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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:

Smith

FORENAME(S):

Joshua

1	Student Number	SM16836261
2	Title of Examination Paper	Digital Signal Processing and Communications
3	Module Code	60EE5003
4	Date and Time of Examination	22/05/25 14:00
5	Examination Venue	68860
6	Seat Number	46
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	
2	
3	
4	
Q1	18
Q2	5
Q3	16
Q4	5
Total	44/100

(Gweler yr ochr arall am y fersiwn Cymraeg)

44 %

Q1

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

$$y_1[n] = x_1[n] - 4 \checkmark$$

$$y_2[n] = x_2[n] - 4 \checkmark$$

$$a_1 y_1[n] + b_1 y_2[n] = a_1 (x_1[n] - 4) + b_1 (x_2[n] - 4)$$

$$H \{a_1 x_1[n] + b_1 x_2[n]\} = a_1 x_1[n] + b_1 x_2[n] - 4$$

The two outputs aren't equal therefore the system is not linear.

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

$$y[n-k] = 2x[n-k-3] \underline{5}$$

$$H \{y[k] \} = x[n-k]$$

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

Outputs are equal here for system is time invariant

c) i) this system is causal as it has no future terms

ii) this system is not causal as it has future terms

Q118/25Q1a4/6Q1b5/6Q1c6/6

d) i) This system is recursive

ii) $a_k = -0.3$

$b_k = 0.7$

$a_0 = ?$

Q2d

3/7

Q2 a) $x[n] = 8 \sin(2\pi f n) u[n]$

i) $\sin(2\pi \times \frac{1000}{10000}) = 0$

$x[n] = 8 \sin(2\pi \times \frac{1000}{10000}) = 4.702$

ii)

$x(0) = 4.702 \times 0 \times u(0) = 1$

$x(1) = 4.702 \times 1 \times u(1) = 4.702$

$x(2) = 9.404 \times 2 \times u(2) = 9.404$

$x(3) = 4.702 \times 3 \times u(3) = 14.1$

$x(4) = 4.702 \times 4 \times u(4) = 18.8$

$x(5) = 4.702 \times 5 \times u(5) = 23.51$

Q2

5/25

Q2a

0/9

Q3

d)

??

Q2d
0/4

$$Q3 \text{ a) } x[n] = (3^n) \cos(0.25\pi n) u[n]$$

$$X(z) = \frac{z}{z^2 - [2a \cos(b)]z + a^2}$$

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

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

show workings

Q3
16/25
Q3a
6/7

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

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

$$3zy[n] - 2z^{-1}y[n] + z^{-2}y[n] = (1 - 0.5z^{-1} + z^{-2})x[n]$$

$$(3z - 2z^{-1} + z^{-2})y[n] = (1 - 0.5z^{-1} + z^{-2})x[n]$$

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

Q3b

5/8

5

$$c) y[n] + 0.5y[n-1] - 0.25y[n-2] \\ = x[n] + 0.6x[n-1] - 0.4x[n-2] = 0$$

Q3c

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

5/10

$$z y[n] + 0.5z^{-1}y[n] - 0.25z^{-2}y[n] \\ = z x[n] + 0.6z^{-1}x[n] - 0.4z^{-2}x[n]$$

$$(1 + 0.5z^{-1} - 0.25z^{-2}) y[n] = (1 - 0.6z^{-1} + 0.4z^{-2}) x[n]$$

$$H_z = \frac{y(z)}{x(z)} = \frac{1 - 0.6z^{-1} + 0.4z^{-2}}{1 + 0.5z^{-1} - 0.25z^{-2}}$$

$$H_{e^{j\omega}} = \frac{y(\omega)}{x(\omega)} = \frac{1 - 0.6e^{-j\omega} + 0.4e^{-j2\omega}}{1 + 0.5e^{-j\omega} - 0.25e^{-j2\omega}}$$

5

$$a) \quad L = 800 \text{ Hz} \\ H = 3000 \text{ Hz}$$

$$\text{Sampling freq} = 12000 \text{ Hz}$$

$$\omega_L = \frac{2\pi \times 800}{12000} = 0.42 \text{ radians} = 0.13\pi \quad \checkmark$$

$$\omega_H = \frac{2\pi \times 3000}{12000} = 0.5\pi \quad \checkmark$$

$$k=0 \quad h(0) = \frac{\omega_H}{\pi} - \frac{\omega_L}{\pi} = \frac{0.5\pi}{\pi} - \frac{0.13\pi}{\pi} = 0.37 \quad \checkmark$$

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

$$= \frac{\sin(0.5\pi)}{\pi} - \frac{\sin(0.13\pi)}{\pi} \quad \checkmark$$

$$= 0.19 \quad \checkmark$$

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

$$= \frac{\sin(0.5\pi \times 2)}{\pi \times 2} - \frac{\sin(0.13\pi \times 2)}{\pi \times 2}$$

$$= -0.12 \quad \checkmark$$

$$b_k = h(k-M) \quad \text{filter} = 2M+1$$

$$b_0 = h(0-2) = h(-2) = 0.12$$

$$b_1 = h(1-2) = h(-1) = -0.19$$

$$b_3$$

Q4

5/25

Q2a

5/10

5

$$\begin{aligned}
 k=3 \quad h(3) &= \frac{\sin(\omega_k \times k)}{\pi \times k} - \frac{\sin(\omega_k \times k)}{\pi \times 3k} \\
 &= \frac{\sin(0.5 \times 3)}{\pi \times 3} - \frac{\sin(\frac{0.13}{3} \times 3)}{\pi \times 3} \\
 &= -0.2
 \end{aligned}$$

$$\begin{aligned}
 k=4 \quad h(4) &= \frac{\sin(0.5 \times 4)}{\pi \times 4} - \frac{\sin(0.13 \times 4)}{\pi \times 4} \\
 &= -0.08
 \end{aligned}$$

$$b_0 = h(0-2) = h(-2) = 0.12$$

$$b_1 = h(1-2) = h(-1) = -0.19$$

$$b_2 = h(2-2) = h(0) = 0.37$$

$$b_3 = h(3-2) = h(1) = 0.19$$

$$b_4 = h(4-2) = h(2) = -0.12$$

$$b_5 = h(5-2) = h(3) = -0.2$$

$$b_6 = h(6-2) = h(4) = -0.08$$

Q4b

0/15