



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.**

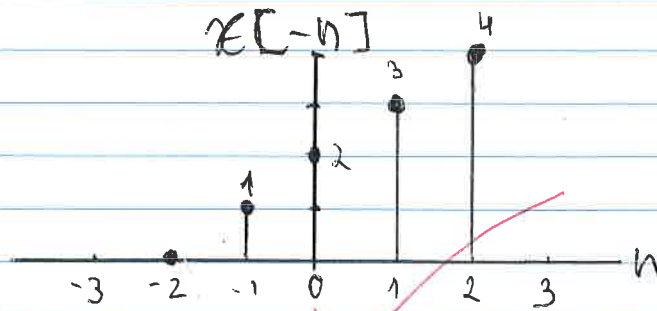
[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)

$$\frac{81}{100}$$
 Her

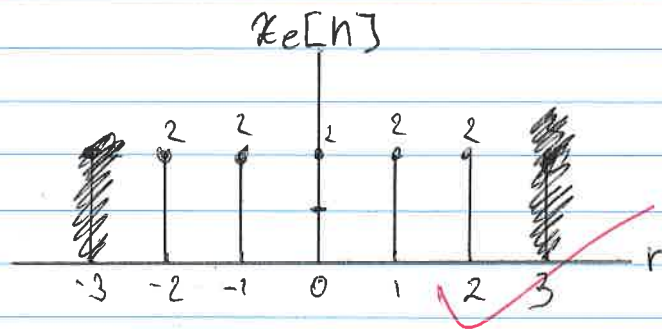
1.

a) i)



$$x_e[n] = \frac{1}{2}(x[n] + x[-n])$$

$$x_o[n] = \frac{1}{2}(x[n] - x[-n])$$



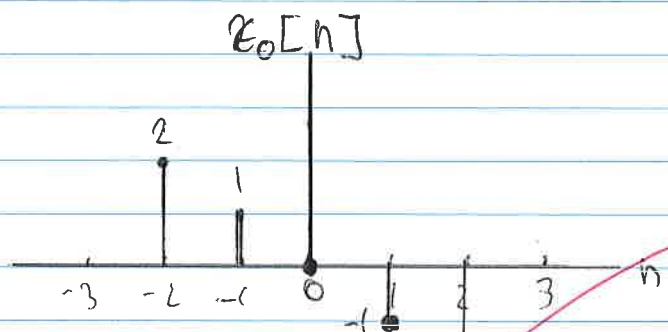
$$(4+0) \div 2 = 4 \div 2 = 2$$

$$(3+1) \div 2 = 4 \div 2 = 2$$

$$(2+2) \div 2 = 4 \div 2 = 2$$

$$(3+1) \div 2 = 4 \div 2 = 2$$

$$(4+0) \div 2 = 4 \div 2 = 2$$



$$(4-0) \div 2 = 4 \div 2 = 2$$

$$(3-1) \div 2 = 2 \div 2 = 1$$

$$(2-2) \div 2 = 0 \div 2 = 0$$

$$(3-1) \div 2 = 2 \div 2 = 1$$

$$(4-0) \div 2 = 4 \div 2 = 2$$

$$(3-1) \div 2 = 2 \div 2 = 1$$

$$(2-2) \div 2 = 0 \div 2 = 0$$

$$(1-3) \div 2 = -2 \div 2 = -1$$

$$(0-4) \div 2 = -4 \div 2 = -2$$

$$ii) x_e[n] + x_o[n] = x[n]$$

$$x_e[n] + x_o[n] = \frac{1}{2}(x[n] + x[-n]) + \frac{1}{2}(x[n] - x[-n])$$

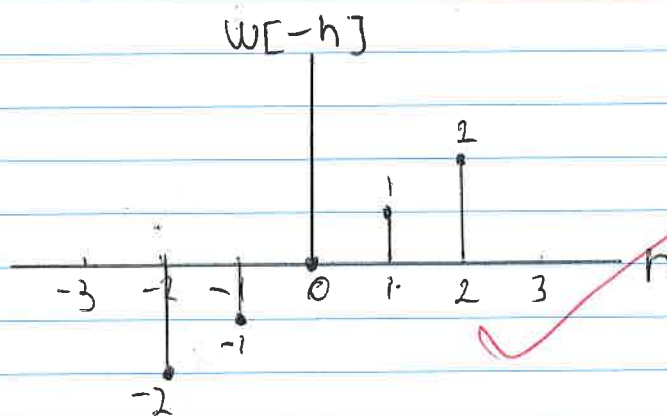
$$x_e[n] + x_o[n] = \frac{1}{2}x[n] + \frac{1}{2}\cancel{x[-n]} + \frac{1}{2}\cancel{x[n]} - \frac{1}{2}\cancel{x[-n]} = \frac{1}{2}x[n]$$

$$x_e[n] + x_o[n] = \frac{1}{2}x[n] + \frac{1}{2}x[n]$$

$$x_e[n] + x_o[n] = \frac{2}{2}x[n] \checkmark$$

$$x_e[n] + x_o[n] = x[n], \text{ hence the proof.}$$

(iii)



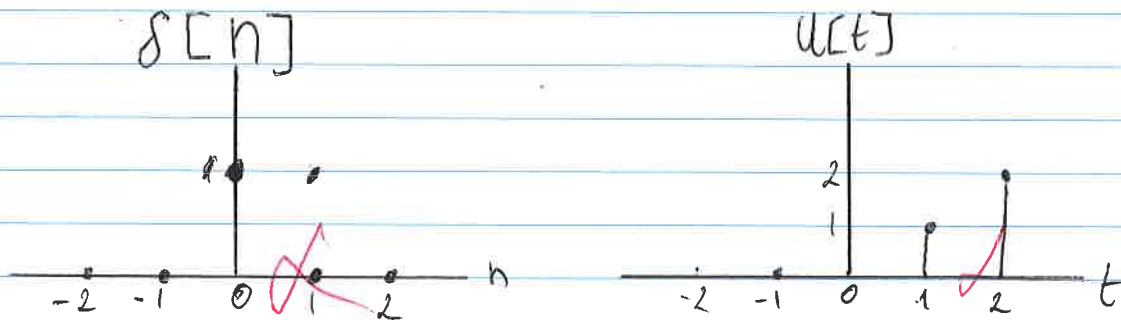
2.

a)

i) $\delta[n]$ is a discrete signal, with a unit ~~step~~ ^{triangle} function.

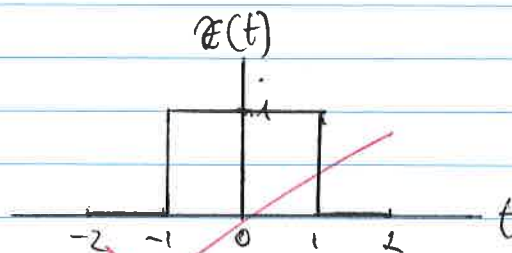
$u[t]$ is a discrete signal, with a unit ramp function.

ii)

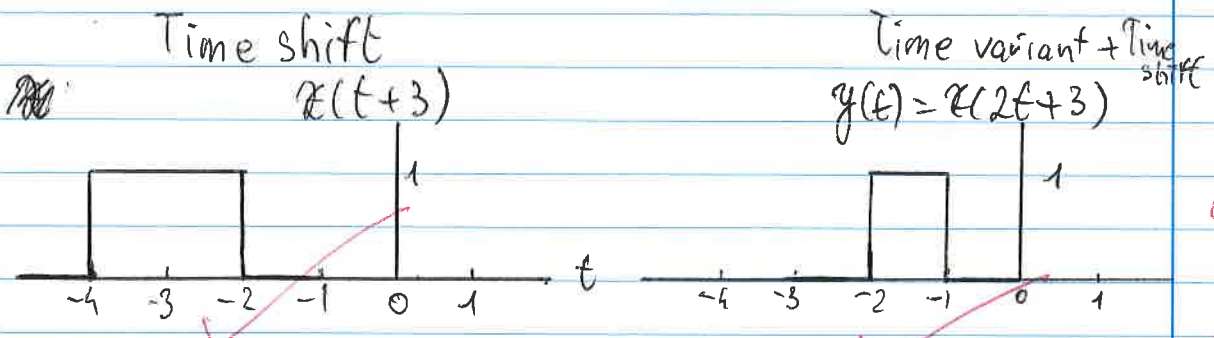


b)

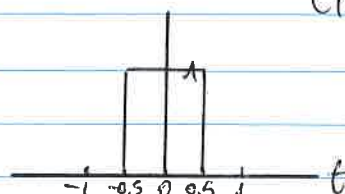
i)



ii)

 $x(2t)$

time variant



3.

a)

i) The transmission protocol is I²C (Inter-Integrated Circuits). 2

ii) The transmission method is full duplex, with multi-masters and multi-slaves. 2

iii) The transmission method is synchronous, with multiple masters and multiple slaves. The speed of the transmission is set by the control unit, usually a few MHz. 2

iv) SDA - ^{Serial} Signal data
SCL - Signal clock

Signal data carries the data to and from masters and slaves. 2

Signal clock sets the clock speed of all the operations within the circuit. 2

v) First example where this protocol might be used is IoT (Internet of things) sensors, such as temperature, humidity and motion sensors. The sensors might be talking to each other and the control unit or microcontroller within the network to give data about the environment in your home and automatically adjust settings based on pre-defined parameters. 2

Second example is consumer electronics such as a sound bar. The audio chip might be talking to the microcontroller to determine what volume sound is playing at, for example.

2 ✓

(2)

$$\frac{15}{20}$$
$$\frac{15}{20}$$

4.
a)
i)



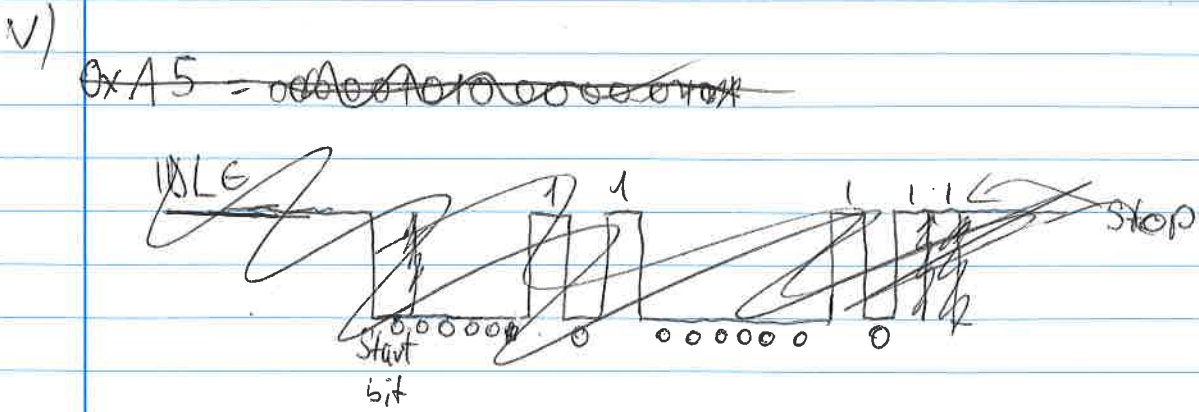
Tx = ~~Trans mission~~ Transmitter
Rx = Receiver
OV = Voltage

ii) RS232 is a serial ~~transmission~~ method.

iii) RS232 is a bidirectional serial transmission method. It is asynchronous, therefore the master and the slave must be communicating at the same clock speed in order for communication to be possible. A logic "1" is represented by voltages between +3V and +15V (typically 12V) and a logic "0" is represented by voltages between -3V and -15V (typically -12V). Typically, data is transmitted in 8 bits; ~~or 4NB~~ 2 bits for start and stop.

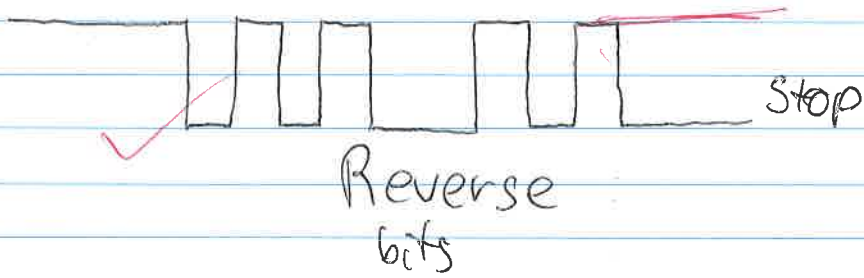
iv) First example where the protocol might be used is in an industrial setting e.g. programmable logic controllers (PLCs), communicating to Human-Machine ~~intef~~ interfaces, via the serial connection.

Second example where they might be used is barcode ~~scan~~ scanners. The scanner transmits the data back to the master.



0xA5 = 10100101

IDLE



2

3

17
20

17
20

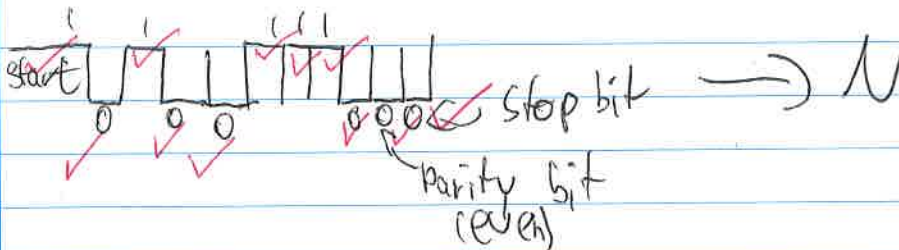
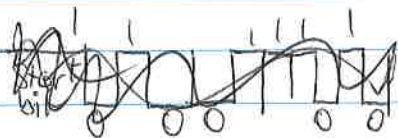
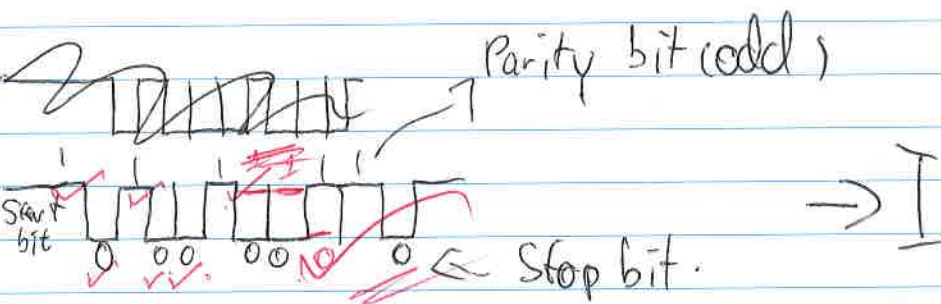
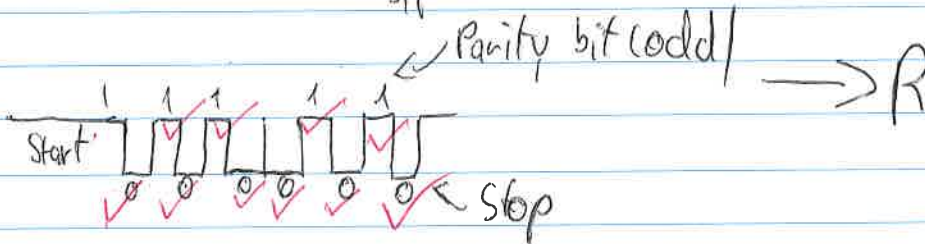
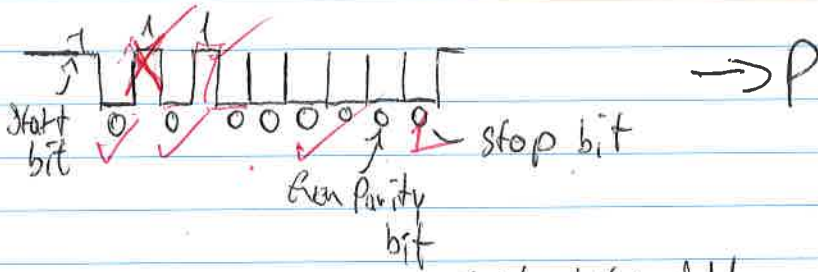
17

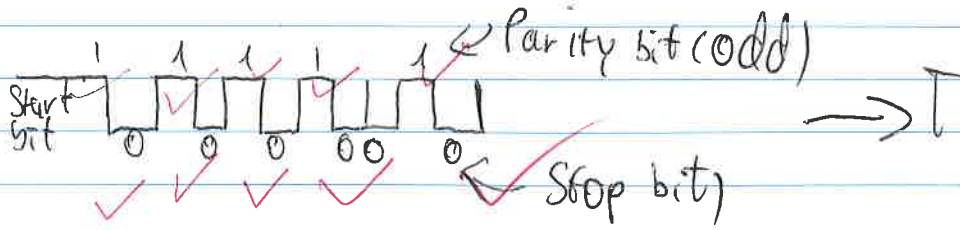
5.

a)

- i) $P = 50 \text{ (Hex)} = \cancel{0000010010000000} \quad 01010000$
 $R = 52 \text{ (Hex)} = 01010010$
 $I = 49 \text{ (Hex)} = 01001001$
 $N = 4E \text{ (Hex)} = 01001110$
 $T = 54 \text{ (Hex)} = 01010100$

ii)





2

20
20

20
20



Examiner Only

Question No.

Rhif y Cwestiwn

Arholwr yn unig