P3·D. $N_1 = 320\,rpm$, $D = 1.2\,m$, $R = 0.6\,m$, $d = 0.8\,m$, $r = 0.4\,m$

$C = 4\,m$, $\mu = 0.25$, $m = 1.8\,kg/m$, $T_o = 2800\,N$.

$$v = \frac{\pi d N_1}{60} = \frac{\pi \times 0.8 \times 320}{60} = 13.4\,m/s$$

$$T_c = mv^2 = 1.8 \times 13.4^2 = 323.4\,N.$$

$$T_o = \frac{T_1 + T_2}{2} + T_c$$

$$\therefore\ 2800 = \frac{T_1 + T_2}{2} + 323.4 \Rightarrow T_1 + T_2 = 4953\,N. \quad -(1)$$

$$\theta = \pi - 2\sin^{-1}\left(\frac{R-r}{C}\right) = \pi - 2\sin^{-1}\left(\frac{0.6-0.4}{2}\right)$$

$$\theta = \pi - 5.73^\circ = \pi - 0.01 = 3.042\ \text{radian}$$

$$\frac{T_1}{T_2} = e^{\mu\theta} \quad \therefore\ \frac{T_1}{T_2} = e^{0.25 \times 3.042} = 2.14$$

$$\therefore\ T_1 = 2.14\,T_2. \quad -(2)$$

From (1) & (2) $T_1 = 3376\,N$, $T_2 = 1577\,N$.

$$P = (T_1 - T_2)v = (3376 - 1577) \times 13.4 = 24106\,W,\ \text{or}\ 24.1\,kW.$$

P3·C. Speed of Cam $N = 1000\,rpm$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 1000}{60} = 104.66\,r/s$$

Min radius of cam $r_b = 30\,mm$

Lift of follower $S = 30\,mm$

Diameter of roller $d_r = 10\,mm$ $\therefore\ r_r = 5\,mm$

Angle of rise, $\theta_o = 150^\circ$

Angle of dwell $\theta_d = 30^\circ$

Angle of return $\theta_r = 90^\circ$

Max velocity during outstroke, $V_{o(max)} = \frac{\pi}{\theta_o}\frac{S}{2}\omega$

$$= \frac{\pi}{\left(150 \times \frac{\pi}{180}\right)} \times \frac{30}{2} \times 104.66$$

$$= \frac{\pi}{\frac{150\pi}{180}} \times 15 \times 104.66 = \frac{180\,\pi \times 15 \times 104.66}{150\,\pi} = 1883.88\,mm/s$$

max acceleration during outstroke $f_o(max) = \pm \frac{\pi^2}{\theta_o^2} \frac{S}{2} \omega^2$

$$f_o(max) = \pm \frac{\pi^2}{\left(150 \times \frac{\pi}{180}\right)^2} \times \frac{30}{2} \times 104.66^2$$

$$= 236632.89 \ mm/sec^2$$

$$= \pm 236.63 \ m/s^2$$

Max velocity of follower during return stroke,

$$V_r(max) = \frac{-2S\omega}{\theta_r}$$

$$= \frac{-2 \times 30}{\left(90 \times \frac{\pi}{180}\right)} \times 104.66 =$$

$$= \frac{-60 \times 180 \times 104.66}{90\pi} = 3.99 \ m/sec$$

Max acceleration during return stroke,

$$f_r(max) = \mp \frac{4S\omega^2}{\theta_r^2}$$

$$= \mp \frac{4 \times 30 \times 104.66^2}{\left(90 \times \frac{\pi}{180}\right)^2} = 533.26 \ m/s^2.$$

Pq D. $T = 48, t = 24, N_1 = 300 rpm, m = 6mm$, $KP = \frac{1}{2} MP$

$PL = \frac{1}{2} PN$.

$R = \frac{mT}{2} = \frac{6 \times 48}{2} = 144 mm$ $\therefore KP = 0.5 MP$

$r = \frac{mt}{2} = \frac{6 \times 24}{2} = 72mm$, $\sqrt{(R_A)^2 - R^2\cos^2\phi} - R\sin\phi = r\sin\phi \times 0.5$

$$\sqrt{(R_A)^2 - 144^2\cos^2(20)} - 144\sin 20 = 72\sin 20 \times 0.5$$

$$\therefore \sqrt{(R_A)^2 - 144^2\cos^2(20)} = 12.312 + 49.248 = 61.56.$$

$$(R_A)^2 - 144^2\cos^2 20 = (61.57)^2 = 3789.633$$

$$(R_A)^2 = 18306.73 + 3789.633 = 22096.363$$

$$R_A = 148.64 \ mm$$

$a_w = R_A - R = 148.64 - 144 = 4.64 \ mm \rightarrow$ addendum of gear

$$a_p = r_A - r.$$

$PL = 0.5\, PN$

$\therefore \sqrt{r_A^2 - r^2\cos^2\phi} - r\sin\phi = 0.5 \times R\sin\phi$

$\sqrt{r_A^2 - 72^2\cos^2 20} - 72\sin 20 = 0.5 \times 144 \sin 20$

$\sqrt{r_A^2 - 72^2\cos^2 20} = 24.624 + 24.624 = 49.248$

$r_A^2 - 72^2\cos^2 20 = 2425.36$

$r_A^2 = 4576.687 + 2425.36 = 83.66$ mm.

$a_p = 83.66 - r = 83.66 - 72 = 11.66$ mm

$KL = KP + PL = 0.5\, r\sin\phi + 0.5\, R\sin\phi$

$= 0.5 \times 72 \times \sin 20 + 0.5 \times 144 \times \sin 20$

$= 12.312 + 24.62 = 36.936$ mm

Length of arc of contact $= \dfrac{KL}{\cos\phi} = \dfrac{36.936}{0.9396} = 39.31$ mm.

Contact ratio $= \dfrac{39.31}{\pi m} = \dfrac{39.31}{\pi \times 6} \approx \underline{\underline{2}}$

Q2 d) $N = 15$.

$N = \dfrac{n(n-1)}{2}$

$V_A = \dfrac{O_1 B}{O A}$

$V_C = \dfrac{AC}{V_A}$

$V_A = 0.41$ m/s

$V_C = 0.312$ m/s

$V_D = \dfrac{CD}{V_C}$.

$V_D = 28.84$ m/sec.