Code No:- 00022663

2 a) $P_{max} = C/R_2$ ∴ $C = P_{max} \times R_2 = 100 \times 10^3 \times 0.06 = 6000\ N/m$

$W = 2\pi C\ (R_1 - R_2) = 2\pi \times 6000\ (0.1 - 0.06) = 1507.96\ N$

$T = n \times \frac{1}{2}\ \mu W\ (R_1 + R_2) = 72.38\ N.m.$

$T = I.\alpha$ ∴ $\alpha = 11.13\ rad/sec^2$ $w_F = w_1 + \alpha.t$

∴ $t = 2.35\ sec.$

K.E. = Frictional torque × Angle of slip = $T\ (\theta_1 - \theta_2)$

$\theta_1 = w_F.t + \frac{1}{2}\alpha t^2 = 61.54\ rad$; $\theta_2 = w_1 t + \frac{1}{2}\alpha t^2 = 30.77\ rad.$

$K.E. = T\ (\theta_1 - \theta_2) = 2227.51\ N.m.$

2 b) $\sin\alpha = (0.18 - 0.02)/0.2$ ∴ $\alpha = 53.13^\circ$

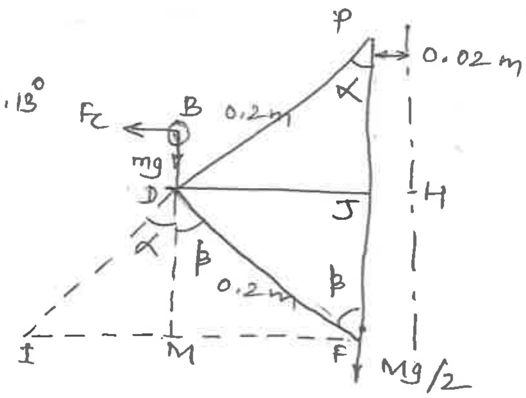
$\cos\alpha = PJ/0.2$ ∴ $PJ = 0.12\ m$

$PJ = JF = DM = h = 0.12\ m$

$N^2 = \frac{DM}{BM} \times \frac{895}{h}\left(\frac{m+M}{m}\right)$

∴ $BM = 0.1715\ m.$

$BD = BM - DM = 0.0515\ m.$



Tension in upper arm ; Let $\Sigma F_y = 0 = mg + \frac{Mg}{2} - T_1 \cos\alpha$

∴ $T_1 = 212.55\ N.$

3 b) Net load on the piston $= F_L = (P_1 - P_2)\ \pi/4\ D^2 = 68730\ N.$

Inertia force $= F_I = m_R.w^2.r.\ (\cos\theta + \cos 2\theta/n) = 19306\ N.$

Piston effort $= F_P = F_L - F_I = 49.42\ KN.$

Pressure on slide bars $= F_N = F_P.\tan\phi = 10.96\ KN.$

Thrust in the connecting rod $= F_Q = F_P/\cos\phi = 50.62\ KN.$

Tangential force on the crank pin $= F_T = F_Q.\sin(\theta + \phi) = 48.28\ KN.$

Turning moment on the crank shaft $= T = F_T \times r = 14.48\ KN.m.$

4 a) $T_1/T_2 = e^{\mu\theta} = 3.25$ —(1)

$P = 2\pi N T_B/60$ ∴ $T_B = 1667 \times 10^3\ N.mm$

$T_B = (T_1 - T_2)\ r$ ∴ $T_1 - T_2 = 5556\ N.$ —(2)

From (1) & (2) ; $T_1 = 8025\ N$; $T_2 = 2469\ N$

Taking moment @ Pt. O. ; $P \times 750 = T_2 \times 62.5\sqrt{2}$ ∴ $P = 291\ N.$

Max. tension in the band (T_1) ; $8025 = \sigma w t$ ∴ $w = 64.2\ mm.$

4b) $d_A + 2d_B = d_C$ ∴ $T_A + 2T_B = T_C$ ∴ $T_B = 43$

	Arm	Gear A	Gear B-D	Gear C	Gear E.
Total Motion	$-y$	$-y-x$	$-y+x.\,T_A/T_B$	$-y+x.\,T_A/T_C$	$-y+x\,T_A/T_B.\,T_D/T_E$

Annular Gear C is fixed ∴ $-y+x\,T_A/T_C=0$ ∴ $-y+0.14x=0$ -(1)

Gear A is rotating at 1200 rpm ∴ $-x-y = 1200$ -(2)

from (1) & (2) $x = -1052.6$ & $y = -147.4$

$N_E = -y+x.\,T_A/T_B.\,T_D/T_E = 4$ rpm (↺)

$T_A = (P_A \times 60)/(2\pi N_A) = 14.7$ N.m. ; $T_E = (P_A \times 60)/(2\pi N_E) = 4416$ N.m

Fixed torque reqd. $= 4416 - 14.7 = 4401.3$ N.m.

5a) Area of the plate sheared $= A_s = \pi d_1 t_1 = 1414 \times 10^{-6}$ m^2.

max. shearing force reqd. for punching $= F_s = A_s.\tau_u = 424200$ N.

Energy reqd. per stroke = Avg. shear force × Thickness of plate.

$= \frac{1}{2} F_s . t_1 = 3817.8$ N.m

Energy reqd. per min = Energy/stroke × No. of working strokes/min.

$= 95450$ N.m.

Power needed $= 95450/(60 \times 0.95) = 1675$ W.

c/s Area of rim $= A = b \times t = 2t \times t = 2t^2$

$\Delta E = 9/10\,(3817.8) = 3436$ N.m.

$\Delta E_{rim} = 0.95.\,\Delta E = 3264$ N.m.

$N = 9 \times 25 = 225$ rpm. ; $\omega = 2\pi(225)/60 = 23.56$ r/s

$\Delta E_{rim} = 3264 = mR^2\omega^2 C_s$ ∴ $m = 120$ kg.

$m = \pi D A \rho = \pi(1.4)\,2t^2\,(7250) = 63782t^2$ ∴ $t = 0.044$ m.

$b = 2t = 0.088$ m.

5b) $C = I\,\omega\,\omega_p = 47.33 \times 10^3$ N.m. (Bow will rise)

$C = I.\omega\,\omega_{p\,max} = 13.92 \times 10^3$ N.m. (Bow towards port).

$\alpha_{max} = \phi . \omega_1^2 = \left(\frac{2\pi}{t_p}\right)^2 \phi = 0.0159$ r/s^2