



SURNAME: Webb

FORENAME(S): Thomas

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.**

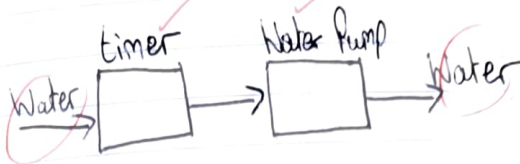
1	Student Number	WEB25887285
2	Title of Examination Paper	Dynamics, Control and Instrumentation
3	Module Code	GOEE4002
4	Date and Time of Examination	12 MAY 2026 10:00
5	Examination Venue	68860
6	Seat Number	D3
7	Number of Answer Books handed in	

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73% Rk

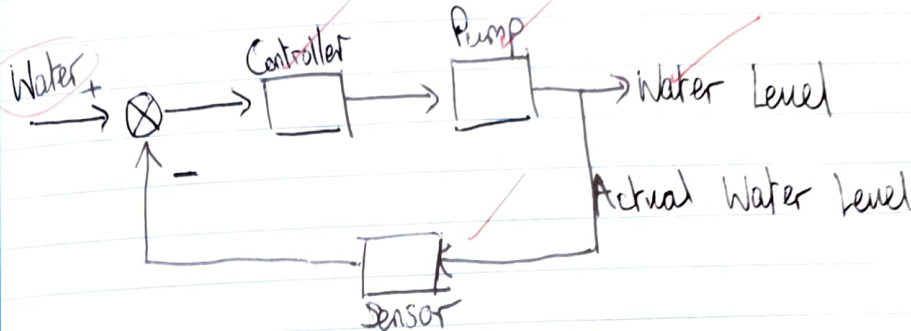
(Gweler yr ochr arall am y fersiwn Cymraeg)

Q1(a)



b) It will not respond or change its behaviour, since there is no feedback. Water level may be too low.

c)



d) Since unity feedback, $H(s) = 1$

$$T(s) = \frac{K_p G(s)}{1 + K_p G(s)} = \frac{\left(\frac{5K_p}{s+3}\right)}{1 + \frac{5K_p}{s+3}}$$

$$\Rightarrow \frac{\frac{5K_p}{s+3}}{\frac{s+3}{s+3} + \frac{5K_p}{s+3}} = \frac{\left(\frac{5K_p}{s+3}\right)}{\frac{s+3+5K_p}{s+3}}$$

$$= \frac{5K_p}{s+3} \times \frac{s+3}{s+3+5K_p} = \frac{5K_p}{s+3+5K_p}$$

ii) Final value theorem: $\lim_{t \rightarrow \infty} Y(t) = \lim_{s \rightarrow 0} s \cdot Y(s)$

$$= \lim_{s \rightarrow 0} s \cdot [F(s) \times R(s)]$$

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Q1(a)
2Q1(b)
1Q1(c)
5Q1(d)
4

$$\text{let } T(s) = \frac{5K_p}{s+3+5K_p}, \quad R(s) = \frac{100}{s}$$

Q.1 d
(w) 5

$$\begin{aligned} & \Rightarrow \lim_{s \rightarrow 0} s \times \frac{5K_p}{s+3+5K_p} \times \frac{100}{s} \\ & = \frac{500K_p}{3+5K_p} \end{aligned}$$

Q2)

a) weight = $mg = 6 \times 9.81 = 58.86 \text{ N}$

Q2
(a) 4

weight parallel to plane = $mg \sin \theta$

= $58.86 \times \sin(20) = 20.13 \text{ N}$

Normal force to surface = $mg \cos \theta$

= $58.86 \times \cos(20) = 55.31 \text{ N}$

Frictional force = $F_f = mg \cos(\theta) \mu = 55.31 \times 0.25$

= 13.83 N

Net Force (F_{net}) = $F_a - F_m - F_f$

= $40 - 20.13 - 13.83 = 6.04 \text{ N}$

$a = \frac{F}{m} = \frac{6.04}{6} = 1.007 \text{ ms}^{-2}$

b) i) During steady state, let $s=0$, $b=0.4$

$$\therefore G(s) = \frac{1}{0.4} = 2.5$$

$$\frac{1.5}{2.5} = 0.6 \text{ ms}^{-2} \text{ input}$$

$$F = ma = 6 \times 0.6 = 3.6 \text{ N}$$

$$F_{\text{net}} - F_{\text{mg}} - F_{\text{g}} = F_{\text{net}} = 9 \text{ N}$$

Error in calculating damping force.

$$F_a = 9 + F_{\text{mg}} + F_{\text{g}} = 9 + 20.13 + 13.83 = 42.96 \text{ N}$$

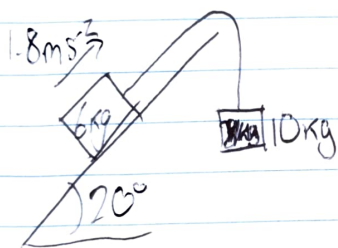
Error carried forward

ii) $G(s)$ when $s=0$

$$= \frac{1}{(6 \times 0) + 0.4} = \frac{1}{0.4} = 2.5$$

It represents the steady state output where there is no oscillation.

c) i)



$$F_{\text{net}} = m_2 g - m_1 g \sin(\theta) - m_1 g \cos(\theta) \mu - F_{\text{ext}}$$

$$= 64.94 \text{ N}$$

$$a = \frac{F_{\text{net}}}{m_{\text{total}}} = \frac{64.94}{16} = 4.06 \text{ ms}^{-2}$$

Error carried forward

$$4 \text{ ms}^{-2} - 1.8 = 2.2 \text{ ms}^{-2} \quad F = 16 \text{ kg} \times 2.2 \text{ ms}^{-2} = 35.36 \text{ N}$$

22/3

Q 2(b)

(i) 2

(ii) 2

Q 2(c)

(i) 1

$$\text{ii)} \quad m_2 g - T_2 = \underbrace{m_{1+2}}_{m_2} \times 1.8 \text{ ms}^{-2}$$

$$T_2 = m_2 g - (\underbrace{m_{1+2}}_{\text{ECF}} \times 1.8) = \boxed{69.3 \text{ N}} \quad (1)$$

$$T_1 - m_1 g \sin(\theta) - m_1 g \mu \cos(\theta) = \underbrace{m_{1+2}}_{m_1} \times 1.8$$

$$T_1 = m_1 g \sin(\theta) + m_1 g \mu \cos(\theta) + (m_{1+2} \times 1.8)$$

$$= 20.13 + 13.83 + 28.8 = \boxed{62.76 \text{ N}}$$

$$62.76 + 69.3 = \underline{132.06 \text{ N}}$$

$$\text{d)} \quad 1.5 \text{ m/s} \times 6 \text{ s} = 9 \text{ m} \quad \checkmark (1)$$

$$0.02 \text{ V/m} \times \underbrace{9 \text{ m}}_{(1)} = 0.18 \text{ V} \quad \checkmark (1)$$

Q 2(c)

(ii) 1

Q 2(d)

3

Q3]

a) Zero at $s+3=0$, $s=-3$ (1)Poles at $s=-4$ (1) $s=-1.5+\frac{\sqrt{15}}{2}j$ (1) $s=-1.5-\frac{\sqrt{15}}{2}j$ (1)

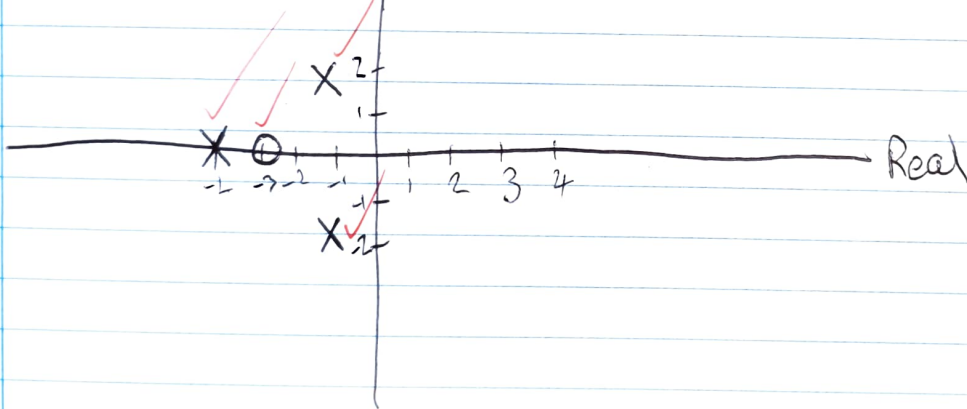
$$s^2+3s+6=0$$

$$\text{Let } a=1, b=3, c=6$$

$$s = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-3 \pm \sqrt{3^2 - 4 \times 1 \times 6}}{2 \times 1}$$

$$= \frac{-3 \pm \sqrt{15}j}{2}$$

b)



c) It will be stable since no poles are in the right-hand plane. It will have steady-state error since no poles at $s=0$.

Q3(b)
4Q3(c)
(1)

d) $G(s) = \frac{s+3}{(s+4)(s^2+3s+6)}$

Let $s = -1 + 2j$

$(-1+2j)^2 = 1 - 4 - 4j = -3 - 4j$

$\Rightarrow G(-1+2j) = \frac{-1+2j+3}{(-1+2j+4)((-1+2j)^2+3(-1+2j)+6)}$

$= \frac{2+2j}{(4+2j)(-3-4j-3+6j+6)}$

Error in subtraction

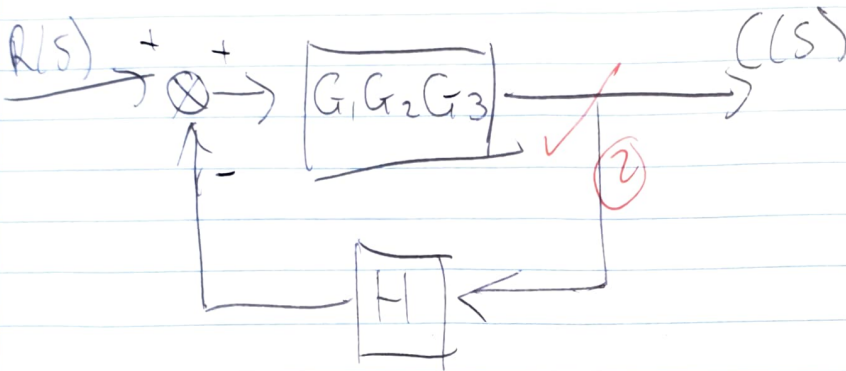
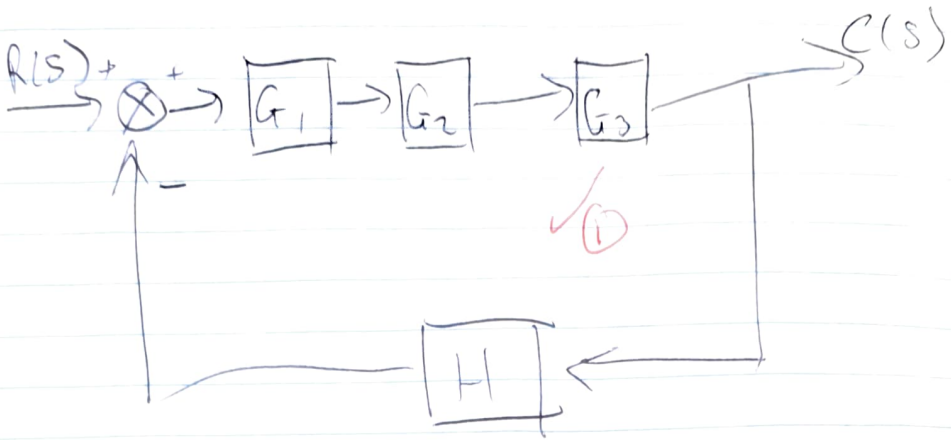
$= \frac{2+2j}{(4+2j)(2j)} = \frac{2(1+j)}{2(-2+4j)}$

Error carried over

$= \frac{1+j}{-2+4j} \times \frac{-2-4j}{-2-4j}$

$= \frac{-2-4j-2j+4}{4+16} = \frac{2-6j}{20} = \frac{1-3j}{10}$

$= 0.1 - 0.3j$

Q4)
a)

$$\frac{Y(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)} \quad \checkmark \textcircled{1}$$

$$R(s) \rightarrow \left[\frac{G_1 G_2 G_3}{1 + G_1 G_2 G_3 H} \right] \rightarrow C(s) \quad \checkmark \textcircled{2}$$

$$\text{Let } G_1 = \frac{4}{s+4}, \quad G_2 = \frac{2}{s+3}, \quad G_3 = \frac{5}{s+1}, \quad H = \frac{s}{s+2}$$

$$G_1 G_2 G_3 = \frac{40}{(s+4)(s+3)(s+1)}$$

$$G_1 G_2 G_3 H = \frac{40s}{(s+4)(s+3)(s+1)(s+2)}$$

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Q4(a)

6

PTO

$$\frac{G_1 G_2 G_3}{1 + G_1 G_2 G_3 H} = \frac{\left(\frac{40}{(s+4)(s+3)(s+1)} \right)}{\left(1 + \frac{40s}{(s+4)(s+3)(s+1)(s+2)} \right)} \quad (2)$$

$$= \frac{\left(\frac{40}{(s+4)(s+3)(s+1)} \right)}{\frac{(s+4)(s+3)(s+1)(s+2) + 40s}{(s+4)(s+3)(s+1)(s+2)}}$$

$$= \frac{40}{(s+4)(s+3)(s+1)} \times \frac{(s+4)(s+3)(s+1)(s+2)}{(s+4)(s+3)(s+1)(s+2) + 40s}$$

$$= \frac{40(s+2)}{(s+4)(s+3)(s+1)(s+2) + 40s} \quad (2)$$

b) This is a third order system
Type 0 since no poles at $s=0$

Q 4(b)

1

$$\text{Let } s=0, \frac{Y(s)}{R(s)} = \frac{80}{24} = 3.33$$

c) The system is stable since no poles on right-hand side of plane. (1)

Q 4 (c)

1

Q5(a)

$$i) H(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{1}{RCs + 1}$$

$$= \frac{1}{(2000 \times (10 \times 10^{-6})s) + 1} = \frac{1}{0.02s + 1}$$

ii) ?! Low on time - need to go!! Sorry Emily :-

iii) The circuit acts as a low pass filter, since capacitive reactance is highest at low frequencies - making circuit a voltage divider. It acts as short circuit at high frequencies

$$b) i) 2\zeta\omega_n = \frac{R}{L} \quad \text{and} \quad \omega_n^2 = \frac{1}{LC}$$

$$\omega_n = \sqrt{\frac{1}{LC}} = \sqrt{\frac{1}{2 \times 25 \times 10^{-6}}} = 141.4 \text{ rad/s}$$

$$\alpha = \frac{R}{2\omega_n L} = \frac{150}{2 \times 141.6 \times 2} = 0.265$$

This system is underdamped since $\alpha < 1$

iii) The steady state current will be 0 since a capacitor acts as an open circuit for DC once charged.

$$iv) i = 0A$$

Q5(a)

(i) 4

(ii) 0

(iii) 2

Q5(b)

(i) 6

(ii) 1

(iii) 1



Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

Llyfr Atebion Arholiadau

12 Tudalen

Cyfarwyddiadau i Ymgeiswyr

1. Rhowch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhowch eich enw yn y lle a ddarparwyd ar y dde, plygwch ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.
3. Rhaid i'r atebion fod mewn llawysgrifen ddarllenadwy. Gall yr Arholwyr naill ai anwybyddu sgript annarllenadwy, neu drefnu iddi gael ei theipio a chael yr ymgeisydd i dalu.
4. Ysgrifennwch eich atebion mewn inc.
5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw fras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.
6. Ni ddylid rhwygo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.
7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyliwr/gwylwyr.
8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

CYFENW: _____

ENW(AU) CYNTAF: _____

1	Rhif Myfyriwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Archoliad	
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

[illegible]

(See the other side for English version)