Code NO:- 00022664

2 a) Radius of C.G. of shoe during engagement is,

$R_G = R + c = 0.18 + 0.006 = 0.186$ m

Centrifugal force on each shoe is,

$F_c = m R_G \cdot \omega^2 = 10\,(0.186)\,(62.83)^2 = 7342.97$ N

Total spring force during engagement is,

F_s = Pull force of spring + (Stiffness × Radial Clearance)

$= 600 + 50 \times 10^3 \times 0.006 = 900$ N.

Frictional force acting tangentially on each shoe is,

$F = \mu\,(F_c - F_s) = 0.4\,(7342.97 - 900) = 2577.18$ N

Torque transmitted $= T = n F R_D = 4 \times 2577.18 \times \frac{0.45}{2} = 2319.47$

Power transmitted $= P = T\omega = 2319.47 \times 62.83 = 145.73 \times 10^3$ W

2 b) $T_1 / T_2 = e^{\mu\theta} = 3.25$ —(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 ; $P \times 750 = T_2 \times OD = T_2 \times 62.5\sqrt{2}$

∴ $P = 291$ N.

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

3 a) $F_{c1} = m r_1 \omega_1^2 = 2.5 \times 0.12 \times (30.36)^2 = 276.67$ N.

$h = b/a\,(r_2 - r_1)$ ∴ $0.015 = 0.08/0.12\,(r_2 - 0.12)$ ∴ $r_2 = 0.14$ m.

$F_{c2} = m r_2 \omega_2^2 = 2.5 \times 0.14 \times (32.46)^2 = 375.43$ N.

$Mg + S_1 = 2(a/b)\,F_{c1}$ ∴ $S_1 = 830$ N

$mg + S_2 = 2\,(a/b)\,F_{c2}$ ∴ $S_2 = 1126$ N

spring stiffness $= (S_2 - S_1)/h = 19751.54$ N/m.

3 b) $C_w = 4 I_w \omega_w \omega_p = 782.73$ N.m ; $C_E = I_E \cdot G \cdot \omega_E \cdot \omega_p = 17.11$ N.m.

(Transverse plane)

Taking moment @ outer wheel; $-2R_i \times 1.5 - F_c \times 0.5 - C_w = 0$ ∴ $R_i = -1637$ N.

Taking moment @ inner wheel; $2R_o \times 1.5 - F_c \times 0.5 - C_w = 0$ ∴ $R_o = 1637$ N.

(Longitudinal plane)

Taking moment @ front wheel; $-2R_R \times 2.5 + mg \times 1 - C_E$ ∴ $R_R = 5882$ N

Taking moment @ Rear wheel; $2R_F \times 2.5 - Mg \times 1.5 - C_E$ ∴ $R_F = 8832$ N

Resultant reaction on, wheel A = $R_o + R_F = 10469$ N

wheel B = $R_o + R_R = 7519$ N

wheel C = $R_I + R_F = 7195$ N.

wheel D = $R_I + R_R = 4245$ N.

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

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

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

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

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

$N_E = -y+x \cdot T_A/T_B \cdot T_D/T_E = 4$ 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.

Fixing torque reqd., $4416 - 14.7 = 4401.3$ N.m

4b) mass placed at small end $= m_1 = \frac{1}{3} m$

for dynamically equivalent system $m_1 + m_2 = m$ ∴ $m_2 = \frac{2}{3} m$.

Length of C.R. = L ; Length of C.G. from small end $l_1 = \frac{2}{3}(L)$

$I_G = mL^2/20$ —(a) $I_G = m(K_G)^2$ —(b)

Equating (a) & (b) $K_G = L/\sqrt{20}$

for dynamically equivalent system $K_G^2 = l_1 l_2$ ∴ $l_2 = \frac{3}{40}(L)$

5a) $C_S = (w_1 - w_2)/w = 0.04$

Centrifugal stress $= \sigma = \rho v^2$ ∴ $7 \times 10^6 = 7200 \times v^2$ ∴ $v = 31.2$ m/s.

$v = \pi D N/60$ ∴ $D = 0.745$ m.

c/s area of flywheel rim $= A = bt = 5t \times t = 5t^2$

ΔE = Max. Energy − min. Energy $= (E+420)-(E-30) = 450$ mm²

$= 450 \times 52.37 = 23566$ N.m.

Max. fluctuation of energy $= \Delta E = mv^2 C_S$ ∴ $m = 604$ kg.

mass of the flywheel rim $= m =$ Vol. × Density $= \pi D A \rho$

$604 = \pi \times 0.745 \times 5t^2 \times 7200$

∴ $t = 85$ mm.

$b = 5t = 425$ mm.