

Complete, fold and seal
(see note 2 below)

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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	(EVA07088607)
2	Title of Examination Paper	DYNAMICS, INSTRUMENTATION 3 CONTROL
3	Module Code	M4X 01405 Q BAC 4005 - 006
4	Date and Time of Examination	16 th MAY 2018 14:00
5	Examination Venue	THE HALL GOWER COLLEGE SWANSEA
6	Seat Number	5
7	Number of Answer Books handed in	

[illegible]

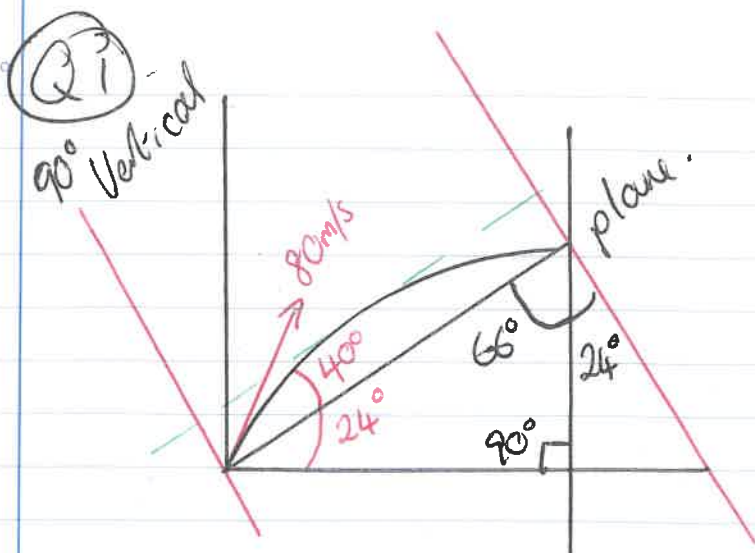
(Gweler yr ochr arall am y fersiwn Cymraeg)

NOTE TO EXAMINER.

THIS STUDENT HAD USED RED AND GREEN INK WITHIN HIS SCRIPT.

Eg. Q₁ Q₃ Q₄(a) Q₄(b)+c AND Q₅.

Linton. Cook.



$$\begin{aligned} a) &= 11.476 \text{ Seconds} \\ b) &= 440.556 \text{ m} \end{aligned}$$

90° Vertical

$$u = 80 \sin(40) = 51.423 \text{ m/s}$$

$$v = 0$$

$$t = 11.476 \text{ Seconds}$$

$$a = -9.81 \cos(24) = -8.962 \text{ m/s}$$

$$s =$$

$$\frac{v - u}{a} = t$$

$$\frac{0 - 51.423}{-8.962} = 5.738 \text{ s}$$

$$5.738 \times 2 = 11.476 \text{ s}$$

Horizontal (Plane)

$$u = 80 \cos(40) \text{ m/s} = 61.284 \text{ m/s}$$

$$v = 80 \cos(40) \text{ m/s} = 61.284 \text{ m/s}$$

$$t = 11.476 \text{ Seconds}$$

$$a = -9.81 \cos(66) \text{ m/s} = -3.99$$

$$s = 440.556 \text{ m}$$

$$s = ut + 0.5(at^2)$$

$$s = (61.284)(11.476) + \left(-1.995 \times (11.476^2)\right)$$

$$s = 440.556 \text{ m} \quad (181.699)$$

Q2

a) Particle (A) = $S = 17t^2 + 10t$

Velocity - $\frac{ds}{dt} = 34t + 10$ ✓

particle (B) = $S = 9t^2 + 30$

Velocity - $\frac{ds}{dt} = 18t$ ✓

So: $34t + 10 = 2(18t)$ ~~$34t + 10 = 18t$~~ ~~$34t + 10 = 36 \times 2t$~~ ~~$34t = 36 - 10(2t)$~~ ~~$34t = 26(2t)$~~ ~~$34t = 2t$~~

~~$34t + 10 = 36t$~~ ~~$10 = 2$~~ ~~$34t = 26$~~ ~~$26t = 2$~~

$34t + 10 = 18 \times 2$
 $34t = 36 - 10 = \frac{34}{26} = t$

* a) = 1.31 seconds *

b) $S = 17(0^2) + 10(0) = 0$
 (A) $S = 17(4^2) + 10(4) = 312 \text{ m}$

$S = 9(0^2) + 30 = 30 \text{ m}$
 $S = 9(4^2) + 30 = 174 \text{ m}$ } $174 - 30 = 144$

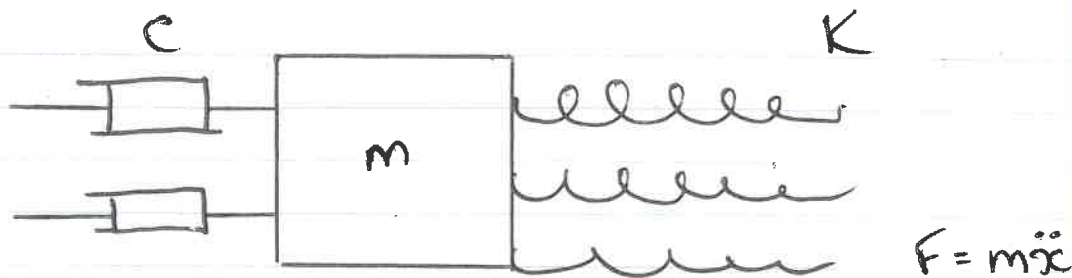
Particle A travels 312 m ✓
 Particle B travels 144 m ✓

c) $\frac{dv}{dt} = 34$ ✓ So: $34 \times 3 = 102 \text{ m/s}$ ✓

acceleration of particle (A) after 3 Seconds

Q3

a)



$$F = m\ddot{x} + 2c\dot{x} + Kx$$

$$F(s) = ms^2 X(s) + 2cs X(s) + 3K X(s)$$

$$F(s) = X(s) (ms^2 + 2cs + 3K)$$

$$\frac{X(s)}{F(s)} = \frac{1}{ms^2 + 2cs + 3K}$$

b) $m = 5 \quad c = 3 \quad K = 10$

$$\frac{1}{5s^2 + 2(3)s + 3(10)} = \frac{1/s}{s^2 + \frac{6}{5} + \frac{30}{5}}$$

$$\omega_n = \sqrt{\frac{30}{5}} = 2.449 \text{ rad/s}$$

$$\frac{2.449}{2\pi} = 0.39 \text{ Hz}$$

c) Damping = $2\zeta\omega_n = \frac{6}{5}$

$$(2)\zeta(2.449) = \frac{6}{5}$$

$$\zeta = \frac{6}{(2)(5)(2.449)} = 0.245$$

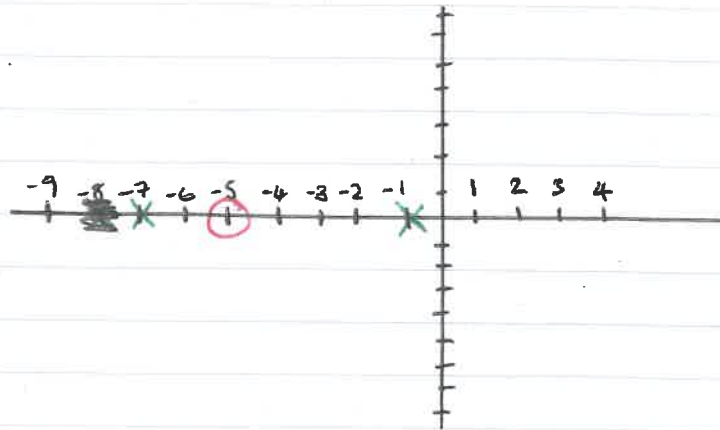
d) System is Under damped < 1

(Q) 4

a)

$$G_s = \frac{(s+5)}{s^2+8s+7}$$

Ns Zero's (o)
Nol. Poles (x)



This is classed as a stable system as there are No roots in the RHP. ✓

$$G_s = \frac{s+5}{(s+1)(s+7)} \quad -1, -5, -7$$

b) DC Response
Make $s=0$

$$\frac{0+5}{(0+1)(0+7)} = \frac{5}{(1)(7)}$$

$$\frac{5}{7}$$

c)

$$\frac{s+5}{(s+1)(s+7)} \cdot \frac{3}{s}$$

$$\frac{3(s+5)}{s(s+1)(s+7)} = \frac{A}{s} + \frac{B}{(s+1)} + \frac{C}{(s+7)}$$

$$3(s+5) = A(s+1)(s+7) + B(s)(s+7) + C(s)(s+1)$$

MAKE $s=0$

$$3(0+5) = A(0+1)(0+7)$$

$$15 = 7A$$

$$\frac{15}{7} = A \quad \checkmark$$

(pro)

$$3(s+5) = A(s+1)(s+7) + B(s)(s+7) + C(s)(s+1)$$

Make $s = -1$

$$3(-1+5) = B(-1)(-1+7)$$

$$12 = -6B$$

$$\frac{12}{-6} = B \quad \checkmark$$

Make $s = -7$

$$3(-7+5) = C(-7)(-7+1)$$

$$-6 = C \cdot 42$$

$$\frac{-6}{42} = C$$

$$G_s = \frac{15}{7} - \frac{12}{6(s+1)} - \frac{6}{42(s+7)} \quad \checkmark \quad \checkmark$$

Laplace

=

$$\frac{15}{7} - \frac{12}{6} e^{-t} - \frac{6}{42} e^{-7t}$$

© Output after 2 seconds

$$\frac{15}{7} - \frac{12}{6} e^{-2} - \frac{6}{42} e^{-14} = 1.872 \quad \checkmark$$

8. ✓

(25)

$$2s^5 + 3s^4 + 2s^3 + 1s^2 - 1s + 4 = 0$$

s^5	a	2	2	1	✓
s^4	b	3	1	4	✓
s^3		$\frac{4}{3}$	$-\frac{11}{3}$	0	✓
s^2		$\frac{37}{4}$	4	0	✓
s^1		$\frac{157}{37}$	0	✓	- Root in RHP
s^0		4		✓	+ Root in RHP

$$\frac{(bc) - (da)}{b}$$

$$\frac{(be) - (fa)}{b}$$

$$\frac{(3 \times 2) - (1 \times 2)}{3} = \frac{4}{3}$$

$$\frac{\left(\frac{4}{3} \times 4\right) - (0 \times 3)}{\frac{4}{3}} = 4$$

$$\frac{(3 \times (-1)) - (4 \times 2)}{3} = -\frac{11}{3}$$

$$\frac{\frac{16}{3}}{\frac{4}{3}} = 4$$

$$\frac{\left(\frac{4}{3} \times 1\right) - \left(-\frac{11}{3} \times 3\right)}{\frac{4}{3}} =$$

$$\frac{\left(\frac{37}{4} \times -\frac{11}{3}\right) - \left(4 \times \frac{4}{3}\right)}{\frac{37}{4}}$$

$$\frac{\frac{37}{3}}{\frac{4}{3}} = \frac{37}{4}$$

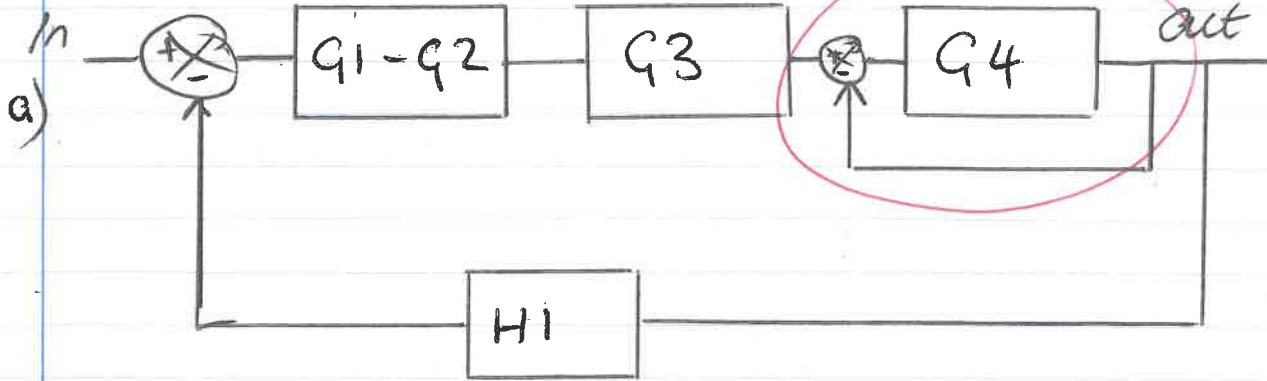
$$\frac{\left(-\frac{407}{12}\right) - \left(\frac{16}{3}\right)}{\frac{37}{4}}$$

$$\frac{\left(-\frac{157}{37} \times 4\right) - (0)}{-\frac{157}{37}}$$

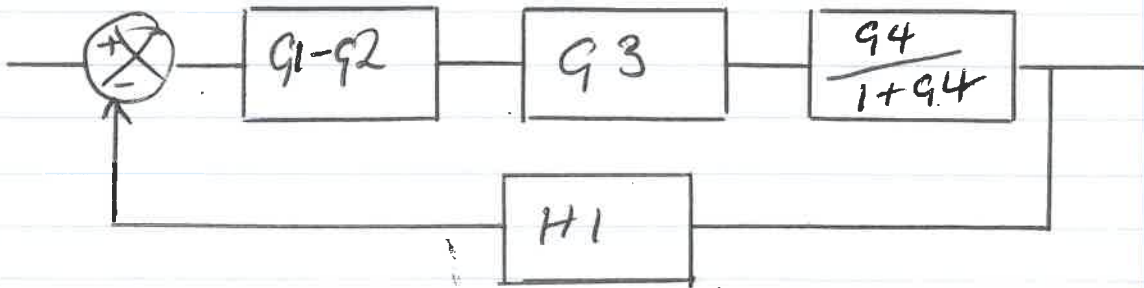
This is an unstable system and has 2 roots in the Right Hand Plane.
(2 POLES) in RHP. ✓

10 ✓

Q6



$$\frac{G_4}{1 + G_4}$$



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

b)

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

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