Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch

384/01

ELECTRONICS

ET4

P.M. TUESDAY, 12 June 2007

($1\frac{1}{4}$ hours)

ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number, and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

Your attention is drawn to the Information for the Use of Candidates on pages 2 and 3 of this paper.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

For Examiner's use only.	
1	
2	
3	
4	
5	
6	
7	
Total	

INFORMATION FOR THE USE OF CANDIDATES

Preferred Values for resistors
The figures shown below and their decade multiples and sub-multiples are the E24 series of preferred values.

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

RC networks	$V_C = V_O\,(1 - e^{-t/RC})$	for a charging capacitor
	$V_C = V_O\,e^{-t/RC}$	for a discharging capacitor
	$t = -RC\ 1n\left(1 - \frac{V_c}{V_o}\right)$	For a charging capacitor
	$t = -RC\ 1n\left(\frac{V_c}{V_o}\right)$	For a discharging capacitor
Alternating Voltages	$V_o = V_{rms}\sqrt{2}$	
	$X_C = \frac{1}{2\pi fC}$	Capacitive reactance
	$X_L = 2\pi fL$	Inductive reactance
	$f_0 = \frac{1}{2\pi\sqrt{LC}}$	Resonant frequency
	$f_{co} = \frac{1}{2\pi RC}$	Cut-off frequency for high pass and low pass filters
	$\phi = \tan^{-1}\frac{R}{X_C}$	Phase shift between V_R and V_c.
Silicon Diode	$V_F \approx 0{\cdot}7V$	
Bipolar Transistor	$h_{FE} = \frac{I_C}{I_B}$	Current gain
	$V_{BE} \approx 0{\cdot}7V$	in the on state
MOSFETs	$I_D = g_M V_{GS}$	

Operational amplifier

$$G = -\frac{R_F}{R_{IN}}$$ Inverting amplifier

$$G = 1 + \frac{R_F}{R_1}$$ Non-inverting amplifier

$$V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$$ Summing amplifier

$$\text{Slew Rate} = \frac{\Delta V_{OUT}}{\Delta t}$$ Slew rate

$$V_{OUT} = V_{DIFF}\left(\frac{R_F}{R_1}\right)$$ Difference amplifier

$$V_L \approx V_Z\left(1 + \frac{R_F}{R_1}\right)$$ Stabilised power supply

Power Amplifier

$$P_{MAX} = \frac{V_S^2}{8R_L}$$ where V_S is rail-to-rail voltage

555 Monostable

$$T = 1{\cdot}1\ RC$$

555 Astable

$$t_H = 0{\cdot}7\ (R_A + R_B)C$$

$$t_L = 0{\cdot}7\ R_B C$$

$$f = \frac{1 \cdot 44}{(R_A + 2R_B)C}$$

Schmitt Astable

$$f \approx \frac{1}{RC}$$

1. The following words/phrases are frequently used when discussing communication systems. Match the correct word/phrase to the descriptions in the table below: [5]

noise *attenuation* *multiplexer* *distortion* *frequency shift keying*

demultiplexer *time division multiplexing* *resonance* *frequency division multiplexing*

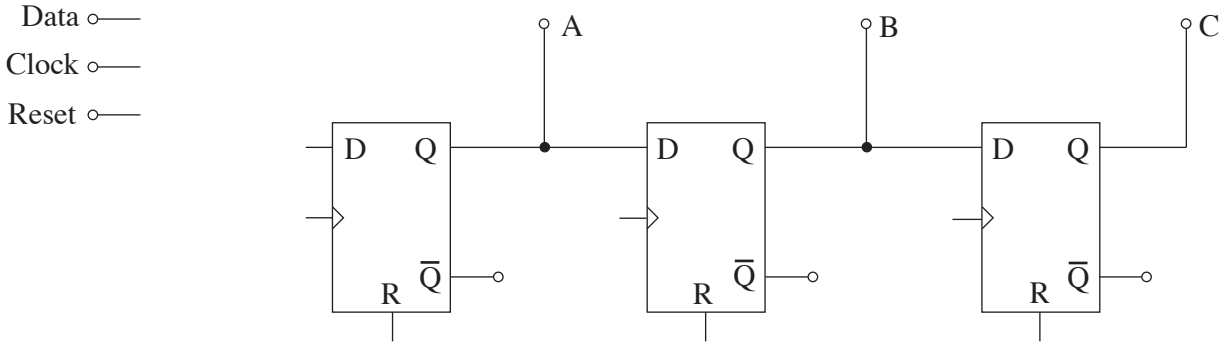
Correct word / phrase	Description
	A device for directing a number of signals into a single transmission channel.
	The amplitude of the signal decreases as it passes down a transmission line.
	Several radio stations broadcast simultaneously, but on separate frequency channels.
	The frequency of an analogue carrier is modified to indicate either a logic 1 or a logic 0 signal.
	Errors introduced into an electronic signal by the components of a circuit.

2. Most radio stations broadcast using either Amplitude Modulation (AM) or Frequency Modulation (FM).

For each statement decide whether it refers to AM or FM. [3]

Statement	AM / FM
The quality of the received signal is improved due to greater immunity to noise.	
An audio signal with base bandwidth of less than 5 kHz will produce a broadcast bandwidth of less than 10 kHz.	
Needs a broadcast bandwidth of at least 200 kHz to transmit the full audio frequency range.	

3. The diagram shows 3 D-Type flip-flops that are *rising-edge triggered*.

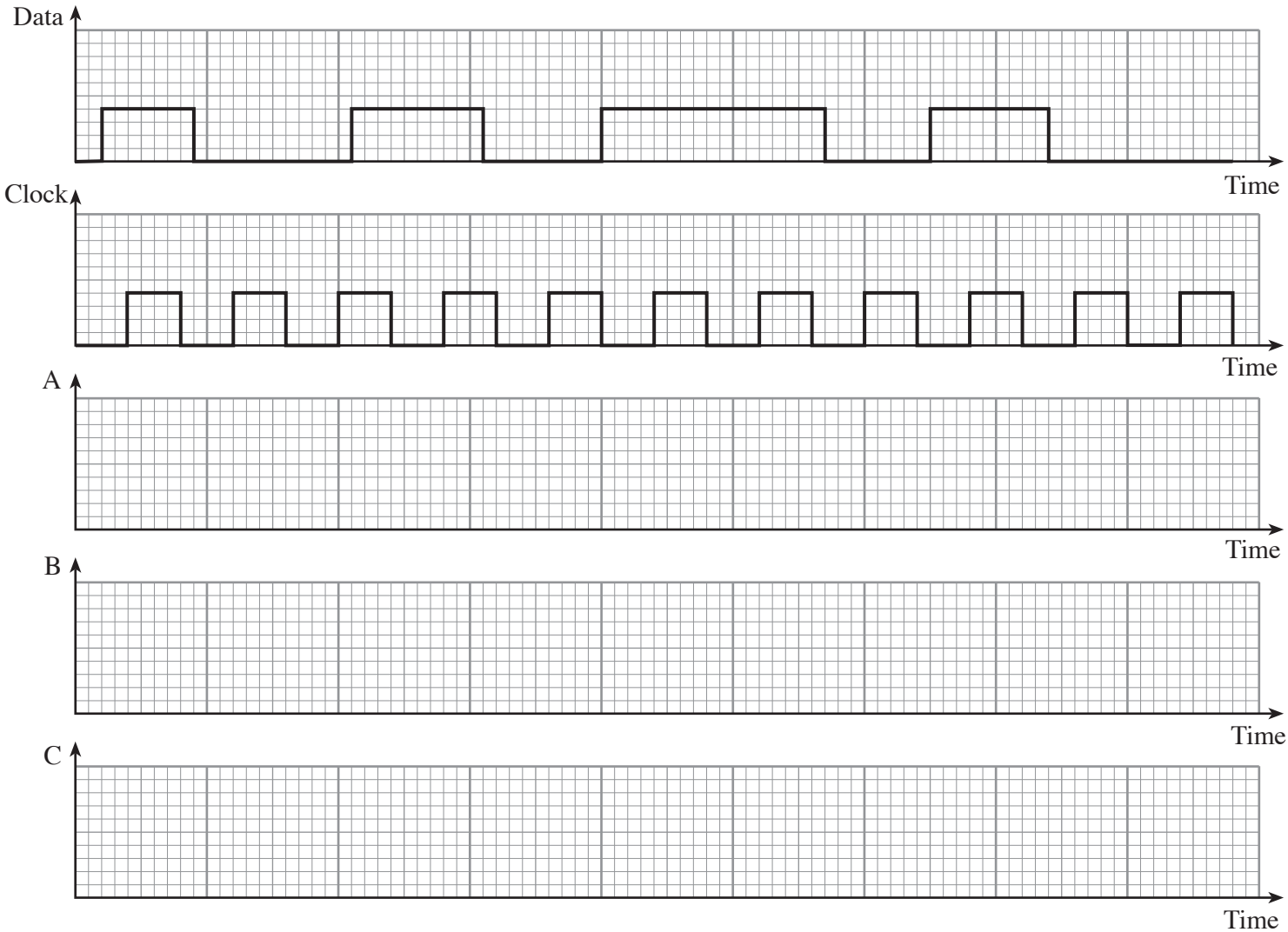


(a) Complete the diagram to show how these are connected to make a 3-bit Serial-In-Parallel-Out (SIPO) shift register, with a reset facility. [4]

(b) Initially all three flip-flops are reset.

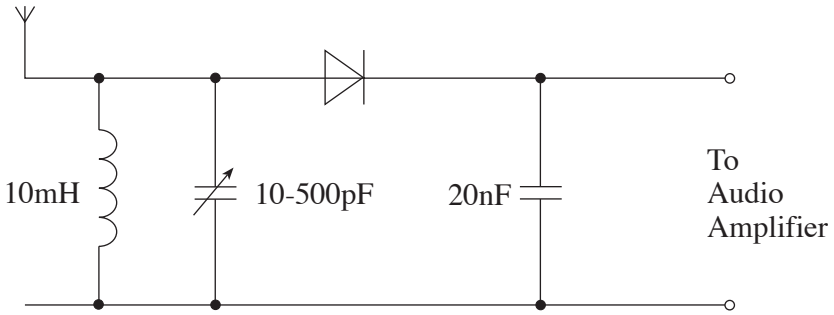
The first two graphs show the signal applied to the data input and clock input.

Use the axes provided to show the corresponding signals at the outputs A, B, and C.



[3]

4. The following shows the circuit diagram for a simple radio receiver.



(a) Explain the purpose of the following components in this receiver.

(i) The inductor and variable capacitor.

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[1]

(ii) The diode.

.....

.....

.....

[1]

(iii) The fixed capacitor.

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.....

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[1]

(b) Calculate the highest carrier frequency that the receiver can select. Give the unit.

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.....

.....

.....

[3]

(c) This simple radio has two major disadvantages in terms of its *sensitivity* and *selectivity*. What is meant by the terms *selectivity* and *sensitivity*?

Sensitivity .....

.....

.....

Selectivity .....

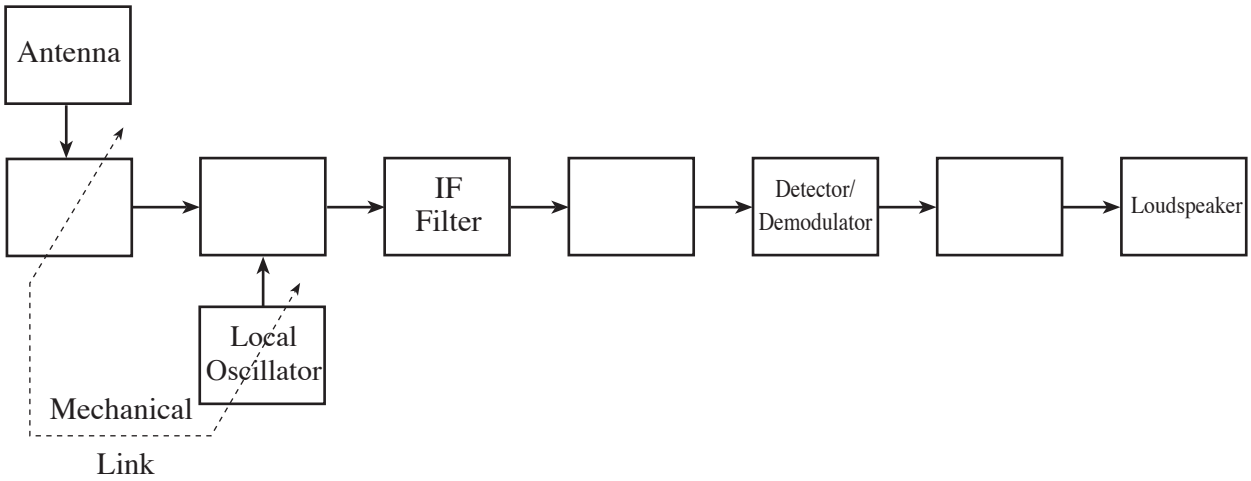
.....

.....

[2]

(d) The superheterodyne receiver overcomes the disadvantages of the simple radio.

Complete the block diagram of the superheterodyne receiver.



[4]

5. *(a)* A computer network uses the RS232 protocol to transmit information through a serial link. The ASCII code is an international code for transmitting keyboard characters. Each character is transmitted as a 10-bit binary numbers, made up of the 7-bit ASCII code, one parity bit, one start bit and one stop bit.

The table below shows the ASCII code for five characters and the corresponding parity bit.

Character	ASCII Code	Parity bit
A	1000001	1
K	1001011	0
P	1010000	1
d	1100100	0
o	1101111	1

(i) Which character has a parity bit that is incorrect for a system that uses **odd** parity?

..... [1]

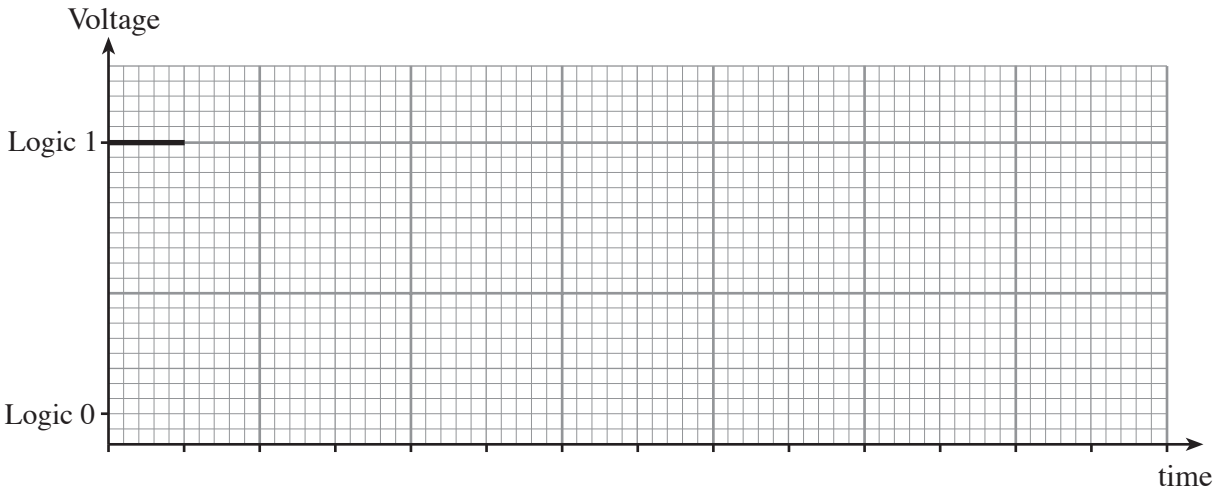
(ii) What is the purpose of the parity bit ?

.....

.....

[1]

(iii) Complete the timing diagram to show the waveform of the 10-bit signal corresponding to the letter '**d**'. The communication link is in standby initially.
Label the start, stop and parity bits.



[4]

(b) The internet currently uses a 32 bit binary address to identify each website. The following binary number is an example of one such address.

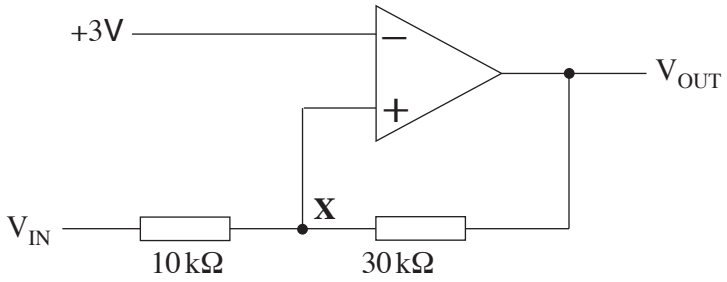
01101010 10101000 00100100 10010011

A shorthand way of writing this binary number is to use *dotted decimal notation*. Convert the binary number given above into *dotted decimal notation*.

....

[2]

6. The following circuit diagram shows an op-amp connected as a Schmitt trigger. The op-amp saturates at +12 V and 0 V.



(a) Is this an *inverting* Schmitt trigger or *non-inverting* Schmitt trigger ? [1]

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(b) Calculate the voltage at X when V_{IN} = +7 V and V_{OUT} = +12 V.

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[2]

(c) Calculate the value of V_{IN} that causes V_{OUT} to change from 0 V to 12 V.

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[2]

(d) Calculate the value of V_{IN} that causes V_{OUT} to change from 12 V to 0 V.

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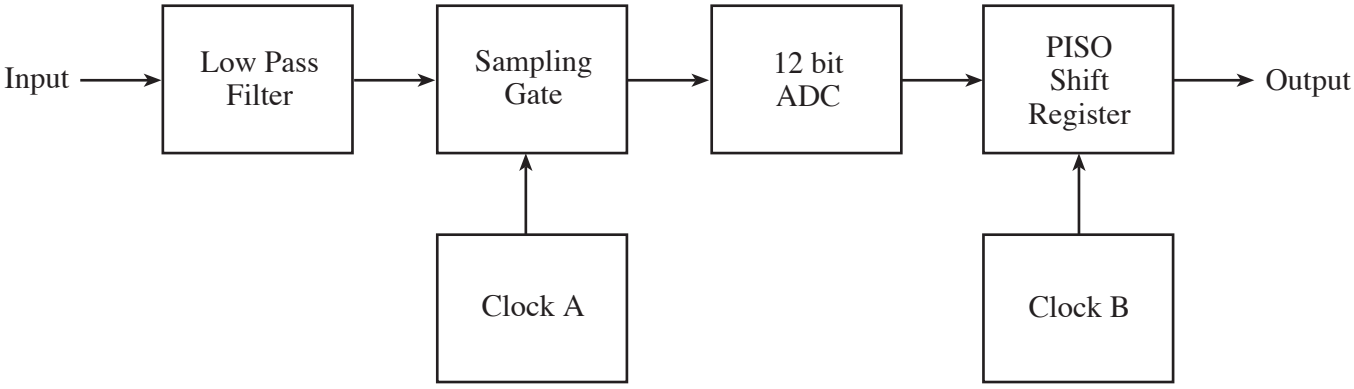
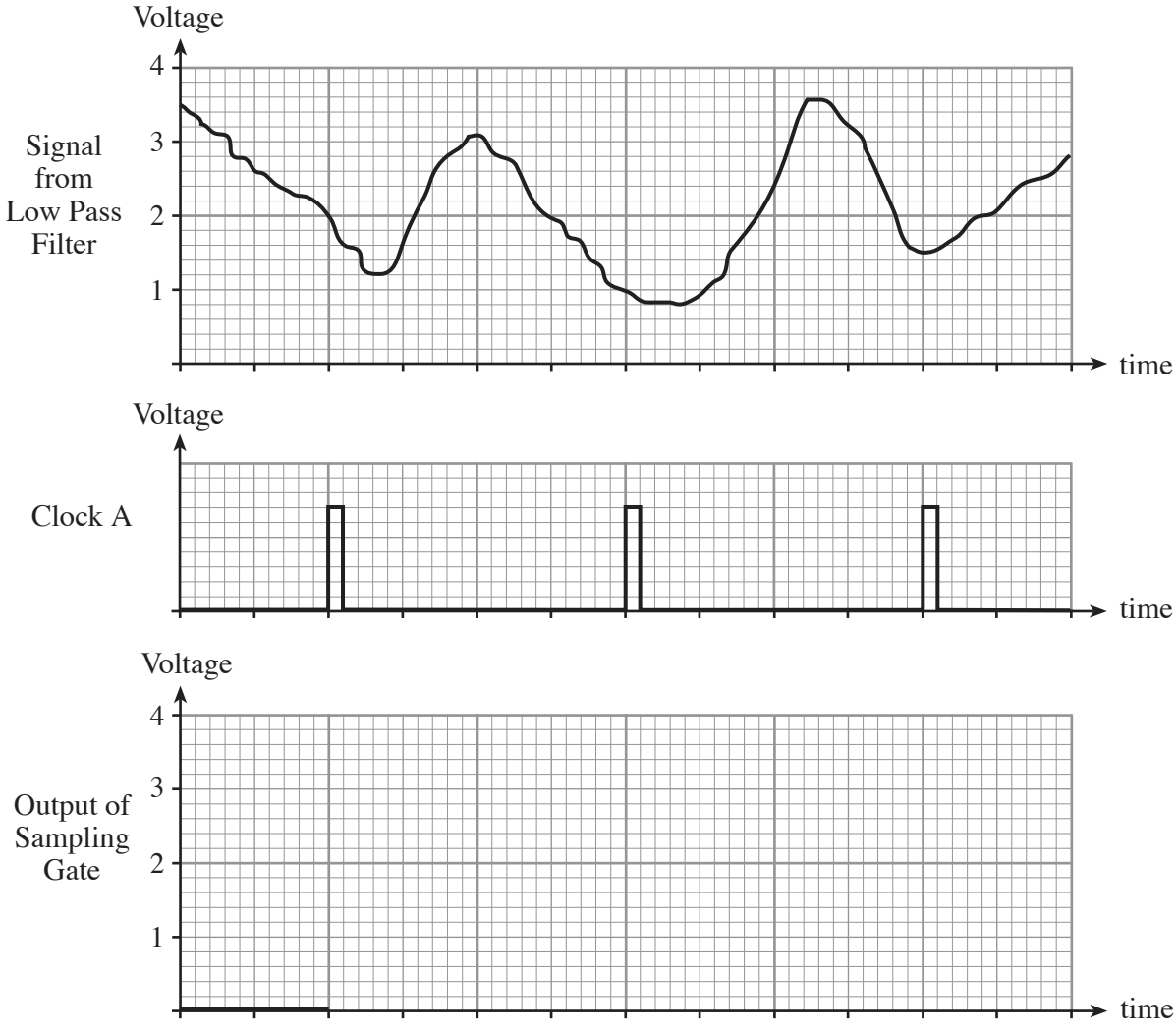
[2]

7. The following block diagram shows a *Pulse Code Modulation* (PCM) Transmitter.



(a) The output of the *Low Pass Filter* and the output of *Clock A* are shown below. Complete the graph to show the output of the *Sampling Gate*.



[3]

(b) The signal from the Low Pass Filter contains frequencies in the range 100 Hz - 4 kHz.

(i) What is the relationship between the input signal frequency range and the minimum sampling frequency required to allow the signal from the low pass filter to be reconstructed at the receiver ?

.....

[1]

(ii) Hence, what is the minimum frequency that can be used for Clock A in this transmitter.

.....

[1]

(c) Clock B must operate at a higher frequency than Clock A for the system to work properly. Explain why this is the case. [1]

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(d) The 12-bit *Analogue to Digital Converter* (ADC) has an input voltage range of 0 to 6 V.

(i) How many sampling (voltage) levels are provided by the ADC? [1]

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.....

(ii) What is the quantisation error (step size) of the system? [1]

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