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Examination Answer Books

12 Pages

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.

Complete, fold and seal
(see note 2 below)

SURNAME: William

FORENAME(S): Jacob Nicolas

1	Student Number	1603333/1
2	Title of Examination Paper	Dynamics Control + Instrumentation
3	Module Code	M4X01405 GORG4005-006
4	Date and Time of Examination	14:00 16/05/18
5	Examination Venue	GCJ
6	Seat Number	13
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1	10
Q2	7
Q3	7
Q4	14
Q5	8
Q6	4
Total	50

71% ✓

	Horizontal	Along the plane	90°
U	$80 \cos(64)$ ✓	$80 \cos(40)$ ✓	$80 \sin(40)$ ✓
V	$80 \cos(64)$ ✓		
A		$-9.81 \cos(66)$ ✓	$-9.81 \cos(24)$ ✓
T	11.4	11.4	~~11.4~~ 11.4
S			0 ✓

a) $s = ut + \frac{1}{2}at^2$

$$0 = 80 \sin(40) \times t + \frac{1}{2} (-9.81 \cos(24)) \times t^2$$

$$0 = t (80 \sin(40)) + (\frac{1}{2} \times -9.81 \cos(24) \times t)$$

Answer 1

$$t = 0$$

Answer 2

$$= 80 \sin(40) + \frac{1}{2} \times -9.81 \cos(24) \times t$$

$$-80 \sin(40) = \frac{1}{2} \times -9.81 \cos(24) \times t$$

$$\frac{-80 \sin(40)}{\frac{1}{2} \times -9.81 \cos(24)} = t$$

$$t = 11.4 \text{ s}$$

$$t = 11.4 \text{ s}$$

b) $s = ut + \frac{1}{2}at^2$

$$= 80 \cos(40) \times 11.4 + \frac{1}{2} \times -9.81 \cos(66) \times 11.4^2$$

$$= 698.6 - 259.3$$

$$s = 439.3 \text{ m}$$

6 ✓

4 ✓

2

$$A \Rightarrow S = 17t^2 + 10t$$

$$B \Rightarrow S = 9t^2 + 30$$

a) $\frac{ds}{dt}$ of A+B

$$A = 34t + 10$$

$$B = 18$$

$$34t + 10 = 18 \times 2$$

$$34t + 10 = 36$$

$$34t = 36 - 10$$

$$t = \frac{26}{34}$$

$$t = 0.765$$

	$T = 0$	$T = 4$	Distance travelled.
A	$= 17t^2 + 10t$ $= 17 \times 0^2 + 10 \times 0$ $= 0$	$= 17 \times 4^2 + 10 \times 4$ $= 272 + 40$ $= 312$	$A = 312 - 0$ $= 312 \text{ m}$
B	$= 9t^2 + 30$ $= 9 \times 0^2 + 30$ $= 30$	$= 9 \times 4^2 + 30$ $= 9 \times 16 + 30$ $= 144 + 30$ $= 174$	$B = 174 - 30$ $= 144 \text{ m}$

c) $\frac{ds^2}{dt^2} = 34$

acceleration after 3 seconds = 34 m/s^2

3

a) $F = ma$

or $\frac{TF}{F(s)} = \frac{\text{Output}}{\text{Input}} = \frac{1}{ms^2 + 2c + 3k}$

b) $m = 5 \quad c = 3 \quad k = 10$

$$\frac{1}{5 + \cancel{6} + 30} = \frac{1/5}{\frac{5}{5} + \frac{6}{5} + \frac{30}{5}}$$

a) $\omega_n^2 = \frac{30}{5}$

$\omega_n = \sqrt{\frac{30}{5}}$

$$\frac{k\omega_n}{s^2 + 2\zeta\omega_n + \omega_n^2}$$

$\omega_n = 2.44 \text{ Hz} \text{ (Radians!!)}$

c) $2\zeta\omega_n = \frac{6}{5}$

$2\zeta \cdot 2.44 = \frac{6}{5}$

$\zeta = \frac{6}{5 \times 2.44 \times 2}$
 $= 0.24$

d) Underdamped system

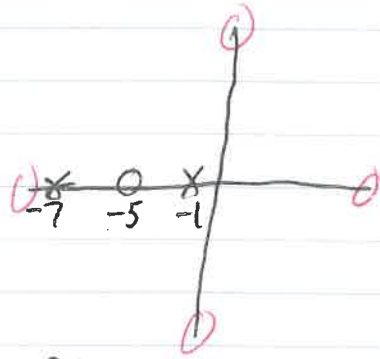
Bl

3 ✓

3 ✓
1 ✓

4.
a)

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



Stable all poles in the left.

b) DC response

make $s=0$

$$\frac{0+5}{(0+7)(0+1)} = \frac{5}{(7)(1)} = \frac{5}{7} \approx 0.714$$

$$c) \left(\frac{s+5}{(s+7)(s+1)} \right) \frac{1}{s} = \frac{s+5}{s(s+7)(s+1)} = \frac{A}{s} + \frac{B}{s+7} + \frac{C}{s+1}$$

$$s+5 = A(s+7)(s+1) + Bs(s+1) + Cs(s+7)$$

To Calculate A make $s=0$

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

$$\frac{5}{7} = A$$

To Calculate B make $s=-7$

$$-7+5 = A(0) + B(-7)(-7+1) + C(0)$$

$$-2 = -42B$$

$$\frac{-2}{-42} = B \quad \text{or } \frac{1}{21}$$

To Calculate C make $s=-1$

$$-1+5 = A(0) + B(0) + C(-1)(-1+7)$$

$$4 = C(-6)$$

$$\frac{4}{-6} = C$$

$$\frac{5}{7}s + \frac{1}{21(s+7)} - \frac{4}{6(s+1)}$$

$$\frac{5}{7} \times 1 + \frac{1}{21} e^{-7t} - \frac{4}{6} e^{-t}$$

$$0.71 + 0.04e^{-7 \times 2} - 0.6e^{-1 \times 2}$$

$$0.71 + 8.32 \times 10^{-8} - 0.36 = 0.35$$

$$= 0.35 \times 3$$

$$= 1.05$$

5)

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

$$s^5 \quad 2 \quad 2 \quad -1 \quad 0$$

$$s^4 \quad 3 \quad 1 \quad 4 \quad 0$$

$$s^3 \quad \frac{4}{3} \quad -\frac{11}{3} \quad 0$$

$$s^2 \quad 9.22 \quad 4 \quad 0$$

$$s^1 \quad -4.2 \quad 0$$

$$s^0 \quad 0$$

$$-\begin{bmatrix} 2 & 2 \\ 3 & 1 \end{bmatrix} = -((2 \times 1) - (2 \times 3))$$

$$= -(2 - 6)$$

$$= +4$$

$$-\begin{bmatrix} 2 & -1 \\ 3 & 4 \end{bmatrix} = -((2 \times 4) - (-1 \times 3))$$

$$= -(8 - (-3))$$

$$= -11$$

$$-\begin{bmatrix} 2 & 0 \\ 3 & 0 \end{bmatrix} = -((2 \times 0) - (0 \times 3))$$

$$= 0$$

$$-\begin{bmatrix} 3 & 1 \\ \frac{4}{3} & -\frac{11}{3} \end{bmatrix} = -((3 \times -\frac{11}{3}) - (1 \times \frac{4}{3}))$$

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

$$= 12.33 = 12.33$$

$$-\begin{bmatrix} 3 & 4 \\ \frac{4}{3} & 0 \end{bmatrix} = -((3 \times 0) - (4 \times \frac{4}{3}))$$

$$= -(0 - (5.33))$$

$$= 5.33 = 5.33$$

$$-\begin{bmatrix} \frac{4}{3} & -\frac{11}{3} \\ 9.22 & 4 \end{bmatrix} = -((\frac{4}{3} \times 4) - (-\frac{11}{3} \times 9.22))$$

$$= -((5.33) - (-33.8))$$

$$= -39.13 = -39.13$$

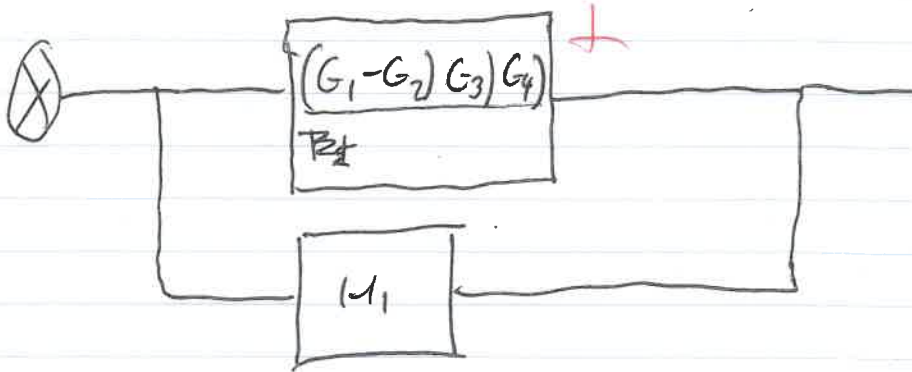
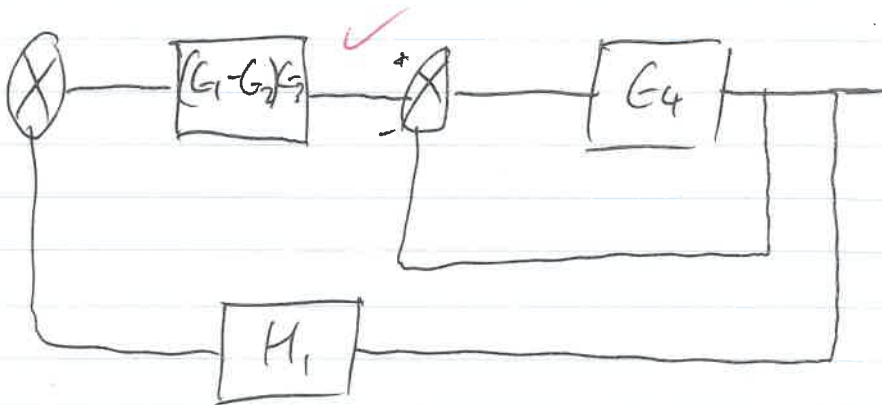
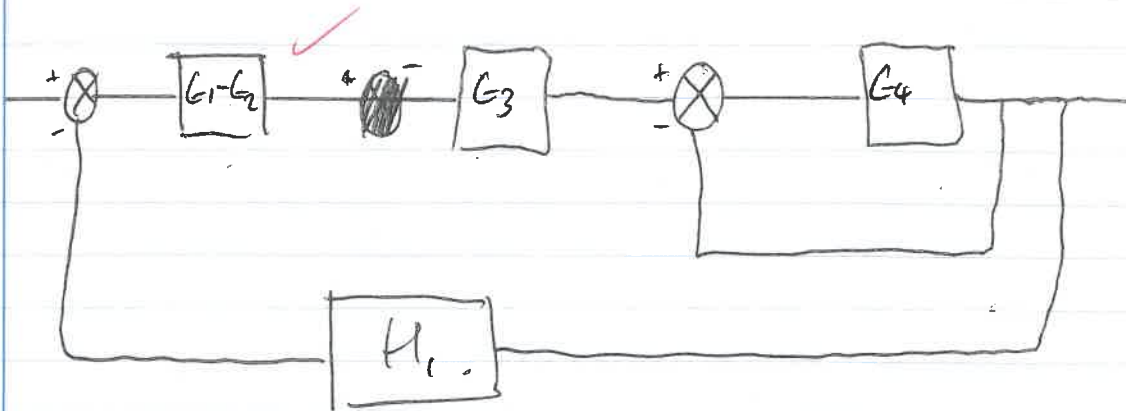
Unstable.

1 pole in the unstable side
as there is one change of
Sign.

8

6

a)

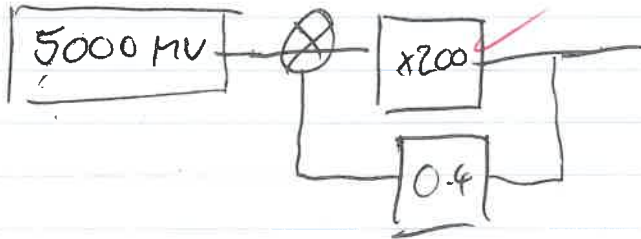
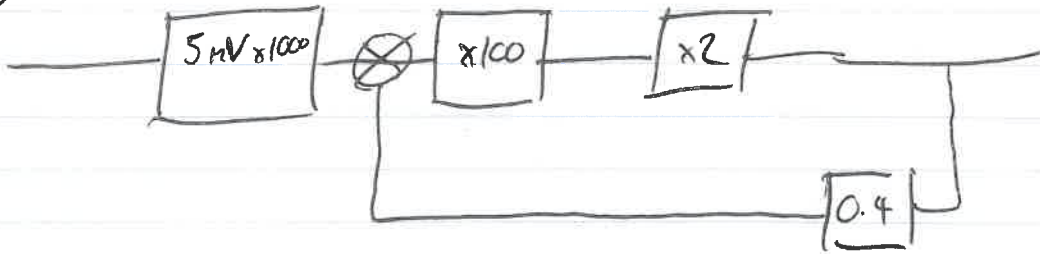


$$\frac{(G_1 - G_2)G_3G_4}{1 + H_1(G_1 - G_2)G_3G_4}$$

$$\frac{(G_1 - G_2)G_3G_4}{1 + H_1(G_1 - G_2)G_3G_4}$$

b)

1000



$$5000 \times \frac{200}{1 + 0.4 \times 200}$$

$$5000 \times 2.46$$

units mV !!

$$5000 \times 2.46 = 12300\text{ V}$$

(2) ✓

Working out for Routh Hurwitz

$$\begin{array}{rclcl}
 s^5 & 2 & 2 & -1 & 0 \\
 s^4 & 3 & 1 & 4 & 0 \\
 s^3 & 4/3 & -1/3 & 0 & 0 \\
 s^2 & 9.22 & 4 & 0 & 0 \\
 s^1 & -4.2 & & & \\
 s^0 & & & &
 \end{array}$$

$$\begin{array}{rcl}
 - \begin{bmatrix} 2 & 2 \\ 3 & 1 \end{bmatrix} & = & -((2 \times 1) - (2 \times 3)) \\
 & = & -(2 - 6) \\
 \hline
 & = & \frac{4}{3} \quad \checkmark
 \end{array}$$

$$\begin{array}{rcl}
 - \begin{bmatrix} 2 & -1 \\ 3 & 4 \end{bmatrix} & = & -((2 \times 4) - (-1 \times 3)) \\
 & = & -(8 + 3) \\
 \hline
 & = & \frac{-11}{3} \quad \checkmark
 \end{array}$$

$$\begin{array}{rcl}
 - \begin{bmatrix} 2 & 0 \\ 3 & 0 \end{bmatrix} & = & 0 \quad \checkmark
 \end{array}$$

$$\begin{array}{rcl}
 - \begin{bmatrix} 3 & 1 \\ 4/3 & -1/3 \end{bmatrix} & = & -((3 \times -1/3) - (1 \times 4/3)) \\
 & = & -(-1 - 1.3) \\
 & = & -(-2.3) \\
 & = & \frac{2.3}{4/3} \\
 & = & 9.22
 \end{array}$$

$$\begin{array}{rcl}
 - \begin{bmatrix} 4/3 & -1/3 \\ 9.22 & 4 \end{bmatrix} & = & -((4/3 \times 4) - (-1/3 \times 9.22)) \\
 & = & -(5.3 - -3.38) \\
 & = & \frac{-8.68}{9.22} \\
 & = & -4.2
 \end{array}$$

$$\begin{array}{rcl}
 - \begin{bmatrix} 3 & 4 \\ 4/3 & 0 \end{bmatrix} & = & -((3 \times 0) - (4 \times 4/3)) \\
 & = & -(0 - 5.3) \\
 & = & \frac{5.3}{4/3} \\
 & = & 4
 \end{array}$$