



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.**

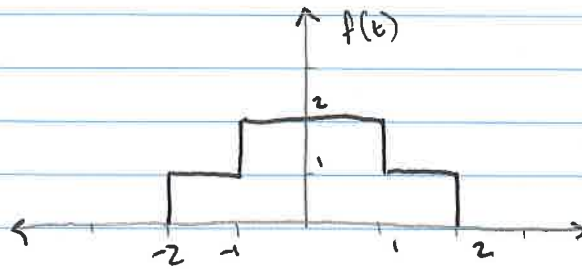
1	Student Number	2116359
2	Title of Examination Paper	ADVANCED DIGITAL SIGNAL PROCESSING SYSTEM
3	Module Code	ACDA6018
4	Date and Time of Examination	8 JANUARY 2025 12.00
5	Examination Venue	SWANSEA IQ BUILDING 310
6	Seat Number	55
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	05 ✓
2	02 ✓
3	16 ✓
4	03 ✓
Q1	5
Q2	2
Q3	16
Q4	3
Total	26/100

26
100
46
P2 P
11/01/25

1a

find Fourier Transform of



$$c. F(j\omega) = 2 \cdot \text{sinc}(\omega) + 4 \cdot \text{sinc}(2\omega)$$

$$f(t) = \begin{cases} 2, & \text{when } -1 \leq t \leq 1 \\ 1, & \text{when } -2 \leq t \leq -1 \text{ or } 1 \leq t \leq 2 \\ 0, & \text{otherwise} \end{cases}$$

b

$$f(t) \rightarrow F(j\omega) = \frac{1}{\omega^2 + 1} e^{-\frac{2\omega^2}{(\omega^2 + 1)}}$$

$$f(t-2) e^{j\omega t} \rightarrow ?$$

$$F(j\omega) e^{-j\omega t_0}$$

$$\text{so } F(j\omega) e^{-j\omega t_0} = \left(\frac{1}{\omega^2 + 1} e^{-\frac{2\omega^2}{(\omega^2 + 1)}} \right) e^{-j\omega t_0}$$

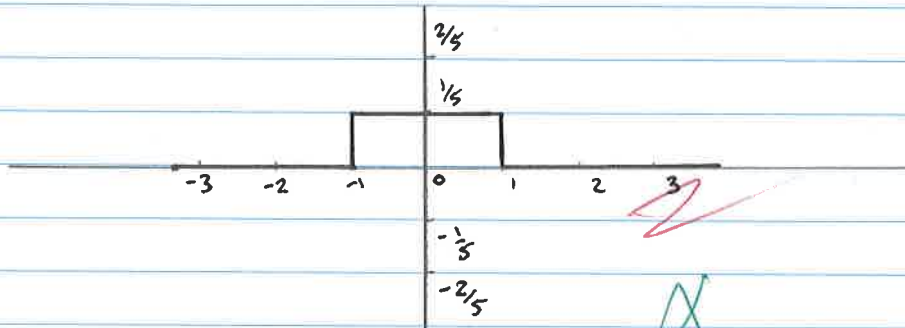
$$Q = 2 + 2 + 1 = 5$$

05
25

2

$$x(n) = \begin{cases} \frac{2}{5}, & \text{for } -1 \leq n \leq 1 \\ 0, & \text{otherwise} \end{cases}$$

so $x(n)$ looks like



a) even function so $a_n = 0$ or $\frac{1}{5}$

$$a_n = \frac{2}{T} \int_0^T f(t) \cos n \omega_0 t \, dt$$

$$\therefore$$

$$0 = \frac{2}{T} \int_{-\infty}^{\infty} f(t) \cos n \omega_0 t \, dt$$

and

$$0 = \frac{2}{T} \int_{-\infty}^{\infty} f(t) \cos n \omega_0 t \, dt$$

$$\frac{1}{5} = \frac{2}{T} \int_{-1}^1 f(t) \cos n \omega_0 t \, dt$$

2b i) Ideal FIR filters are difficult to implement due to the need to compromise between sharpness of the filter cutoff and the level of signal reduction that is achieved.

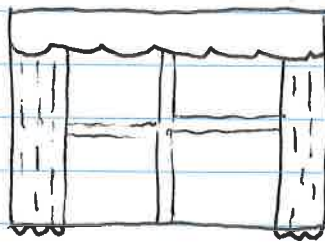
2

(2)

02
25

$Q_2 = 2$

2b ii) $x(n) = 12.5, 8, 8, 12.5$



①

3

SDR

 $S(t)$ $A = 3$ $f_r = 1200 \text{ Hz}$ $\varphi = \pi/6$

LO

 LO_{INPHASE} $A = 2$ LO_{QPHASE} $f_{LO} = 1150 \text{ Hz}$ $f_{\text{INTERFERENCE}} = 1230 \text{ Hz}$ a) specify $I(t)$ $Q(t)$ and $Z(t)$

$$I(t) = S(t) \cdot LO_{\text{INPHASE}}$$

$$S(t) = A(2\pi \cos f_r + \varphi)$$

$$\& LO_{\text{INPHASE}} = 2\pi \cos f_0$$

$$I(t) = A(2\pi \cos f_r + \varphi)(2\pi \cos f_0)$$

// apply
 $\cos A \cdot \cos B$

$$\frac{A}{2} \left(2\pi \cos(2\pi f_r + \varphi + f_0) + 2\pi \cos(f_r + \varphi - f_0) \right)$$

$$= \frac{3}{2} \left(2\pi \cos(2350 + \pi/6) + 2\pi \cos(50 + \pi/6) \right)$$

$$Q(t) = S(t) \cdot LO_{\text{QPHASE}}$$

$$LO_{\text{QPHASE}} = -2\pi \sin f_0$$

$$\begin{aligned} & A(2\pi \cos f_r + \varphi) \times -2\pi \sin f_0 \\ &= \frac{A}{2} \left(2\pi \cos(f_r + \varphi + f_0) - 2\pi \sin(f_r + \varphi - f_0) \right) \\ &= \frac{A}{2} \left(2\pi \cos(2350 + \pi/6) - 2\pi \sin(50 + \pi/6) \right) \end{aligned}$$

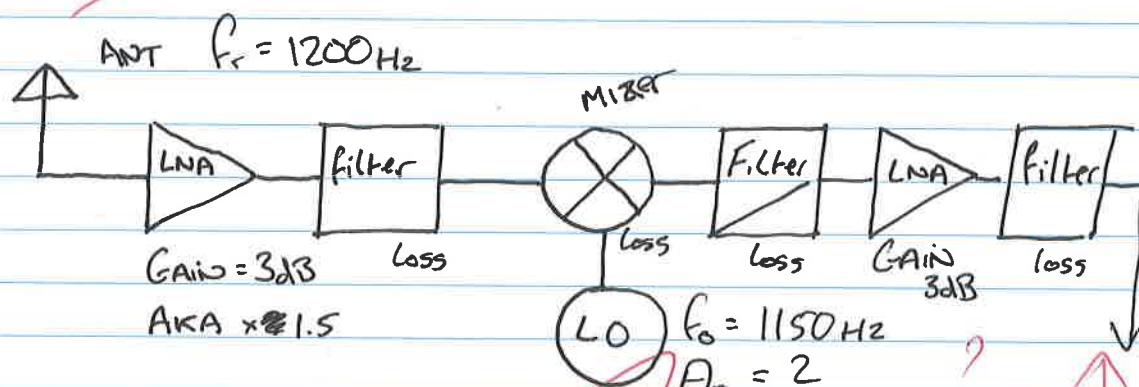
// apply
 $\cos A \cdot \sin B$

3ai continued

$$Z(t) = I(t) \cdot Q(t)$$

$$= \frac{3}{2} \left(2\pi \cos \left(2350 + \frac{\pi}{6} \right) + 2\pi \cos \left(50 + \frac{\pi}{6} \right) \right) \times \frac{3}{2} \left(2\pi \cos \left(2350 + \frac{\pi}{6} \right) - 2\pi \sin \left(50 + \frac{\pi}{6} \right) \right)$$

ii)



iii)

The RF input from the antenna is amplified then filtered before being mixed with the LO. Mixing with the LO produces components at higher and lower frequency to that of the incoming signal. This is used to downconvert the RF input to the base band. The output of the mixer is filtered to remove induced noise before a final amplification and filtering.

10/25

3b

Interference	1230 Hz
RF _{in}	1200 Hz
LO	1150 Hz

i) without adequate filtering on the input, interference will be ~~processed~~ processed by the system. The resulting frequencies after mixing would be:

$$1230 + 1150 = 2380 \text{ Hz}$$

and

$$1230 - 1150 = 80 \text{ Hz}$$

with the application of a Low Pass filter the 80 Hz interference signal is likely to be retained.

ii) The addition of interference ~~is~~ will not affect the main signal unless the bandwidth of the signal exceeds 60 Hz at which point the main signal and the interference will affect each other.

iii) In order to protect the desired signal I would place a BAND PASS filter on the input, centred on 1200 Hz which would effectively block any interference.

$$Q_3 = 1+1+2+3+2+2+2+1+2 = 16$$

4 a) $y(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$
 1 2 3 4 5 6 7 8

even terms

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

odd terms

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

03
25

$P_4 = 1 + 2 = 3$



Question No.

Examiner Only

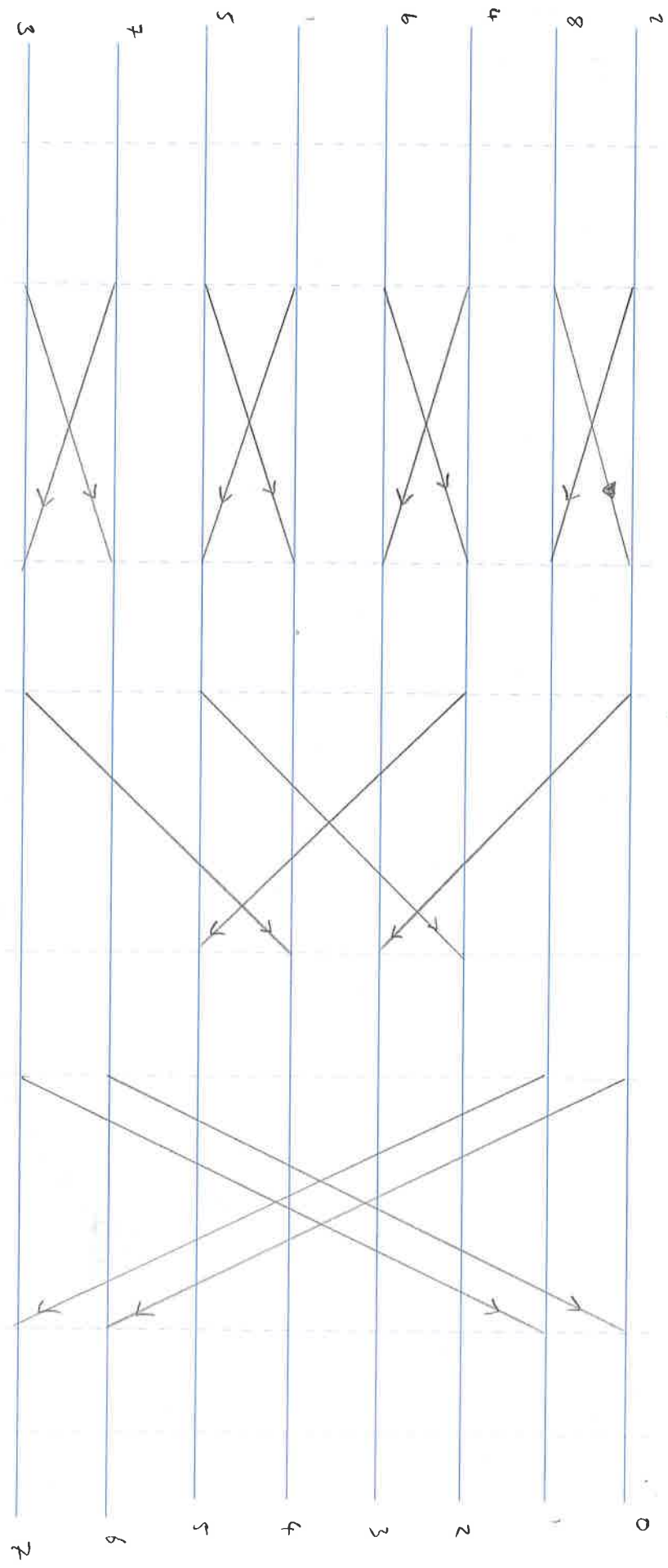
Arholwr yn unig

Rhif y Cwestiwn

4b

2

fermet



2
3
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11
12