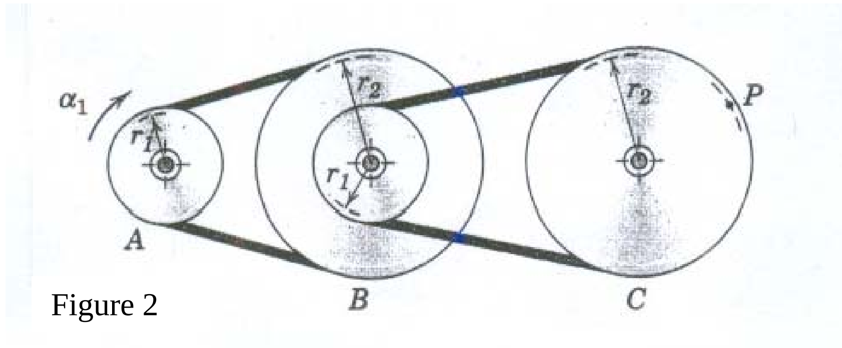


Figure 2

3. A device which tests the resistance to wear of two materials A and B is shown. If the link EO has a velocity of 1.2 m/s to the right when $\theta = 45°$, determine the rubbing velocity v_A.

Ans. v_A =2.76 m/s

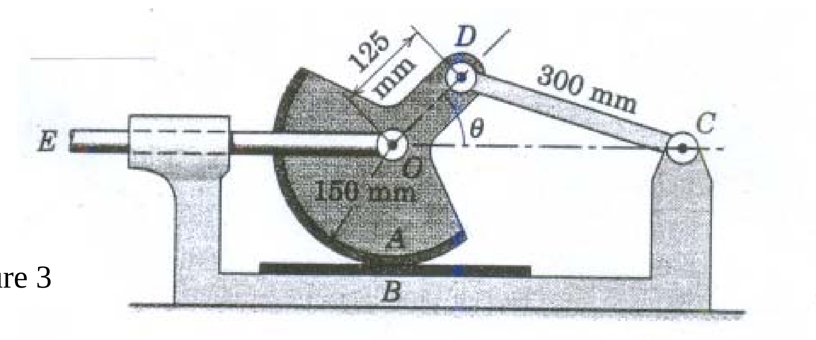


Figure 3

4. Slider A moves in the horizontal slot with a constant speed v for a short interval of motion. Determine the angular velocity ω of bar AB in terms of the displacement x_A.

$$Ans. \quad \omega = \frac{\sqrt{3}v}{2L\sqrt{1 - \frac{3}{4}\frac{x_A^2}{L^2}}}$$

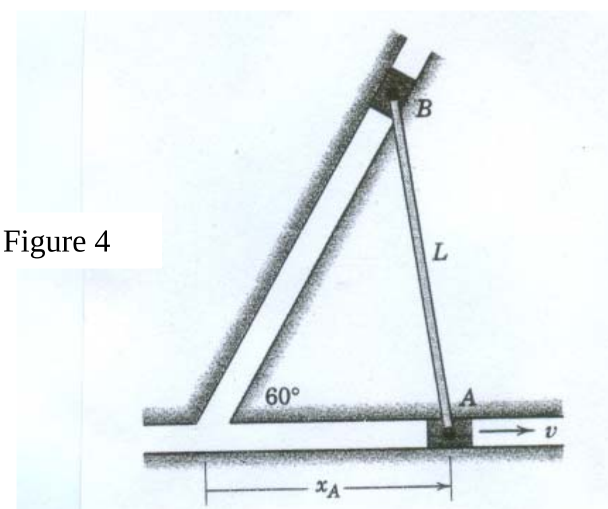


Figure 4

5. The punch is operated by a simple harmonic oscillation of the pivoted sector given by $\theta = \theta_0 \sin 2\pi t$ where the amplitude is $\theta_0 = \pi/12\, rad\ (15°)$ and the time for one complete oscillation is 1 second. Determine the acceleration of the punch when $(a)\, \theta = 0$ and $(b)\, \theta = \pi/12$.

Ans. (a) $a = 0.909$ m/s^2 up
(b) $a = 0.918$ m/s^2 down

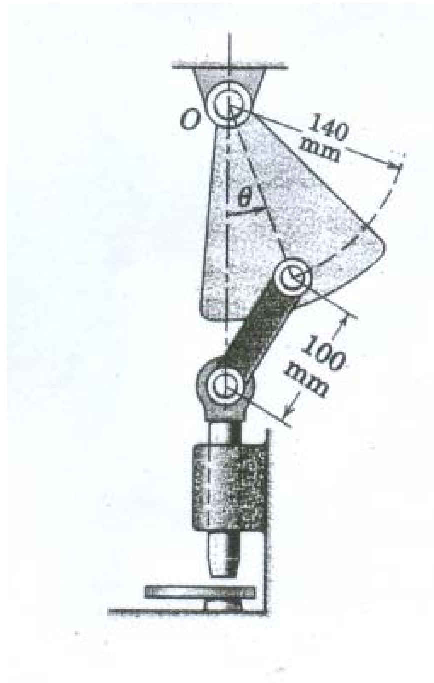


Figure 5

6. For the instant represented, crank OB has a clockwise angular velocity $\omega =$ 0.8 rad/s and is passing the horizontal position. Determine the corresponding velocity of the guide roller A in the $20°$ slot and the velocity of point C midway between A and B.

Ans. $v_A = 0.226$ m/s, $v_C = 0.1747$ m/s

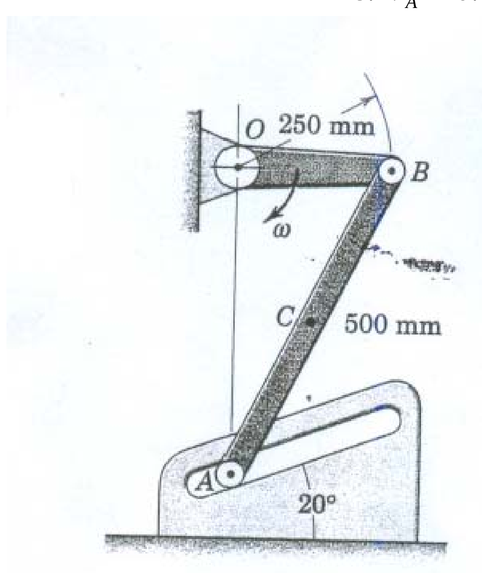
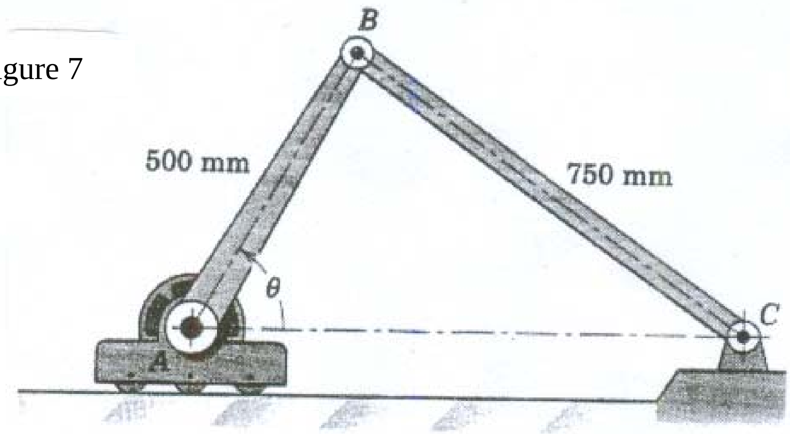


Figure 6

7. The unit at A consists of a high-torque geared motor which rotates link AB at the constant rate $\dot{\theta} = 0.5$ rad/s. Unit A is free to roll along the horizontal surface. Determine the velocity v_A of unit A when θ reaches $60°$.

Ans. $v_A = 305$ mm/s

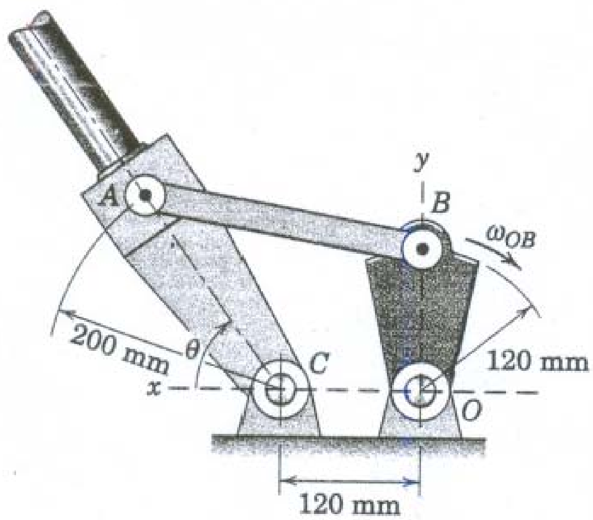
Figure 7



8. The elements of the mechanism for deployment of a spacecraft magnetometer boom are shown. Determine the angular velocity of the boom when the driving link OB crosses the y-axis with an angular velocity $\omega_{OB} =$ 0.5 rad/s if $\tan\theta = 4/3$ at this instant.

Ans. $\omega_{CA} = 0.429\mathbf{k}$ rad/s

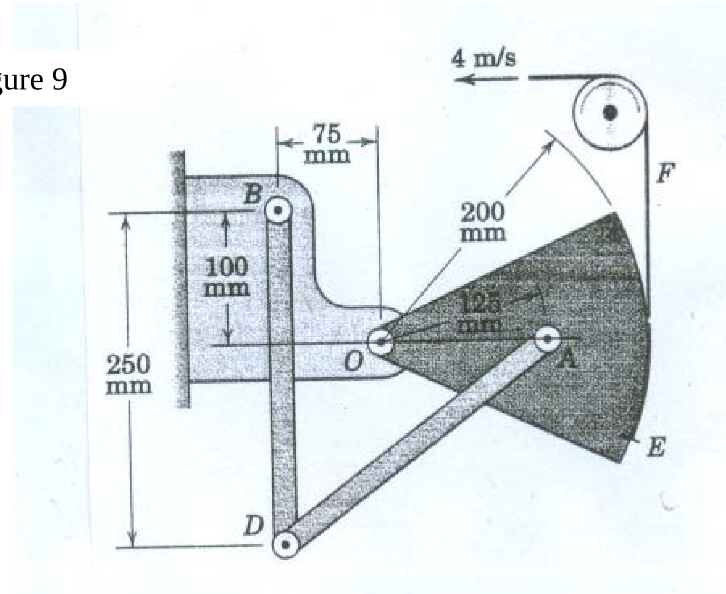
Figure 8



9. The flexible band F is attached at E to the rotating sector and leads over the guide pulley. Determine the angular velocities of AD and BD for the position shown if the band has a velocity of 4 m/s.

Ans. $\omega_{AD} = 12.5$ rad/s, $\omega_{BD} = 7.5$ rad/s

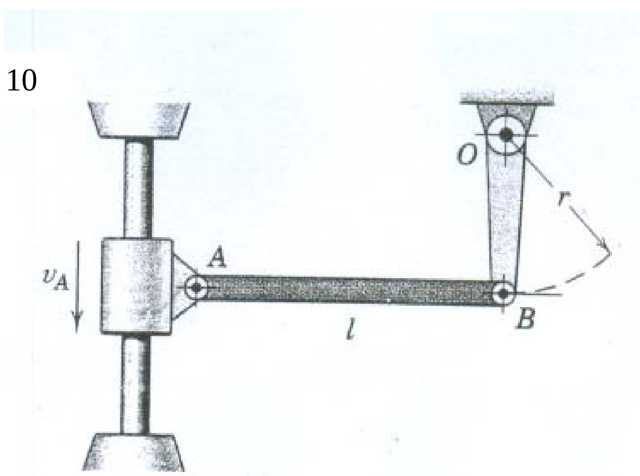
Figure 9



10. The sliding collar moves up and down the shaft, causing an oscillation of crank OB. If the velocity of A is not changing as it passes the null position where AB is horizontal and OB is vertical, determine the angular acceleration of OB in that position.

$$Ans.\ \alpha_{OB} = \frac{v_A^2}{rl} CW$$

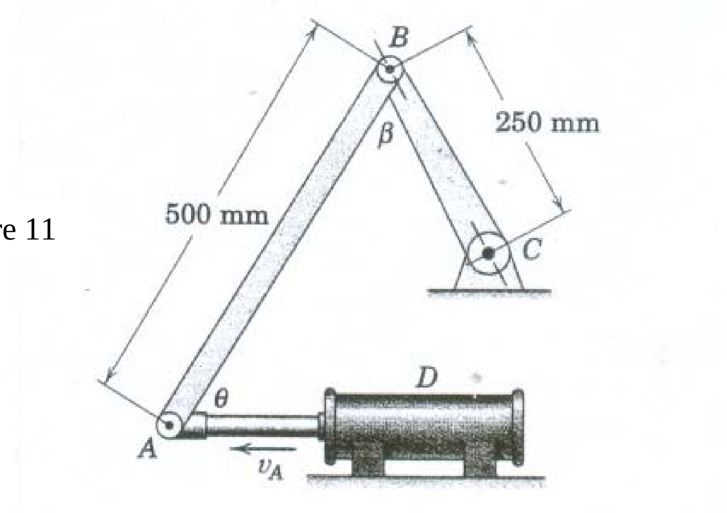
Figure 10



11. The linkage of Prob. 5/66 is shown again here. For the instant when $\theta = \beta = 60°$, the hydraulic cylinder gives A a velocity $v_A = 1.2$ m/s which is increasing by 0.9 m/s each second. For this instant determine the angular acceleration of link BC.

$$Ans.\ \alpha_{BC} = 2.08\ rad/s^2\ CCW$$

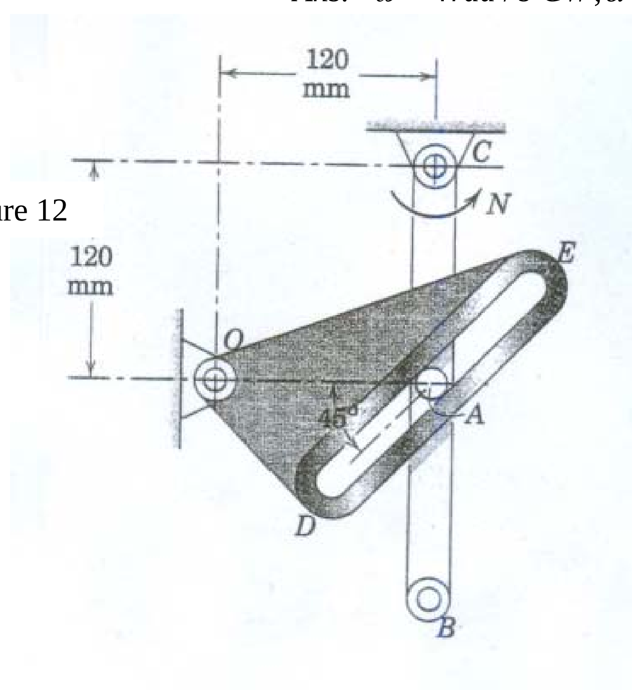
Figure 11



12. For the instant represented, link CB is rotating counterclockwise at a constant rate $N = 4$ rad/s, and its pin A causes a clockwise rotation of the slotted member ODE. Determine the angular velocity ω and angular acceleration α of ODE for this instant.

Ans. $\omega = 4\,rad/s\ CW, \alpha = 64.0\,rad/s^2\ CCW$

Figure 12



13. For the linkage shown, if $v_A = 500$ mm/s and is constant when the two links become perpendicular to one another, determine the angular acceleration of CB for this position.

Ans. $\alpha_{CB} = 5.76\,rad/s^2\ CW$

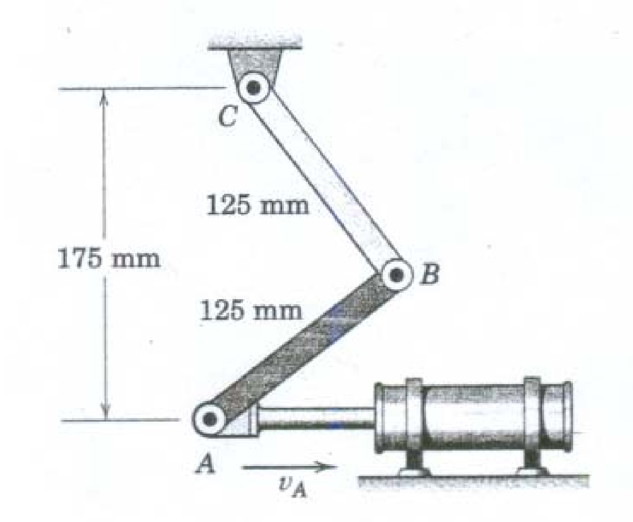


Figure 13

14. The pin A in the bell crank AOD is guided by the flanges of the collar B, which slides with a constant velocity v_B of 0.9 m/s along the fixed shaft for an interval of motion. For the position $\theta = 30°$ determine the acceleration of the plunger CE, whose upper end is positioned by the radial slot in the bell crank.

Ans. $a_C = 24.9\ \text{m/s}^2$ up

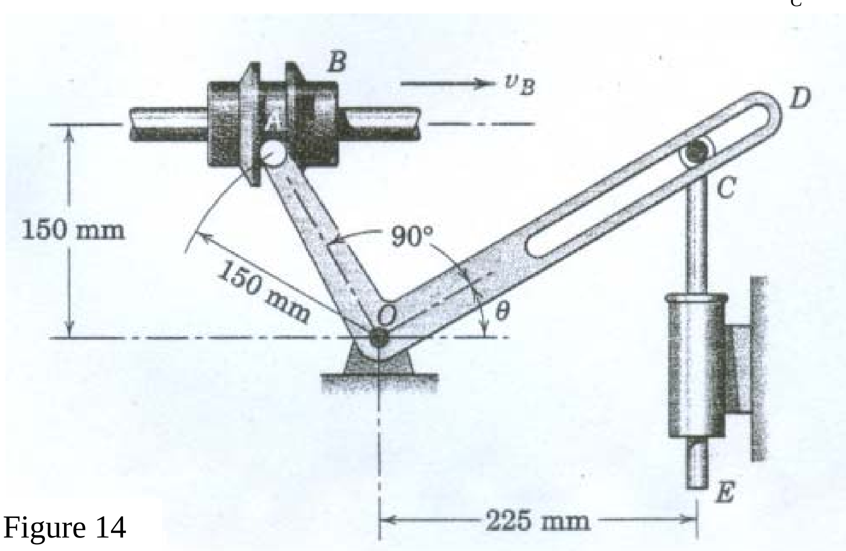


Figure 14