

12 Pages

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	1708439/1
2	Title of Examination Paper	DSP and Communications
3	Module Code	MAX8515
4	Date and Time of Examination	10-05-2019 PM
5	Examination Venue	Hall
6	Seat Number	37
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
Q1	1 ✓
Q2	7 ✓
Q3	4 ✓
Q4	5 7
Q5	5 ✓
Total	22

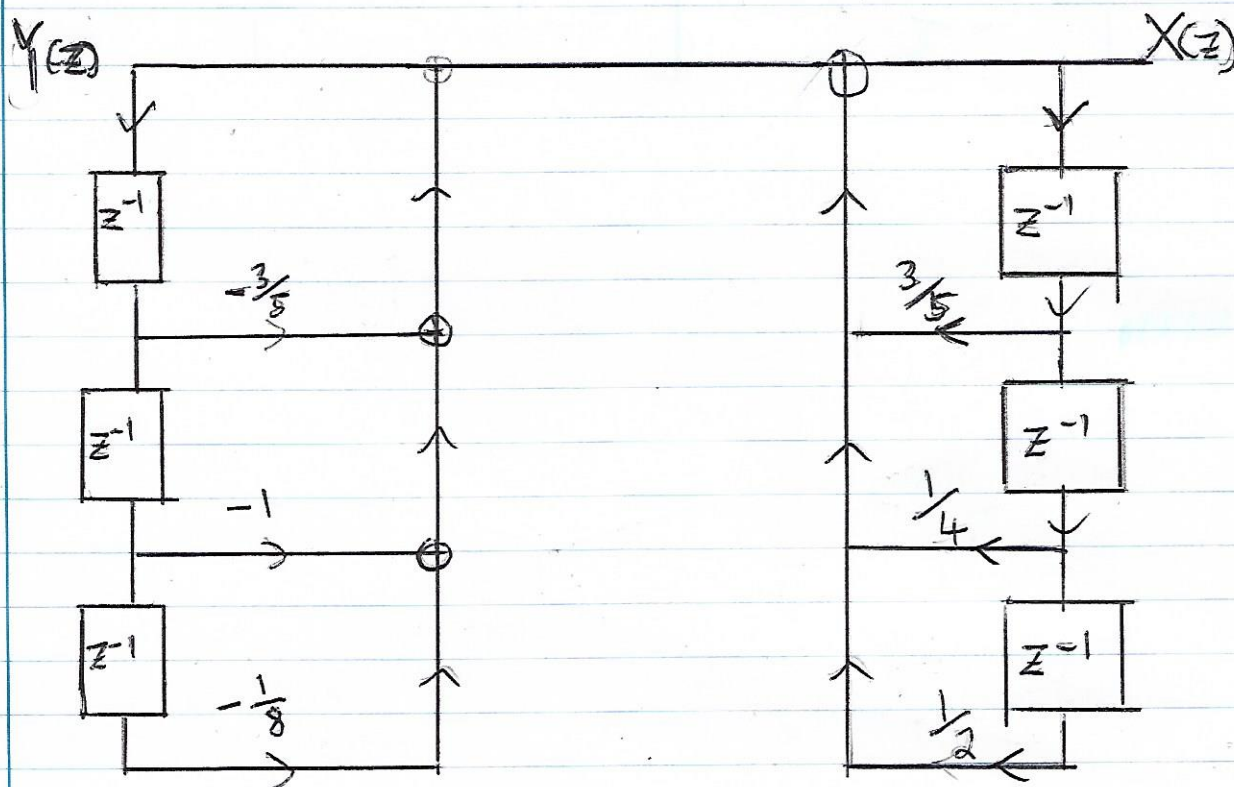
(Gweler yr ochr arall am y fersiwn Cymraeg)

1) a) Transfer function = $\frac{Y}{X}$

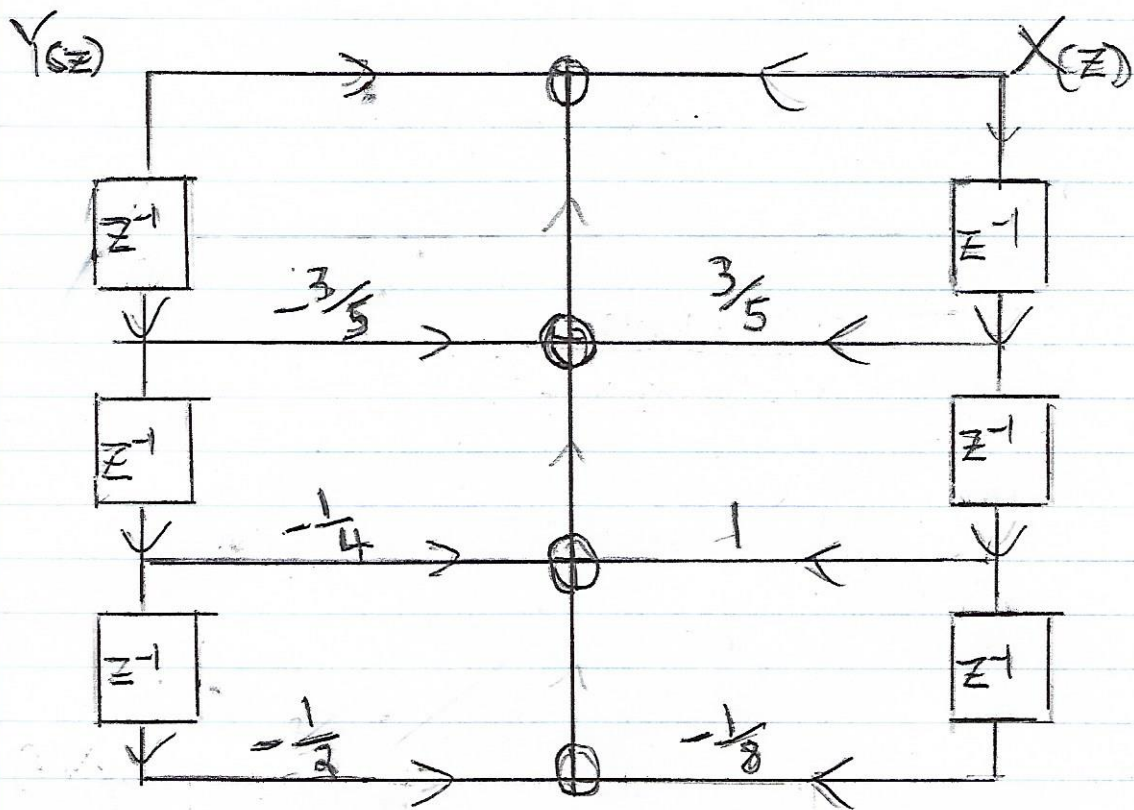
$$Y(z) - \frac{3}{5} Y(z^{-1}) + \frac{1}{8} Y(z^{-2}) = \frac{3}{5} X(z) + \frac{1}{4} X(z^{-1}) + \frac{1}{2} X(z^{-2})$$

$$T.F = \frac{Y(z) - \frac{3}{5} Y(z^{-1}) + \frac{1}{8} Y(z^{-2})}{\frac{3}{5} X(z) + \frac{1}{4} X(z^{-1}) + \frac{1}{2} X(z^{-2})}$$

b) Direct form I



1) c) Direct form II



1) d)

- 2 a) ^{Source} ~~Channel~~ coding protects the source code and ~~the~~ detects ~~on~~ any errors using parity bits.
^{Channel} ~~Source~~ coding is used to streamline the message by decreasing the number of bits needed to ~~transmit~~ ~~transmission~~ transmit data, e.g. ~~huffman coding~~ huffman coding.

b)

i	2	3	4	5	6	7	8	9	10	11	12
1	0	1	0	1	0	0	1	1	0	0	1
P ₁	P ₂		P ₄				P ₈				

$$P_1 = ? \quad 1 \quad 1 \quad 0 \quad 1 \quad 0 = 3 + 1 \quad \checkmark$$

$$P_2 = ? \quad 1 \quad 0 \quad 0 \quad 0 \quad 0 = 1 + 1 \quad \times$$

$$P_4 = ? \quad 1 \quad 0 \quad 0 \quad 1 = 2 + 0 \quad \checkmark$$

$$P_8 = ? \quad 1 \quad 0 \quad 0 \quad 1 = 2 + 0 \quad \times$$

$2 + 8 = 10$. Error is in bit number 10.

~~data stream~~

Data stream should read: 101010011101

2) c) S L O W _ D O W N _ N O W .

$$S = 1$$

$$L = 1$$

$$O = 3$$

$$W = 3$$

$$_ = 2$$

$$D = 1$$

$$N = 2$$

$$13 \times 3 = 39 \text{ bits}$$

Worst case.

$$S_1 = 000$$

$$L_1 = 001$$

$$O_3 = 010$$

$$W_3 = 011$$

$$_2 = 100$$

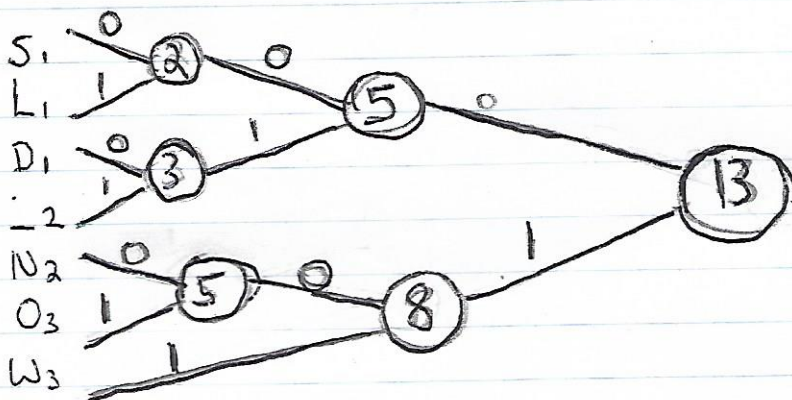
$$D_1 = 101$$

$$N_2 = 110$$

13

$$13 \times 3 = 39 \text{ bits}$$

Huffman code.



S L O W _ D O W N _ N O W

000 100 101 11 110 010 101 11 001 110 001 101 11

3 3 3 2 3 3 3 2 3 3 3 3 2

Using Huffman code reduced to 36 bits to send the same data

3 a) $\omega = 2\pi F, F = \frac{\omega}{2\pi}$

Minimum sample rate is $2 \times$ ~~highest~~ highest frequency.
Nyquist rate.

Minimum sample rate = $2 \times 10000 = 20,000 \text{ Hz}$.

b) $DT = 4 \cos\left(\frac{2000}{4000}\right) \times 2\pi n + 5 \cos\left(\frac{5000}{4000}\right) \times 2\pi n +$
 $2 \sin\left(\frac{3000}{4000}\right) \times 2\pi n:$

$DT = 4 \cos\left(\frac{1}{2}\right) \times 2\pi n + 5 \cos\left(1 - \frac{5}{4}\right) \times 2\pi n + 2 \sin\left(1 - \frac{3}{4}\right) \times 2\pi n$

$DT = 4 \cos\left(\frac{1}{2}\right) \times 2\pi n + 5 \cos \times 2\pi n + 2 \sin\left(\frac{1}{2}\right) \times 2\pi n.$

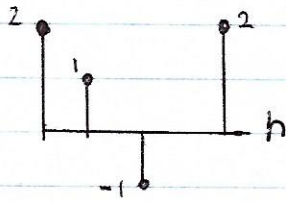
c) Recoverable signal = 5000 Hz .

$\frac{1}{2} \times 4000 \pi = 2000 \pi$, $1 \times 10000 \pi = 10000 \pi$, $\frac{1}{2} \times 6000 \pi = 3000 \pi$
Original = 2000 Hz , Original = 5000 Hz , $\frac{1}{2}$ Original = 3000 Hz

d) To avoid alias signals, the highest frequency should be measured during pre-processing. Sampling should be done at twice the highest frequency to avoid alias signals.
Nyquist rate.

4) a)

$$h(n) = [2, 1, -1, 2]$$

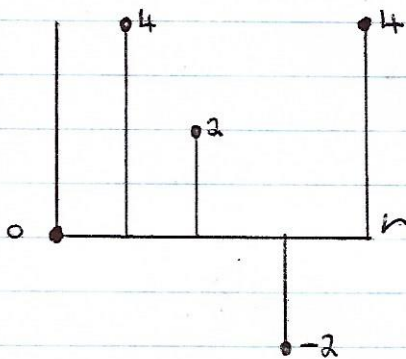
b) $2h(n-1)$

$$2 \quad 1 \quad -1 \quad 2$$

~~0 2 1 -1 2~~

$$0 \quad 2 \quad 1 \quad -1 \quad 2$$

$$0 \quad 4 \quad 2 \quad -2 \quad 4$$

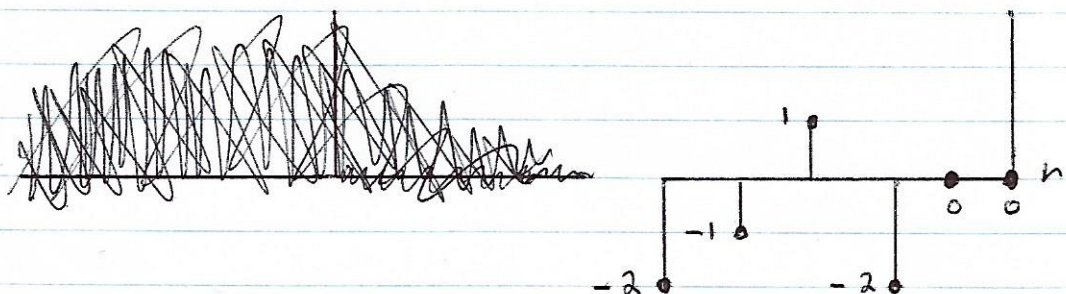


$h(-n+2)$

~~0 2 1 -1 2~~

$$-2 \quad -1 \quad 2 \quad 1 \quad -1 \quad 2$$

$$-2 \quad -1 \quad 1 \quad -2 \quad 0 \quad 0$$



4)c)

$$h(n) = [2, 1, -1, 2]$$

$$x(n) = [2, -1, 2, -1]$$

$$x(0)h(n) = \begin{array}{cccc} 4 & 1 & -2 & 4 \end{array}$$

$$x(1)h(n-1) = \begin{array}{cccc} 0 & -2 & -1 & 1 \end{array} \quad \begin{array}{c} -2 \\ -2 \end{array}$$

$$x(2)h(n-2) = \begin{array}{cccc} 0 & 0 & 4 & 2 \end{array} \quad \begin{array}{cc} -2 & 4 \end{array}$$

$$x(3)h(n-3) = \begin{array}{cccc} 0 & 0 & 0 & -2 \end{array} \quad \begin{array}{ccc} -1 & 1 & -2 \end{array}$$

$$\begin{array}{cccc} 4 & -1 & -3 & 5 \end{array} \quad \begin{array}{ccc} -5 & 5 & -2 \end{array}$$

✗

✓

✓

✓

✓

✓

✓

5) C.F = 2437 MHz.
Band = 2427 MHz to 2447 MHz = 20 MHz. ✓

Thermal noise = $1.38 \times 10^{-23} \times 25 + 273 = 4.1124 \times 10^{-21} \text{ W/Hz}$ ✓

Thermal noise = $4.1124 \times 10^{-21} \times 20 \times 10^6 = 8.2248 \times 10^{-14} \text{ W}$. ✓

FSPL = $20 \log_{10}(d) + 20 \log_{10}(f) + 32.44$
= $20 \log_{10}(1) + 20 \log_{10}(2437) + 32.44$

FSPL = 100.17 Hz. ✓