



SURNAME: Elder

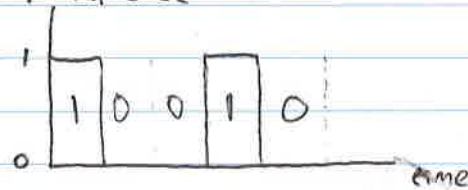
12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right of the answer book 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.**

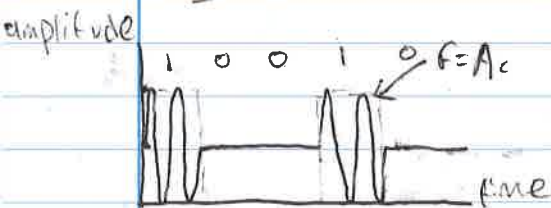
List the numbers of the questions you have attempted	Office Use
1	10
2	~~4~~ 5
3	19
Total	34 / 60 57%

(Gweler yr ochr arall am y fersiwn Cymraeg)

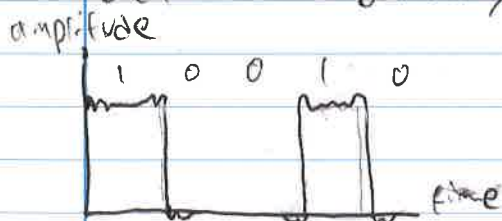
2.a) $x(t)$ represents the ^{binary} signal that is getting modulated
i.e. 10010 or; amplitude



this ~~sig~~ digital signal is combined with the analogue carrier wave $A_c \cos(2\pi f_c t)$ by using a multiplication function which gives the modulated signal (for our example):



After combining this modulated signal by the original carrier wave and running the resulting waveform with a low pass filter the result $(x_c(t))$ should ideally look like the $x(t)$ signal although in practice there will be some noise each time the "digital" signal switches between binary bits as seen below.



A description of what happens in the spectrum should have better.

2.6) $M(x) = 10001$ $G(x) = x^3 + x^2 + 1 = 1101$

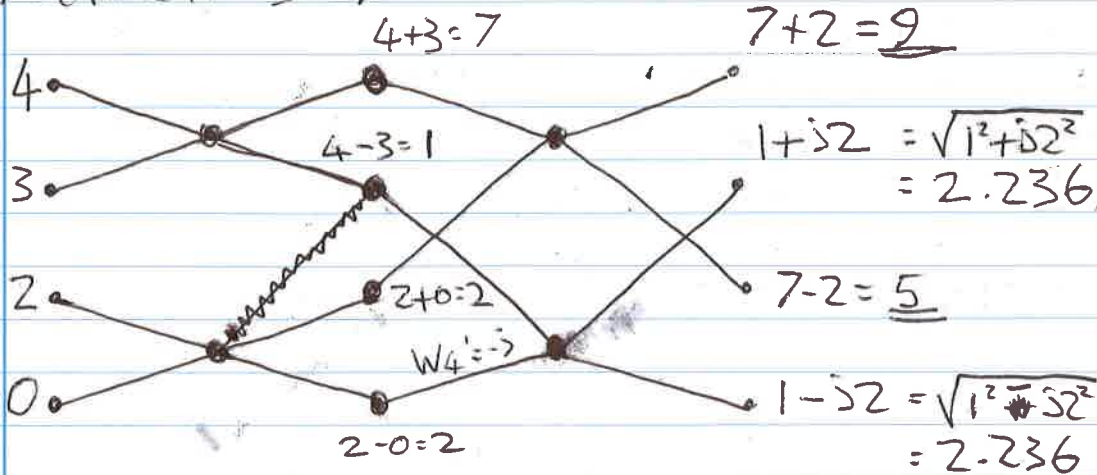
~~$$\begin{array}{r} 1101 \\ \hline 1101 \overline{) 10001000} \\ \underline{1101} \\ 1100 \\ \underline{1101} \\ 0101 \\ \underline{0000} \\ 1010 \\ \underline{0101} \\ 1001 \\ \underline{1101} \\ 1111 \end{array}$$~~

[illegible]

$$\begin{array}{r}
 11011 \quad 000 \\
 \hline
 1101 \quad 10001000 \\
 \hline
 1101 \\
 \hline
 1100 \\
 \hline
 1101 \\
 0101 \\
 \hline
 0000 \\
 1010 \\
 \hline
 1101 \\
 1001 \\
 \hline
 1101 \\
 1111 \\
 \hline
 0000
 \end{array}$$

$$\begin{array}{r}
 1101 \overline{) 10101000} \\
 \underline{1101} \\
 1000 \\
 \underline{1101} \\
 1101 \\
 \underline{1101} \\
 0111 \\
 \underline{0111} \\
 0000 \\
 1110 \\
 \underline{1110} \\
 0000
 \end{array}$$

3.a) $x(k) = \{4, 2, 3, 0\}$



$X(0) = 9$ $X(1) = 2.236$ $X(2) = 5$ $X(3) = 2.236$

b) $x(k) = \{5, 1, 4, 2\}$ $N=4$ $k = \{0, 1, 2, 3\}$

$$X(m) = \sum_{k=0}^{N-1} x(k) e^{-j2\pi \frac{m}{N} k}$$

$m=0$

$X(0) = 5 + 1 + 4 + 2 = 12$

$m=1$

$$X(1) = \sum_{k=0}^3 x(k) e^{-j2\pi \frac{1}{4} k} = \sum_{k=0}^3 x(k) (\cos(\pi \frac{k}{2}) - j \sin(\pi \frac{k}{2}))$$

$$= 5(0 - j1) + 1(-1 - j0) + 4(0 + j1) + 2(1 - j0)$$

$$= -j5 - 1 + j4 + 2 = 2 - j = \sqrt{2^2 - 3^2} = 1.4142$$

$m=2$

$$X(2) = \sum_{k=0}^3 x(k) e^{-j2\pi \frac{2}{4} k} = \sum_{k=0}^3 x(k) (\cos(\pi k) - j \sin(\pi k))$$

$$= 5(1 - j0) + 1(-1 - j0) + 4(1 - j0) + 2(-1 - j0)$$

$$= 6 - 1 + 4 - 2 = 7$$

$m=3$

$$X(3) = \sum_{k=0}^3 x(k) (\cos(\pi \frac{3k}{2}) - j \sin(\pi \frac{3k}{2}))$$

4

1

2

4

3

$$\begin{aligned}X(s) &= 5(1-s) + 1(0+j1) + 4(-1-j0) + 2(0-j1) \\&= 5 + j - 4 - j2 \\&= 1 - j \\&= \sqrt{1^2 + 1^2} \\&= \underline{0}\end{aligned}$$

$$\underline{X(m) = \{12, 14, 42, 7, 0\}}$$

(4)

(1)

(19)

2.b) $M(x) = 10001$ $G(x) = x^3 + x^2 + 1 = 1101$

No error :

$$\begin{array}{r} 11101 \\ 1101 \overline{) 10001000} \\ \underline{1101} \\ 1000 \\ \underline{1101} \\ 1010 \\ \underline{1101} \\ 0010 \\ 0000 \\ 1000 \\ 1101 \end{array}$$

2

5

with error 3rd bit from the right

$$\begin{array}{r} 10000 \\ 1101 \overline{) 10101000} \\ \underline{1101} \\ 0000 \\ 0000 \end{array}$$

~~4b) $N = 7$~~

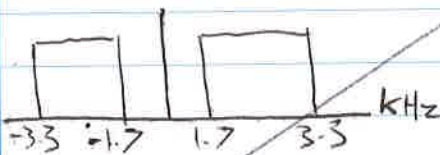
~~Cutoff = 1.7 kHz~~

~~Cutoff = 3.3 kHz~~

~~$f_s = 12 \text{ kHz}$~~

~~Ideal filter =~~

~~normalized $x_{\text{con}} = \frac{1.7}{12} = 0.4166$~~



~~normalized $x_{\text{coff}} = \frac{3.3}{12} = 0.275$~~



- i. 6 errors are detectable
 ii. 1 error is correctable

Explains Request

$$b) \bar{H} = \left(\begin{array}{ccc|ccc} 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 \end{array} \right) \quad \bar{U}_1 = (0101) \quad \bar{U}_2 = (1101) \quad \bar{U}_3 = (1010)$$

$$\bar{U}_1 \bar{S} = \left(\begin{array}{ccc|ccc} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{array} \right) \quad R_{(1)} = \bar{S} \cdot [0101] = \begin{array}{l} 0 \oplus 1 \oplus 1 \oplus 0 \oplus 0 \oplus 0 \oplus 1 \oplus 1 \\ 0 \oplus 0 \oplus 1 \oplus 0 \oplus 0 \oplus 0 \oplus 0 \oplus 1 \\ 0 \oplus 0 \oplus 0 \oplus 1 \oplus 0 \oplus 0 \oplus 1 \oplus 1 \end{array}$$

$$\bar{G}_1 = [100] \quad \bar{G}_1 = [010 | 100]$$

$$\bar{U}_2 \bar{R}(A) = \bar{S} \cdot [1101] = \begin{array}{l} 1 \oplus 1 \oplus 1 \oplus 0 \oplus 0 \oplus 0 \oplus 1 \oplus 1 \\ 1 \oplus 1 \oplus 1 \oplus 0 \oplus 0 \oplus 0 \oplus 1 \oplus 1 \\ 1 \oplus 0 \oplus 0 \oplus 1 \oplus 0 \oplus 0 \oplus 1 \oplus 1 \end{array} = \begin{array}{l} 0 \\ 1 \\ 0 \end{array}$$

$$\bar{G}_2 = [110 | 010]$$

$$\bar{U}_3 \bar{R}(A) = \bar{S} \cdot [1010] = \begin{array}{l} 1 \oplus 1 \oplus 0 \oplus 0 \oplus 0 \oplus 1 \oplus 0 \oplus 1 \\ 1 \oplus 1 \oplus 0 \oplus 0 \oplus 1 \oplus 0 \oplus 0 \oplus 1 \\ 1 \oplus 0 \oplus 0 \oplus 0 \oplus 1 \oplus 1 \oplus 0 \oplus 1 \end{array} = \begin{array}{l} 0 \\ 1 \\ 1 \end{array}$$

$$\bar{G}_3 = [1010 | 011]$$