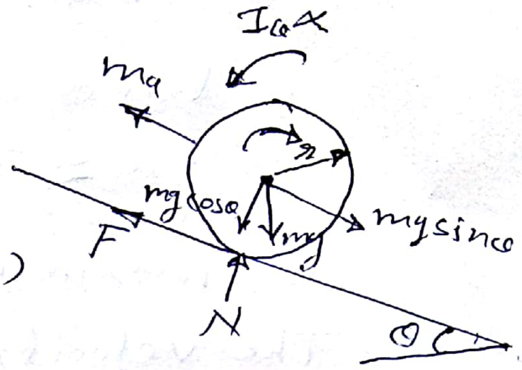
Q.P code 40120

Q:2a)




1) $\Sigma F_x = 0$, $mg\sin\theta - ma - F = 0$

$\therefore mg\sin\theta - F = ma$ ---(i)

$\Sigma F_y = 0$.

$N - mg\cos\theta = 0$

$N = mg\cos\theta$ --- ii)

$\Sigma M_G = 0$, $-F.r + I_G\alpha = 0$ ---(iii)

As, roller rolls without slipping $a = r\alpha$

$\therefore \alpha = a/r$

$\therefore F.r = I_G(a/r)$ $\therefore F = I_G \cdot a/r^2$

& $\therefore$ from eqn (i)

$mg\sin\theta - I_G \cdot a/r^2 = ma$.

$mg\sin\theta - ma = I_G a/r^2$

$a = \dfrac{mg\sin\theta}{\left[m + \frac{I_G}{r^2}\right]}$ $\qquad I_G = \dfrac{mr^2}{2}$

$\therefore a = \dfrac{mg\sin\theta}{m + \frac{mr^2}{2r^2}}$ $\qquad \therefore a = \frac{2}{3} g\sin\theta$ ... Ans

2) from eqn (iii)

$F = \dfrac{I_G \cdot \alpha}{r} = \dfrac{mr^2}{2r}\left(\dfrac{a}{r}\right) = \dfrac{ma}{2}$

$a = \frac{2}{3} g\sin\theta$ $\qquad \therefore F = \frac{m}{2} \cdot \frac{2}{3} g\sin\theta = \dfrac{mg\sin\theta}{3}$

Max. frictional force $\mu N = \mu \cdot mg\cos\theta$

for cylinder to roll without slipping

$F < \mu mg\cos\theta$

$\therefore \dfrac{mg\sin\theta}{3} < \mu mg\cos\theta$

$\therefore \tan\theta < 3\mu < 3(0.2) < 0.6$

$\theta \leq 30.96^\circ$

3 The maximum value of $\theta$ can be $30.96^\circ$

The velocity after rolling a distance of 1m along the plane is given by

$v^2 = u^2 + 2as$

The velocity is maximum when $\theta = 30.96^\circ$

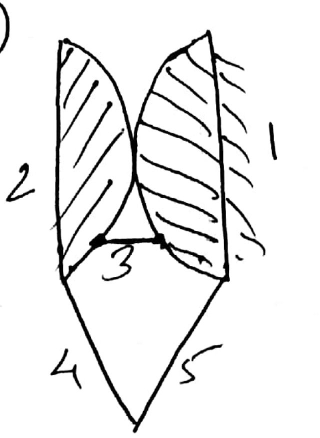
$\therefore a = \frac{2}{3} g\sin\theta = \frac{2}{3} \times 9.81 \times \sin 30.96$

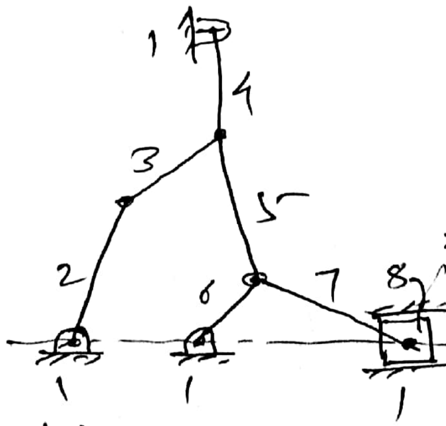
$a = 3.36\ m/s^2$

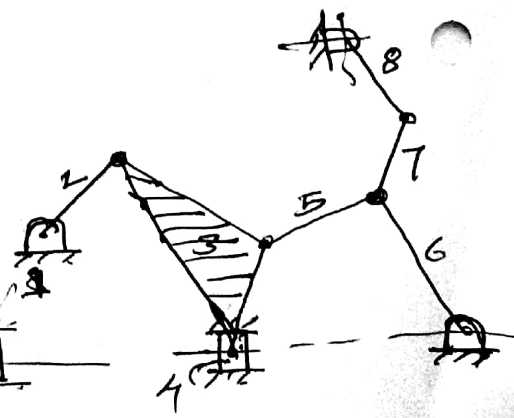
$v^2 = 0 + 2(3.36)(1)$

$\therefore v = 2.59\ m/s$ ---- Ans

Q: 2(b)




$n = 5,\ P_1 = 5,\ P_2 = 1$

$DOF = 3(n-1) - 2P_1 - 1P_2$

$= 3(5-1) - 2\times 5 - 1\times 1$

$= 1$

$n = 8,\ P_1 = 10,\ P_2 = 0$

$Dof = 3(n-1) - 2P_1 - P_2$

$= 3(8-1) - 2\times 10 + 0$

$= 1$

$n = 8,\ P_1 = 10,\ P_2 = 0$

$Dof = 3(8-1) - 2\times 10 - 0$

$= 1$

3(a) $r = \frac{m.t}{2} = \frac{10\times 40}{2} = 200\text{ mm}$

$R = \frac{m.T}{2} = \frac{10\times 50}{2} = 250\text{mm}$

$KP = \frac{2}{3} MP$

$\therefore \sqrt{(R_A)^2 - R^2\cos^2\phi} - R\sin\phi = r.\sin\phi \times 2/3 \quad (\because MP = r\sin\phi)$

$\sqrt{R_A^2 - 250^2\cos^2 20} = 133.33 \sin 20 + 250 \sin 20$

$\sqrt{R_A^2 - 55188.8} = 131.10$

$R_A^2 - 55188.8 = (131.10)^2$

$\therefore R_A = 269.02\text{ mm}$

Addendum, $a_w = R_A - R = 269.02 - 250 = \underline{19.02\text{mm}}$

Length of path of recess, $PL = 2/3\, PN$

$\sqrt{(r_A)^2 - r^2\cos^2\phi} - r\sin\phi = R\sin\phi \times 2/3 \quad (\because PN = R\sin\phi)$

$\sqrt{r_A^2 - 200^2\cos^2 20} = 166.66 \sin 20 + 200 \sin 20$

$\sqrt{r_A^2 - 200^2\cos^2 20} = 125.40$

$r_A = 225.33\text{ mm}$

$\therefore$ Addendum of Pinion $a_p$

$a_p = r_A - r = 225.33 - 200 = 25.33\text{ mm}$

$\therefore$ Length of path of contact $= KP + PL$

$KL = \frac{2}{3} MP + \frac{2}{3} PN = \frac{(MP + PN)}{3/2}$

$= \frac{(r\sin\phi + R\sin\phi)}{3/2} = \frac{(r+R)\sin\phi}{3/2}$

$= \frac{(200+300)\sin 20}{3/2} = 102.60\text{ mm}$ Ans.

Length of arc of contact $= \frac{KL}{\cos\phi} = \frac{102.60}{\cos 20} = 109.19\ mm$

Contact ratio $= \frac{\text{Arc of contact}}{\pi . m} = \frac{109.19}{\pi \times 10}$

$= 3.47$ say ~~3~~ 4

3(b) $N_{AO} = 60$ rpm $\quad \omega_{AO} = \frac{2\pi N_{AO}}{60} = \frac{2\pi \times 60}{60} = 2\pi$ rad/s

$\omega_2 = 6.28$ rad/s.

Velocity of slides B, $V_B = V_5 = \omega_2 \cdot (I_{12} - I_{25})$

$= 6.28 \times 0.266 = 1.67$ m/s

Velocity of slides D, $V_D = V_6 = \omega_2 \cdot (I_{12} - I_{26})$

$= 6.28 \times 0.066 = \underline{0.414\ m/s}$

Ans

$$\frac{\omega_4}{\omega_2} = \frac{I_{12}\ I_{24}}{I_{14}\ I_{24}}$$

$\therefore \frac{\omega_4}{6.28} = \frac{0.366}{1.166} \Rightarrow \omega_4 = \omega_{CD} = \underline{1.97\ rad/s}$

Ans

4a) $V_a = \frac{2\pi \times N_2}{60} \times 0.150 = \frac{2\pi \times 60}{60} \times 0.150 = 0.942\ m/s$

(i) Velocity of point B $= \frac{4.52\ m/s}{5 (\text{scale})} = 0.90\ m/s$

Velocity of slides D $= 0.54$ m/s

(ii) Angular velocity of AB $= 0.94$ rad/s

Angular velocity of BC $= 2.63$ rad/s

Angular velocity of BD $= 1.959$ rad/s.

Q: 5(a) $T_A = 60 \quad T_B = 180$

$$T_B = 2\left[\frac{T_A}{2} + T_C\right] \Rightarrow 180 = 2\left[\frac{60}{2} + T_C\right]$$

$T_C = 60$

| Action | a | A | C/D | B |
|---|---|---|---|---|
| a fixed, A+1 Rev | 0 | 1 | $-\frac{60}{60}$ | $-\frac{60}{60} \times \frac{60}{180}$ |
| a fixed, A+x Rev. | 0 | x | $-1 \times x$ | $-\frac{1}{3}x$ |
| Add y | y | y+x | y−x | $y - \frac{1}{3}x$ |

(i) $y + x = 120$ or $y = 120 - x$

& $y - \frac{1}{3}x = -60$ or $120 - x - \frac{1}{3}x = -60$

$\therefore x = 135$ & $y = -15$

$\therefore$ Speed of arm a = 15 rpm counterclockwise

(ii) $y + x = 120$ rpm or $y = 120 - x$

$y - \frac{1}{3}x = 0 \Rightarrow 120 - x - \frac{1}{3}x = 0$

$\therefore x = 90$ & $y = 30$

$\therefore$ Speed of arm a = 30 rpm clockwise.

5(b) V.R. $\frac{N_2}{N_1} = \frac{d_1}{d_2} \Rightarrow \frac{300}{N_1} = \frac{600}{240}$ $N_1 = 120$ r.p.m.

Velocity of belt $v = \frac{\pi d_1 N_1}{60}$ or $\frac{\pi d_2 N_2}{60}$

$= \frac{\pi \times 0.6 \times 120}{60} = 3.769$ m/s -- Ans.

Angle of contact for driven (smaller) pulley

$\theta = 180 - 2\alpha$

$\alpha = \sin^{-1}\left(\frac{r_1 - r_2}{C}\right) \Rightarrow \sin^{-1}\left(\frac{0.6 - 0.24}{3}\right)$

$\alpha = 6.892^{\circ}$

$\therefore \theta = 180 - 2 \times 6.892 = 166.215^{\circ} = 2.9$ rad.

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.3 \times 2.9}$ $\therefore T_1 = 2.3876\, T_2$

$P = (T_1 - T_2)\, v$ $\therefore 4 \times 10^3 = (T_1 - T_2) \times 3.769$

$\therefore T_2 = 764.818$ N & $T_1 = 1826.08$ N

Minimum width of belt

$\sigma = \frac{T_1}{b \times t}$ $\therefore 10 = \frac{1826.08}{b \times 1}$ $(\because t = 1)$

$b = 182.6$ mm --- Ans.

(ii) Initial belt tension

$T_0 = \frac{T_1 + T_2}{2} = \frac{1826.08 + 764.818}{2}$

$T_0 = 1295.449$ N ---. Ans

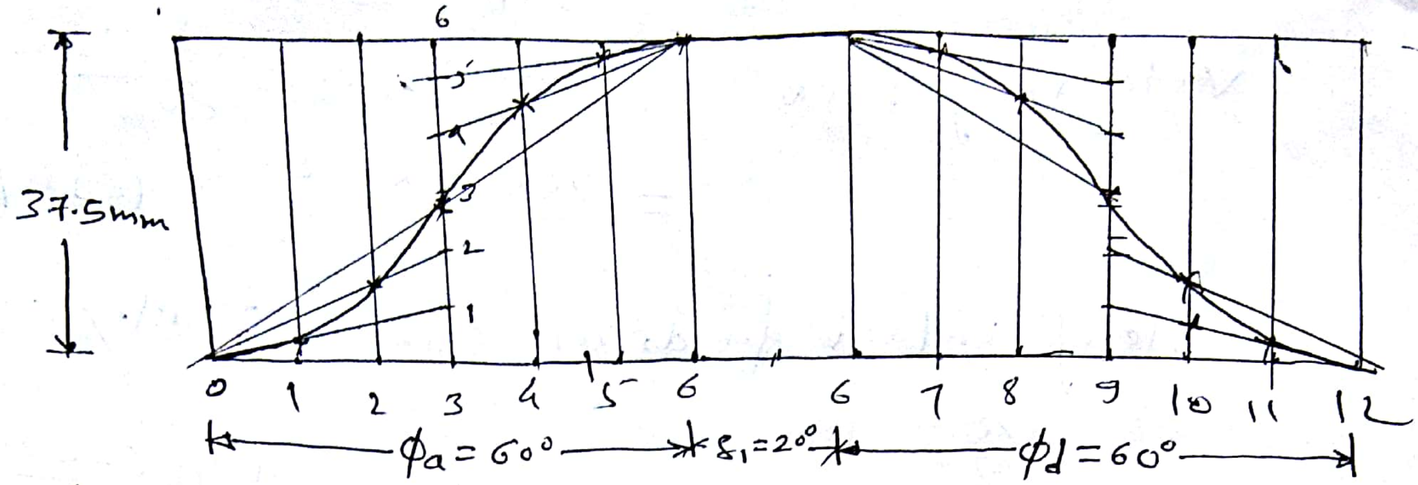
(iii) Length of belt required

$L = \pi(r_1 + r_2) + 2C + \frac{(r_1 - r_2)^2}{C}$

$= \pi(6 + 240) + 2 \times 3000 + \frac{(600 - 240)^2}{3000}$

$L = 8682.137$ mm Ans

6 (b)




& cam profile.