

1.)

Vehicle

dynamics

Exam

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$$\begin{aligned}
 \text{1.) Gear AB} &= 118 \div 24 = 4.92 \\
 \text{Gear CD} &= 132 \div 32 = 4.125 \\
 \text{Gear EF} &= 104 \div 12 = 8.6
 \end{aligned}$$

$$\text{Gear ratio} = 4.92 \times 4.125 \times 8.6 = 174.54$$

b.) ~~Diagram of a gear train with gears A, B, C, D, E, F and shafts 1, 2, 3, 4, 5, 6.~~ Speed and direction

$$= \frac{3000}{174.54} = 17.19 \text{ rpm clockwise}$$

c.) Input power = $\frac{2\pi NT}{60}$

$$\frac{2\pi \times 3000 \times 130}{60} = 40840.71 \text{ W}$$

$$\text{Output power} = 0.82 \times 40840.71 = 33489.38 \text{ W}$$

d.) $T_1 + T_2 + T_3 = 0$

130 +

$$T_2 = \frac{60 P_2}{2\pi N_2} = \frac{60 \times 33489.38}{2\pi \times 17.19} = 18603.84$$

$$130 \neq 18603.84 + T_3 = 0$$

$$T_2 = 18603.84 - 130 = 18473.84 \text{ Nm to hold.}$$

E.)

Step	Action	A	B	C	D
1	Revolve at	1	1	1	1

2.)

R_1 inner radius = $105 \div 2 = 52.5 \text{ mm}$
 R_2 outer radius = $190 \div 2 = 95$
 μ value = 0.32

$$T = \frac{2}{3} \mu W \frac{(r_2^3 - r_1^3)}{(r_2^2 - r_1^2)}$$

$$P = T \times \frac{2 \pi N}{60}$$

$$T = \frac{60P}{2\pi N}$$

$$W = \frac{3T(r_2^2 - r_1^2)}{2\mu(r_2^3 - r_1^3)}$$

~~$$W = 3 \times 925 (95^2 - 52.5^2)$$~~

$$W = \frac{3 \times 925 (95^2 - 52.5^2)}{2 \times 0.32 (95^3 - 52.5^3)}$$

$$W = 248 \times 10^{-5}$$

d.) R_1 = inner radius = 30 mm
 R_2 = outer radius = 57.5 mm
 μ = 0.45

Spring rate 1200 N/mm

fixed load = 7000 N

$$P = 450,000 \text{ W}$$

$$W = \frac{2500}{1000} + 2 \pi / 60$$

$$W = 7000 \text{ N}$$

$$W = 785.4 \text{ rad/s}$$

~~π~~ Uniform pressure

$$T = P/W = \frac{450,000}{785.4} = 572.96 \text{ Nm}$$

$$T = \frac{2}{3} \mu W \frac{(r_2^3 - r_1^3)}{(r_2^2 - r_1^2)} \times 2n$$

$$\frac{572.96}{2n} = \frac{2}{3} \times 0.45 \times 7000 \times \frac{(0.00575^3 - 0.003^3)}{(0.00575^2 - 0.003^2)} \times \frac{2n}{2n}$$

$$n = \frac{3T(r_2^2 - r_1^2)}{4\mu W(r_2^3 - r_1^3)} = \frac{3 \times 572.96 \times (0.00575^2 - 0.003^2)}{4 \times 0.45 \times 7000 (0.00575^3 - 0.003^3)}$$

$$n = 1.73$$

$n = 2$ plates required pressure theory.

(i) Uniform wear plates

$$n = \frac{T}{\mu W(r_2 + r_1)} = \frac{572.96}{0.45 \times 7000 \times (0.00575 + 0.003)}$$

$$n = 5.017$$

$n = 6$ plates required.

$$e.) T = \frac{\mu W(D_o + D_i)}{4 \sin \beta}$$

$$D_o = 0.005 \quad D_i = 0.00475$$

$$\text{Outer radius} = 50 \text{ mm}$$

$$\text{inner radius} = 47.5 \text{ mm}$$

$$W = 1200 \text{ N}$$

$$\mu = 0.15$$

$$\text{Angle } 6^\circ$$

$$T = \frac{0.15 \times 1200 (0.005 + 0.00475)}{4 \sin 6^\circ}$$

$$T = 1.022 \text{ Nm}$$

- 3.) Pedal Ratio = 4.2 : 1 Vehicle mass = 650 kg
 Master cylinder D = 14.5 mm Static m
 Slave cyl d = 45 mm
 No of Slaves per wheel = 2
 Effective pad radius = 165 mm
 Pad N = 0.5
 Wheel fair radius = 0.245 m

Static mass distribution = f:R 45% : 55%
 L R 50% : 50%

$$\cos \text{ height} = 0.31$$

Height

$$a = 1.19 \cdot r$$

$$\text{Wheelbase} = 2.4 \text{ m}$$

$$a.) \quad LT = \frac{mah}{w} = \frac{\frac{650}{2} \times (0.8 \times 9.81) \times 0.31}{2.4}$$

$$LT = 658.9 \text{ N}$$

$$b.) \quad \text{Static tyre load} = \text{Front} = \frac{650 \times 0.45}{2} = 146.25 \text{ kg}$$

$$\text{dynamic load} = (146.25 \times 9.81) + \frac{658.9}{2} = 1764.16 \text{ N} \quad \text{Per wheel}$$

$$c.) \quad \text{Approx } 2200 \text{ N force}$$

$$\text{Approx } 9000 \text{ N total force}$$

d.) Assuming front and rear brakes are identical

$$\therefore F_w = \frac{9000}{4} = 2250 \text{ N per wheel}$$

$$\therefore T = f_w \times R = 2250 \times 0.245$$

$$T = 551.25 \text{ Nm}$$

$$\text{Then } F_s = \frac{T}{\mu R} = \frac{725}{0.5 \times 0.165}$$

$$F_s = 8787.8 \text{ N}$$

$$P = \frac{F_s}{A_s}$$

7.

$$4.) \quad T_R = \frac{1}{2} \rho C_d A V^2 + mg(\sin \theta + \text{crr}(\cos \theta))$$

$$\frac{1}{2} (1.223) (0.36) (1.4) (35^2) + (1600) (9.81) (0.017)$$

$$T_R = 644.37$$

$$8.) \quad n_s = 0.8 \quad v = 70 \quad R = 0.36 \quad \text{RPM} \quad 6500$$

$$v = \frac{2\pi R N}{60 f n_s}$$

$$v = \frac{2\pi \times 0.36}{60 \times f n_s}$$

$$f = \frac{2\pi R N}{60 v n_s}$$

$$f = \frac{2\pi (0.36) (6500)}{60 (70) (0.8)}$$

$$f = 4.38.$$