

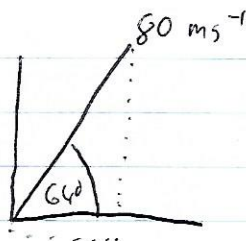
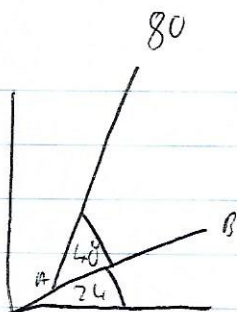
12 Pages

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	1809249/1
2	Title of Examination Paper	Dynamics control and Instrumentation
3	Module Code	MEK x 01405
4	Date and Time of Examination	15/05/19
5	Examination Venue	Ward 2 ~~Hill~~ Gower College
6	Seat Number	2
7	Number of Answer Books handed in	

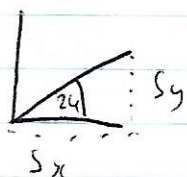
List the numbers of the questions you have attempted	Office Use
Q ₁	10 ✓
Q ₂	9 ✓
Q ₃	0 ✓
Q ₄	12 ✓
Q ₅	9 ✓
Q ₆	7 ✓
Total	43 ✓ 61%

1a)



$$u_x = 80 \cos(64) \\ = 35.070 \text{ ms}^{-1}$$

$$u_y = 80 \sin(64) \\ = 71.904 \text{ ms}^{-1}$$



$$\tan(24) = \frac{s_y}{s_x} \\ s_x = \frac{s_y}{\tan(24)}$$

$$s_x = ut + \frac{1}{2}at^2 \\ = 35.070t + \frac{0}{2}t^2 \\ = 35.070t$$

$$s_y = ut + \frac{1}{2}at^2 \\ = 71.904t + \frac{-9.81}{2}t^2 \\ = 71.904t - \frac{9.81}{2}t^2$$

$$s_x = \frac{s_y}{\tan(24)} = 35.070t$$

$$s_y = 35.070t \times \tan(24) \\ = 15.614t$$

$$s_y = 71.904t - \frac{9.81}{2}t^2$$

$$15.614t = 71.904t - \frac{9.81}{2}t^2$$

$$0 = 71.904t - 15.614t - \frac{9.81}{2}t^2$$

$$0 = 56.290t - \frac{9.81}{2}t^2$$

$$0 = t \left(56.290 - \frac{9.81}{2}t \right)$$

either
 $t = 0$

OR

$$0 = 56.290 - \frac{9.81}{2}t$$

$$+ \frac{9.81}{2}t = 56.290$$

$$t = \frac{56.290 \times 2}{9.81}$$

$$t = 11.476 \text{ s} \quad \checkmark$$

6v

$$1b \quad S_x = u t + \frac{1}{2} a t^2$$

$$S_x = 35.070 t$$

$$S_y = 15.614 t$$

$$t = 11.676 s$$

$$S_x = 402.463 m \quad \checkmark$$

$$S_y = 181.814 m$$

$$S_y = 179.186 m \quad \checkmark$$

$$\overrightarrow{AB} = \sqrt{(402.463)^2 + (179.186)^2}$$

$$= 440.550 m \quad \checkmark$$

4

$$2a) S_A = 24t^2 + 18t - 17$$

$$\frac{dS_A}{dt} = v_A = 48t + 18 \quad \checkmark$$

$$S_B = 14t^2 + 5t + 25$$

$$\frac{dS_B}{dt} = v_B = 28t + 5 \quad \checkmark$$

$$v_A = 3v_B \quad \checkmark$$

$$48t + 18 = 3(28t + 5) \quad \text{Error-corrected.}$$

$$48t + 18 = 84t + 15$$

$$48t - 84t + 18 - 15 = 0$$

$$-36t + 3 = 0$$

$$3 = 36t$$

$$t = \frac{3}{36}$$

$$t = \frac{1}{12} = 0.083 \quad \checkmark \text{ with one.}$$

$$2b) S_A = 24t^2 + 18t - 17$$

$$t = 0$$

$$S_A = 24(0) + 18(0) - 17$$

$$= -17 \text{ m}$$

$$S_B = 14t^2 + 5t + 25$$

$$t = 0$$

$$S_B = 14(0) + 5(0) + 25$$

$$= 25 \text{ m}$$

$$t = 4$$

$$S_A = 24(4^2) + 18(4) - 17$$

$$= 439 \text{ m}$$

$$t = 4$$

$$S_B = (14)(4^2) + 5(4) + 25$$

$$= 269 \text{ m}$$

A travelled $439 - (-17) \text{ m}$ From $0 - 4$ seconds

$\therefore$ A travelled 456 m $\checkmark$

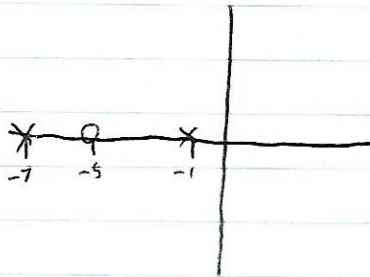
B travelled $269 - 25 \text{ m}$ From $0 - 4$ seconds

$\therefore$ B travelled 244 m $\checkmark$

$$c) v_A = 48t + 18$$

$$\frac{dv_A}{dt} = a_A = 48 \text{ ms}^{-2} \quad \checkmark$$

4a) $G(s) = \frac{(s+5)}{s^2+8s+7} = \frac{(s+5)}{(s+1)(s+7)}$ Zero = -5
Poles = -1, -7



System is stable. ✓

b) DC response at $\frac{s+5}{s^2+8s+7}$ when $s=0$

$$\frac{0+5}{0^2+8(0)+7} = \frac{5}{7} = 0.714285 \checkmark$$

= 0.714285

c) $\frac{s+5}{(s+1)(s+7)}$ system output $\frac{3}{s}$

$$\therefore \frac{3(s+5)}{(s)(s+1)(s+7)} = \frac{A}{s} + \frac{B}{(s+1)} + \frac{C}{(s+7)} \checkmark$$

$$\times (s)(s+1)(s+7)$$

$$3(s+5) = A(s+1)(s+7) + B(s)(s+7) + C(s)(s+1)$$

$$s=0$$

$$3(0+5) = A(0+1)(0+7) + B(0) + C(0) \checkmark$$

$$15 = 7A$$

$$A = \frac{15}{7}$$

$$40) \quad s = -1$$

$$3(-1+s) = A(0) + B(-1)(-1+7) + C(0)$$

$$12 = -6B$$

$$\frac{12}{-6} = B$$

$$B = -2$$

$$s = -7$$

$$3(-7+s) = A(0) + B(0) + C(-7)(-7+1)$$

$$-6 = 42C$$

$$\frac{-6}{42} = C$$

$$C = -\frac{1}{7}$$

$$\frac{3(s+5)}{(s)(s+1)(s+7)} = \frac{15}{7s} - \frac{2}{(s+1)} - \frac{1}{7(s+7)} \quad \checkmark$$

(5) ✓

$$\textcircled{5} \quad e^{-at} = \frac{1}{s+a} \quad t=2$$

$$e^{-a^2}$$

$$\frac{3(s+5)}{(s+1)(s+7)}$$

?

$$\frac{3e^{-5t}}{e^{-1t}e^{-7t}} \quad t=2 \quad = 1210.286$$

5a) $2s^5 + 3s^4 + 2s^3 + s^2 - s + 4$

	1	2	3	4
s^5	2	2	-1	0
s^4	3	1	4	0
s^3	$\frac{4}{3}$	$-\frac{11}{3}$	0	0
s^2	$\frac{37}{4}$	4	0	
s^1	$-\frac{157}{37}$	0	0	
s^0	-4	0		

$$s^3 \cdot 1 = - \begin{vmatrix} 2 & 2 \\ 3 & 1 \end{vmatrix}$$

$$= - \frac{(2 \times 1) - (3 \times 2)}{3}$$

$$= \frac{4}{3}$$

$$s^1 \cdot 2 = \begin{vmatrix} 2 & -1 \\ 3 & 4 \end{vmatrix}$$

$$= - \frac{(2 \times 4) - (3 \times -1)}{3}$$

$$= - \frac{11}{3}$$

not stable as 1 sign change ✓

1 pole in R H plane.

$$s^2 \cdot 1 = \begin{vmatrix} 3 & 1 \\ \frac{4}{3} & -\frac{11}{3} \end{vmatrix}$$

$$= - \frac{(3 \times -\frac{11}{3}) - (\frac{4}{3} \times 1)}{\frac{4}{3}}$$

$$= \frac{37}{4}$$

$$s^2 \cdot 2 = \begin{vmatrix} 3 & 4 \\ \frac{4}{3} & 0 \end{vmatrix}$$

$$= - \frac{(3 \times 0) - (\frac{4}{3} \times 4)}{\frac{4}{3}}$$

$$= 4$$

$$s^0 \cdot 1 = \begin{vmatrix} \frac{37}{4} & 4 \\ -\frac{157}{37} & 0 \end{vmatrix}$$

$$= - \frac{(-\frac{157}{37} \times 4) - (\frac{37}{4} \times 0)}{-\frac{157}{37}}$$

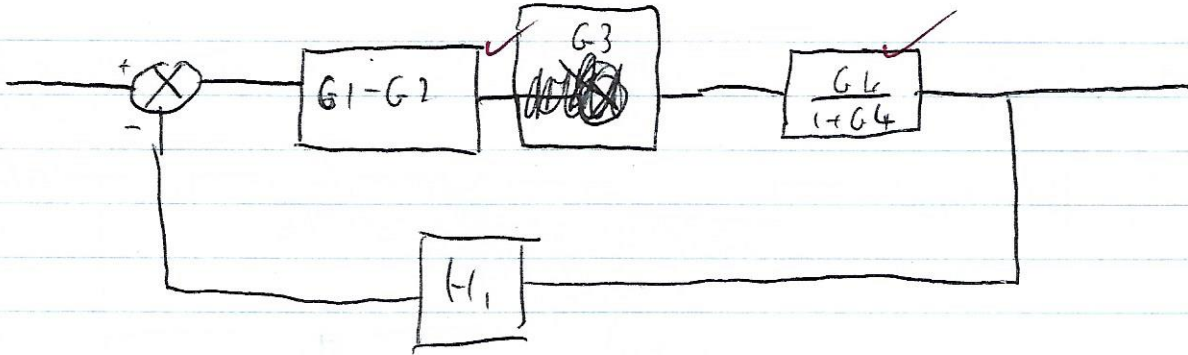
$$= -4$$

$$s^1 \cdot 1 = \begin{vmatrix} \frac{4}{3} & -\frac{11}{3} \\ \frac{37}{4} & 4 \end{vmatrix}$$

$$= - \frac{(\frac{4}{3} \times 4) - (\frac{37}{4} \times -\frac{11}{3})}{\frac{37}{4}}$$

$$= - \frac{157}{37}$$

6a)



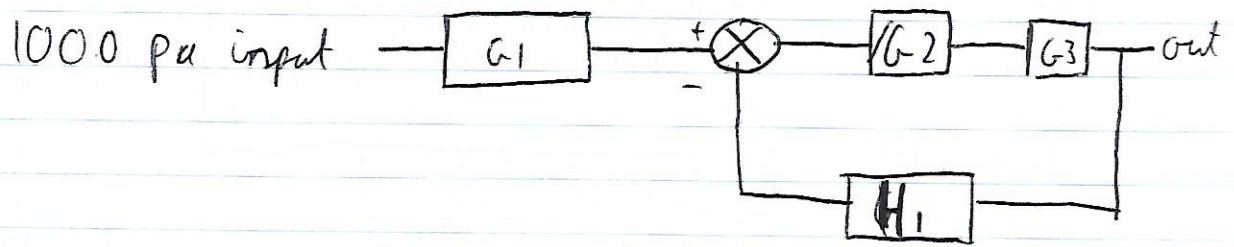
$$\frac{(G_1 - G_2)(G_3)\left(\frac{G_4}{1 + G_4}\right)}{1 + \frac{(G_1 - G_2)(G_3)\left(\frac{G_4}{1 + G_4}\right)}{H_1(G_1 - G_2)(G_3)\left(\frac{G_4}{1 + G_4}\right)}}$$

$$= \frac{(G_1 - G_2)(G_3)(G_4)}{(1 + G_4) \frac{(G_1 - G_2)(G_3)(G_4)}{H_1(G_1 - G_2)(G_3)(G_4)}}$$

3.

✓

G6



$$G1: 5 \times 10^{-3} \text{ V/Pa}$$

$$G2: \times 100$$

$$G3: 2 \text{ deg/V}$$

$$H1: 0.4 \times 10^{-3} \text{ V/deg}$$

$$\frac{G2 G3}{1 + \frac{(G2 G3)}{(H1 G2 G3)}} \quad \times$$

$$G1 \rightarrow 5 \times 10^{-3} \times 1000 \text{ Pa} = 5 \text{ V}$$

$$G2 \rightarrow \times 100 = 500 \text{ V}$$

$$G2 G3 = 1000^\circ$$

$$G3 \rightarrow 2^\circ/\text{V} \rightarrow 2 \times 500 = 1000^\circ$$

$$H1 \rightarrow 0.4 \times 10^{-3} \text{ V/deg} = 0.4 \times 10^{-3} \times 1000 = 4^\circ$$

$$\frac{1000}{1 + \frac{1000}{4 \times 1000}} = 800^\circ$$

$$3a \quad F = ma$$

$$\text{Spring} = kx$$

$$F = kx$$

$$F(t) = ma$$

$$3f = 3kDC$$

dumper

$$3kx \times m$$

$$(3kx \times ma) - \text{damper}(c)$$

+