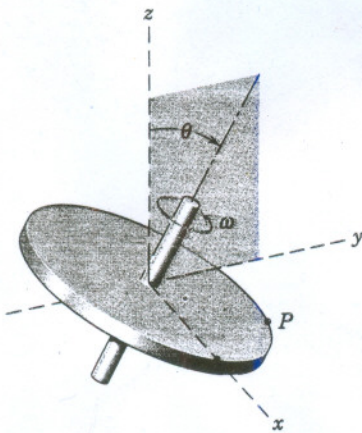


ELEMENTS OF VIBRATION

Assignment-3

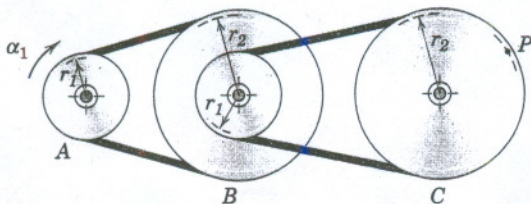
1. The circular disk rotates with a constant angular velocity $\omega = 40 \text{ rad/s}$ about its axis, which is inclined in the $y-z$ plane at the angle $\theta = \tan^{-1} \frac{3}{4}$. Determine the vector expressions for the velocity and acceleration of point P , whose position vector at the instant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

Ans. $\mathbf{v} = -20\mathbf{i} + 12\mathbf{j} - 9\mathbf{k} \text{ m/s}$
 $\mathbf{a} = -600\mathbf{i} - 640\mathbf{j} + 480\mathbf{k} \text{ m/s}^2$



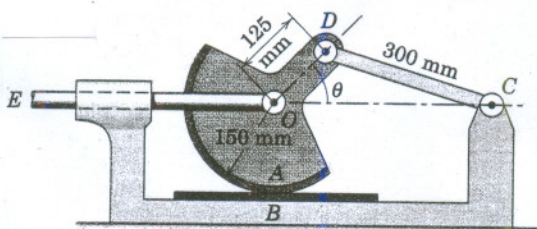
2. A V-belt speed-reduction drive is shown where pulley A drives the two integral pulleys B which in turn drive pulley C. If A starts from rest at time $t = 0$ and is given a constant angular acceleration α_1 , derive expressions for the angular velocity of C and the magnitude of the acceleration of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

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



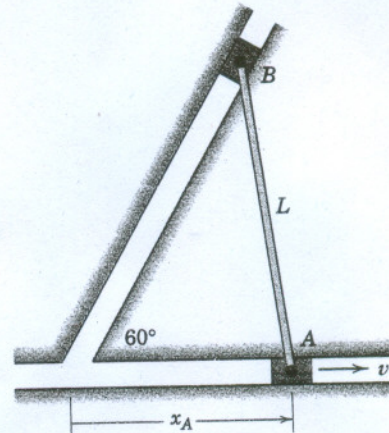
3. A device which tests the resistance to wear of two materials A and B is shown. If the link EO has a velocity of 1.2 m/s to the right when $\theta = 45^\circ$, determine the rubbing velocity v_A .

Ans. $v_A = 2.76 \text{ m/s}$



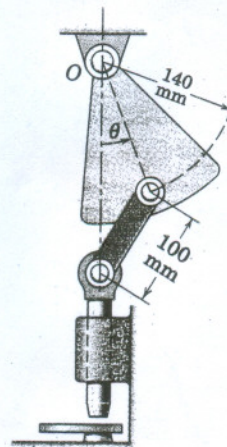
4. Slider A moves in the horizontal slot with a constant speed v for a short interval of motion. Determine the angular velocity ω of bar AB in terms of the displacement x_A .

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



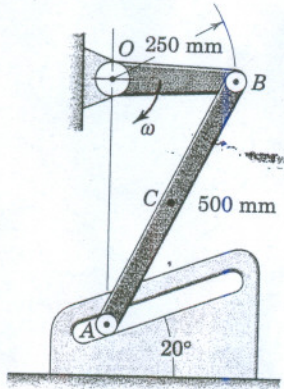
5. The punch is operated by a simple harmonic oscillation of the pivoted sector given by $\theta = \theta_0 \sin 2\pi t$ where the amplitude is $\theta_0 = \pi/12 \text{ rad}$ (15°) and the time for one complete oscillation is 1 second. Determine the acceleration of the punch when (a) $\theta = 0$ and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

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



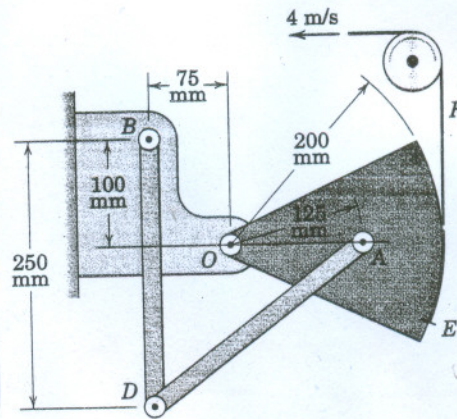
6. For the instant represented, crank OB has a clockwise angular velocity $\omega = 0.8 \text{ rad/s}$ and is passing the horizontal position. Determine the corresponding velocity of the guide roller A in the 20° slot and the velocity of point C midway between A and B .

Ans. $v_A = 0.226 \text{ m/s}$, $v_C = 0.1747 \text{ m/s}$



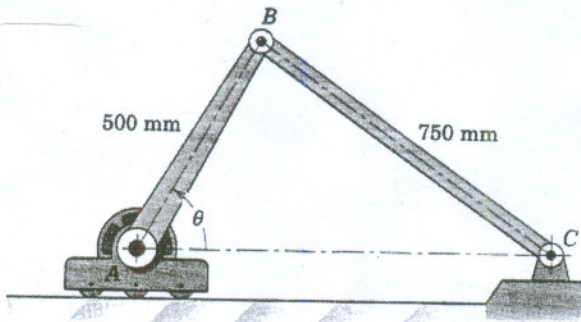
9. The flexible band F is attached at E to the rotating sector and leads over the guide pulley. Determine the angular velocities of AD and BD for the position shown if the band has a velocity of 4 m/s .

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



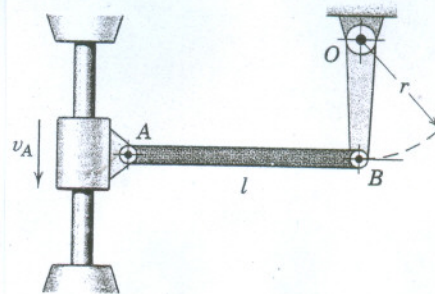
7. The unit at A consists of a high-torque geared motor which rotates link AB at the constant rate $\dot{\theta} = 0.5 \text{ rad/s}$. Unit A is free to roll along the horizontal surface. Determine the velocity v_A of unit A when θ reaches 60° .

Ans. $v_A = 305 \text{ mm/s}$



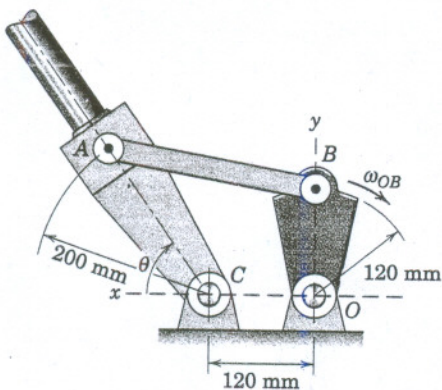
10. The sliding collar moves up and down the shaft, causing an oscillation of crank OB . If the velocity of A is not changing as it passes the null position where AB is horizontal and OB is vertical, determine the angular acceleration of OB in that position.

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



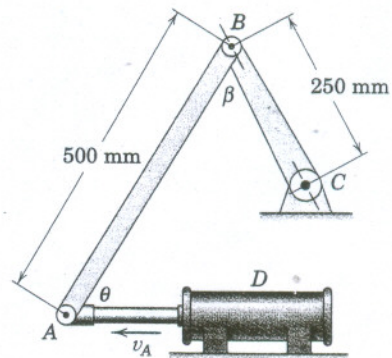
8. The elements of the mechanism for deployment of a spacecraft magnetometer boom are shown. Determine the angular velocity of the boom when the driving link OB crosses the y -axis with an angular velocity $\omega_{OB} = 0.5 \text{ rad/s}$ if $\tan \theta = 4/3$ at this instant.

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



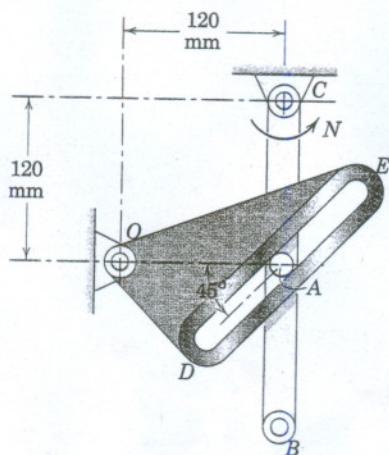
11. The linkage of Prob. 5/66 is shown again here. For the instant when $\theta = \beta = 60^\circ$, the hydraulic cylinder gives A a velocity $v_A = 1.2 \text{ m/s}$ which is increasing by 0.9 m/s each second. For this instant determine the angular acceleration of link BC .

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



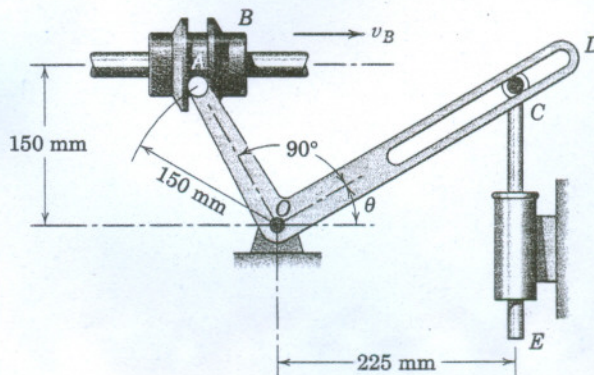
12. For the instant represented, link CB is rotating counterclockwise at a constant rate $N = 4 \text{ rad/s}$, and its pin A causes a clockwise rotation of the slotted member ODE . Determine the angular velocity ω and angular acceleration α of ODE for this instant.

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



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 $\theta = 30^\circ$ determine the acceleration of the plunger CE , whose upper end is positioned by the radial slot in the bell crank.

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



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

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

