

Question 1:

$$T_1 = 130 \text{ Nm}$$

~~B 1600 RPM~~

$$N_1 = 3000 \text{ (clockwise)}$$

$$\eta = 82\% = 0.82$$

16/05/2022

Autodynamics
Dynamics

A.G. Bennett
2004205

$$\text{Gear A: } 24 \text{ T}$$

$$Q \text{ " B: } 118 \text{ T}$$

$$Q \text{ " C: } 32 \text{ T}$$

$$Q \text{ " D: } 132 \text{ T}$$

$$Q \text{ " E: } 12 \text{ T}$$

$$Q \text{ " F: } 164 \text{ T}$$

A) Stage 1:

$$\frac{118}{24} = 4.92$$

$$G.R. = 4.92 \times 4.13 \times 8.67$$

$$G.R. = 176.17 : 1$$

Stage 2:

$$\frac{132}{32} = 4.13$$

B) Anti-clockwise

Stage 3:

$$\frac{164}{12} = 8.67$$

$$C) T_1 = 130 \text{ Nm}$$

$$N_1 = 3000 \text{ RPM}$$

$$G.R. = 176.17$$

$$G.R. = \frac{N_1}{N_2} \quad N_2 = \frac{N_1}{G.R.} = \frac{3000}{176.17}$$

$$N_2 = 17.03 \text{ RPM}$$

$$P_1 = \frac{2\pi N_1 T_1}{60}$$

$$P_2 = P_1 \times \eta$$

$$P_2 = 40.84 \times 10^3 \times 0.82$$

$$P_1 = \frac{2\pi \times 3000 \times 130}{60}$$

$$P_2 = 33.49 \times 10^3 \text{ W}$$

$$P_1 = 40.84 \times 10^3 \text{ W}$$

$$T_2 = \frac{60 \times P_2}{2\pi N_2} = \frac{60 \times 33.49 \times 10^3}{2\pi \times 17.03}$$

$$T_2 = 18.78 \times 10^3 \text{ Nm}$$

1

A) D) $T_1 + T_2 + T_3 = 0$

Q. $T_1 = 130$

D. $T_2 = 18.78 \times 10^3$

D. $130 + 18.78 \times 10^3 + T_3 = 0$

W. $T_3 = 18.78 \times 10^3 - 130$

S. $T_3 = -18650 \text{ Nm}$

A) E) Ring Gear C = 260 T

Planet Gear B = 32 T

Sun Gear D = 180 T

Input Arm A, output is Sun Gear D.

Step	Action	A	B	C	D
1	round	1	1	0	1
2	return B	0	2	0.5	1
3	Total	1	3	0.5	2

A) Ratio = 1.05

B) G.R. = $\frac{\text{Input Speed}}{\text{Output Speed}}$

$\eta = \frac{\text{Power out}}{\text{Power in}} = \frac{2\pi N_2 T_2 \times 60}{2\pi N_1 T_1 \times 60} = \frac{N_2 T_2}{N_1 T_1}$

C)

2

Automotive Dynamics:

16th May 2022

1004205

A.G. Bennett

Question 2:

$$D_1 = 0.105/2 \quad r_1 = 0.0525 \text{ m}$$

$$D_2 = 0.19/2 \quad r_2 = 0.095 \text{ m}$$

$$\mu = 0.32$$

$$W = 6500 \text{ N}$$

$$S_{PR} = 925 \text{ N/mm}$$

Uniform pressure:

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

$$T = \frac{2}{3} \times 0.32 \times 6500 \times \frac{(0.095^3 - 0.0525^3)}{(0.095^2 - 0.0525^2)}$$

$$T = 157.65 \text{ Nm}$$

$$B) \quad W = 6500 \times (985 \times 1.2)$$

$$W = 5390$$

Uniform wear

$$T = \frac{\mu W (r_2 + r_1)}{2}$$

$$T = \frac{0.32 \times 5390 \times (0.095 + 0.0525)}{2}$$

$$T = 127.204 \text{ Nm}$$

c)
D. Question 2 (continued):

P, $D_1 = 0.06$ $r_1 = 0.03$

$$P = 450 \times 10^3 \text{ W}$$

W $D_2 = 0.115$ $r_2 = 0.0575$

$$\text{PRPM} = 7500 \text{ RPM}$$

$\mu = 0.45$

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

$$\text{SPR} = 1200 \text{ N/mm}$$

D) Uniform Pressure Theory:

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

$$T = \frac{2}{3} \times 0.45 \times 7000 \times \frac{(0.0575^3 - 0.03^3)}{(0.0575^2 - 0.03^2)}$$

$$T = 165.89 \times 10^3 \text{ Nm}$$

c) Uniform Wear Theory:

$$7000 \times 1200 = 8400 \text{ W}$$

$$T = \frac{\mu W (r_2 + r_1)}{2}$$

$$T = \frac{0.45 \times 7000 (0.0575 + 0.03)}{2}$$

$$T = 137.81 \text{ Nm}$$

c)

$$D_2 = 0.1 \text{ m}$$

$$D_1 = 0.095 \text{ m}$$

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

$$\mu = 0.15$$

$$A = 6^\circ$$

Question 2 continued

$$T = \frac{\mu W (D_0 + D_1)}{4 \sin \beta}$$

$$T = \frac{0.15 \times 1200 \times (0.1 + 0.095)}{4 \sin 6}$$

$$T = 83.95 \text{ Nm.}$$

Automotive Dynamics:

Question 3:

16th May 2022

A.G. Bennett
2002-2005

$$P.R. = 4.2:1$$

$$m = 650 \text{ kg}$$

$$M_{cyl} = 14.5 \text{ mm} = 0.0145$$

$$\text{Mass Dis F:R } 45\%:55\%$$

$$S_{cyl} = 45 \text{ mm} = 0.045$$

$$\text{Mass Dis L:R } 50\%:50\%$$

$$N_o = 2$$

$$CoGH = 0.31 \text{ m}$$

$$PadR = 165 \text{ mm} = 0.165 \text{ m}$$

$$W_{base} = 2.4 \text{ m}$$

$$\mu = 0.5$$

$$W_{RR} = 0.265 \text{ m}$$

$$A) L_{Tlong} = \frac{m a h}{w} = \frac{650 \times (0.8 \times 9.81) \times 0.31}{2.4}$$

$$L_{Tlong} = 658.71 \text{ N}$$

$$B) F = ma$$

$$F = 650 \times 9.81$$

$$F = 6376.5 \text{ N}$$

$$C) \text{ Longitudinal reaction force from o.1} \\ = 1100 \text{ N}$$

Question 3 Continued:

A
D

$$D) P = \frac{F_{\text{cyl}}}{A_{\text{cyl}}}$$

$$\frac{\pi \times 0.0145^2}{4} = 165.13 \times 10^{-6} \text{ m}^2$$

$$P = mV$$

$$P = 650 \times 9.81$$

$$P = 6376.5$$

Come back to:

$$E) L_{\text{T long}} = \frac{2207.25 \text{ N}}{4}$$

$$I) L_{\text{T long}} = 1103.63 \text{ N}$$

$$II) F_W = \frac{T}{R}$$

$$F_W = 4679.37 \times 0.265$$

$$F_W = 1240.03 \text{ N}$$

$$T = F_{\text{cyl}} \times \mu \times r$$

$$T = 1240.03 \times 0.42 \times 0.17$$

$$T = 88.54 \text{ Nm}$$

$$\text{Auto Dyn III} = 88.54 \times 4$$

$$= 354.16 \text{ N}$$

Qu

$$M = \text{IV} = F:R$$

$$F_A = 354.16/2$$

$$d = 177.08.$$

Cr

Pmax

Pmax

Tmax

Tmax

$\eta =$

No.

RR

T

r

Automotive Chassis Systems/Automotive Dynamics Exam:

16th May 2022
2009205

A.G. Bennett

Question 4:

$$M = 1200 \text{ kg}$$

$$F_A = 1.4 \text{ m}^2$$

$$C_d = 0.36$$

$$C_{rr} = 0.017$$

$$P_{max} = 168 \times 10^3 \text{ W}$$

$$P_{max} \text{ RPM} = 6500 \text{ RPM}$$

$$T_{max} = 200 \text{ Nm}$$

$$T_{max} \text{ RPM} = 5200 \text{ RPM}$$

$$\eta = 0.875$$

$$N_o = 5$$

$$R_R = 0.28 \text{ m}$$

$$A) T_R = mg(\sin \theta + C_{rr} \cos \theta)$$

$$T_R = \frac{1}{2} \rho C_d A (V^2) + mg \times 0.017$$

$$T_R = \frac{1}{2} \times 1.22 \times 0.36 \times 1.4 \times (35)^2 + 1200 \times 9.81 \times (0.017)$$

$$T_R = 576.74 \text{ N}$$

$$B) V = \frac{2\pi R N}{60 f A}$$

$$f = \frac{2\pi R N}{60 v n} = \frac{2\pi \times 0.28 \times 6500}{60 \times 70 \times 0.8}$$

$$f = 3.40$$

$$T_E = \frac{T_f n_i \eta}{R}$$

$$n_i = \frac{576.74 \times 0.28}{200 \times 3.4 \times 0.875}$$

$$n_i = \frac{T_E \times R}{T_f \times \eta}$$

$$n_i = 0.27$$

$$c) \mu_s = 0.8 \quad V = 70 \quad P_{max} = 6500 \text{ RPM}$$

$$\tan^{-1}\left(\frac{1}{3}\right) = 18.43^\circ$$

$$T_R = Mg(\sin \theta + 0.017 \cos \theta)$$

$$T_R = 1200 \times 9.81 (\sin 18.43 + 0.017 \cos 18.43)$$

$$T_R = 3724.81 \text{ N}$$

$$V = \frac{2\pi R N}{60 f \eta}$$

$$T_E = \frac{T_f n_1 \eta}{R}$$

$$f = \frac{2\pi \times 0.28 \times 6500}{60 \times 70 \times 0.8}$$

$$n_1 = \frac{T_E \times R}{T_f \times \eta}$$

$$f = 3.4$$

$$n_1 = \frac{3724.81 \times 0.28}{200 \times 3.4 \times 0.875}$$

$$SR = \frac{T_{max} \text{ RPM}}{P_{max} \text{ RPM}}$$

$$n_1 = 1.75$$

$$d) n_x = n_1 \times$$

$$SR = \frac{5200}{6500} = 0.8$$

$$n_{2c} = n_1 \times 0.8^{x-1}$$

$$n_2 = 1.75 \times 0.8^{2-1} = 1.4$$

$$n_3 = 1.75 \times 0.8^{3-1} = 1.12$$

$$n_4 = 1.75 \times 0.8^{4-1} = 0.89$$