



Complete, fold and seal
(see note 2 below)

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GRESHAM

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

1	Student Number	P149661
2	Title of Examination Paper	VEHICLE DYNAMICS
3	Module Code	MSX00407
4	Date and Time of Examination	11/01/19 9:00
5	Examination Venue	Vivian Hall Dylan Thomas Centre
6	Seat Number	G093
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	10
2	13 1/2
3	6
	~~29 1/2~~
Office Use	49.2

Q1) a) $m = 1500 \text{ kg}$. $\rightarrow 750 \text{ kg}$ per wheel.

$$\mu = 1.2$$

$$RR = 0.32 \text{ m}$$

$$9.81 \times 750 \times 1.2 = 8829 \text{ N}$$

$$\frac{8829}{0.32} = 27590.63 \text{ N}$$

1/2

b) 3000 Nm

$$O_d = 100 \text{ mm} = 0.05 \text{ m radius}$$

$$I_d = 95 \text{ mm} = 0.0475 \text{ m radius}$$

$$\alpha = 7$$

$$C_f = 0.2$$

$$T = \frac{1}{\sin \alpha} \times \frac{2}{3} \mu F \left(\frac{r_0^3 - r_1^3}{r_0^2 - r_1^2} \right)$$

$$\frac{3}{2} T \sin \alpha \times \mu \times \left(\frac{r_0^2 - r_1^2}{r_0^3 - r_1^3} \right) = F$$

$$\frac{3}{2} \times 3000 \times \sin(7) \times 0.2 \times \left(\frac{0.05^2 - 0.0475^2}{0.05^3 - 0.0475^3} \right) = F$$

3/6

$$F = \frac{3}{2} \times 73.1216 \times (13.6722)$$

$$F = 1499.6 \text{ N}$$

$\times 2$ (faces)

$$F_{\text{total}} = 2999.2 \text{ N}$$

c)

0/3

$$d) \quad 1,000,000 \text{ J} \quad \text{max rpm} = 10000 \\ 0.5 \text{ m} \quad = 1047.20 \text{ rad/sec}$$

$$E = \frac{1}{2} I \omega^2$$

$$1000000 = 0.5 \times I \times 1047.2^2$$

$$\frac{1000000}{0.5 \times 1047.2^2} = I = 1.824$$

$$K = 0.25 \times 0.707 = 0.17675$$

$$I = m k^2$$

$$\frac{I}{k^2} = m = \frac{1.824}{0.17675^2} = 58.38 \text{ kg}$$

4/4

$$e) \quad m = A \times L \times \rho$$

$$58.38 = (\pi \times 0.25^2) \times L \times 7700$$

$$\frac{58.38}{(\pi \times 0.25^2 \times 7700)} = L = 0.0386 \text{ m}$$

2/3

f) ~~A cone shaped clutch would be used and increasing the size of it would decrease packaging and~~

0/2

10/20

Q2) $W_d = 2m$ $H = 3m$ $acc = 1m/s^2$

$C_d = 0.7$

$P_{air} = 1.2$

$RR = 0.005N/N_{vert.}$

$V = 40km/h = 11.11m/s$

$W = 5500kg + (20 \times 100) = 7500kg$

$acc/decc = 20km/h = 5.56m/s$

80% eff.

$d = 600m$

a) $7500 \times 9.81 \times 0.005 = 367.875N$ (R_F)

$0.5 \times (2 \times 3) \times 1.2 \times 0.7 \times 5.56^2 = 77.902N$ (A_F)

$R_F = 367.875 + 77.902 = 445.78N$
 $= (445.78N)$

$F = ma = 7500 \times 1 = 7500N$

$7500 + 445.78N = 7945.78N$

~~7500~~
1500

kgm/s^2
 kgm/s

b) $\frac{11.11m/s}{1m/s^2} = 11.1s$

$11.1 \times 7500 = 83325$

~~7945.78~~ ~~715~~ ~~83325~~

~~7945.78~~ ~~83325~~ ~~83325~~

c) $\frac{83325}{7945.78} = 10.486m$

c) $F \times d =$
 $7945.78 \times 10.486 \times \frac{1}{0.8}$
 $= 104.188kJ$

d) $K_c = \frac{1}{2}mv^2 = 0.5 \times 7500 \times 11.1^2$
 $= 462037.5J = 462.037kJ \times \frac{1}{0.8}$
 $= 577.546kJ$

e) $104.188 \text{ kJ} = 104188 \text{ J}$
 $577.546 \text{ kJ} = 577546 \text{ J}$

$$577546 - 104188 = 473358 \text{ J}$$

$$473358 \times 0.8 = 378686.4 \text{ J}$$

f) $577546 \times 0.2 = 115509.2 \text{ J}$

$$378686.4 + 115509.2 = 494195.6 \text{ J}$$

$$= 494.2 \text{ kJ}$$

g) $1.2 \text{ MJ} = 1200000 \text{ J}$

$$1000 \text{ rpm} - 5000 \text{ rpm}$$

$$4000 \text{ rpm} \times \frac{2\pi}{60} = 418.88 \text{ rad/sec}$$

$$\frac{418.88}{60} = 6.98 \text{ rads/sec}^2 = \alpha$$

$$K_e = \frac{1}{2} I \omega^2$$

$$5000 \times \frac{2\pi}{60} = 523.599 \text{ rad/sec}$$

$$1200000 = 0.5 \times I \times 523.599^2$$

$$\frac{1200000}{0.5 \times 523^2} = I = 8.754 \checkmark$$

$$\tau = I \alpha$$

$$\tau = 8.754 \times 6.98$$

$$\tau = 61.1 \text{ Nm}$$

Q3) $F_m = 900$ $R_m = 900$ $RR = 0.35m$
 $C_g = 0.7$ $T_w = 1.5m$ $W_b = 2.8m$



a) 

$$\frac{900 \times 9.81}{0.7 + 0.35} = 8408.57 \text{ N}$$

1/4

b) $450 \times 9.81 \times 0.1 = 441.45 \text{ Nm}$
 $450 \times 9.81 \times 1 = 4414.5 \text{ Nm}$

Open so $T_L = T_R = 441.45 \times 2 = 882.9 \text{ Nm}$

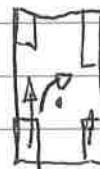
2/4

$\Rightarrow \frac{882.9}{8408.57} = 0.105 \text{ m/s}^2$

c) $441.45 \times 3 = 1324.35 = T_L$
 $1324.35 + 441.45 = 1765.8 \text{ Nm}$
 $\frac{1765.8}{8408.57} = 0.21 \text{ m/s}^2$

2/3

d) $4414.5 \times 2 = \frac{8829}{8408.57} = 1.05 \text{ m/s}^2$



1/5

The vehicle will try to turn towards the low run region, as a moment will occur around the C.G. of the vehicle, therefore the driver will have to steer towards the high run region.

$$e) E = \frac{1}{2}mv^2$$

$$E = \frac{1}{2} \times 450 \times \left(10 \times \frac{1000}{3600}\right)^2$$

$$E = 0.5 \times 450 \times 7.72$$

$$E = 1736.15$$

0
4

6
20