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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 accept answers written in cursive 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	2112087
2	Title of Examination Paper	Advanced digital Signal Processing
3	Module Code	ACDA6018
4	Date and Time of Examination	1200 08/01/2025
5	Examination Venue	Swansea - IQ
6	Seat Number	057
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1	15
Q2	17
Q3	11
Q4	21
Q1	15
Q2	18
Q3	10
Q4	21
Total	64/100

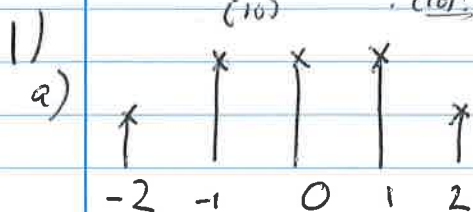
(Gweler yr ochr arall am y fersiwn Cymraeg)

Sum

A ~ 15
(10)B ~ 15
(10)C
 ~ 5
(20)D ~ 20
(5)

1b 3ai

answer: (C)



$$f(t)e^{j\omega_0 t} \rightarrow F(j\omega - j\omega_0)$$

2 for $-1 < t < 1$ 1 for $-2 < t < -1$ 1 for $1 < t < 2$

$$F(j\omega) = \int_{-1}^1 2e^{j\omega t} dt + \int_{-2}^{-1} e^{j\omega t} dt + \int_1^2 e^{j\omega t} dt$$

$$f(j\omega) = [2e^{j\omega t} / j\omega]_{-1}^1 + [e^{j\omega t} / j\omega]_{-2}^{-1} + [e^{j\omega t} / j\omega]_1^2$$

$$f(j\omega) = (2e^{j\omega(1)} - 2e^{j\omega(-1)}) / j\omega + (e^{j\omega(-1)} - e^{j\omega(-2)}) / j\omega + (e^{j\omega(2)} - e^{j\omega(1)}) / j\omega$$

$$F(j\omega) = 1/j\omega [2(e^{j\omega} - e^{-j\omega}) + (e^{j\omega} - e^{2j\omega}) + (e^{-2j\omega} - e^{-j\omega})]$$

$$F(j\omega) = 1/j\omega [-4/2 \cdot (e^{j\omega} - e^{-j\omega}) - 2/2 \cdot (e^{j\omega} - e^{2j\omega}) - 2/2 \cdot (e^{-2j\omega} - e^{-j\omega})]$$

$$= 1/j\omega \{-4/2 \cdot (e^{j\omega} - e^{-j\omega}) - 2/2 \cdot (e^{j\omega} - e^{2j\omega}) - 2/2 \cdot (e^{-2j\omega} - e^{-j\omega})\}$$

$$= 1/j\omega \{-4/2 e^{j\omega} + 4/2 e^{-j\omega} - 2/2 e^{j\omega} + 2/2 e^{2j\omega} - 2/2 e^{-2j\omega} + 2/2 e^{-j\omega}\}$$

$$= 1/\omega [4/2j e^{j\omega} - 4/2j e^{-j\omega} + 2/2j e^{2j\omega} - 2/2j e^{-2j\omega} - 2/2j e^{j\omega} + 2/2j e^{-j\omega}]$$

$$= 1/\omega (4 \sin(\omega) - 4 \sin(\omega) + 2 \sin(2\omega) - 2 \sin(2\omega) - 2 \sin(\omega) + 2 \sin(\omega))$$

$$= 1/\omega (2 \sin(2\omega) - 2 \sin(2\omega) - 2 \sin(\omega) + 2 \sin(\omega))$$

$$= 1/\omega (2 \sin(2\omega) - 2 \sin(2\omega) - 2 \sin(\omega) + 2 \sin(\omega))$$

$$= \sin(\omega) = \sin(\omega) / \omega$$

$$= 2 \cdot \sin(\omega) + 4 \cdot \sin(2\omega)$$

QED

b) (a)

$$f(t) e^{j\omega_0 t} \leftrightarrow F(j\omega - j\omega_0)$$

1 (1)

15
95

$$Q_1 = 2 + 4 + 3 + 3 + 2 + 1 = 15$$

2)

$$a \quad x(n) = \frac{1}{3} \text{ for } -1 \leq n \leq 1$$

 x_k

$$x = \left\{ \frac{1}{3}, \frac{1}{3}, \frac{1}{3} \right\}$$

 $x(k)$ where

$$\omega = \frac{2\pi k}{N}$$

$$X_k = \sum_{n=-1}^1 x(n) e^{-j\omega n}$$

$$X_k = \frac{1}{3} e^{-j\omega(-1)} + \frac{1}{3} e^{-j\omega(0)} + \frac{1}{3} e^{-j\omega(1)}$$

$$X_k = \frac{1}{3} (e^{j\omega} + 1 + e^{-j\omega})$$

$$e^{j\omega} + e^{-j\omega} = 2 \cos(\omega)$$

$$X_k = \frac{1}{3} (1 + 2 \cos(\omega))$$

$$\omega = 2\pi k / N$$

$$X_k = \frac{1}{3} (1 + 2 \cos(2\pi k / 3)) \quad \text{for } 0, 1, 2 \quad k$$

$$N = 3$$

(1)

1.

(4)

4.

0

(1)

b)

- i) Transfer function represents non causal of infinite duration
C.Finite can be applied through truncation
ii) This truncation can cause oscillations if ended/truncated abruptly,
causing issues against a perfect.

ii) Leakage of 12.5, 8, 8, 12.5 hamming window

~~n=0~~

$$W(n) = 0.54 - 0.46 \cos(2\pi n / (N-1))$$

for $n=0$

$$W(0) = 0.54 - 0.46 \cos(2\pi(0)/(4-1))$$

$$W(0) = 0.08$$

for $n=1$

$$W(1) = 0.54 - 0.46 \cos(2\pi(1)/(4-1))$$

$$= 0.54 - 0.46 \cos(2\pi/3)$$

$$= 0.54 - 0.46(-0.5)$$

$$W(1) = 0.77$$

for $n=2$

$$W(2) = 0.54 - 0.46 \cos(2\pi(2)/(4-1))$$

$$= 0.54 + 0.23 = 0.77$$

for
 $n=3$

$$W(3) = 0.54 - 0.46 \cos(2\pi(3)/(4-1))$$

$$0.54 - 0.46 = 0.08$$

$$//$$

$$= 0.08, 0.77, 0.77, 0.08$$

$$Y(n) = X(n) * W(n)$$

$$12.5 * 0.08$$

$$Y(0) = 1$$

for $n=1$

$$0.77 * 8$$

$$Y(1) = 6.16$$

$n=2$

$$8 * 0.77$$

$$Y(2) = 6.16$$

$n=3$

$$12.5 * 0.08$$

$$Y(3) = 1$$

{ 3 } ?

$$Q_2 = 1+4+1+2+1+1+4$$

$$= 17$$

3) Amp 3 Sfreq 1200 Hz Phase $\frac{\pi}{6}$ (Rec)
 Amp 2 Sfreq 1150 (Lo)
 1230 (Inter)

Signal =

$$S(t) = 4 \cos(2\pi(1200)t + \pi/4)$$

$$LO_{in-phase} = 2 \cos(2\pi(1150)t)$$

$$LO_{q-phase} = -2 \sin(2\pi(1150)t)$$

$$I(t) = S(t) \cdot LO_{in-phase}$$

$$I(t) = 4 \cos(2\pi(2350)t + \pi/4) \cdot \cos(2\pi(50)t + \pi/4)$$

$$Q(t) = S(t) \cdot LO_{q-phase}$$

$$Q(t) = -4 \sin(2\pi(2350)t + \pi/4) \cdot \sin(2\pi(50)t + \pi/4)$$

$$I(t) = 4 \cos(2\pi(50)t + \pi/4)$$

$$Q(t) = 4 \sin(2\pi(50)t + \pi/4)$$

$$Z(t) = I(t) + Q(t)$$

$$Z(t) = 4 \cos(2\pi(50)t + \pi/4)$$

①

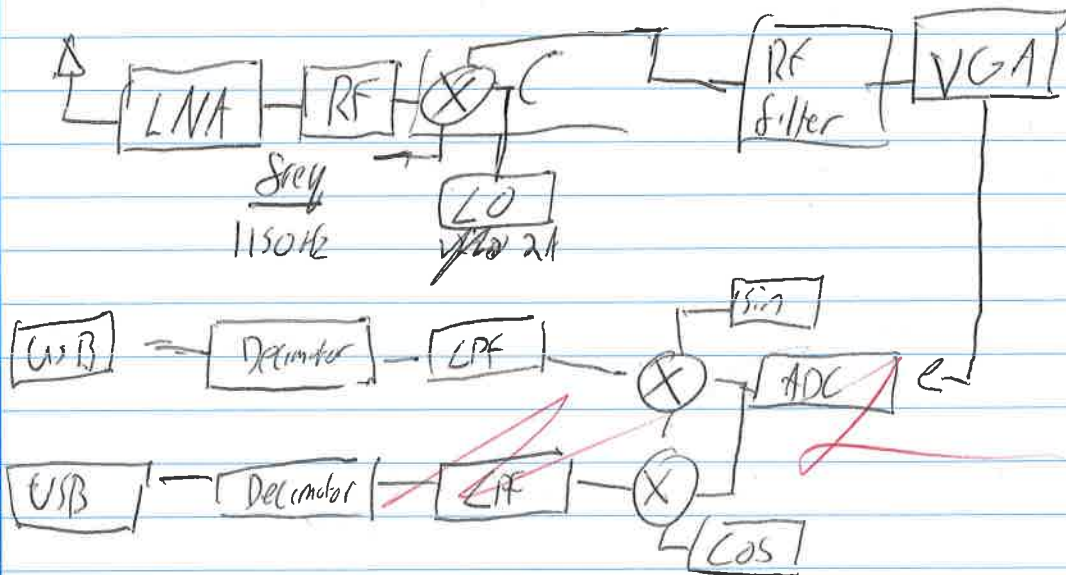
②

①

③

①

ii



vi

Mixes two components, sum and difference.
Compass removes high frequency.

b)

 1.414 Hz

The H_2SO_4 should be returned in a LP filter.

ii) added interference amplifies frequency in most cases when compared to their interference-less end ~~counterparts~~.

(ii) depends on the application - band pass filtering might be applicable but otherwise mixing with constructive sources for the original signal or windowing might suffice, depending on the level.

$$Q_2 = 2 + 1 + 3 + 1 + 1 + 1 = 10$$

4)

$$y(n)_{\text{even}} = 1, 3, 4, 2$$

$$y(n)_{\text{odd}} = 2, 4, 3, 1$$

$$w_N^0 = 1$$

$$w_N^k = e^{-j\frac{2\pi}{N}k}$$

$$w_N^1 = 0.707 - 0.707j$$

$$w_N^2 = -j$$

$$w_N^3 = -0.707 - 0.707j$$

See attached ~~Add 1~~ Item 1

Final:

$$\text{place 0} = 20$$

$$\text{place 1} = -5.828 - 2.414j$$

$$\text{place 2} = 0$$

$$\text{place 3} = 0.772 - 0.414j$$

$$\text{place 4} = 0$$

$$\text{place 5} = -0.772 + 0.414j$$

$$\text{place 6} = 0$$

$$\text{place 7} = -5.828 + 2.414j$$

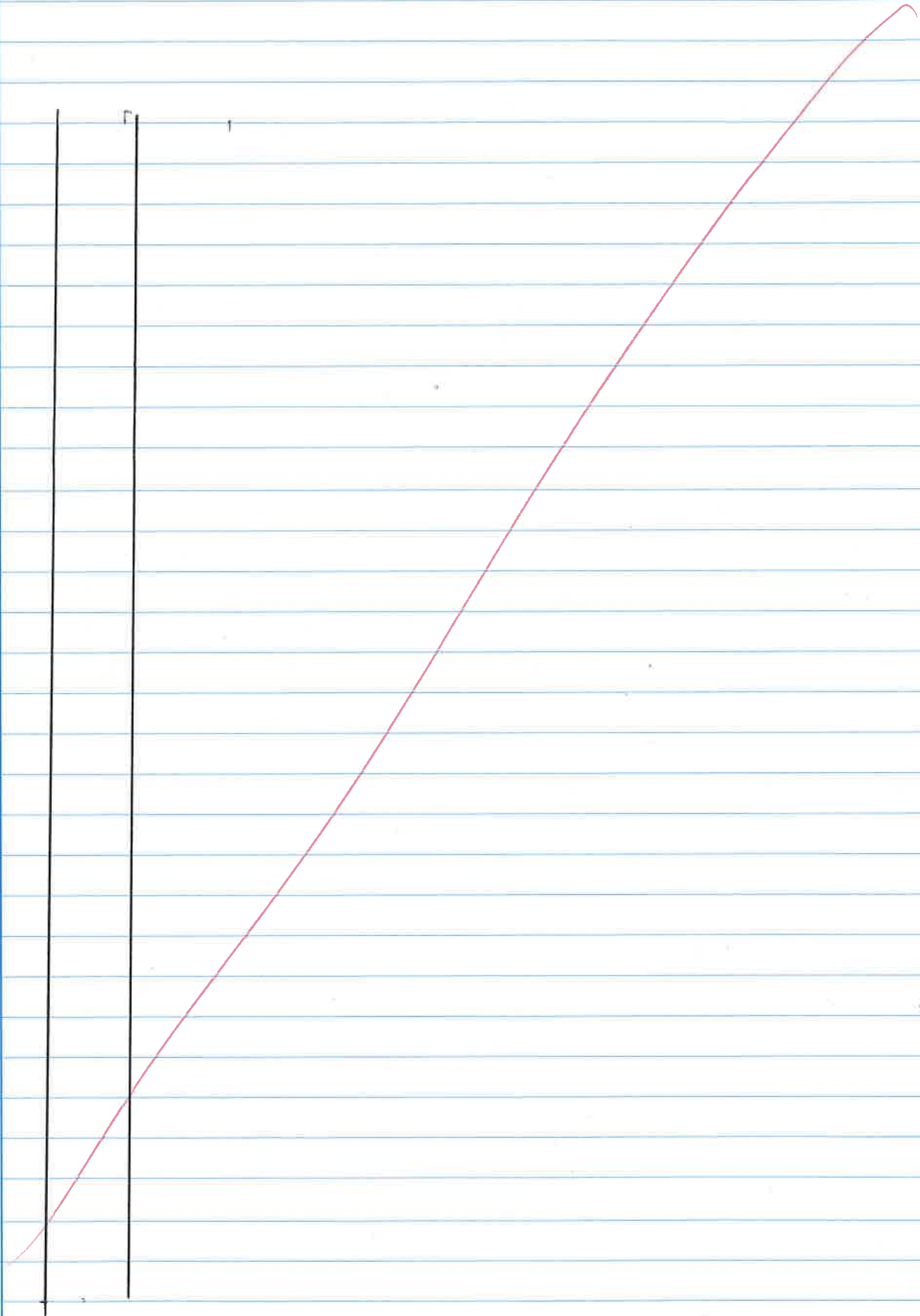
$$Q_4 = 19 + 2 = 21$$

$$\frac{21}{25}$$



Question No.

Examiner Only



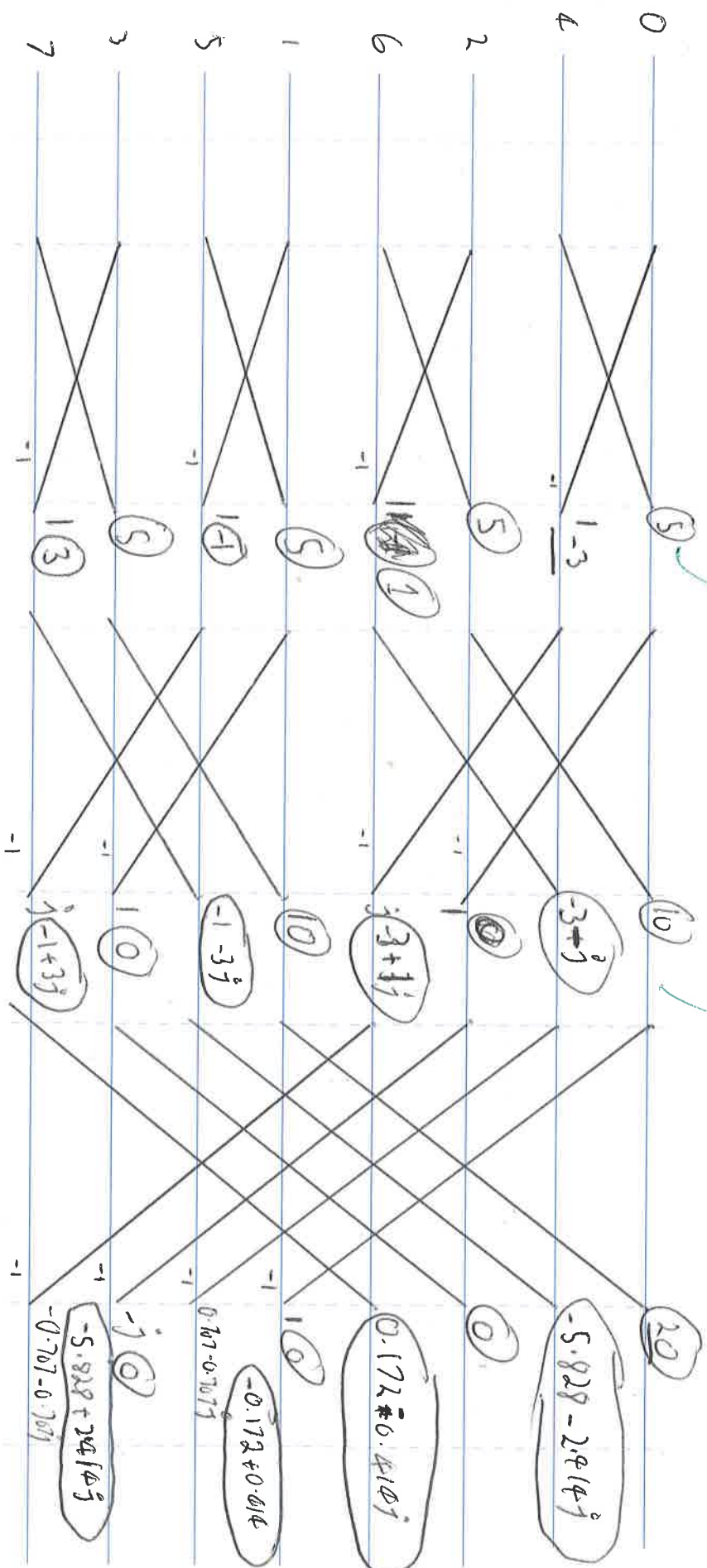
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Module ACD+6018

~~Alf~~

Item 1

format



①

2

2

2