



12 Pages

**Complete, fold and seal
(see note 2 below)**

SURNAME: *Tavner*

FORENAME(S): SCOTT ALGREN

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	Tav 19892707 326
2	Title of Examination Paper	Dynamics Control and instrumentation.
3	Module Code	GOEE4002
4	Date and Time of Examination	24/09/23 10:02
5	Examination Venue	Tycoch 068860
6	Seat Number	16
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	8
2	3
3	16.5
4	7.5 ✓
Total	35 60

(Gweler yr ochr arall am y fersiwn Cymraeg)

RK

$$\frac{35}{60} = 59\%$$

Question 1

1. $F = MA$

$$F_{\text{net}} = F + (-F_g) = 50 + (-10)$$

$$50\text{N} + (-10\text{N}) = 40\text{N}$$

$$A = \frac{F}{M} = \frac{40\text{N}}{20\text{kg}} = 2\text{m/s}^2$$

2. a) $u = 25\text{m/s}$

$$a = 10\text{m/s}^2$$

$$t = 5\text{s}$$

$$v = ? \quad \text{or} \quad v = u + at = 25 + 10 \times 5 = 75\text{m/s}$$

b)

$$s = ? \quad s = \left(\frac{u+v}{2} \right) t = \left(\frac{25+75}{2} \right) 5 = 250\text{m}$$

3.

$$TF(s) = \frac{1}{\text{determinant}} \left(\frac{\text{sum of all individual loop gains}}{\text{product of non touching loop gains}} \right)$$

$n = \text{number of forward paths}$

$\Delta = \text{determinant}$

$P_i = \text{gain product of loop gains}$

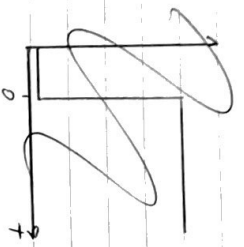
$\Delta_i = \text{determinant of forward paths}$



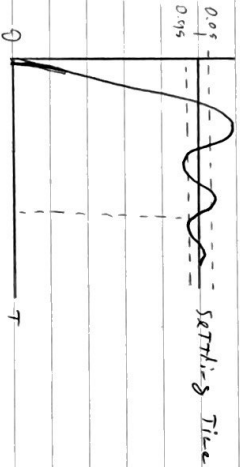
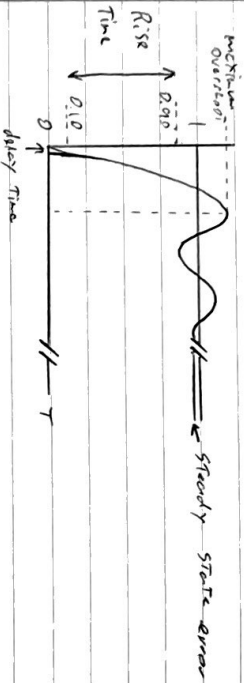
3

3

2



3a)



- a) Rise Time - This is the time taken for the signal to go from 0.10 and 0.90. ✓
- b) Settling Time - This is the time it takes for the signal to stay within 0.05 and 0.95. ✓
- c) Steady state error - This is when the signal has stabilized but is lower than our desired value. ✓

- d) Maximum overshoot - ~~the highest~~ This is the time when the signal reaches its highest point.

- e) delay time - This is the time when the signal begins to increase after 0s. ✓

Question Three

a) T when $V_B = 3V_A$ ✓

$$V_A = \frac{ds_A}{dt} = 6T + 10 \text{ m/s}$$

$$V_B = \frac{ds_B}{dt} = 21T^2 + 8T \text{ m/s}$$

$$21T^2 + 8T = 3(6T + 10)$$

$$21T^2 + 8T = 18T + 30$$

$$21T^2 - 10T - 30 = 0$$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{-(-10) \pm \sqrt{10^2 - 4(21)(-30)}}{2(21)} = T = 1.46 \text{ s}$$

b) T when $a_B = a_C$

$$a_B = \frac{d^2s_B}{dt^2} = 42T + 8$$

$$V_C = 30T^2 - 30$$

$$a_C = \frac{d^2s_C}{dt^2} = 60T$$

$$42T + 8 = 60T$$

$$8 = 60T - 42T$$

$$8 = 18T$$

$$\frac{8}{18} = T = 0.444$$

Question Three

c)



$$\Delta = 4 - 0 = 4 \text{ s}$$

3/2

$$S_A = (3(4)^2 + 10(4) + 8) = 80 \text{ m}$$

$$S_B = (7(4)^3 + 4(4)^2 + 4) = 516 \text{ m}$$

$$S_C = (10(4)^3 - 30(4) + 2) = 522 \text{ m}$$

1.5

d)

$$V_B = 10 \text{ m/s}$$

$$V_B = \frac{ds_B}{dt} = 21T^2 + 8T \text{ m/s}$$

$$21T^2 + 8T = 10$$

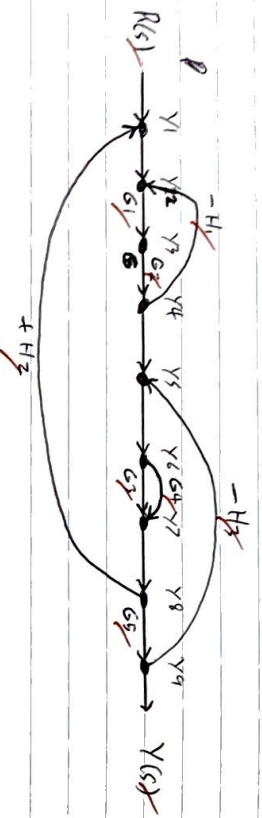
$$21T^2 + 8T - 10 = 0$$

$$\frac{-(-8) \pm \sqrt{8^2 - 4(21)(-10)}}{2(21)} = 0.27 \text{ s } T = 0.53 \text{ s}$$

5

Question 800

a)



b) forward paths

$$P_1 = G_1 G_2 G_3 G_4 G_5$$

$$P_2 = G_1 G_2 G_4 G_5$$

individual loops

$$L_1 = G_1 G_2 - H_1 = -G_1 G_2 H_1$$

$$L_2 = G_3 G_5 - H_2 = -G_3 G_5 H_2$$

$$L_3 = G_3 G_4$$

$$L_4 = G_1 G_2 G_3 G_5 H_2$$

non touching loops

L_1 and L_2

L_1 and L_3

Question 800

b)

$$\frac{Y(s)}{R(s)} = \frac{1}{\Delta} \left(\sum_i P_i \Delta_i \right)$$

N.T.L. = non touching loops

$$\Delta = 1 - \left(\sum \text{sum of all individual} \right) + \left(\sum \text{sum of the product} \right)$$

(loop gains)

Delta

sum of all individual loop gains = 0

$$\Delta = 1 + (G_1 G_2 H_1 - G_3 G_5 H_2 + G_3 G_4 + G_1 G_2 G_3 G_5 H_2) +$$

$$G_1 G_2 H_1 (G_3 G_5 H_2 + G_3 G_4) + G_1 G_2 H_1 G_3 G_4$$

$\Delta \neq 1$ if breaking the path you wish to calculate will break a loop or is there or no N.T.L.

$$\Delta = 1 - (G_1 G_2 H_1 - G_3 G_5 H_2 + G_3 G_4 + G_1 G_2 G_3 G_5 H_2) + G_1 G_2 H_1 (G_3 G_5 H_2 + G_3 G_4) + G_1 G_2 H_1 G_3 G_4$$

$$P_1 = G_1 G_2 H_1 G_3 G_5 H_2 G_3 G_4 + G_1 G_2 G_3 G_5 H_2$$

$$\frac{P_1 \Delta}{\Delta} = \frac{Y(s)}{R(s)}$$