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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	WIL17831767
2	Title of Examination Paper	Dynamics control and Instrumentation
3	Module Code	GOEE4002
4	Date and Time of Examination	24 th MAY 2023 10:00
5	Examination Venue	TYCOCH COLLEGE
6	Seat Number	I2
7	Number of Answer Books handed in	1

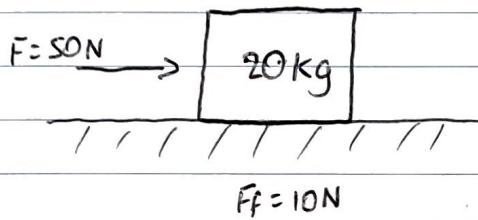
[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

RK

= 94%

(1a)



$$F_{\text{net}} = ma$$

$$F_{\text{net}} = F + (-F_f)$$

$$F_{\text{net}} = 50 - 10$$

$$F_{\text{net}} = 40\text{ N}$$

$$40 = 20a$$

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

(2)

$$u = 25\text{ m/s} \quad a = 10\text{ m/s}^2$$

$$a) \quad t = 5\text{ secs}$$

$$v = u + at$$

$$v = 25 + 10 \times 5$$

$$v = 75\text{ m/s}$$

$$b) \quad s = \frac{u+v}{2} t$$

$$s = \frac{(25 + 75)}{2} \times 5$$

$$s = 250\text{ m}$$

~~2/3~~

(3)

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

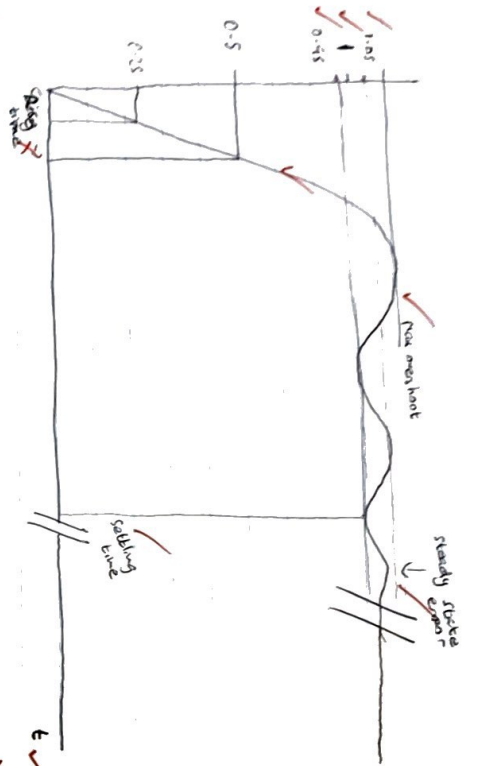
$$\Delta = \text{determinant} = 1 - \left(\text{sum of all individual loop gains} \right) + \left(\text{product of the sum of all NTL (non-touching loops)} \right)$$

$$\sum_i = \text{sum of}$$

 P_i = gains of the forward paths

 Δ_i = determinant of the forward path gain

 $\Delta_i = 1$ IF when the forward path is broken all loops are broken
 OR there are no NTL



Rise time - time taken to reach 0.5
 Settling time - time taken for the response to fall between 0.95 and 1.05
 Steady state error - value in between 1.05 and 0.95
 Max Overshoot - how far over the response goes (max)
 Delay time - time taken to reach 0.95 between 0.5 and 0.25

a) t when $3V_B = V_A$ $V_B = 3V_A$

$$S_A = 3t^2 + 10t - 8$$

$$S_B = 7t^2 + 4t^2 + 4$$

$$V_A = 6t + 10$$

$$V_B = 21t^2 + 8t$$

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

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

$$-21t^2 + 10t - 30 = 0$$

$$-63t^2 + 18t - 10 = 0$$

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

$$-21t^2 + 10t - 30 = 0$$

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

$$a = 21$$

$$b = -10$$

$$c = -30$$

$$\frac{-(-10) \pm \sqrt{(-10)^2 - 4(21)(-30)}}{2(21)}$$

$$\frac{10 \pm \sqrt{100 + 2520}}{42}$$

$$\frac{10 \pm \sqrt{2620}}{42}$$

b)

$$A_B = 42t + 8$$

$$A_C = 60t$$

$$V_C = 30t^2 - 30$$

$$42t + 8 = 60t$$

$$8 = 60t - 42t$$

$$8 = 18t$$

$$t = 8/18$$

$$t = 0.444s$$

c)

$$S_A = 3t^2 + 10t - 8$$

$$S_B = 7t^3 + 4t^2 + 4$$

$$S_C = 10t^3 - 30t + 2$$

$$3(0)^2 + 10(0) - 8 = 7(0)^3 + 4(0)^2 + 4 = 10(0)^3 - 30(0) + 2 =$$

$$S = -8m$$

$$S = 4m$$

$$S = 2m$$

$$t = 4$$

$$t = 4$$

$$t = 4$$

$$3(4)^2 + 10(4) - 8 = 7(4)^3 + 4(4)^2 + 4 = 10(4)^3 - 30(4) + 2 =$$

$$S = 80m$$

$$S = 516m$$

$$S = 522m$$

$$S = 80 - 8m$$

$$S = 516 - 4$$

$$S = 522 - 2$$

$$S = 8m$$

$$S = 512m$$

$$S = 520m$$

3

$$d) S_b = 7t^3 + 4t^2 + 4$$

$$V_b = 21t^2 + 8t$$

$$I_0 = 21t^2 + 8t$$

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

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

$$a = 21$$

$$b = 8$$

$$c = -10$$

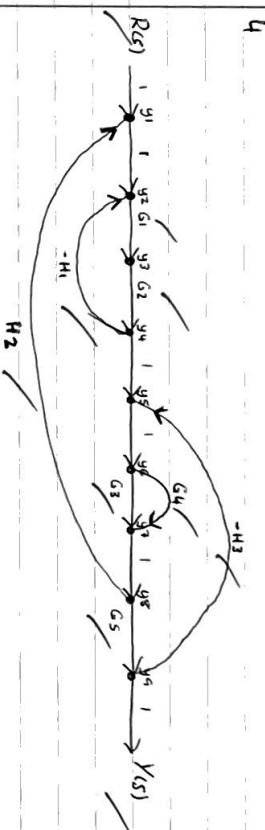
$$\frac{-8 \pm \sqrt{64 + 840}}{42} = t \text{ (secs)}$$

$$t = 0.53 \text{ s}$$

S

4

a)



S

b)

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

First all forward paths:

$$P_1 = G_1 G_2 G_3 G_5 \quad P_{i1} \quad \Delta_{i1} = 1$$

$$P_2 = G_1 G_2 G_4 G_5 \quad P_{i2} \quad \Delta_{i2} = 1$$

Now all loops:

$$L_1 = -G_1 G_2 H_1 \quad \text{or} \quad y_2 y_3 y_4 y_5$$

$$L_2 = G_4 G_5 \quad \text{or} \quad y_6 y_7 y_8$$

$$L_3 = G_1 G_2 G_3 H_2 \quad \text{or} \quad y_1 y_2 y_3 y_4 y_5 y_6 y_7 y_8$$

$$L_4 = -G_3 G_5 H_3 \quad \text{or} \quad y_5 y_6 y_7 y_8 y_9$$

All NTL

$$NTL_1 = L_1 L_2$$

$$NTL_2 = L_1 L_4$$

Now find the determinant = Δ

$$\Delta = 1 - \left(\text{sum of all natural} \right) + \left(\text{product of sum of all NTL pairs gains} \right)$$

$$\Delta = 1 - \left((-G_1 G_2 H_1) + (G_4 G_5) + (G_1 G_2 G_3 H_2) - (G_3 G_5 H_3) \right) + \left((-G_1 G_2 H_1 G_4 G_5) + (G_1 G_2 H_1 G_3 G_5 H_3) \right)$$

 P_i = forward path gains Δ_i = determinant of forward path gains

$\Delta_i = 1$ if the forward path is broken all loops are broken OR if there are no NTL. When forward paths are broken all loops are broken therefore $\Delta_{i1} = 1$ $\Delta_{i2} = 1$

$$P_{i1} = G_1 G_2 G_3 \quad \Delta_{i1} = 1$$

$$P_{i2} = G_1 G_2 G_4 G_5 \quad \Delta_{i2} = 1$$

$$\frac{1}{\Delta} (G_1 G_2 G_3 G_5 + G_1 G_2 G_4 G_5)$$

S

5

$$b) T_{FS} = \frac{1}{(A) \quad (P_{i1}) \quad (P_{i2})}$$

$$TF_{\alpha} = \frac{1}{4} \left((G_{\alpha} G_2 H_1) + (G_{\alpha} G_3) + (G_{\alpha} G_2 G_4 H_2) - (G_{\alpha} G_3 H_1) + (G_{\alpha} G_2 H_1 G_4 G_2) + (G_{\alpha} G_2 H_1 G_3 H_1) + (G_{\alpha} G_2 G_3) + (G_{\alpha} G_2 G_4) \right)$$

15