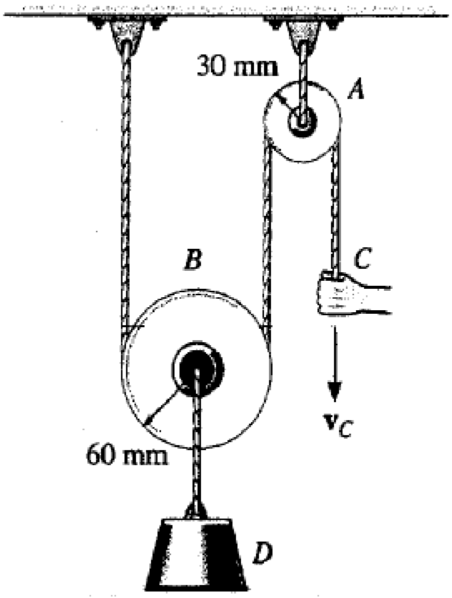
DİNAMİK SINAVLARA HAZIRLIK, ÇALIŞMA SORULARI

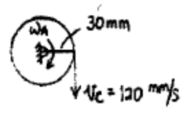
RİJİTCİSMİN DÜZLEMSEL HAREKETİ

Örnek

If the end of the cord is pulled downward with a speed $v_C = 120$ mm/s, determine the angular velocities of pulleys A and B and the speed of block D. Assume that the cord does not slip on the pulleys.



For pulley A : Motion about a fixed axis through the center applies.



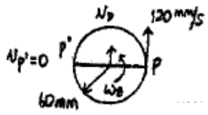
$$v_C = r_A \omega_A$$

$$120 = 30\omega_A$$

$$\omega_A = 4 \text{ rad/s} \qquad \textbf{Ans}$$

For pulley B : Point P' is at rest during the instant considered.

Thus,



$$\mathbf{v}_P = \mathbf{v}_{P'} + \mathbf{v}_{P/P'}$$

$$(+\uparrow) \quad 120 = 0 + 120(\omega_B)$$

$$\omega_B = 1 \text{ rad/s} \qquad \textbf{Ans}$$

$$\mathbf{v}_D = \mathbf{v}_{P'} + \mathbf{v}_{D/P'}$$

$$(+\uparrow) \quad v_D = 0 + 60(1)$$

$$v_D = 60 \text{ mm/s} \qquad \textbf{Ans}$$

Örnek

16-1. A wheel has an initial clockwise angular velocity of 10 rad/s and a constant angular acceleration of 3 rad/s^2. Determine the number of revolutions it must undergo to acquire a clockwise angular velocity of 15 rad/s. What time is required?

$$\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$$

$$(15)^2 = (10)^2 + 2(3)(\theta - 0)$$

$$\theta = 20.83 \text{ rad} = 20.83\left(\frac{1}{2\pi}\right) = 3.32 \text{ rev.} \qquad \textbf{Ans}$$

$$\omega = \omega_0 + \alpha_c t$$

$$15 = 10 + 3t$$

$$t = 1.67 \text{ s} \qquad \textbf{Ans}$$

Örnek

16-2. A flywheel has its angular speed increased uniformly from 15 rad/s to 60 rad/s. in 80s. If the diameter of the wheel is 2 ft, determine the magnitudes of the normal and tangential components of acceleration of a point on the rim of the wheel when $t = 80$ s, and the total distance the point travels during the time period.

$$\omega = \omega_0 + \alpha_c t$$

$$60 = 15 + \alpha_c(80)$$

$$\alpha_c = 0.5625 \text{ rad/s}^2$$

$$a_t = \alpha r = (0.5625)(1) = 0.562 \text{ ft/s}^2 \qquad \textbf{Ans}$$

$$a_n = \omega^2 r = (60)^2(1) = 3600 \text{ ft/s}^2 \qquad \textbf{Ans}$$

$$\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$$

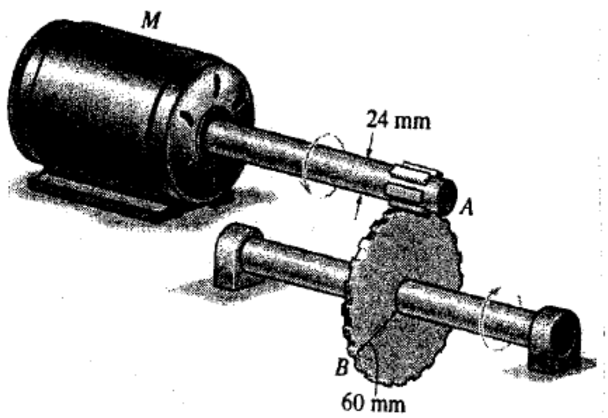
$$(60)^2 = (15)^2 + 2(0.5625)(\theta - 0)$$

$$\theta = 3000 \text{ rad}$$

$$s = \theta r = 3000(1) = 3000 \text{ ft} \qquad \textbf{Ans}$$

Örnek

Due to an increase in power, the motor M rotates the shaft A with an angular acceleration of $\alpha = (0.06\theta^2)$ rad/s², where θ is in radians. If the shaft is initially turning at $\omega_0 = 50$ rad/s, determine the angular velocity of gear B after the shaft undergoes an angular displacement $\Delta\theta = 10$ rev.



$$\omega \, d\omega = \alpha \, d\theta$$

$$\int_{50}^{\omega} \omega \, d\omega = \int_0^{2\pi(10)} 0.06\theta^2 \, d\theta$$

$$\frac{1}{2}\omega^2 \Big|_{50}^{\omega} = 0.02\theta^3 \Big|_0^{2\pi(10)}$$

$$0.5\omega^2 - 1250 = 4961$$

$$\omega = 111.45 \text{ rad/s}$$

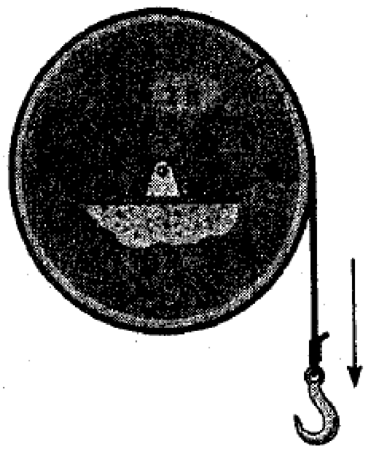
$$\omega_A r_A = \omega_B r_B$$

$$(111.45)(12) = \omega_B(60)$$

$$\omega_B = 22.3 \text{ rad/s} \qquad \textbf{Ans}$$

Örnek

The hook moves from rest with an acceleration of 20 ft/s². If it is attached to a cord which is wound around the drum, determine the angular acceleration of the drum and its angular velocity after the drum has completed 10 rev. How many more revolutions will the drum turn after it has first completed 10 rev and the hook continues to move downward for 4 s?



$a_t = \alpha r,$

$20 = \alpha(2)$

$\alpha = 10.0 \text{ rad/s}^2$ **Ans**

$\alpha_c = \alpha = 10.0 \text{ rad/s}^2$

$\theta = (10 \text{ rev}) \times \left(\dfrac{2\pi \text{ rad}}{1 \text{ rev}}\right)$

$\theta = 20\pi \text{ rad}$ **Ans**

The angular displacement of the drum 4 s after it has completed 10 revolutions can be determine by applying Eq. with $\omega_0 = 35.45$ rad/s.

$$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha_c t^2$$

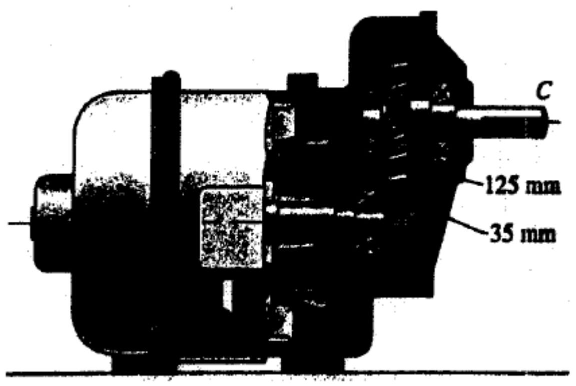
$$= 0 + 35.45(4) + \frac{1}{2}(10.0)(4^2)$$

$$= (221.79 \text{ rad}) \times \left(\frac{1 \text{ rev}}{2\pi \text{ rad}}\right) = 35.3 \text{ rev}$$ **Ans**

Örnek

Şekil çok iyi anlaşılmıyor. Motor miline bağlı yarıçapı 35 mm olan bir dişli, çıkış miline bağlı yarıcapı 125 mm olan birbiriyle çalışan iki dişli vardır.

The pinion gear *A* on the motor shaft is given a constant angular acceleration $\alpha = 3$ rad/s². If the gears *A* and *B* have the dimensions shown, determine the angular velocity and angular displacement of the output shaft *C*, when $t = 2$ s starting from rest. The shaft is fixed to *B* and turns with it.



$\omega = \omega_0 + \alpha_c t$

$\omega_A = 0 + 3(2) = 6 \text{ rad/s}$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha_c t^2$

$\theta_A = 0 + 0 + \frac{1}{2}(3)(2)^2$

$\theta_A = 6 \text{ rad}$

$\omega_A r_A = \omega_B r_B$

$6(35) = \omega_B(125)$

$\omega_C = \omega_B = 1.68 \text{ rad/s}$ **Ans**

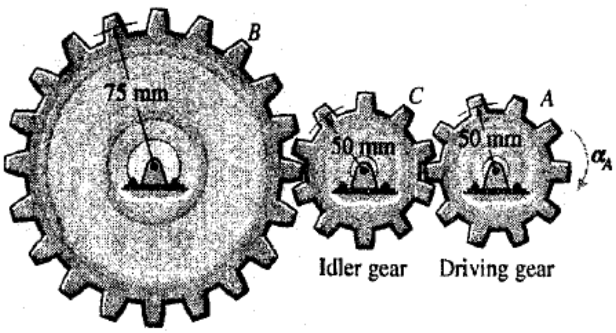
$\theta_A r_A = \theta_B r_B$

$6(35) = \theta_B(125)$

$\theta_C = \theta_B = 1.68 \text{ rad}$ **Ans**

Örnek

When only two gears are in mesh, the driving gear A and the driven gear B will always turn in opposite directions. In order to get them to turn in the *same direction* an idler gear C is used. In the case shown, determine the angular velocity of gear B when $t = 5$ s, if gear A starts from rest and has an angular acceleration of $\alpha_A = (3t + 2)$ rad/s^2, where t is in seconds.



$d\omega = \alpha\, dt$

$$\int_0^{\omega_A} d\omega_A = \int_0^t (3t+2)\, dt$$

$$\omega_A = 1.5t^2 + 2t|_{t=5} = 47.5 \text{ rad/s}$$

$$(47.5)(50) = \omega_C(50)$$

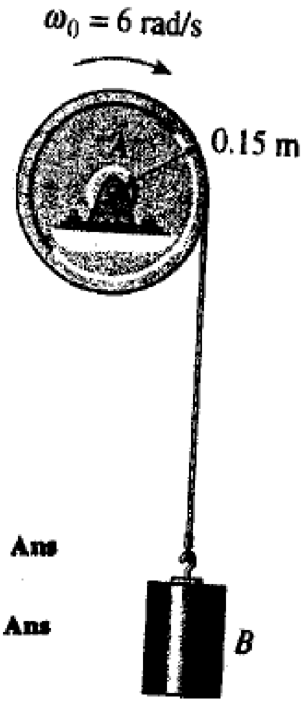
$$\omega_C = 47.5 \text{ rad/s}$$

$$\omega_B(75) = 47.5(50)$$

$$\omega_B = 31.7 \text{ rad/s} \quad \textbf{Ans}$$

Örnek

A motor gives disk A an angular acceleration of $\alpha_A = (0.6t^2 + 0.75)$ rad/s^2, where t is in seconds. If the initial angular velocity of the disk is $\omega_0 = 6$ rad/s, determine the magnitudes of the velocity and acceleration of block B when $t = 2$ s.



$$d\omega = \alpha\, dt$$

$$\int_6^{\omega} d\omega = \int_0^2 (0.6t^2 + 0.75)\, dt$$

$$\omega - 6 = (0.2t^3 + 0.75t)|_0^2$$

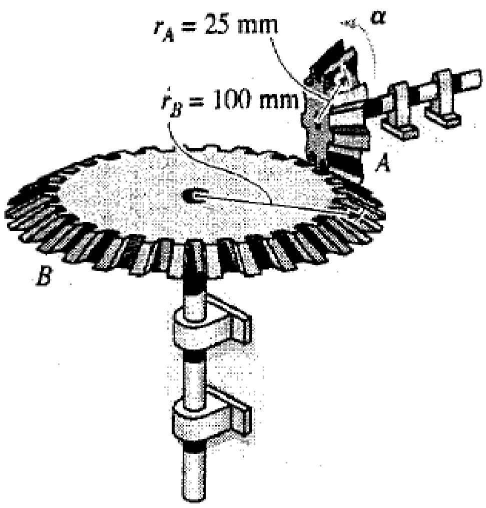
$$\omega = 9.10 \text{ rad/s}$$

$$v_B = \omega r = 9.10(0.15) = 1.37 \text{ m/s} \quad \textbf{Ans}$$

$$a_B = a_t = \alpha r = [0.6(2)^2 + 0.75](0.15) = 0.472 \text{ m/s}^2 \quad \textbf{Ans}$$

Örnek

Gear A is in mesh with gear B as shown. If A starts from rest and has a constant angular acceleration of $\alpha_A = 2\ \text{rad/s}^2$, determine the time needed for B to attain an angular velocity of $\omega_B = 50\ \text{rad/s}$.



Angular Motion: The angular acceleration of gear B must be determined first. Here, $\alpha_A r_A = \alpha_B r_B$. Then,

$$\alpha_B = \frac{r_A}{r_B}\alpha_A = \left(\frac{25}{100}\right)(2) = 0.5\ \text{rad/s}^2$$

The time for gear B to attain an angular velocity of $\omega_B = 50$ rad/s can be obtained by applying Eq. 16-5.

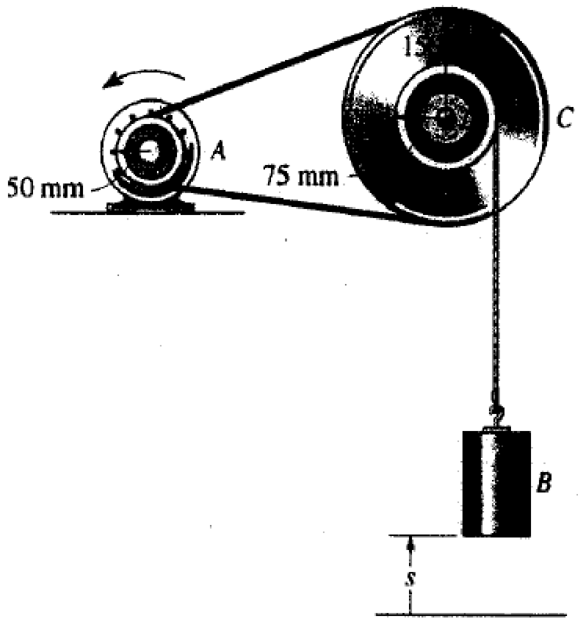
$$\omega_B = (\omega_0)_B + \alpha_B t$$

$$50 = 0 + 0.5t$$

$$t = 100\ \text{s} \qquad \textbf{Ans}$$

Örnek

Starting from rest when $s = 0$, pulley A is given a constant angular acceleration $\alpha_c = 6 \text{ rad/s}^2$. Determine the speed of block B when it has risen $s = 6$ m. The pulley has an inner hub D which is fixed to C and turns with it.



$$\alpha_A r_A = \alpha_C r_C$$

$$6(50) = \alpha_C(150)$$

$$\alpha_C = 2 \text{ rad/s}^2$$

$$a_B = \alpha_C r_B = 2(0.075) = 0.15 \text{ m/s}^2$$

$$(+\uparrow) \quad v^2 = v_0^2 + 2a_c(s - s_0)$$

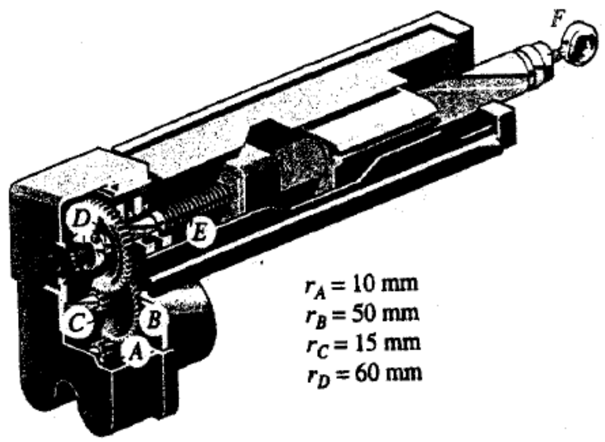
$$v^2 = 0 + 2(0.15)(6 - 0)$$

$$v = 1.34 \text{ m/s}$$

Ans

Örnek

Due to the screw at E, the actuator provides linear motion to the arm at F when the motor turns the gear at A. If the gears have the radii listed in the figure, and the screw at E has a pitch $p = 2$ mm, determine the speed at F when the motor turns A at $\omega_A = 20$ rad/s. *Hint:* The screw pitch indicates the amount of advance of the screw for each full revolution.



$$\omega_A r_A = \omega_B r_B$$

$$\omega_C r_C = \omega_D r_D$$

Thus,

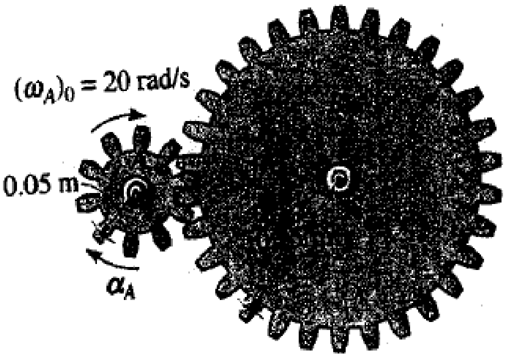
$$\omega_D = \frac{r_A}{r_B}\frac{r_C}{r_D}\omega_A = \frac{10}{50}\frac{15}{60}20 = 1 \text{ rad/s}$$

$$v_F = \frac{1 \text{ rad/s}}{2\pi \text{ rad}} \frac{1 \text{ rev}}{}(2 \text{ mm}) = 0.318 \text{ mm/s}$$

Ans

Örnek

A motor gives gear A an angular acceleration of $\alpha_A = (0.25\theta^3 + 0.5)$ rad/s^2, where θ is in radians. If this gear is initially turning at $(\omega_A)_0 = 20$ rad/s, determine the angular velocity of gear B after A undergoes an angular displacement of 10 rev.



$$\alpha_A = 0.25\theta^3 + 0.5$$

$$\alpha\, d\theta = \omega\, d\omega$$

$$\int_0^{20\pi}(0.25\theta^3 + 0.5)d\theta_A = \int_{20}^{\omega_A} \omega_A\, d\omega_A$$

$$(0.0625\theta^4 + 0.5\theta)\Big|_0^{20\pi} = \frac{1}{2}(\omega_A)^2\Big|_{20}^{\omega_A}$$

$$\omega_A = 1395.94 \text{ rad/s}$$

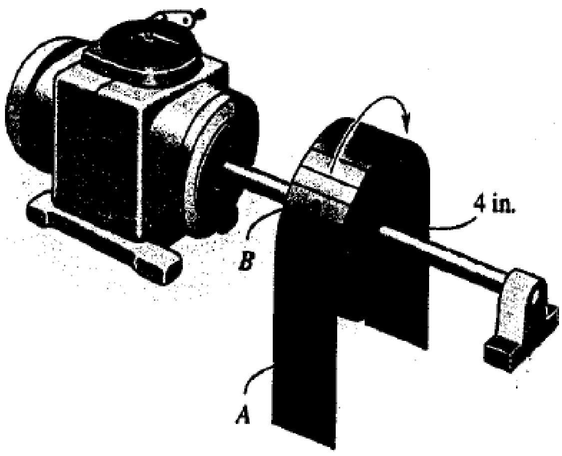
$$\omega_A r_A = \omega_B r_B$$

$$1395.94(0.05) = \omega_B(0.15)$$

$$\omega_B = 465 \text{ rad/s} \qquad \textbf{Ans}$$

Örnek

If the angular velocity of the drum is increased uniformly from 6 rad/s when $t = 0$ to 12 rad/s when $t = 5$ s, determine the magnitudes of the velocity and acceleration of points A and B on the belt when $t = 1$ s. At this instant the points are located as shown.



$$\omega = \omega_0 + \alpha_c t$$

$$12 = 6 + \alpha(5) \qquad \alpha = 1.2 \text{ rad/s}^2$$

At $t = 1$ s,

$$\omega = 6 + 1.2(1) = 7.2 \text{ rad/s}$$

$$v_A = v_B = \omega r = 7.2\left(\frac{4}{12}\right) = 2.4 \text{ ft/s} \qquad \textbf{Ans}$$

$$a_A = \alpha r = 1.2\left(\frac{4}{12}\right) = 0.4 \text{ ft/s}^2 \qquad \textbf{Ans}$$

$$(a_B)_t = \alpha r = 1.2\left(\frac{4}{12}\right) = 0.4 \text{ ft/s}^2$$

$$(a_B)_n = \omega^2 r = (7.2)^2\left(\frac{4}{12}\right) = 17.28 \text{ ft/s}^2$$

$$a_B = \sqrt{(a_B)_t^2 + (a_B)_n^2} = \sqrt{0.4^2 + 17.28^2} = 17.3 \text{ ft/s}^2 \qquad \textbf{Ans}$$