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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.

1	Student Number	DAN19848477
2	Title of Examination Paper	DSP and communication
3	Module Code	GOEE 5003
4	Date and Time of Examination	Tuesday 23 rd May 1:38 PM
5	Examination Venue	Tycoch
6	Seat Number	F1
7	Number of Answer Books handed in	1

Complete, fold and seal
(see note 2 below)

SURNAME: Daniel

FORENAME(S): Connor

List the numbers of the questions you have attempted	Office Use
1	
2	
3	
4	
Q1	12 ✓
Q2	12 ✓
Q3	25 ✓
Q4	20 ✓
Total	69/100 ✓

69%

G.M.

Q1) i) $y[n] = x[2n] + 8$

Q1

$$y_1[n] = x_1[2n] + 8$$

$$y_2[n] = x_2[2n] + 8$$

12/15

The weighted sum

$$= a_1 x_1[2n] + a_2 x_2[2n] + 8(a_1 + a_2) \quad (1)$$

$$y_3[n] = a_1 x_1[2n] + 8 + a_2 x_2[2n] + 8$$

$$y_3[n] = a_1 x_1[2n] + a_2 x_2[2n] + 16 \quad (2)$$

System is non-linear as (1) and (2) are not equal.

ii) The system is not causal as it relies on a future value. $(2n)$.

iii) $y[n] = x[2n+8]$

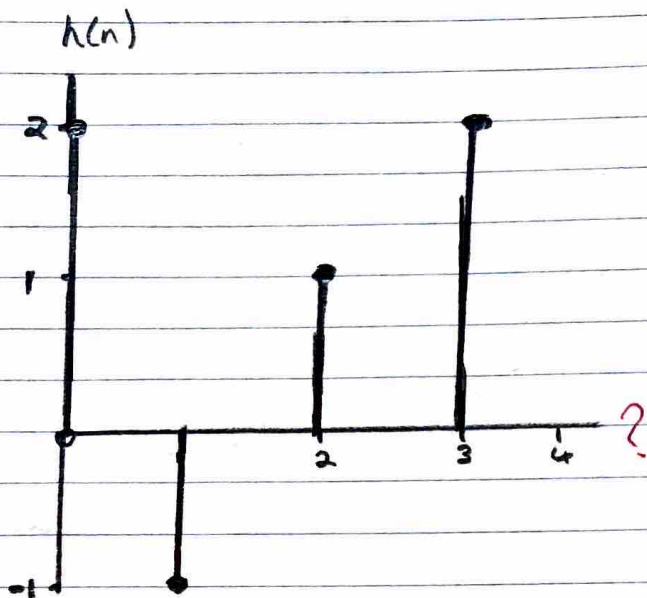
$$y(n-k) = x[2n-2k] + 8 \quad (1)$$

$$y(n,k) = x[2n-k] + 8 \quad (2)$$

show working out

System is time varying as (1) and (2) are not equal.

Q2
a)



2

Q2

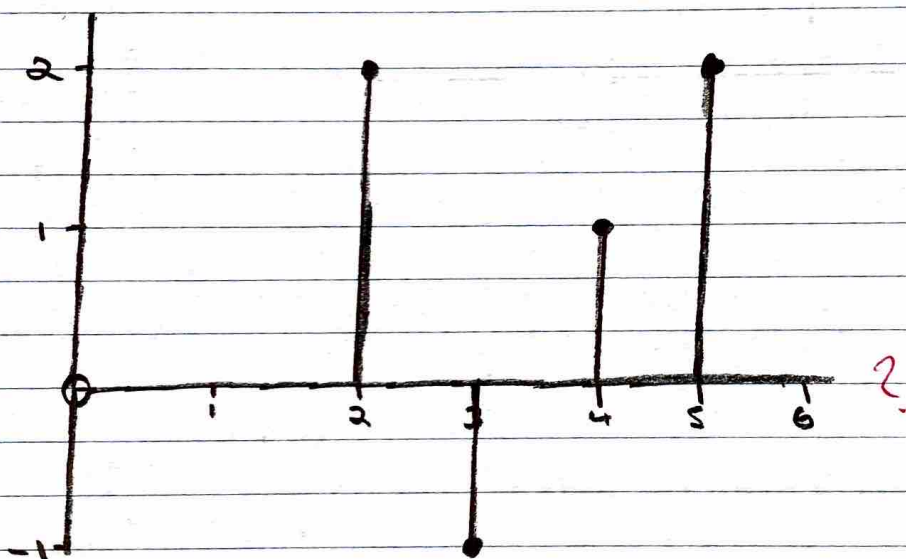
12/15

Q2a

2/2

b)

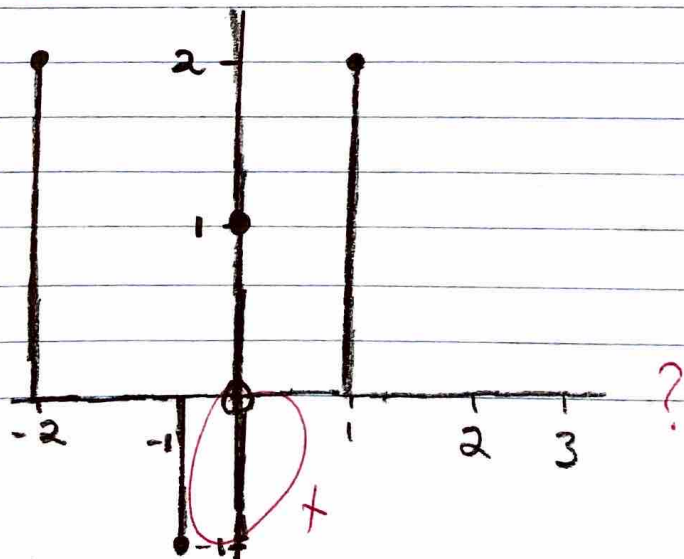
$h(n-2)$



Q2b

3/4

$h(n+3)$



Q2
c)

n	0	1	2	3	4	5	6
$h[n]$	2	-1	1	2			
$x[n]$	1	-2	3	2			
$x[n]h[n]$	2	-1	1	2			
$x[1]h[n-1]$	delay	-4	2	-2	-4		
$x[2]h[n-2]$	delay	delay	6	-3	3	6	
$x[3]h[n-3]$	delay	delay	delay	4	-2	2	4
$y[n]$	2	-5	9	1	-3	8	4

$$y[n] = 2 - 5 \quad 9 \quad 1 - 3 \quad 8 \quad 4$$

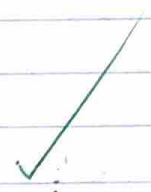
Con. equation

Q2C
7/9

Q3
a)

$$x[n] = 25 \sin(0.167\pi n) u[n]$$

$$X(z) = 25 \frac{z \sin(0.167\pi)}{z^2 - 2z \cos(0.167\pi) + 1}$$



Q3
25/30
Q3a
3/6

b)

$$y[n] + 1.2y[n-1] + 0.3y[n-2] - x[n-1] + x[n-3] = 0$$

$$y[n] + 1.2y[n-1] + 0.3y[n-2] = x[n-1] - x[n-3]$$

$$Y(z) + 1.2z^{-1}Y(z) + 0.3z^{-2}Y(z) = z^{-1}X(z) - z^{-3}X(z)$$

Q3b

$$Y(z)(1 + 1.2z^{-1} + 0.3z^{-2}) = X(z)(z^{-1} - z^{-3})$$

12/12

$$Y(z)(1 + 1.2z^{-1} + 0.3z^{-2}) = z^{-1} - z^{-3}$$

$$\frac{Y(z)}{X(z)} = \frac{z^{-1} - z^{-3}}{1 + 1.2z^{-1} + 0.3z^{-2}}$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{z^{-1} - z^{-3}}{1 + 1.2z^{-1} + 0.3z^{-2}}$$

Q3

$$y[n] - \frac{1}{2}y[n-1] + \frac{1}{16}y[n-2] - x[n] = 0$$

$$y[n] - \frac{1}{2}y[n-1] + \frac{1}{16}y[n-2] = x[n]$$

$$Y(z) - \frac{1}{2}z^{-1}Y(z) + \frac{1}{16}z^{-2}Y(z) = X(z)$$

$$Y(z)(1 - \frac{1}{2}z^{-1} + \frac{1}{16}z^{-2}) = X(z)$$

$$\frac{Y(z)}{X(z)} = \frac{1}{1 - \frac{1}{2}z^{-1} + \frac{1}{16}z^{-2}}$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1 - \frac{1}{2}z^{-1} + \frac{1}{16}z^{-2}}$$

$$H(e^{j\omega}) = \frac{Y(\omega)}{X(\omega)} = \frac{1}{1 - \frac{1}{2}e^{-j\omega} + \frac{1}{16}e^{-2j\omega}}$$

Q4

a) Low cutoff 3 tap Sampling rate
1000 Hz 10000 Hz

$$\omega_c = 2\pi f_c T_s = \frac{2\pi f_c}{f_s}$$

$$\omega_c = 2\pi \frac{1000}{10000} = 0.2\pi \text{ radians}$$

$$2M+1=3 \therefore M=1$$

$$h(0) = \frac{\omega_c}{\pi} = \frac{0.2\pi}{\pi} = 0.2$$

$$h(0) = 0.2$$

Q3C

10/12

Q4
20/25
Q4a

8/10

Q4
a)

Cont.
$$h(1) = \frac{\sin(\omega_c(1))}{\pi(1)} = \frac{\sin(0.2\pi(1))}{\pi(1)} = \frac{\sin(0.2\pi)}{\pi}$$

$$h(1) = 0.187$$

$$h(-1) = h(1) \text{ due to symmetry}$$

$$\therefore h(-1) = 0.187$$

filter coefficients = $b_0 = ?$

$$h(-1) = 0.187 \quad b_1 = ?$$

$$h(0) = 0.2 \quad b_2 = ?$$

$$h(1) = 0.187$$

b) 5 tap band pass ω_L ω_H F_s
1000 1250 5000Hz

$$\omega_L = 2\pi \frac{1000}{5000} = 0.4\pi \text{ radians.}$$

$$\omega_H = 2\pi \frac{1250}{5000} = 0.5\pi \text{ radians.}$$

$$2M+1=5 \therefore M=2$$

$$h(0) = \frac{\omega_H - \omega_L}{\pi} = \frac{0.5\pi - 0.4\pi}{\pi}$$

$$h(0) = 0.1$$

Cont on next page.

Q4b

12/15

Q4
b)

Cont

$$h(2) = \frac{\sin(\omega_H(2))}{\pi(2)} - \frac{\sin(\omega_L(2))}{\pi(2)} \quad \checkmark$$

$$h(2) = \frac{\sin(0.5\pi(2))}{\pi(2)} - \frac{\sin(0.4\pi(2))}{\pi(2)} \quad \checkmark$$

$$h(2) = -0.0935 \quad \checkmark$$

$$h(-2) = h(2) \text{ due to symmetry} \quad \checkmark$$

$$\therefore h(-2) = -0.0935 \quad \checkmark$$

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

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

$$h(1) = \frac{\sin(0.5\pi)}{\pi} - \frac{\sin(0.4\pi)}{\pi} \quad \checkmark$$

$$h(1) = 0.01558$$

$$h(-1) = h(1) \text{ due to symmetry}$$

$$\therefore h(-1) = 0.01558$$

Filter coefficients =

$$h(-2) = -0.0935$$

$$h(-1) = 0.01558$$

$$h(0) = 0.1$$

$$h(1) = 0.01558$$

$$h(2) = -0.0935$$

 $b_0, b_1, b_2, b_3, b_4 ?$ 