

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	KIS13818258
2	Title of Examination Paper	DYNAMICS CONTROL AND INSTRUMENTATION
3	Module Code	G00EE4002
4	Date and Time of Examination	12.5.2026 10:00 AM
5	Examination Venue	CENTRE MAIN HALL
6	Seat Number	C3
7	Number of Answer Books handed in	Q1, Q2, Q3, Q4 Q5

List the numbers of the questions you have attempted	Office Use
Q3 (a)	4
(b)	4
(c)	2
(d)	14
Q4 (a)	4
Q5 (a)	4
(b)	7
Q2 (a)	2
(b)	6
(c)	5
(d)	3
Q1 (a)	4
(b)	1
(c)	5
Total	65% ENI

Q3

Q3 a)

4

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

a, ~~Poles~~ Zeros

$$s+3=0 \rightarrow s = -3$$

Poles

$$s+4=0 \rightarrow s = -4$$

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

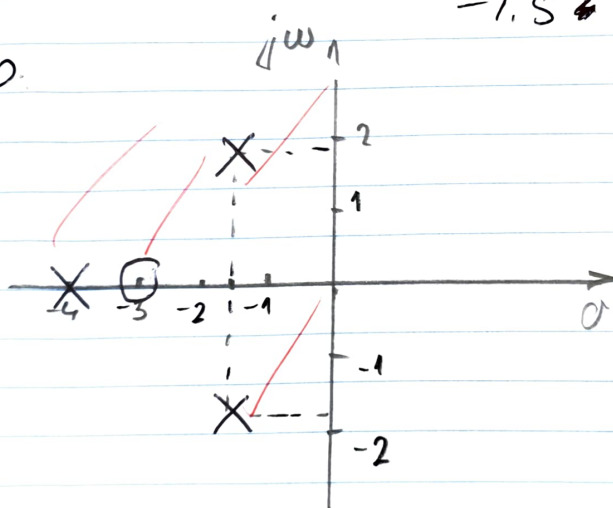
$$\frac{-3 \pm \sqrt{3^2 - 4(6 \cdot 1)}}{2} = \frac{-3 \pm \sqrt{9-24}}{2} = \frac{-3 \pm j\sqrt{15}}{2}$$

$$= \frac{-3 \pm j3.872}{2} \rightarrow \begin{cases} -1.5 + 1.93j \\ -1.5 - 1.93j \end{cases}$$

Q3 b)

4

b.

c, ~~Open loop system doesn't use feedback~~ Q3 c)

THE SYSTEM IS STADY AS ALL THE
POLES AND ZEROS ARE IN THE
NEGATIVE ZONE

2

$$d, \quad s = -1 + 2j$$

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

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

$$(-1+2j)(-1+2j) = 1 - 2j - 2j + 4j^2 \quad j^2 = -1$$

$$= -3 - 4j \quad \textcircled{1} \quad -3 - 4j + 6j - 3 + 6$$

$$3(-1+2j) = -3 + 6j \quad \textcircled{1}$$

$$-3 - 4j + 6j - 3 + 6 = -4 + 2j \quad \textcircled{1}$$

$$(3+2j)(-4+6j) = -12 + 6j - 8j + 12j^2 \quad j^2 = -1$$

$$= -4 + 6j \quad \textcircled{1}$$

$$\rightarrow \frac{2+2j}{14+18j} \cdot \frac{14-18j}{14-18j} = \frac{(2+2j)(14-18j)}{(14+18j)(14-18j)} = \frac{64-8j}{520}$$

$$(2+2j)(14-18j) = 28 - 36j + 28j - 36j^2 \quad j^2 = -1$$

$$= 64 - 8j$$

$$(14+18j)(14-18j) = 196 - 252j + 252j - 324j^2 \quad j^2 = -1$$

$$= 196 + 324 = 520$$

~~$$G = \frac{64 - 8j}{520} = 0.123 - 0.01j$$~~

Q.3d)
6

~~$$G = \sqrt{0.123^2 - 0.01^2} = 0.123$$~~

~~$$\tan \phi = \frac{0.01}{0.123} = 0.08$$~~

~~$$\phi = 4.64^\circ$$~~

~~$$G = 4.64^\circ \pm 0.123$$~~

$$\rightarrow G = \frac{2+2j}{-4+6j} \cdot \frac{-4-6j}{-4-6j} = \frac{(2+2j)(-4-6j)}{(-4+6j)(-4-6j)} = \frac{4-20j}{52}$$

$$(2+2j)(-4-6j) = -8-12j-8j-12j^2$$

$$= 4-20j \quad \checkmark$$

$$(-4+6j)(-4-6j) = 16-24j+24j-36j^2 \quad j^2 = -1$$

$$= 52 \quad \checkmark$$

$$G = 0.07 - 0.38j = \sqrt{0.07^2 + 0.38^2} = 0.386$$

$$\tan \phi = \frac{0.38}{0.07}$$

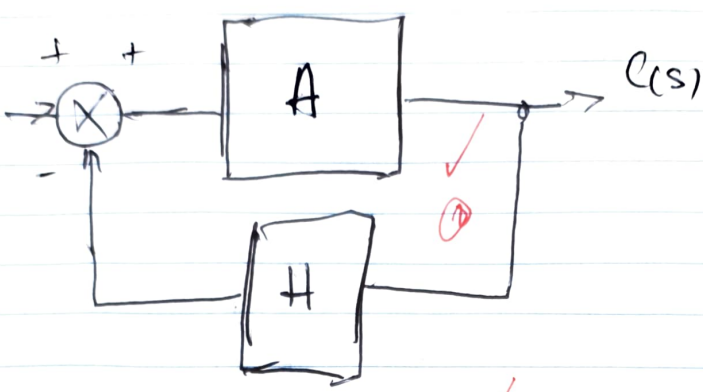
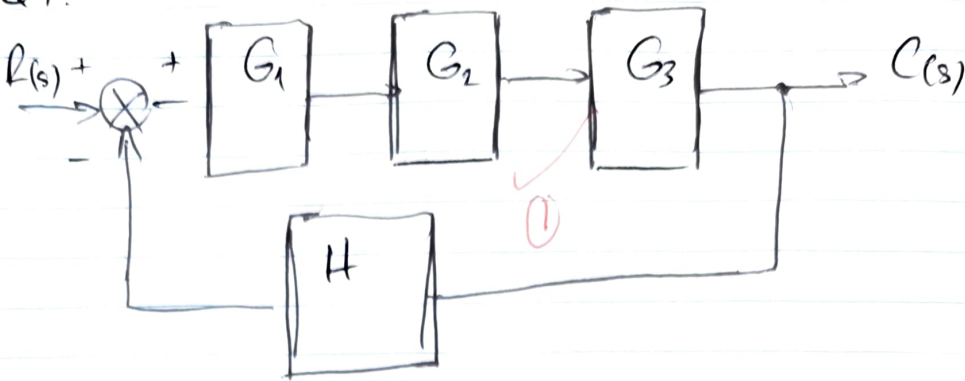
① Error in rounding off
Error carried over.

$$\phi = 79.6^\circ \quad \checkmark \text{ ①}$$

$$G = 79.6^\circ \quad 0.386$$

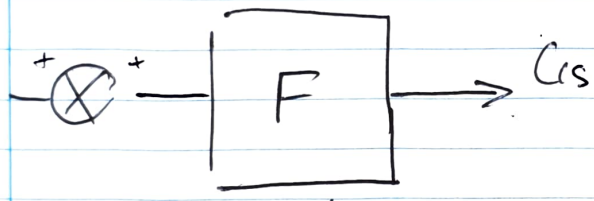
Q4.

Q4av
4



$$A = G_1 \cdot G_2 \cdot G_3$$

$$F = \frac{1}{1 + AH}$$



$$F = \frac{1}{1 + (G_1 G_2 G_3)H}$$

$$F = \frac{1}{1 + (G_1 G_2 G_3) \cdot H}$$

$$A = \left(\frac{4}{s+4} \right) \cdot \left(\frac{2}{s+3} \right) \cdot \left(\frac{5}{s+1} \right) = \frac{4(s+3)}{2(s+4)} \cdot \frac{5}{(s+1)}$$

$$= \frac{4s+12}{2s+8} \cdot \frac{5}{(s+1)} = \frac{10s+40}{4s^2+16s+12}$$

$$(4s+12)(s+1) = 4s^2+4s+12s+12$$

$$\frac{C(s)}{R(s)} = \frac{1}{1 + \left(\frac{10s+40}{4s^2+16s+12} \right) \left(\frac{s}{s+2} \right)}$$

Q5. a, i.

$$H(s) = \frac{V_o(s)}{V_{in}(s)}$$

$$R = 2k\Omega = Z_R$$

$$Z_C = \frac{1}{sC}$$

$$\frac{V_o(s)}{V_{in}(s)} = \frac{Z_C}{Z_R + Z_C} = \frac{\frac{1}{sC}}{R + \frac{1}{sC}} = \frac{1}{1 + R s C}$$

∴ THE CIRCUIT BEHAVES AS A LOW PASS FILTER BASED ON THE TRANSFER FUNCTION.

Q5 (a)
(iii) 1

b₁ $R = 150 \Omega$ $L = 2H$ $C = 25 \mu F$ $\omega_n = \omega_0$ Q5(b)
(9b)

$$\frac{d^2 i}{dt^2} + \frac{R}{L} \frac{di}{dt} + \frac{1}{LC} i = \frac{V}{CL}$$

$$2\zeta = \frac{R}{L} \rightarrow \zeta = \frac{R}{2L}$$

$$\frac{d^2 i}{dt^2} + 2\zeta\omega_n \frac{di}{dt} + \omega_n^2 i = \frac{150}{4} = 37.5$$

$$2\zeta\omega_n = \frac{R}{L} \quad \omega_n^2 = \frac{1}{LC} \rightarrow \omega_n = \sqrt{\frac{1}{LC}}$$

$$\omega_n = \sqrt{\frac{1}{2 \cdot 25 \cdot 10^{-6}}} = \sqrt{20000} = 141.42 \text{ rad/s} = \omega_0$$

$$2\zeta\omega_n = \frac{R}{L} \rightarrow \zeta = \frac{R}{L \cdot 2\omega_n} = \frac{150}{2 \cdot 2 \cdot 141.42} = 0.265$$

$$0 < \zeta < 1 \quad 0 < 0.265 < 1$$

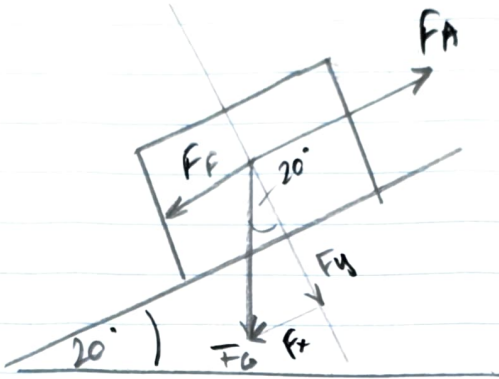
THE SYSTEM IS UNDERDAMPED

III. FOR A CONSTANT DC INPUT
~~WILL BE EQUAL TO~~ THE CURRENT
 WILL BE EQUAL TO THE VOLTAGE
 AS THE CAPACITOR BEHAVES AS AN
 OPEN CIRCUIT.

Q5(b)

(ii) 1

Q2a. $m = 6 \text{ kg}$ $\theta = 20^\circ$ $\mu = 0.25$
 $F_A = 40 \text{ N}$



$F_f = \mu \cdot m \cdot g$
 $F_f = 1.5 \times 14.715 \text{ N}$
 Error in calculating F_f

$F_G = m \cdot g = 6 \text{ kg} \cdot 9.81 \text{ m/s}^2 = 58.86 \text{ N}$
 $F_{Gx} = F_G \cdot \sin \theta = 58.86 \text{ N} \cdot \sin 20^\circ = 20.131 \text{ N}$

$F_A - F_{Gx} - F_f = m \cdot a \rightarrow a = \frac{F_A - F_{Gx} - F_f}{m} = \frac{40 - 20.131 - 14.715}{6}$

$= \frac{5.154}{6} \text{ m/s}^2 = \boxed{0.859 \text{ m/s}^2}$

$F_A = m \cdot a \rightarrow a = \frac{F_A}{m} = \frac{40}{6} = 6.66 \text{ m/s}^2$

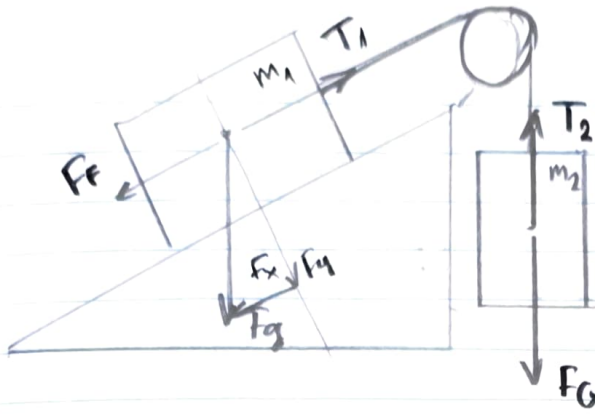
b, $v_{ss} = 1.5 \text{ m/s}$ $s = 0$

$G(s) = \frac{1}{m \cdot s + b} = \frac{1}{b} = \frac{1}{0.4} = 2.5$

$G_s = v_{ss} \cdot F_{ss}$ $v_{ss} = G_s \cdot F_{ss} \rightarrow F_{ss} = \frac{v_{ss}}{2.5} = 0.6 \text{ N}$

Error carried over from Q2a

$F_A = F_{ss} + F_{Gx} + F_f = 0.6 \text{ N} + 14.715 \text{ N} + 20.131 \text{ N}$
 $= \underline{\underline{35.446 \text{ N}}}$

C₁

$$m_1 : T_1 - F_f - F_x = m_1 \cdot a \quad (1)$$

 $a =$

$$m_2 : F_G - T_2 = m_2 \cdot a \quad (1)$$

$$m_1 : T_1 = (m_1 \cdot a) + F_f + F_x = (6 \text{ kg} \cdot 1.8 \text{ m/s}^2) + 15 \text{ N} + 20.13 \text{ N}$$

$$= 32.431 \text{ N} \quad T_1 = \underline{\underline{45.646 \text{ N}}}$$

$$m_2 = \frac{T_2}{m_2 \cdot a} = \frac{F_G}{m_2 \cdot a} = \frac{10 \times 9.81}{10 \times 1.8} = \frac{98.1}{18} = \underline{\underline{5.45 \text{ N}}}$$

$$d, \quad s = v \cdot t = 1.5 \text{ m/s} \cdot 6 \text{ s} = 9 \text{ m}$$

$$V_s = 0.02 \text{ V} \cdot 9 = \underline{\underline{0.18 \text{ V}}}$$

Q. 2(c)

(i) 2

(iii) 3

Grav centre
over beam (cm)
14.715

Q2(d)

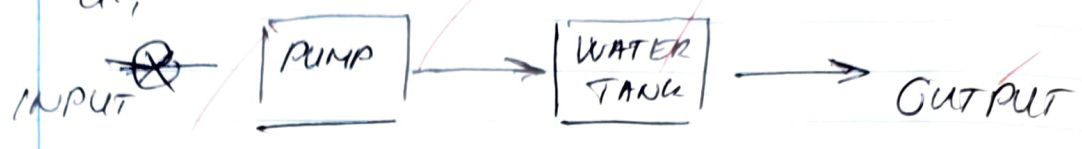
3

Q1.

Q1 (a)

a.

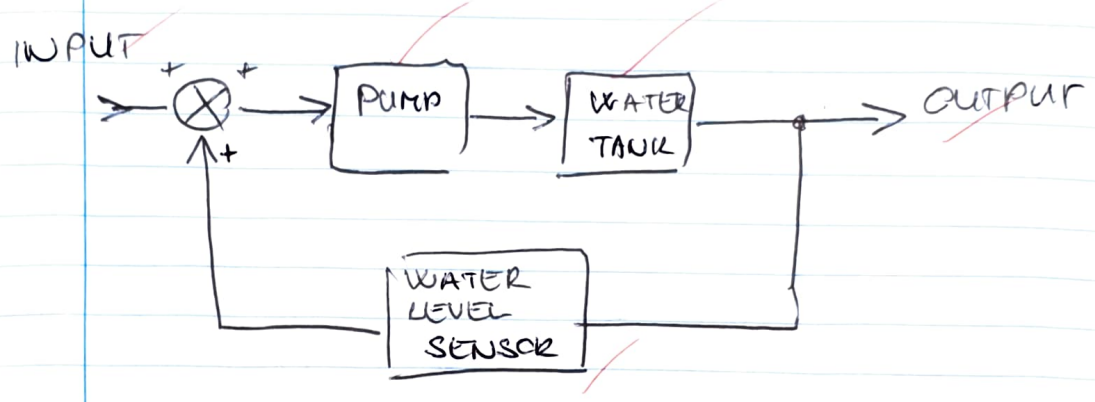
4



b, THE SYSTEM NOT RESPOND BEACUSE IN OPEN-LOOP SYSTEM DON'T HAVE ANY FEEDBACK

Q1 (b)

1



Q1 (c)

5

d, $G(s) = \frac{5}{(s+3)}$ K_p

Q1 (d)

0

$$T(s) = \frac{K_p G(s)}{1 - \cancel{G(s)} K_p G(s) H(s)}$$

$$\lim_{t \rightarrow \infty} f(t) \rightarrow \lim_{s \rightarrow 0} F(s)$$



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 'sgrïpt 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.

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

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	

Rhestrwch rifau'r cwestiynau a ymgeisiwyd gennych	At Ddibenion y Swyddfa
Cyfanswm	