

SURNAME: Solomon

FORENAME(S): Jack

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	1503512/1
2	Title of Examination Paper	DSP and Communications
3	Module Code	MX8515
4	Date and Time of Examination	10.5.19 1:30
5	Examination Venue	~~AA~~ Hall
6	Seat Number	36
7	Number of Answer Books handed in	

[illegible]

94% ✓

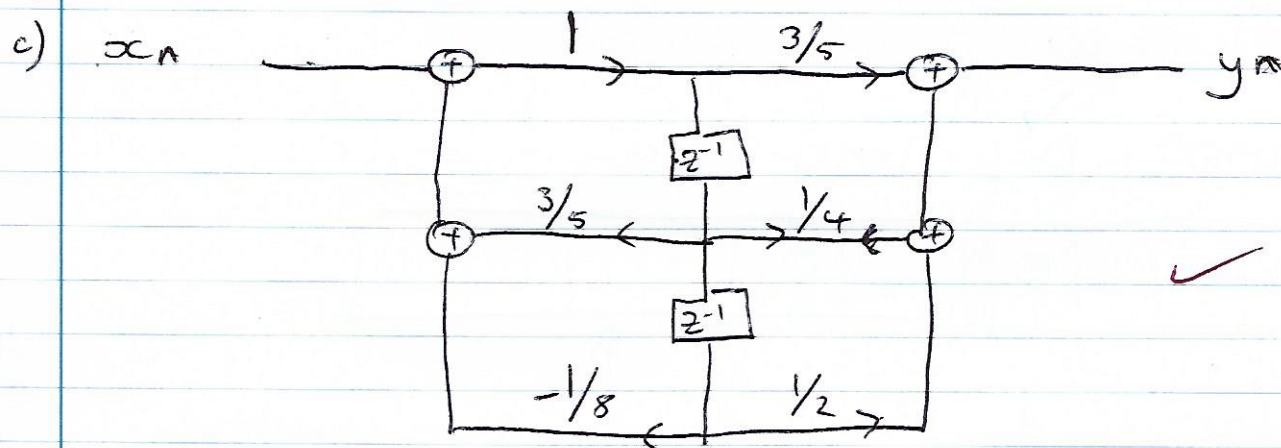
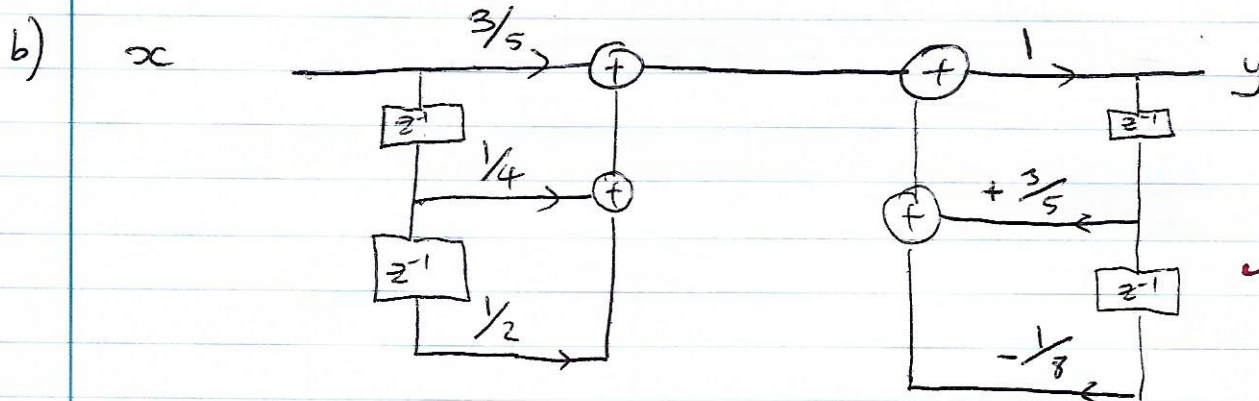
i a) $y(n) - \frac{3}{5} y(n-1] + \frac{1}{8} y(n-2) = \frac{3}{5} x(n) + \frac{1}{4} x(n-1) + \frac{1}{2} x(n-2)$

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

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

Transfer Function $= \frac{Y(z)}{X(z)}$

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



- d) ~~makes the transfer~~
The efficiency of the process ~~becomes~~ increases when direct form II is used. Direct form I is less efficient.

e)

- 2a) Channel coding prevents the source code from becoming corrupt / prevents errors. ✓
Source coding makes the message more efficient. ✓

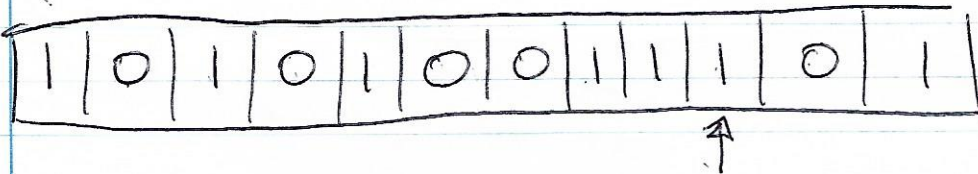
- b)
- | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
- ← code with error.

~~1 = 4~~

$$\begin{aligned}
 1 &= 4 \quad \checkmark \\
 2 &= 1 \quad \times \\
 4 &= 2 \quad \checkmark \\
 8 &= 3 \quad \times
 \end{aligned}$$

$$2 + 8 = 10 \quad \checkmark$$

~~101010011001~~



above is the code with the error correction. ✓

c) SLOW-DOWN-NOW $13 \times 3 = 39 \text{ bits.}$

$$S = 000 \times 1 = 3$$

$$L = 001 \times 1 = 3$$

$$O = 010 \times 3 = 9$$

$$W = 011 \times 3 = 9$$

$$- = 100 \times 2 = 6$$

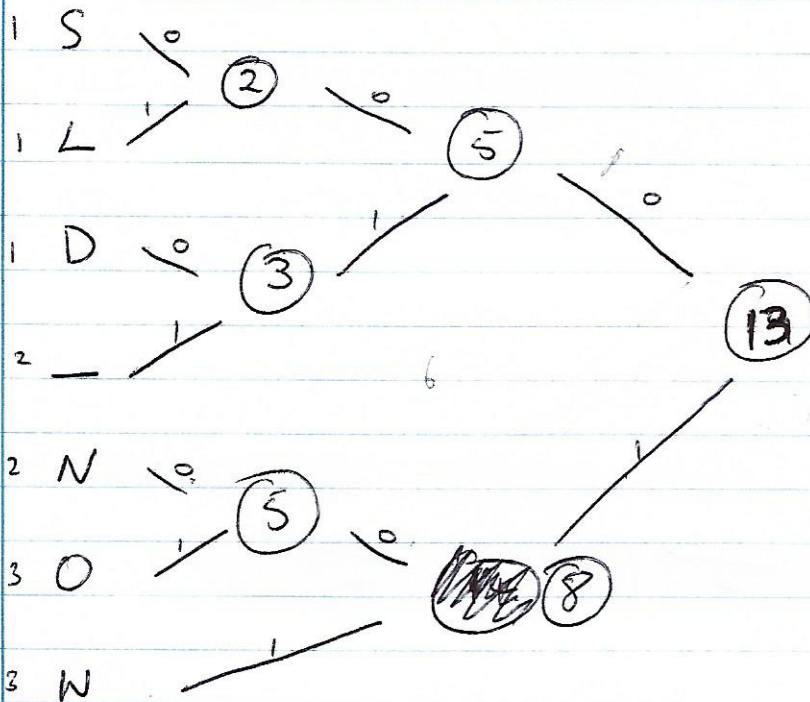
$$D = 101 \times 1 = 3$$

$$N = 110 \times 2 = 6$$

39 bits.

Without Huffman code.

Huffman Code



$$S = 000 \times 1 = 3$$

$$L = 001 \times 1 = 3$$

$$D = 010 \times 1 = 3$$

$$- = 011 \times 2 = 6$$

$$N = 100 \times 2 = 6$$

$$O = 101 \times 3 = 9$$

$$W = 11 \times 3 = 6$$

36 bits.

$\Rightarrow$ 3 bits have been saved using Huffman code.

$$3a) \quad x(t) = 4 \cos(4000\pi t) + 5 \cos(10000\pi t) + 2 \sin(6000\pi t).$$

$$\frac{\omega}{2\pi} = F.$$

$$F_1 = \frac{4000\pi}{2\pi} = 2000 \text{ Hz}$$

$$F_2 = \frac{10000\pi}{2\pi} = 5000 \text{ Hz}$$

$$F_3 = \frac{6000\pi}{2\pi} = 3000 \text{ Hz.}$$

$$\text{Minimum Sample rate} = F_2 \times 2$$

$$(\text{Nyquist Rate}) = 5000 \times 2$$

$$= 10,000 \text{ s/s.}$$

$$b) \quad x(t) = \frac{2000}{4000} (2\pi n) + \frac{5000}{4000} (2\pi n) + 2 \sin \frac{3000}{4000} (2\pi n).$$

$$= \frac{2}{4} (2\pi n) + 1\frac{1}{4} (2\pi n) + \frac{3}{4} (2\pi n).$$

$$\text{DT Signal} = \frac{2}{4} (2\pi n) + \frac{1}{4} (2\pi n) + \frac{3}{4} (2\pi n).$$

$$c) \quad = \frac{2}{4} (4000) (2\pi n) + \frac{1}{4} (4000) (2\pi n) + \frac{3}{4} (4000) (2\pi n).$$

$$= \frac{8000}{4} (2\pi n) + \frac{4000}{4} (2\pi n) + \frac{12000}{4} (2\pi n)$$

$$\begin{aligned}
 b) \quad x(t) &= 4 \cos \frac{2000}{4000} (2\pi n) + \overset{5 \cos}{\cancel{1 \cos}} \frac{5000}{4000} (2\pi n) + 2 \sin \frac{3000}{4000} (2\pi n) \\
 &= 4 \cos \frac{2}{4} (2\pi n) + \frac{5 \cos 1 + \frac{1}{4} (2\pi n)}{5 \cos 1 + \frac{1}{4} (2\pi n)} + 2 \sin \frac{3}{4} (2\pi n) \\
 &= 4 \cos \frac{2}{4} (2\pi n) + 5 \cos \frac{1}{4} (2\pi n) + 2 \sin \frac{3}{4} (2\pi n).
 \end{aligned}$$

DT Signal

$$\begin{aligned}
 c) &= 4 \cos \frac{2}{4} (4000) (2\pi n) + 5 \cos \frac{1}{4} (4000) (2\pi n) + 2 \sin \frac{3}{4} (4000) (2\pi n) \\
 &\quad + \cancel{5 \cos \frac{1}{4} (4000) (2\pi n)} + \cancel{2 \sin \frac{3}{4} (4000) (2\pi n)} \\
 &= 4 \cos \frac{8000}{4} (2\pi n) + 5 \cos \frac{4000}{4} (2\pi n) + 2 \sin \frac{12000}{4} (2\pi n) \\
 &= 4 \cos (4000) (\pi n) + \underline{5 \cos (2000) (\pi n)} + 2 \sin (6000) (\pi n).
 \end{aligned}$$

When sampled at 4000Hz there is a clear alias in this signal, this is because it is sampled below the minimum sample rate.

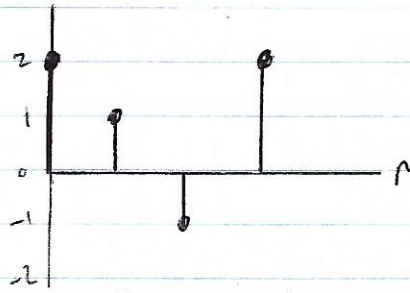
Original signal;

$$\cancel{4 \cos (4000) (\pi t)} + \cancel{5 \cos (10000) (\pi t)}$$

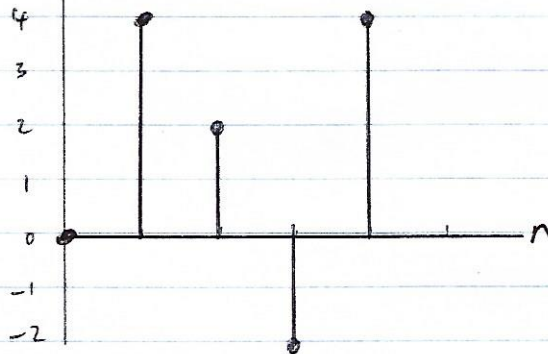
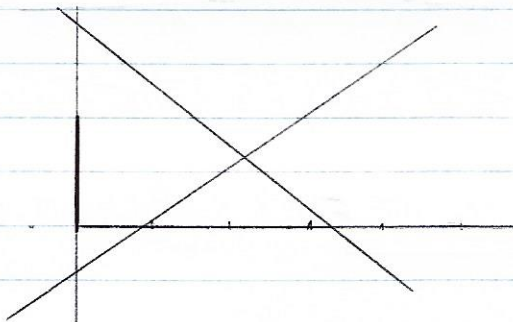
$$4 \cos (4000 \pi t) + \underline{5 \cos (10000 \pi t)} + 2 \sin (6000 \pi t)$$

- d) Make sure that the sample signal is sampled at a higher level than the minimum sample rate.

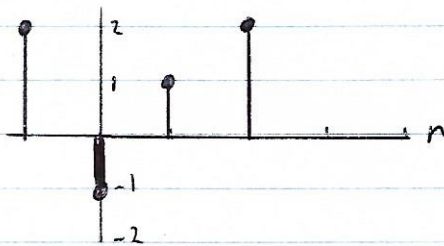
4 a) $2, 1, -1, 2 \leftarrow h(n)$



b) $2, 1, -1, 2 \leftarrow h(n)$
 $0, 4, 2, -2, 4 \leftarrow 2(h-1)$



$2, 1, -1, 2 \leftarrow h(n)$
 $2, -1, +1, 2 \leftarrow h(-n)$
 $2, -1, +1, 2 \leftarrow h(-n+2)$



c) $y(n) = h(n) * x(n)$.

$h(n)$	2	1	-1	2			
$x(n)$	2	-1	2	-1			
$h_0 x_0$	4	2	-2	4			
$h_1 x_1$	0	-2	-1	1	-2		
$h_2 x_2$	0	0	4	2	-2	4	
$h_3 x_3$	0	0	0	-2	-1	1	-2
$y_n =$	4	0	-1	5	-5	5	-2

5. ✓

5. $1W = 10 \log\left(\frac{1000}{1}\right)$
 $= 30 + 6 \text{ db (gain)}$
 $= 36 \text{ dbm}.$

Temp = $25^\circ \text{C} \Rightarrow$ in K = $25 + 273$
 $= 298 \text{ K}.$

Noise $\Rightarrow$ KTB.

$= 1.38 \times 10^{-23} \times 298 \times 20 \times 10^6$
 $= 8.2248 \times 10^{-14} \text{ W}$
 $= 8.2248 \times 10^{-11} \text{ mW}$

Signal $\Rightarrow 20 \log_{10}(d) + 20 \log_{10}(f) + 32.44.$

$= 20 \log_{10}(1) + 20 \log_{10}(2437) + 32.44.$
 $= 100 \text{ db}.$

$36 - 100 = -64 \text{ db dbm dbm}$

$= -64 \div 10$

$= -6.4$

$= 10^{-6.4}$

$= 3.98 \times 10^{-7} \text{ mW}$

Turn Over...

$$C = B \log_2 \left(1 + \frac{S}{N} \right) :$$

$$= 20 \times 10^6 \log_2 \left(1 + \frac{3.98 \times 10^{-7}}{8.2248 \times 10^{-11}} \right) :$$

$$= 244,815,966.4 \text{ b/s} \quad \checkmark$$

Channel capacity = 244.8 mb/s.

10 ✓