



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.**

SURNAME: R. Hill

FORENAME(S): Edward

[illegible]

1 a) 8

	Ddebechle	Gommedchle	Amir
a	0	0	0
b	2	1	2
c	2	1	2
d	3	1	3
e	2	1	2
f	3	1	3
g	3	1	3
h	2	1	2



b)

$$F = \begin{bmatrix} 1 & 0 & 1 & 1 & | & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & | & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & | & 0 & 0 & 1 \end{bmatrix}$$

$$\bar{G} = \begin{bmatrix} 1 & 0 & 0 & 0 & | & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & | & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & | & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & | & 1 & 1 & 1 \end{bmatrix}$$

$$u_1 = [0101 \quad 0 \oplus 0 \oplus 0 \oplus 1 \quad 0 \oplus 1 \oplus 0 \oplus 1 \quad 0 \oplus 1 \oplus 0 \oplus 1]$$

1 0 0

$$u_2 = [1101 \quad 1 \oplus 0 \oplus 0 \oplus 1 \quad 1 \oplus 1 \oplus 0 \oplus 1 \quad 0 \oplus 1 \oplus 0 \oplus 1]$$

0 1 0

$$u_3 = [1010 \quad 1 \oplus 0 \oplus 1 \oplus 0 \quad 1 \oplus 0 \oplus 0 \oplus 0 \quad 0 \oplus 0 \oplus 1 \oplus 0]$$

0 1 1

$$u_1 = 100$$

$$u_2 = 010$$

$$u_3 = 011$$

(10)

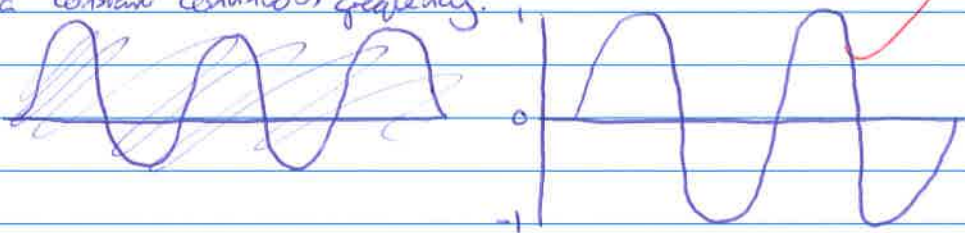
(10)

2a)

$x(t)$ is the original data carrying signal. It is a binary square wave as can be seen in the below sketch.



$A_c \cos(2\pi f_c t)$ is the mathematical equation of a sine wave. This sine wave is used as a carrier wave in the modulation of the original binary signal. It has a constant continuous frequency.



⊗ is a product block where the binary signal $x(t)$ and the carrier wave $A_c \cos(2\pi f_c t)$ are combined as part of the modulation.



Channel is a Additive White Gaussian Noise Block ~~adding~~ which adds AWGN Noise to the modulated signal.



⊗ This is another product block where another carrier wave is added to the signal to demodulate and return to the original signal.

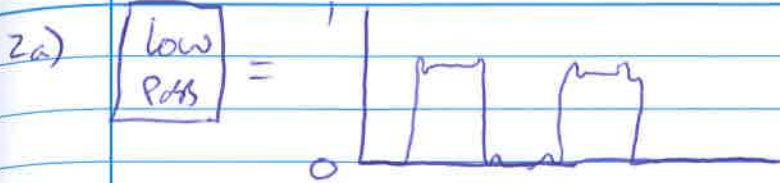
$A_c \cos(2\pi f_c t)$ is another carrier wave identical to the first.

Low Pass

is a low pass filter block to reduce noise and smooth the signal by cutting off frequencies beyond a certain cut off frequency.

A special description will be seen

6



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

$$\begin{array}{r} 11100 \\ 1101 \overline{) 10001000} \\ \underline{1101} \\ 1011 \\ \underline{1101} \\ 1100 \\ \underline{1101} \\ 0010 \\ \underline{0000} \\ 0100 \\ \underline{0000} \\ 100 \end{array}$$

checksum = 100

~~$R(x) = 1101 \overline{) 10001000}$~~

$$\begin{array}{r} \cancel{1101} \\ \cancel{1101} \overline{) 10001000} \\ \cancel{01011} \\ \cancel{0000} \\ \cancel{1000} \end{array}$$

No errors detected

$$\begin{array}{r} 11100 \\ 1101 \overline{) 10001100} \\ \underline{1101} \\ 1011 \\ \underline{1101} \\ 1101 \\ \underline{1101} \\ 0000 \\ \underline{0000} \\ 0000 \\ \underline{0000} \\ 000 \end{array}$$

4

4

2b) $M(x) = 10001$
 $G(x) = x^3 + x^2 + 1 = 1101$
 checkSum = 100

Error 3rd bit from the right.

$$\begin{array}{r}
 11100 \\
 1101 \overline{) 10001000} \\
 \underline{1101} \\
 1011 \\
 \underline{1101} \\
 1100 \\
 \underline{1101} \\
 0010 \\
 \underline{0000} \\
 0100 \\
 \underline{0000} \\
 100 \\
 \hline
 \end{array}$$

Error detected.



(4)

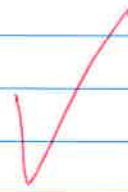
(18)

4a) $x(k) = 2, 3, 2, 1$
 $h(k) = 2, 1, 2, 3$

$$\begin{array}{cccc} & 2 & 3 & 2 & 1 \\ 2 & 3 & & & \end{array}$$

$$\begin{array}{cccc} & 2 & 3 & 2 & 1 \\ 3 & 2 & 1 & 2 & \\ & 3 & 2 & 1 & 2 \\ & & 3 & 2 & 1 & 2 \\ & & & 3 & 2 & 1 \\ & & & & 3 & 2 \\ & & & & & 3 \end{array}$$

$$\begin{aligned} y_0 &= 4 \\ y_1 &= 8 \\ y_2 &= 11 \\ y_3 &= 16 \\ y_4 &= 14 \\ y_5 &= 8 \\ y_6 &= 3 \end{aligned}$$



(4)

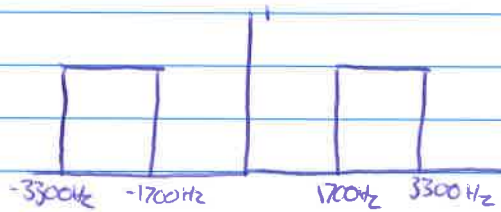
$$\begin{aligned} y_0 &= 2 \times 2 = 4 \\ y_1 &= (2 \times 3) + (2 \times 1) = 8 \\ y_2 &= (2 \times 2) + (3 \times 1) + (2 \times 2) = 11 \\ y_3 &= (2 \times 1) + (1 \times 2) + (2 \times 3) + (3 \times 2) = 16 \\ y_4 &= (1 \times 1) + (2 \times 2) + (3 \times 3) = 14 \\ y_5 &= (2 \times 1) + (3 \times 2) = 8 \\ y_6 &= 3 \times 1 = 3 \end{aligned}$$

4b) $N=7$

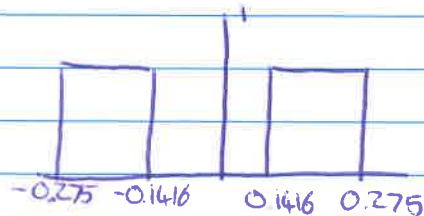
$\alpha = \frac{N-1}{2} = 3$

~~1700~~ 1700 Hz to 3300 Hz

$f_s = 12000 \text{ Hz}$



$v_c = \frac{1700 \text{ Hz}}{12000 \text{ Hz}} = 0.1416$



$v_u = \frac{3300 \text{ Hz}}{12000 \text{ Hz}} = 0.275$

$h_{bp}(k) = [2 \cos(2\pi(k-\alpha)v_u)] h_{lp}(k)$

$v_0 = \frac{v_u + v_c}{2} = \frac{0.275 + 0.1416}{2} = 0.2083$

$2v_c = v_u - v_c \therefore v_c = \frac{v_u - v_c}{2} = 0.0667$

$h_{bp}(k) = \frac{1}{\pi(k-\alpha)} \sin(2\pi(k-\alpha)v_c) = \frac{1}{\pi(k-3)} \sin(2\pi(k-3)0.0667)$

k	$h_{lp}(k)$	$h_{bp}(k)$	~~Window~~
0	0.1009	-0.1428	
1	0.1183	-0.2049	
2	0.1295	0.0671	
3	0.1334	0.2668	
4	0.1295	0.0671	
5	0.1183	-0.2049	
6	0.1009	-0.1428	

(12)

4c)

k	$h_{LP}(k)$	$h_{HP}(k)$	$w(k)$
0	0.1009	-0.1428	0.1256
1	0.1183	-0.2049	0.4376
2	0.1296	0.0671	0.8268
3	0.1334	0.2668	1
4	0.1296	0.0671	0.8268
5	0.1183	-0.2049	0.4376
6	0.1009	-0.1428	0.1256

Not Finished

2

$$w(k) = 0.54 + 0.46 \cos\left(\frac{2\pi(k-3)}{N}\right), 0 \leq k \leq 2\pi$$

18