



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

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).
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1	Student Number	IVE20857781
2	Title of Examination Paper	DSP and Communications
3	Module Code	G0EE5003
4	Date and Time of Examination	22/05/25
5	Examination Venue	Main hall 68860
6	Seat Number	H2
7	Number of Answer Books handed in	

Complete, fold and seal
(see note 2 below)

SURNAME: Ivey

FORENAME(S): James

List the numbers of the questions you have attempted	Office Use
Q1	4
Q2	10
Q3	22
Q4	4
Total	40/100

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40% ✓

1a) Linear?

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

$$y'[n] = x'[n] - 4$$

$$y''[n] = x''[n] - 4$$

$$ay_1[n] + by_2[n] = ax_1[n] - 4 + b(x_2[n] - 4)$$

The system is not linear. *show workings*

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

$$y[n-k] = 2x[n-3-k]$$

Time invariance $4\{x[n-k]\} = ???$

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

This system is non-causal as it does not rely on future values or terms.

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

This system is causal as it relies on the future terms of $[n+2]$ and $[n+1]$

D) i) This is a non-recursive equation.

$$ii) a_R = 0.3 = a_1$$

$$a_0 = ??$$

$$b_R = 0.7 = b_0$$

$$iii) y[n] = -0.3y[n-1] + 0.7x[n]$$

$$y[-1] = -0.3y[-1-1] + 0.7x[-1]$$

$$y[-2] = -0.3y[-2-1] + 0.7x[-2]$$

$$y[-3] = -0.3y[-3-1] + 0.7x[-3]$$

$$y[-4] = -0.3y[-4-1] + 0.7x[-4]$$

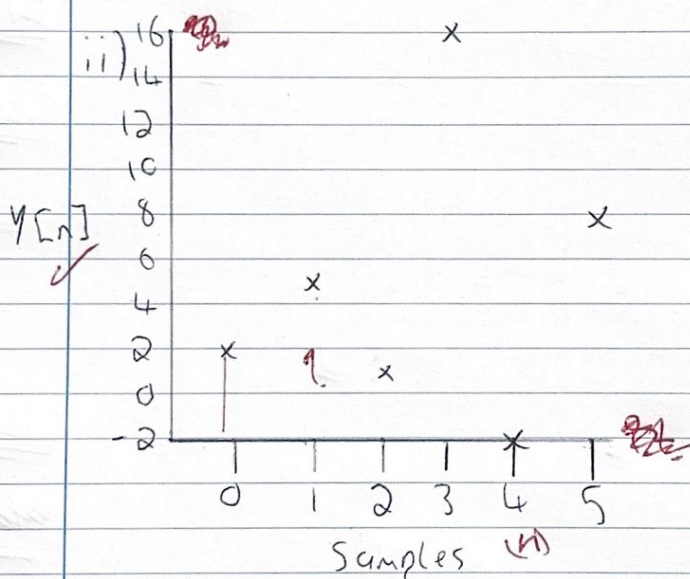
$$y[0] = -0.3y[0-1] + 0.7x[0]$$

$$2c) \quad h[n] = [2 \ -1 \ 4] \\ x[n] = [1 \ 3 \ 0 \ 2]$$

i) 11

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

$$y[n] = [2 \ 5 \ 1 \ 16 \ -2 \ 8]$$



$$D) \quad x(t) = 4 \cos(6000\pi t) + 2 \cos(16000\pi t) \dots \\ - 2 \cos(8000\pi t)$$

$$\text{Nyquist} = f_{\max}$$

$$f = \frac{6000}{2} = 3000 \text{ Hz}$$

$$\omega = 2\pi f = 2 \times \pi \times 3000$$

$$= 18,8 \text{ } \cancel{\text{ms}} \text{ } 50$$

$$4 \cos(2\pi f t) \\ 4 \cos(2 \times \pi \times 3000 t)$$

$$T = \frac{2\pi}{\omega} = 0.00033$$

continued...

Q2

10/25

Q2a

0/4

Q2b

4/4

Q2c

6/8

Q2d

0/4

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

$$\text{Line 12: } a^n \cos(bn) u(n) = \frac{z[z - a \cos(b)]}{z^2 - [2a \cos(b)]z + a^2}$$

$$a = 3$$

$$b = 0.25\pi$$

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

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

$$?? = \frac{z[z - 2.12]}{z^2 - (4.24)z + 9} = \frac{z^2 - 2.12z}{z^2 - 4.24z + 9}$$

$$b) 3y[n] - 2y[n-1] + y[n-2] - x[n] + 0.5x[n-1] - x[n-2] = 0$$

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

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

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

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

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

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

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

Q3

22/25

Q3a

5/7

Q3b

7/8

Q3c

10/10

$$3c) H(e^{j\omega}) = \frac{Y(\omega)}{X(\omega)} = \frac{(1 - 0.6e^{-j\omega} + 0.4e^{-2j\omega})}{(1 + 0.5e^{-j\omega} - 0.25e^{-2j\omega})}$$

4) a) 7 Tap. Low = 800 Hz, High = 3000 Hz. Sampling = 12000 Hz

$$2\pi \times \frac{800}{12000} = 0.419 = \omega_L$$

$$2\pi \times \frac{3000}{12000} = 1.57 = \omega_H$$

$$h(0) = \frac{\omega_H - \omega_L}{\pi} = \frac{1.57 - 0.419}{\pi} = 0.367$$

$$h(0) = \frac{\sin(\omega_H/0)}{\pi/0} - \frac{\sin(\omega_L/0)}{\pi/0} \quad h(0) = 0.367$$

$$h(1) = \frac{\sin(\omega_H k)}{\pi k} - \frac{\sin(\omega_L k)}{\pi k}$$

$$h(1) = \frac{\sin(1.57 \times 1)}{\pi \times 1} - \frac{\sin(0.419 \times 1)}{\pi \times 1} = 0.0064$$

$$h(2) = \frac{\sin(1.57 \times 2)}{\pi \times 2} - \frac{\sin(0.419 \times 2)}{\pi \times 2} = 0.0064$$

$$h(3) = \frac{\sin(1.57 \times 3)}{\pi \times 3} - \frac{\sin(0.419 \times 3)}{\pi \times 3} = 0.0064$$

$$b_0 = 0.0064$$

$$b_1 = 0.0064$$

$$b_2 = 0.367$$

$$b_3 = 0.0064$$

$$b_4 = 0.0064$$

Q4

4/25

Q4a

4/10

Q4b

0/15

$$2D) \quad (2\pi ft) = (2 \times \pi \times 3000 \times 0.00033) = 6.22$$

$$x(t) = 4 \cos(6.22) + \dots$$

$$\frac{16000}{2} = 8000 \text{ Hz}$$

$$\omega = 2\pi f = 2\pi \times 8000$$

$$\omega = 50,265.48 \quad T = \frac{2\pi}{\omega} = \frac{2\pi}{50,265.48}$$

$$T = 0.000125$$

$$(2\pi ft) = (2 \times \pi \times 8000 \times 0.000125) = 6.283$$

$$x(t) = 4 \cos(6.22) + 2 \cos(6.283) \dots$$

$$\frac{8000}{2} = 4000 \text{ Hz}$$

$$\omega = 2\pi f = 2\pi \times 4000 = 25,132.7$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{25,132.7} = 0.00025$$

$$2\pi ft = 2 \times \pi \times 4000 \times 0.00025 = 6.283$$

$$x(t) = 4 \cos(6.22) + 2 \cos(6.283) - 2 \cos(6.283)$$

$$x(t) = 3.976$$

$$\text{Nyquist frequency} = 3.976$$

2a) $x(t) = 8 \sin(2\pi f t) u(t)$, $f_s = 10 \text{ kHz}$

$$2\pi f = \omega = 2\pi \times 1000 = 6283 \text{ rads}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{6283} = 0.001 \quad \times 0$$

$$8 \sin(2\pi \times 1000 \times 0.001) = 0.88 = x[n]$$

ii) $x[n] = 8 \sin(2\pi f t) u[n] =$

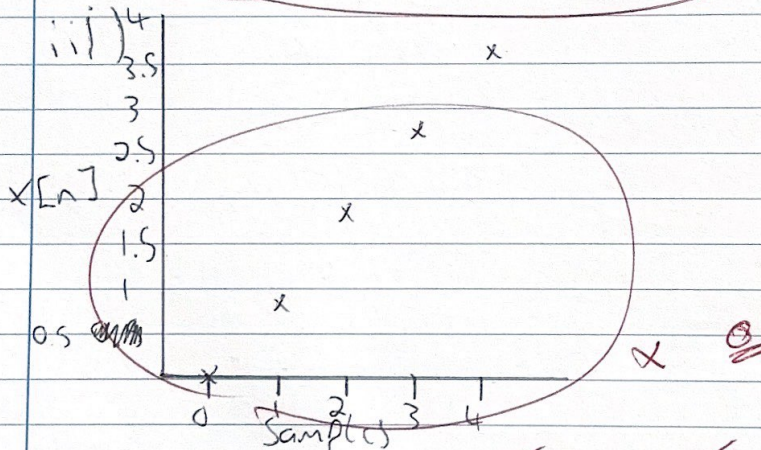
$$x[0] = 8 \sin(2\pi f t) u[0] = 0$$

$$x[1] = 8 \sin(2\pi f t) u[1] = 0.88$$

$$x[2] = 8 \sin(2\pi f t) u[2] = 1.76$$

$$x[3] = 8 \sin(2\pi f t) u[3] = 2.64 \quad \times 0$$

$$x[4] = 8 \sin(2\pi f t) u[4] = 3.52$$



b) $+5\delta(n+4) - 2\delta(n+2) + 2\delta(n) - 4\delta(n-1) + 3\delta(n-3) - 2\delta(n-5) + 1\delta(n-6)$

Q2b

4/4