APL 100

Practice problems 3

Problems: P 1.24, Q 1.32 (b) and P 2.9 (a)

24. An arm OA rotates at angular velocity ω_1 and angular acceleration $\dot{\omega}_1$ at the instant shown in Fig. P1.24. Find $\vec{v}_P$ and $\vec{a}_P$ at the given instant.

$[\omega_1 r\,\vec{\mathrm{i}} + \omega_1 r\,\vec{\mathrm{j}},\ (\dot{\omega}_1 r - 2\omega_1^2 r)\,\vec{\mathrm{i}} + (\dot{\omega}_1 r - 0.5\omega_1^2 r)\,\vec{\mathrm{j}}]$

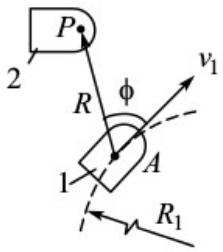


Fig. P1.23

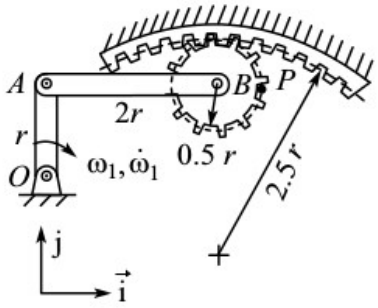


Fig. P1.24

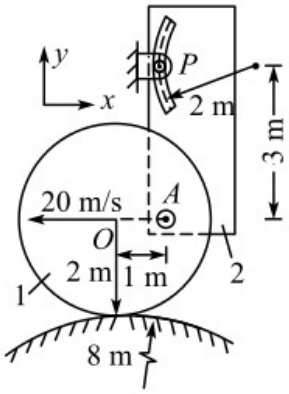


Fig. P1.25

32. (a) Gear 2 rotates at ω (Fig. Q1.32a) and the bent bar 1 rotates at ω_1. Find the angular velocity Ω of gear 3 relative to bar 1 and its angular acceleration relative to the ground if ω, ω_1 increase at the rates $\dot{\omega}$, $\dot{\omega}_1$. (b) Disc 2 rotates relative to the shaft (Fig. P1.32b). The shaft is rotated about the vertical axis. The disc rolls without slip on the ground at its point A. Find $\dot{\vec{\omega}}_2$, $\vec{a}_A$ and its instantaneous axis of rotation (i) for $\theta = \pi/2$ and (ii) for the general value of θ. [Hint: The system is equivalent to an epicyclic gear train of part (a) with disc meshing at A with a gear of radius $(L\sin\theta - R\cos\theta)$ fixed to the ground.]

$[(\mathrm{a})\ \Omega = (\omega - \omega_1)R_2/R_3,\ \dot{\omega}_1\,\vec{\mathrm{E}} + (\dot{\omega} - \dot{\omega}_1)R_2\,\vec{\mathrm{e}}/R_3 + \omega_1(\omega - \omega_1)R_2\,\vec{\mathrm{E}} \times \vec{\mathrm{e}}/R_3$

(b) $\dot{\omega}\sin\theta(\vec{\mathrm{j}} - \frac{L}{R}\vec{\mathrm{i}}) + \frac{\omega^2 r}{R}\sin\theta\,\vec{\mathrm{k}}$ with $r = L\sin\theta - R\cos\theta,\ \omega^2 r\sin\theta(\vec{\mathrm{i}} + \frac{L}{R}\vec{\mathrm{j}}),\ OA]$

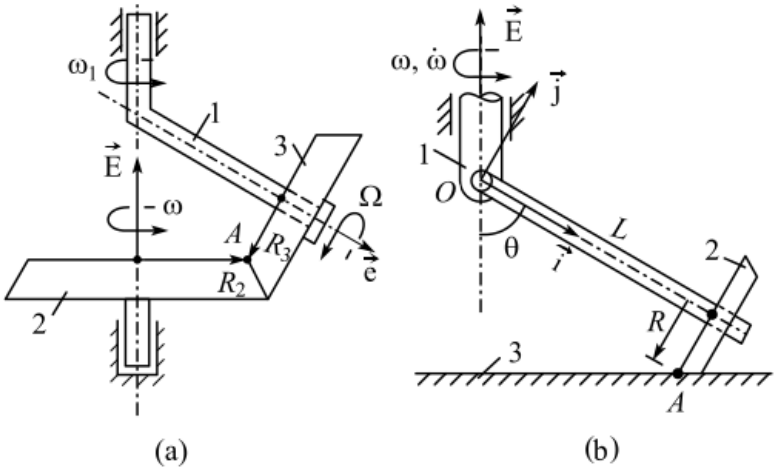


Fig. Q1.32

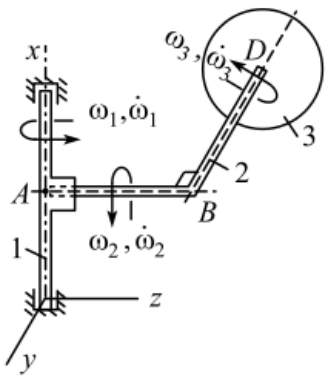
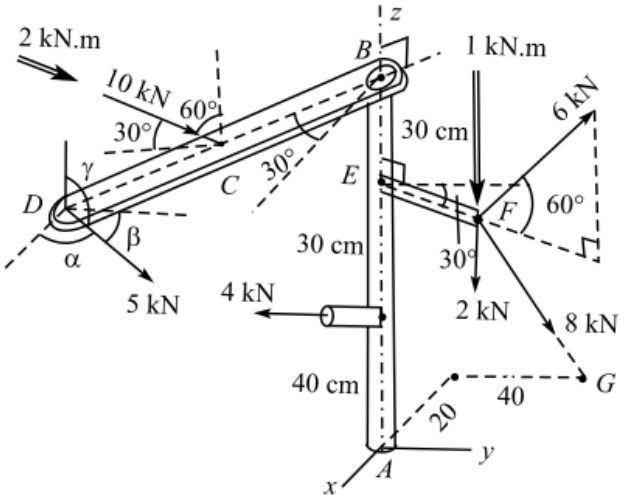


Fig. Q1.33

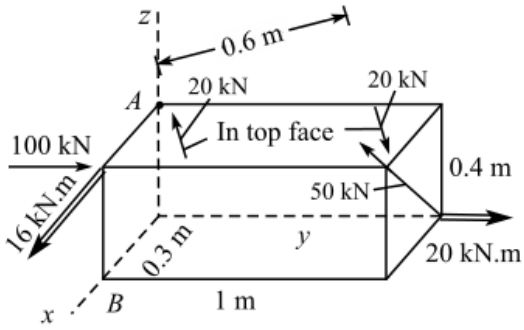
9. A column of a machine and a concrete anchor block are subjected to the forces shown in Fig. P2.9. In Fig. P2.9a, $\alpha = 60°$, $\beta = 45°, \gamma = 120°$, $BC = CD = 40$ cm, $EF = 20$ cm. Find M_{AB} and resultant at A for each force system.

[(a) 5.201 kN.m, $.9797\,\vec{i}+13.08\,\vec{j}-11.35\,\vec{k}$ kN & $-12.68\,\vec{i}+7.017\,\vec{j}+5.201\,\vec{k}$ kN.m

(b) 43.2 kN.m, $30\,\vec{i}+100\,\vec{j}+40\,\vec{k}$ kN & $56\,\vec{i}+8\,\vec{j}-12\,\vec{k}$ kN.m]



(a)



(b)