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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.

Complete, fold and seal
(see note 2 below)

SURNAME:

Roberts

FORENAME(S):

hogan

1	Student Number	ROB2487664
2	Title of Examination Paper	OSP end communications
3	Module Code	FOEE5003
4	Date and Time of Examination	22 May 2025 2:00PM
5	Examination Venue	Main Hall
6	Seat Number	H5
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1	8
Q2	7
Q3	8
Q4	11
Total	34/100

(Gweler yr ochr arall am y fersiwn Cymraeg)

34%✓

Q.1.

a) $y[n] = x[n] - 4$

~~$y[n-k] = x[n-k] - 4$~~

$y = x[-4]$

0/2

This system is not linear as they are not equal.

Q18/25Q1a0/6

b. $y[n] = 2x[n-3]$

$y[n-k] = 2x[n-k-3]$ ✓ 2/2

$y = 2x[-3]$ ✗

This system is time varying as they are not equal.

Q1b2/6

c. i. $y[n] = 4x[n-1] - 3x[n-2] + 2y[n-1]$

The system is causal as $y[n]$ does not use future terms of x or y . ✓ 3/3

Q1c6/6

ii. $y[n] = 6x[n+2] - 7x[n] + y[n+1]$

The system is not causal as $y[n]$ uses future terms of x and y . (which are $[n+2]$ and $[n+1]$)

Q1d0/7

Q.4

a) 7-tap bandpass FIR filter

$$\text{Lower} = 800\text{Hz}$$

$$\text{Higher} = 3000\text{Hz}$$

$$\text{Sampling} = 12,000\text{Hz}$$

$$\omega_L = \frac{2\pi f_L}{f_s} = \frac{2\pi \times 800}{12000} = 0.419 \text{ radians} \quad \text{or } 0.419$$

$$\omega_H = \frac{2\pi f_H}{f_s} = \frac{2\pi \times 3000}{12000} = 0.5\pi \text{ radians} \quad \text{or } 1.571$$

$$h(0) = \frac{\omega_H - \omega_L}{\pi} = \frac{0.5\pi - \frac{2}{15}\pi}{\pi} = 0.367$$

$$h(1) = \frac{\sin(\omega_H \times 1)}{\pi \times 1} - \frac{\sin(\omega_L \times 1)}{\pi \times 1} = \frac{\sin(0.5\pi)}{\pi} - \frac{\sin(\frac{2}{15}\pi)}{\pi}$$

$$h(1) = 0.189$$

$$h(2) = \frac{\sin(0.5\pi \times 2)}{2\pi} - \frac{\sin(\frac{2}{15}\pi \times 2)}{2\pi} = -0.118$$

$$h(3) = \frac{\sin(0.5 \times 3\pi)}{3\pi} - \frac{\sin(\frac{2}{15} \times 3\pi)}{3\pi} = -0.207$$

$$h(0) = 0.367$$

$$h(1) = h(-1) = 0.189$$

$$h(1) = 0.189$$

$$h(2) = h(-2) = -0.118$$

$$h(2) = -0.118$$

$$h(3) = h(-3) = -0.207$$

$$h(3) = -0.207$$

Q4

11/25

Q4a

10/10

Q.4.

$$\begin{aligned}
 a) \quad b_0 &= h(-3) = 20.207 \\
 b_1 &= h(-2) = -0.118 \\
 b_2 &= h(-1) = 0.189 \\
 b_3 &= h(0) = 0.367 \\
 b_4 &= h(1) = 0.189 \\
 b_5 &= h(2) = -0.118 \\
 b_6 &= h(3) = -0.207
 \end{aligned}$$

b). i) Multiplexing : allows different frequencies to be on the same channel without interfering with one another.

Q4b1/15

ii) Analogue Modulation: reads and processes analogue signals

iii) ASK digital modulation: reads and process digital signals

iv) FSK digital Modulation: reads and processes digital signals

v.) Baseband system: A system that allows communication to happen between different channels.

Q. 3.

$$b) \quad 3y[n] - 2y[n-1] + y[n-2] - x[n] + 0.5x[n-1] - x[n-2]$$

~~3y[n]~~

$$3y[n] - 2y[n-1] + y[n-2] = -x[n] + 0.5x[n-1] - x[n-2]$$

$$3Y(z) - 2Y(z^{-1}) + Y(z^{-2}) = -X(z) + 0.5X(z^{-1}) - X(z^{-2})$$

$$H(z) = \frac{Y(z)}{X(z)}$$

$$H(z) = \frac{-X(z) + 0.5X(z^{-1}) - X(z^{-2})}{3Y(z) - 2Y(z^{-1}) + Y(z^{-2})}$$

$$c. \quad y[n] + 0.5y[n-1] - 0.25y[n-2] - x[n] + 0.6x[n-1] - 0.4x[n-2]$$

$$y[n] + 0.5y[n-1] - 0.25y[n-2] = x[n] + 0.6x[n-1] - 0.4x[n-2]$$

$$Y(z) + 0.5Y(z^{-1}) - 0.25Y(z^{-2}) = X(z) + 0.6X(z^{-1}) - 0.4X(z^{-2})$$

$$H(z) = \frac{Y(z)}{X(z)}$$

$$H(z) = \frac{X(z) + 0.6X(z^{-1}) - 0.4X(z^{-2})}{Y(z) + 0.5Y(z^{-1}) - 0.25Y(z^{-2})}$$

$$H(e^{j\omega}) = \frac{X(e^{j\omega}) + 0.6X(e^{-j\omega}) - 0.4X(e^{-2j\omega})}{Y(e^{j\omega}) + 0.5Y(e^{-j\omega}) - 0.25Y(e^{-2j\omega})}$$

Q.3

$$c) \quad x(n) = (3^n) \cos(0.25\pi n) u(n)$$

$$x(n) = \frac{z[z - a \cos(b)]}{z^2 - [2a \cos(b)]z + a^2} = a^n \cos(bn) u(n)$$

 $x(z)$

$$x(n) = \frac{z[z - 3 \cos(0.25\pi)]}{z^2 - [2 \times 3 \times \cos(0.25\pi)]z + 3^2}$$

$$x(n) = \frac{z^2 - 2 \cdot 1.21z}{z^2 - 4.24z + 9}$$

$$x(n) = \frac{z^2 - 2 \cdot 1.21z}{z^2 - 4.24z + 9}$$

$$x(n) = \frac{z^2 - 2 \cdot 1.21z}{z^2 + 4.758}$$

Q3a3173

Q.2.

b) (B)

M

~~$$x[n] = 8\delta[n] - 7\delta[n-1] + 6\delta[n-2] - 5\delta[n-3]$$~~

~~$$x[n] = 0\delta[n] + 0\delta[n-1]$$~~

$$\begin{aligned}
 x[n] = & 0\delta[n+8] + 0\delta[n+7] + 0\delta[n+6] + 0\delta[n+5] \\
 & + 5\delta[n+4] + 0\delta[n+3] - 3\delta[n+2] + 0\delta[n+1] \\
 & + 2\delta[n] - 4\delta[n-1] + 0\delta[n-2] + 3\delta[n-3] \\
 & + 0\delta[n-4] - 2\delta[n-5] + 1\delta[n-6] + 0\delta[n-7] \\
 & + 0\delta[n-8].
 \end{aligned}$$

~~$$w[n] = 2, -1, 4$$~~

$$x[n] = 1, 3, 0, 2.$$

	0	1	2	3	4	5
~~$H(n)$~~	2	-1	4			
~~$x(n)$~~	1	3	0	2		

Q27/25Q2b4/44Q2d0/4

Q2

$$c) h[n] = [2, -1, 4]$$

$$x[n] = [1, 3, 0, 2]$$

3Q2C3/8

	0	1	2	3	4	5	6
$h[n]$	2 ✓	-1 ✓	4 ✓				
$x[n]$	1 ✓	3 ✓	0 ✓	2 ✓			
$x[n]h[0]$	2 ✓	-1 ✓	4 ✓				
$x[n]h[1]$	delay y	6 ✓	-3 ✓	12 ✓			
$x[n]h[2]$	delay y	delay	0 ✓	0 ✓	0 ✓		
$x[n]h[3]$	delay y	delay	delay	4 ✓	-2 ✓	8 ✓	
	2	-1	4	16	-2	8	
$y[n]$	2 ✓	-1 ✓	4 ✓	16 ✓	-2 ✓	8 ✓	
$y[n]$	2	-1	4	16	-2	8	

$$y[n] = [2, -1, 4, 16, -2, 8]$$

Q.2

$$a) x(t) = 8 \sin(2\pi f t) u(t)$$

Sampling frequency = 10 kHz

$$i. x(n) = 8 \sin(2\pi f t) u(t)$$

$$x(n) = 8 \sin(2\pi \times 10^3) u(t) \quad \times$$

for ii.)

$$x(n)0 = 8$$

$$x(n)1 = 2.314$$

$$x(n)2 = -4.430$$

$$x(n)3 = 6.168$$

$$x(n)4 =$$

$$x(n)0 = 8 \sin(2\pi \times 1000) = 2.314$$

$$x(n)0 = 2.314$$

$$x(n)0 = 2.314$$

$$x(n)1 = -4.430$$

$$x(n)2 = 6.168$$

$$x(n)3 = -7.378$$

$$x(n)4 = 7.957$$

ii.)

