



**Complete, fold and seal
(see note 2 below)**

AcM

Alexander

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.**

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

Question 1

$$⑥ \quad H = \left[\begin{array}{ccc|ccc} 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 & 1 \end{array} \right]$$

$$\bar{G} = \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array} \right]$$

$$\bar{T}_1 = \bar{U}_1 \alpha \bar{G}$$

$$\bar{U}_1 = [0 \ 1 \ 0 \ 1]$$

$$[0 \ 1 \ 0 \ 1] \cdot \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array} \right]$$

$$\begin{aligned} &= (0 \oplus 0 \oplus 0 \oplus 1) = 1 \\ &= (0 \oplus 1 \oplus 0 \oplus 0) = 1 \\ &= (0 \oplus 1 \oplus 0 \oplus 1) = 0 \end{aligned}$$

$$\text{So } \bar{T}_1 = 0 \ 1 \ 0 \ 1 \ 0 \ 1$$

$$\bar{T}_2 = \bar{U}_2 \times G$$

$$\bar{U}_2 = [1 \ 0 \ 1]$$

$$[1 \ 0 \ 1] \cdot \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{array} \right] \begin{aligned} &= (1 \oplus 0 \oplus 0 \oplus 0) = 1 \\ &= (1 \oplus 0 \oplus 0 \oplus 0) = 1 \\ &= (0 \oplus 1 \oplus 0 \oplus 0) = 1 \end{aligned}$$

$$\bar{T}_2 = 1 \ 0 \ 1 \ 1 \ 0 \ 1 \ 0 \ 1$$

①

②

③

$$\overline{T_3} = \overline{U_3} \cdot \overline{G}$$

$$\overline{U_3} = [1010]$$

$$[1010] \cdot \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{aligned} &= (1 \oplus 0 \oplus 0 \oplus 0) = 1 \\ &= (1 \oplus 0 \oplus 0 \oplus 0) = 1 \\ &= (0 \oplus 0 \oplus 1 \oplus 0) = 1 \end{aligned}$$

$$So \overline{T_3} = 1010011$$

Question 2

(B) CRC

$$M(x) = 10001$$

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

$$\begin{array}{r} 111001 \\ 1101 \overline{) 10001000} \\ \underline{1101} \\ 1101 \\ \underline{1101} \\ 0010 \\ \underline{0000} \\ 0100 \\ \underline{0000} \\ 100 \end{array}$$

~~111011000100~~
~~110111111111~~
~~110111111111~~
~~110111111111~~
~~110111111111~~
~~000000000000~~
~~000000000000~~
~~000000000000~~
~~000000000000~~
~~000000000000~~

4464
Wrong

111000
11011000100
110111111111
110111111111
110111111111
110111111111
000000000000
000000000000
000000000000
000000000000
000 = No errors

✓
✓

4

ADD incorrect bit to 3rd bit from Right

111001
110110001000
110111111111
110111111111
110111111111
110111111111
000000000000
000000000000
000000000000
000000000000
000 = 1 error

✓

4

Question 4

(a)

$$x(k) = 2 \ 3 \ 2 \ 1$$

$$h(k) = 2 \ 1 \ 2 \ 3$$

$$\begin{array}{r}
 \underline{2 \ 1 \ 2 \ 3} \\
 + \underline{2 \ 3 \ 2} \\
 \hline
 2 \ 1 \ 2 \ 3
 \end{array}$$

$$\begin{array}{r}
 2 \ 1 \ 2 \ 3 \\
 1 \ 2 \ 3 \ 2 \\
 1 \ 2 \ 3 \ 2 \\
 1 \ 2 \ 3 \ 2 \\
 1 \ 2 \ 3 \\
 1 \ 2 \\
 1
 \end{array}$$

~~y(k)~~

$$y(0) \cancel{y(1)} = 2 \times 2 = 4$$

$$y(1) \cancel{y(2)} = (2 \times 3) + (1 \times 2) = 6 + 2 = 8$$

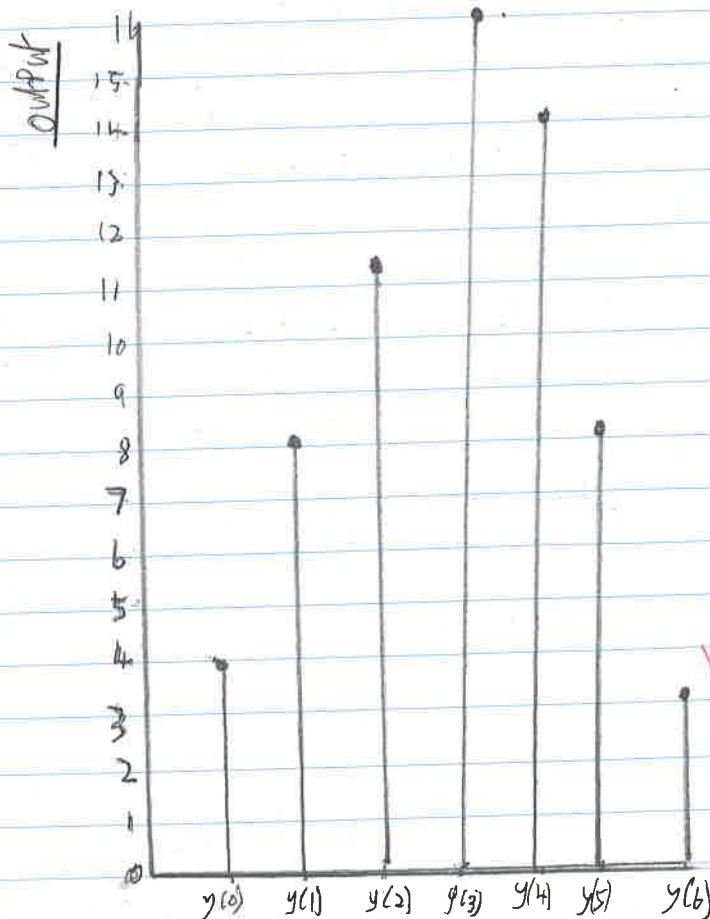
$$y(2) \cancel{y(3)} = (2 \times 2) + (1 \times 3) + (2 \times 2) = 4 + 3 + 4 = 11$$

$$y(3) \cancel{y(4)} = (2 \times 1) + (1 \times 2) + (2 \times 3) + (3 \times 2) = 2 + 2 + 6 + 6 = 16$$

$$y(4) \cancel{y(5)} = (1 \times 1) + (2 \times 2) + (3 \times 3) = 1 + 4 + 9 = 14$$

$$y(5) \cancel{y(6)} = (1 \times 2) + (2 \times 3) = 2 + 6 = 8$$

$$y(6) \cancel{y(7)} = (1 \times 3) = 3$$

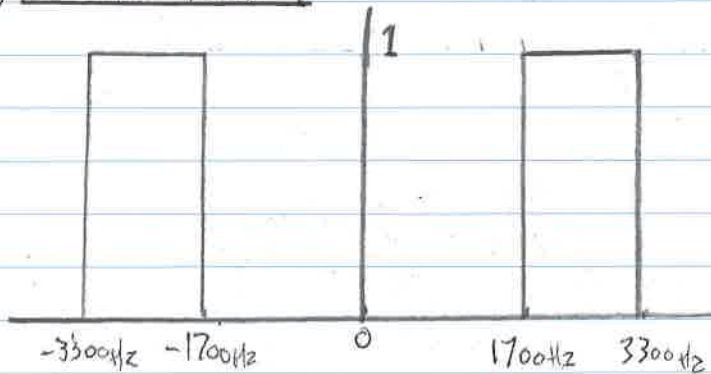


(b) Frequency transform of band pass

$$N = 7 \quad \alpha = \frac{N-1}{2} = \frac{7-1}{2} = 3 \quad \checkmark$$

cut off/on = 1.7×10^3 Hz and 3.3×10^3 Hz or 1700 Hz and 3300 Hz
 $f_c = 1.2 \times 10^4$ Hz or 12000 Hz

① Draw ideal



② Normalize

$$f_{L\text{norm}} V_L = \frac{1700}{12000} \rightarrow 0.1416 \quad \checkmark$$

$$V_u = \frac{3300}{12000} = 0.275 \quad \checkmark$$

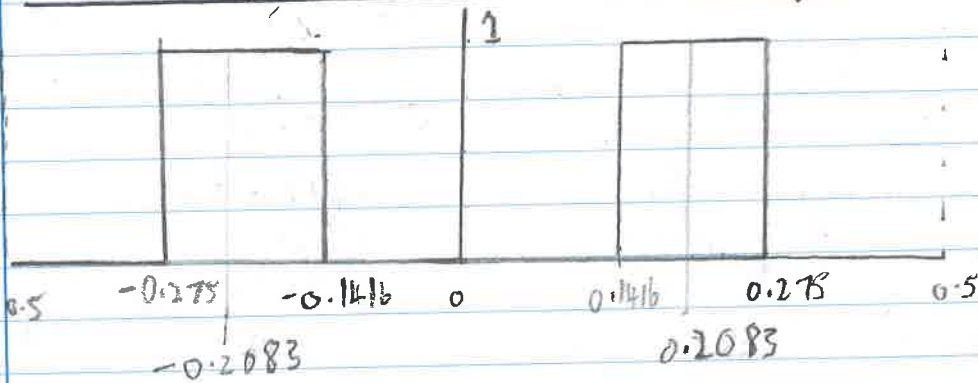
$$\text{and } V_c = V_u - V_L = 0.275 - 0.1416 = 0.1334$$

$$\text{so } V_c = \frac{0.1334}{2} = 0.0667 \quad \checkmark$$

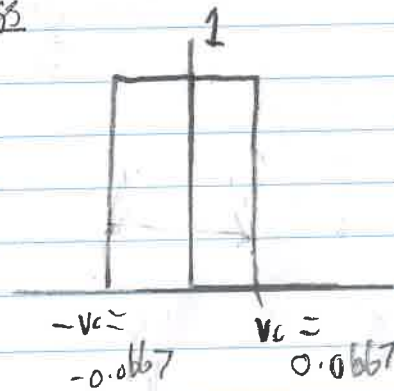
$$\text{and } V_o = \frac{V_u + V_L}{2} = \frac{0.275 + 0.1416}{2} = \frac{0.4166}{2}$$

$$\text{so } V_o = 0.2083 \quad \checkmark$$

Re-Drow band pass with Normalised Figures



Draw low pass



Add for formula for low pass

$$h_{LP} = \frac{1}{T(k-\alpha)} \times \sin(2\pi T(k-\alpha)V_c)$$

K	$h_{LP}(k)$	$h_{BP}(k)$
0	0.1009	-0.1428
1	0.1183	-0.2049
2	0.1300	0.0673
3	~~0.1300~~ 0.2083	0.4166
4	0.1300	0.0673
5	0.1183	-0.2049
6	0.1009	-0.1428

$$h(p(k)) = \frac{1}{\pi(0-3)} \times \sin(2 \times \pi(0-3) 0.0667)$$

When $K = 0$
 $h(p(k)) = 0.1009$

$$h(p(k)) = \frac{1}{\pi(1-3)} \times \sin(2 \times \pi(1-3) 0.0667)$$

When $K = 1$
 $h(p(k)) = 0.1183$

$$h(p(k)) = \frac{1}{\pi(2-3)} \times \sin(2 \times \pi(2-3) 0.0667)$$

When $K = 2$
 $h(p(k)) = 0.1300$

formula for bandpass

$$h_{BP}(k) = [2 \cos(2\pi(k - \alpha)U_0)] h_{LP}(k)$$

$$h_{BP}(k) = [2 \cos(2 \times \pi(0-3) 0.2083)] \times h_{LP}(k)$$

When $K = 0$
 $h_{BP}(k) = -0.1428$

$$h_{BP}(k) = [2 \cos(2 \times \pi(1-3) 0.2083)] \times h_{LP}(k)$$

When $K = 1$
 $h_{BP}(k) = -0.2049$

$$h_{BP}(k) = [2 \cos(2 \times \pi(2-3) 0.2083)] \times 0.1300$$

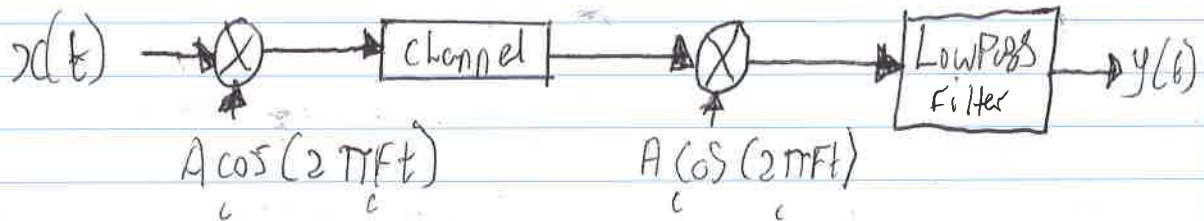
When $K = 2$
 $h_{BP}(k) = 0.0673$

②

Question 2

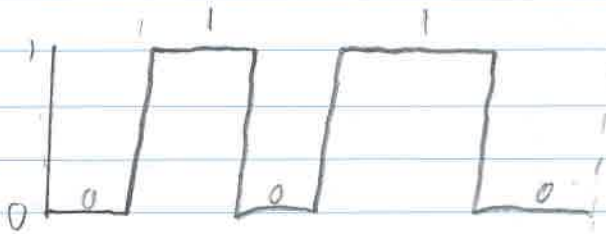
ASK Modulation and demodulation

(a)

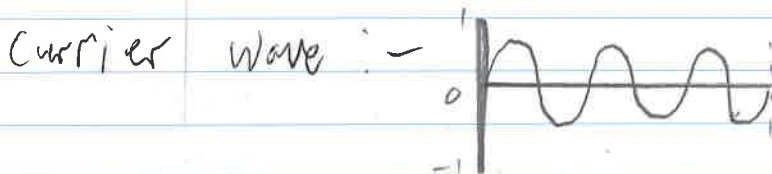


$x(t)$ is the data signal and is usually made up of binary digits (1's or 0's)

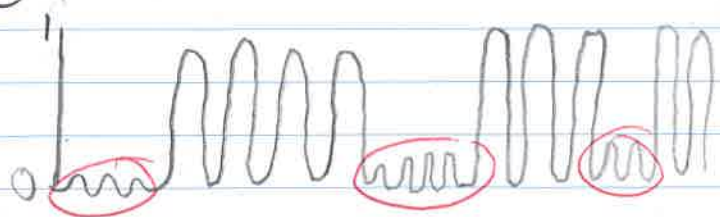
the input wave looks like this :-



then it is combined with an carrier signal the $A \cos(2\pi f_c t)$ to give an modulated signal which looks like this :-

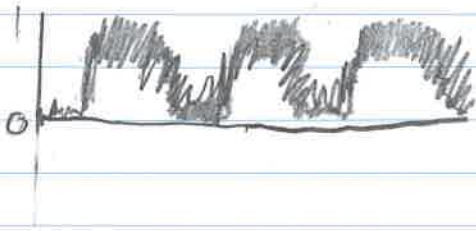


Modulated signal :-

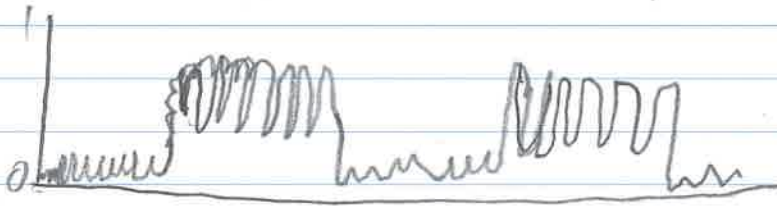


The ~~that~~ channel is used to signify the noise being injected into the ~~transmit~~ system.

The noise signal would look like this:-



Then another signal identical to the carrier wave is added to the noisy signal to add the shape back to the data and the signal will then look like:-



Finally the low pass filter will be used to take the noise out of the signal and give out the $y(t)$ which is the demodulated signal and should look like this:-

Spectral Diagram will have graph here

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