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Complete, fold and seal  
(see note 2 below)

SURNAME: Srihin

FORENAME(S): Nour

## 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.**

|   |                                  |                                                                |
|---|----------------------------------|----------------------------------------------------------------|
| 1 | Student Number                   | 1809251/1                                                      |
| 2 | Title of Examination Paper       | <del>Handwritten</del><br>Dynamics Control and Instrumentation |
| 3 | Module Code                      | M4X01405                                                       |
| 4 | Date and Time of Examination     | 15.05.2019                                                     |
| 5 | Examination Venue                |                                                                |
| 6 | Seat Number                      | 7                                                              |
| 7 | Number of Answer Books handed in |                                                                |

| List the numbers of the questions you have attempted | Office Use |
|------------------------------------------------------|------------|
| Q1                                                   | 5 ✓        |
| Q2                                                   | 9 ✓        |
| Q3                                                   | 12 ✓       |
| Q4                                                   | 8 ✓        |
| Q5                                                   | 5 ✓        |
| Q6                                                   | 3 ✓        |
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|                                                      |            |
| Total                                                | 42 ✓       |

60% ✓

Question 1:

|   | V            | H                    | Plane            |
|---|--------------|----------------------|------------------|
| S |              |                      |                  |
| U | $80 \sin 64$ | $80 \cos 64^\circ$ ✓ | $80 \sin 40$ ✓   |
| V |              | $80 \cos 64^\circ$ ✓ |                  |
| A |              |                      | $9.81 \cos 24$ ✓ |
| T |              |                      |                  |

$$s = ut + \frac{1}{2}at^2 \quad \checkmark \quad -11.50$$

$$\frac{80 \sin 40}{-4.9 \cos 24} = -11.48$$

$$b- \quad 80 \cos 64 \times 11.48 = 402.6$$

$$80 \sin 40 t + \frac{1}{2} - 9.81 \cos 24 t^2 \quad \uparrow \begin{matrix} v \\ \sin \end{matrix}$$

 ~~$80 \sin 40$~~ 

$$= \frac{51.42}{4.47} = 11.50 \text{ s} \quad \overrightarrow{\cos} \quad \checkmark \quad 5 \checkmark$$

## Question Two:

9)

$$A \quad S = 24t^2 + 18t - 17$$

$$B \quad S = 14t^2 + 5t + 25$$

$S$  = displacement in m ,  $t$  = time in s

$$A = 3B$$

$$\begin{aligned} \text{The velocity is } &= 24t^2 + 18t - 17 \\ &= 48t + 18 \end{aligned} \quad \left. \vphantom{\begin{aligned} \text{The velocity is } &= 24t^2 + 18t - 17 \\ &= 48t + 18 \end{aligned}} \right\} \text{ in A}$$

$$\begin{aligned} &= 14t^2 + 5t + 25 \\ &= 28t + 5 \end{aligned} \quad \left. \vphantom{\begin{aligned} &= 14t^2 + 5t + 25 \\ &= 28t + 5 \end{aligned}} \right\} \text{ in B}$$

$$\text{so } A = 3B$$

$$48t + 18 = 3 \times (28t + 5)$$

b) when  $t=0$

$$\begin{aligned} A &= 24(0)^2 + 18(0) - 17 \\ A &= -17 \end{aligned}$$

$$\begin{aligned} B &= 14(0)^2 + 5(0) + 25 \\ B &= 25 \end{aligned}$$

$$\text{so } 25 - (-17) =$$

when  $t=4s$

$$\begin{aligned} A &= 24(4)^2 + 18(4) - 17 \\ &= 439 \end{aligned}$$

$$\begin{aligned} B &= 14(4)^2 + 5(4) + 25 \\ &= 269 \end{aligned}$$

$$\ln A = 439 - (-17) = 456. \checkmark$$

$$\ln B = 269 - 25 = 244. \checkmark$$

c) The acceleration is the ~~the~~ second derivative of ~~the~~  $s$  ✓

$$\begin{aligned} \text{for A} &= 24t^2 + 18t - 17 \\ &= 48t + 18 \\ &= 48 \end{aligned} \checkmark$$

$$\begin{aligned} \text{for B} &= 14t^2 + 5t + 25 \\ &= 28t + 5 \\ &= 28. \end{aligned} \checkmark$$

Question Three,

$$\frac{1}{ms^2 + (C_1 + C_2)s + (K_1 + K_2 + K_3)}$$

$$= \frac{1}{6s^2 + (3+3)s + (8+8+8)}$$

$$= \frac{1}{6s^2 + (6)s + (24)}$$

Then

$$\frac{1}{s^2 + \frac{6}{6}s + \frac{24}{6}}$$

$$\frac{\frac{1}{m}}{ms^2 + (6)s + (24)}$$

$$= \frac{1}{s^2 + \frac{6}{6}s + \frac{24}{6}}$$

$$= \frac{1}{s^2 + \frac{6}{6}s + 4}$$

$$= \frac{1}{s^2 + 2s + 4}$$

$$f = \frac{\omega_n}{2\pi} \quad \cos \quad \omega_n = f 2\pi$$

$$\text{so } f = \frac{\sqrt{4}}{2\pi} = \omega_n = 2 \text{ rad/s}$$

$$\omega_n^2 = 4$$

$$f = \frac{2}{2\pi} = 0.31 \text{ Hz}$$

$$2 \times 2s = \frac{6}{6}s$$

$$2 \times 2 = \frac{6}{6}s$$

$$= 2 \times 4 = \frac{6}{6}$$

$$Z = \frac{6}{6 \times 4} = 0.25 \quad \checkmark \quad 3 \checkmark$$

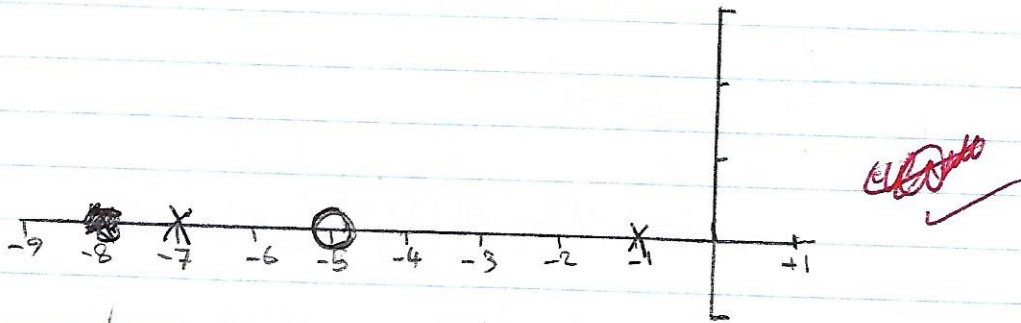
d) -

$$0.25 < 1$$

it's under damping.  $\checkmark \quad 1 \checkmark$

## Question four:

a)  $G(s) = \frac{(s+5)}{s^2+8s+7}$  ← zero = 0  
 ← poles = X



all poles are in the Left hand side  
 so it is stable ✓

b) The D.C response is = 0.71

if  $s=0$   $\frac{(0+5)}{0^2+0^2+7} = \frac{5}{7}$  ✓

c)  $= \frac{3}{s} \left( \frac{(s+5)}{(s+7)(s+1)} \right)$

$\frac{A}{s} = \frac{B}{(s+7)} + \frac{C}{(s+1)}$  ✓

$A(s+7)(s+1) + B(s)(s+1) + C(s)(s+7)$

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

$$\text{if } s=0$$

$$\frac{3}{s} = A(0+7)(0+1) + B(0)(0+1) + C(0)$$

$$\frac{3}{0} = A \cdot 7$$

$$\text{if } s = -1$$

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

$$\frac{3}{s} = 0 + 0 + C(-6)$$

$$\text{if } s = -7$$

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

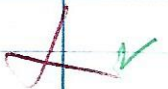
$$= A \cdot 0 + B \cdot 42 + C \cdot 0$$

$$\frac{3}{s} = B \cdot 42$$

$$= \frac{3}{7} + \frac{3}{42} - \frac{3}{7}$$

$$= \frac{3}{7} + \frac{3}{42} e^{-\frac{1}{7}(2)} - \frac{3}{7} e^{-1(2)}$$

2 seconds



Question five

$$\underline{2s^5} + 3s^4 + \underline{2s^3} + s^2 - \underline{s} + 4$$

|       |       |        |      |   |
|-------|-------|--------|------|---|
| $s^5$ | 2     | 2      | -1   | ✓ |
| $s^4$ | 3     | 1      | 4    | ✓ |
| $s^3$ | 1.3   | -3.6   | 0    | ✓ |
| $s^2$ | 7.30  | 16.769 | -1.5 |   |
| $s^1$ | -0.61 | -2.73  |      |   |
| $s^0$ | 121.2 |        |      |   |

$$\frac{(-1 \times 1) - (2 \times 4)}{1} = 9$$

$$1) \quad - \left| \begin{array}{cc|c} 2 & 2 & \\ 3 & 1 & \end{array} \right| \quad - \frac{(2 \times 3) - (2 \times 1)}{3} = -1.3$$

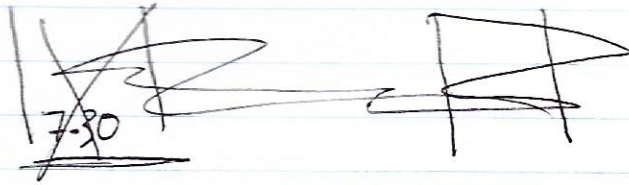
$$\frac{(6) - (2)}{3} =$$

$$2) \quad - \left| \begin{array}{cc|c} 2 & \times & -1 \\ 3 & \times & 4 \end{array} \right| \quad - \frac{(3 \times -1) - (2 \times 4)}{3} = -3.6$$

$$3) \quad - \left| \begin{array}{cc|c} 3 & 1 & \\ 1.3 & -3.6 & \end{array} \right| \quad - \frac{(1.3 \times 1) - (3.6 \times 3)}{1.3} = 7.30$$

$$4) \quad - \left| \begin{array}{cc|c} 3 & \times & 4 \\ 1.3 & \times & 9 \end{array} \right| \quad = 16.769$$

$$\frac{1.3}{1.3}$$



$$- \begin{vmatrix} 1.3 & 3.6 \\ 7.30 & 16.769 \end{vmatrix} = -0.61$$

7.30

$$- \begin{vmatrix} 1 & 4 \\ 3.6 & 9 \end{vmatrix} = -1.5$$

3.6

$$- \begin{vmatrix} 1.3 & 9 \\ 7.30 & -1.5 \end{vmatrix} = -8.73$$

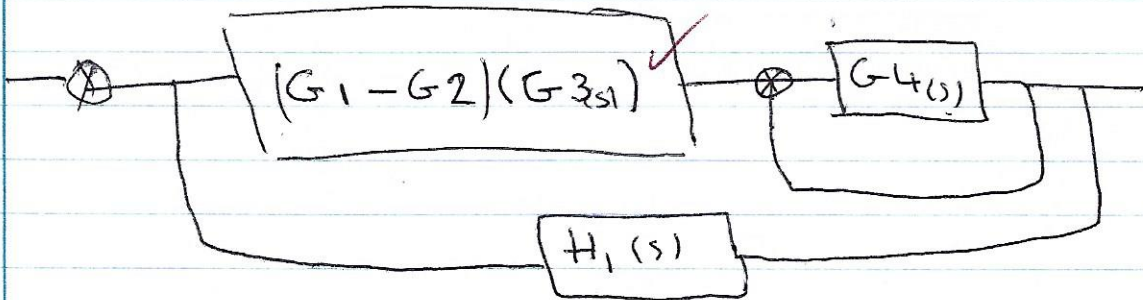
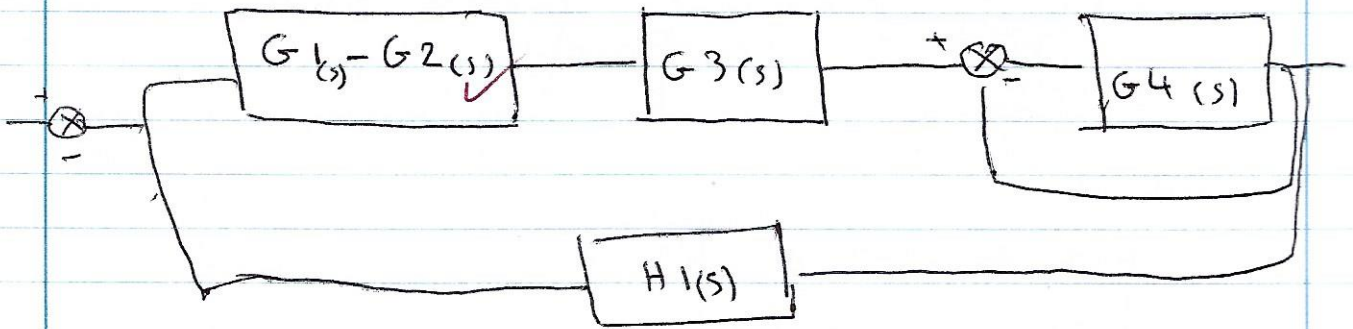
7.30

$$- \begin{vmatrix} 7.30 & 16.7 \\ -0.61 & -8.73 \end{vmatrix} = -0.61$$

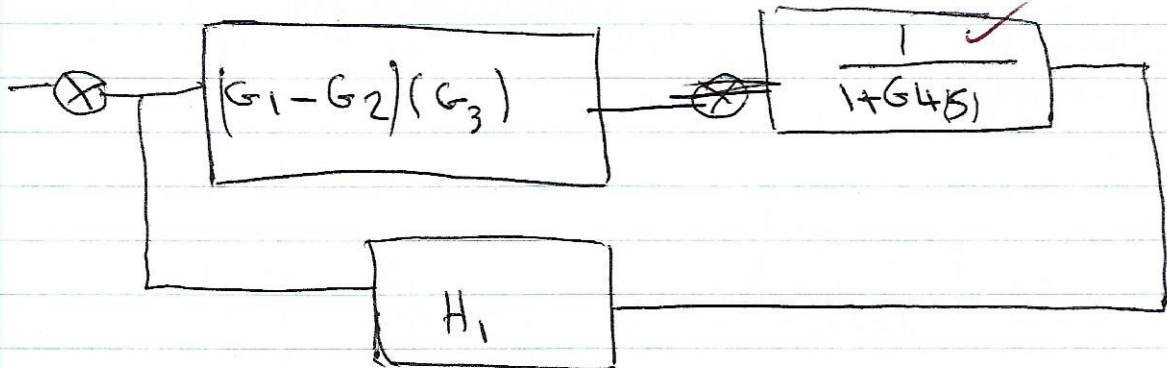
-0.61

£

Question six:

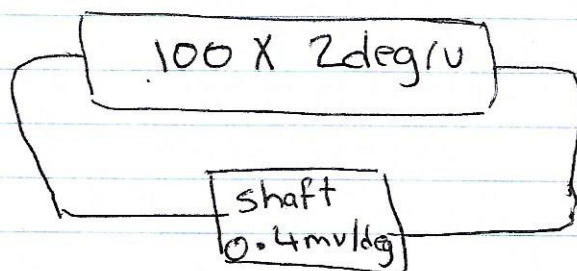


$$\frac{G_4(s)}{1 + H_1(s)(G_1 - G_2)(G_3) + G_4(s)}$$



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

b)-



$$\frac{100 \times 2}{1 + 0.4(100 \times 2)} = 2.46$$

$$2.46 \times 5 = 12.34$$