Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1144/01

S16-1144-01

ELECTRONICS – ET4

A.M. TUESDAY, 14 June 2016

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**3**	
2.	**4**	
3.	**5**	
4.	**6**	
5.	**6**	
6.	**7**	
7.	**11**	
8.	**8**	
Total	**50**	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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 total number of marks available for this paper is 50.

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.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

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.

Standard Multipliers:

Prefix	Multiplier
T	$\times 10^{12}$
G	$\times 10^{9}$
M	$\times 10^{6}$
k	$\times 10^{3}$

Prefix	Multiplier
m	$\times 10^{-3}$
μ	$\times 10^{-6}$
n	$\times 10^{-9}$
p	$\times 10^{-12}$

Filters

$f_b = \dfrac{1}{2\pi RC}$ — Break frequency for high pass and low pass filters

$X_C = \dfrac{1}{2\pi fC}$ — Capacitive reactance

$X_L = 2\pi fL$ — Inductive reactance

$Z = \sqrt{R^2 + X_C^2}$ — For a series RC circuit

$f_0 = \dfrac{1}{2\pi\sqrt{LC}}$ — Resonant frequency

$R_D = \dfrac{L}{r_L C}$ — Dynamic resistance

$Q = \dfrac{2\pi f_0 L}{r_L}$

$Q = \dfrac{f_0}{B}$

Modulation

$m = \dfrac{(V_{max} - V_{min})}{(V_{max} + V_{min})} \times 100\%$ — Depth of modulation

$\beta = \dfrac{\Delta f_c}{f_i}$ — Modulation index

resolution $= \dfrac{\text{i/p voltage range}}{2^n}$ — PCM

Bandwidth $= 2(\Delta f_c + f_i)$

Bandwidth $= 2(1+\beta)f_i$

} Transmitted FM Bandwidth

Radio receivers

$C = \dfrac{1}{4\pi^2 f_0^{\,2} L}$

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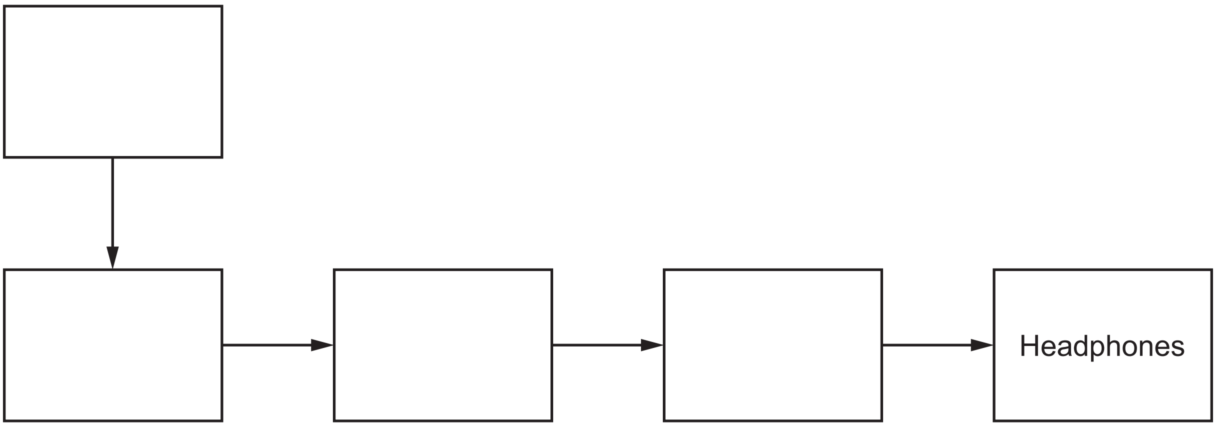
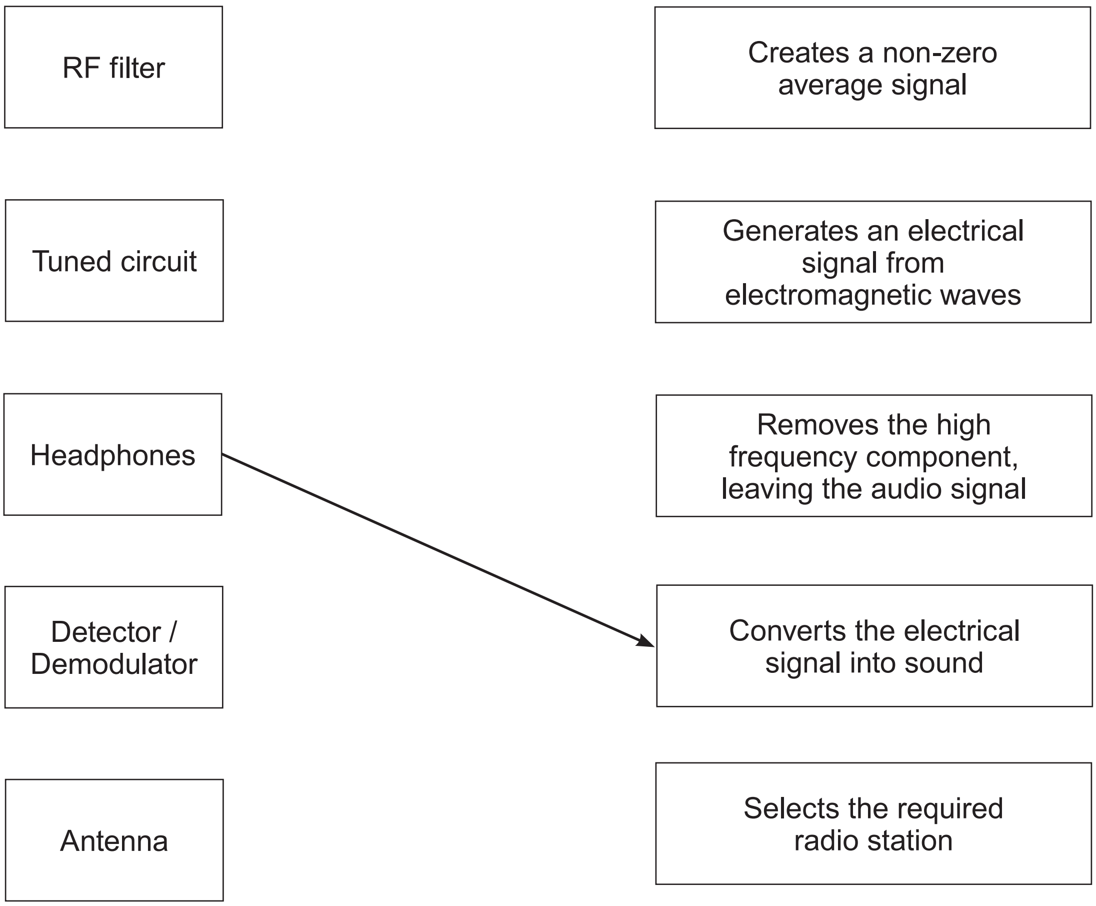
Answer **all** *questions.*

1. *(a)* Complete the following block diagram for the simple radio receiver, using the functional blocks in the list below. [1]

RF filter Tuned circuit Detector/Demodulator Antenna



(b) Match each part of the simple radio receiver with its function. One has been done for you. [2]



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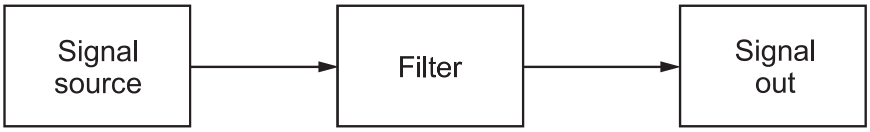
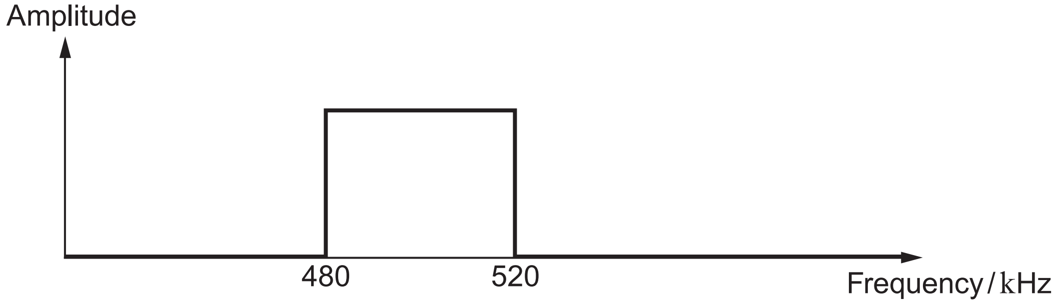
2. An engineer investigated the behaviour of a filter in response to different input signals. A block diagram of the test system is shown below.



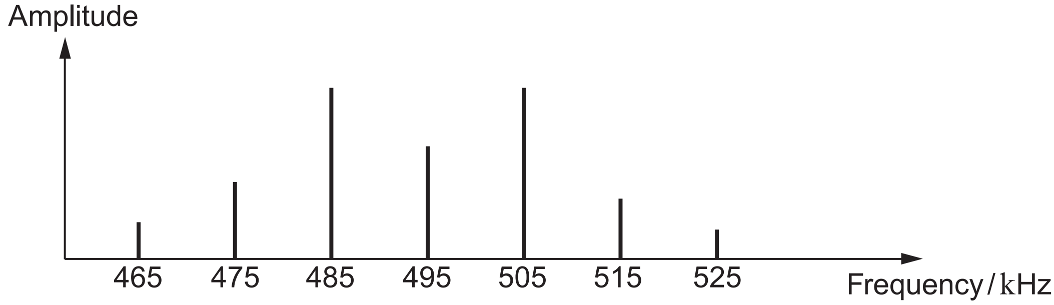
The frequency response of the filter is shown in the following graph.



(a) What is the name of the type of filter which has this frequency response? [1]

....

(b) A Frequency Modulated signal having the following frequency spectrum is connected to the input of the filter.



Sketch the frequency spectrum of the filter output, labelling all relevant frequencies. [1]

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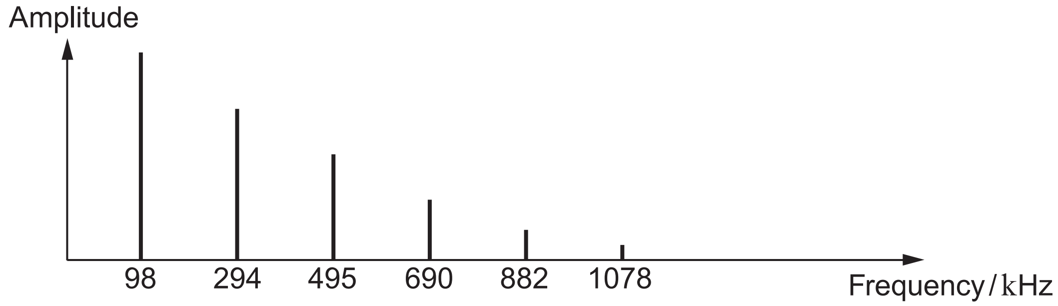
(c) A square wave signal having the following frequency spectrum is connected to the input of the filter.



Sketch the frequency spectrum of the filter output, labelling all relevant frequencies. [1]

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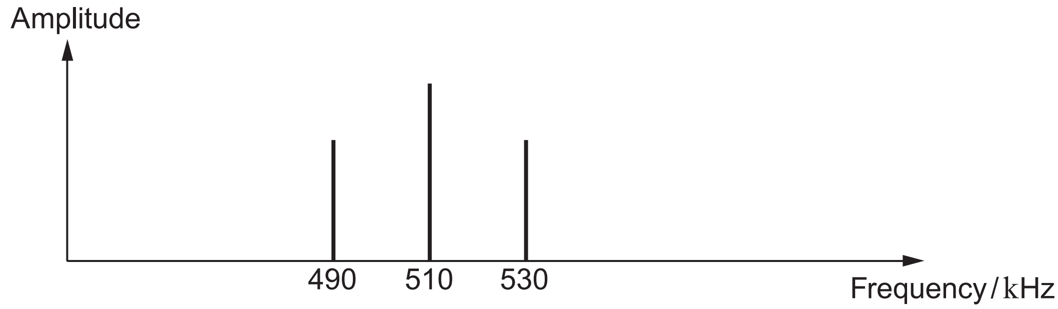
(d) An Amplitude Modulated signal having the following frequency spectrum is connected to the input of the filter.



Sketch the frequency spectrum of the filter output, labelling all relevant frequencies. [1]

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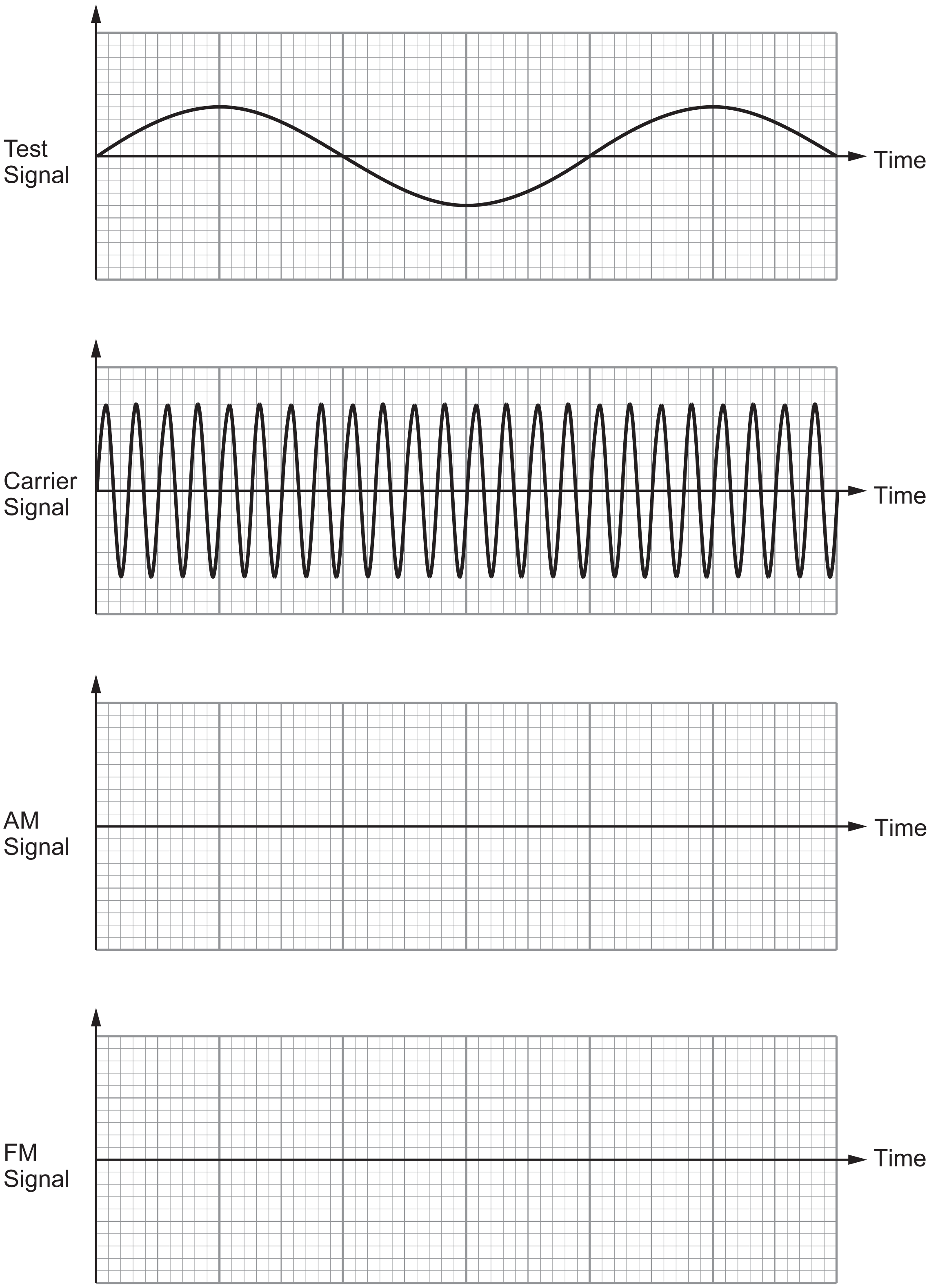
3. *(a)* Two modulation techniques used for radio communication are Amplitude Modulation and Frequency Modulation.

The test signal below is used to modulate the carrier signal using these modulation techniques. Use the axes provided to sketch the output of the modulation process in each case. [2]



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(b) A 260 MHz carrier is frequency modulated by an audio signal in the range 100 Hz to 20 kHz. The frequency deviation is 80 kHz. Calculate:

(i) the modulation index; [1]

....

....

(ii) the bandwidth of the resulting FM waveform. [2]

....

....

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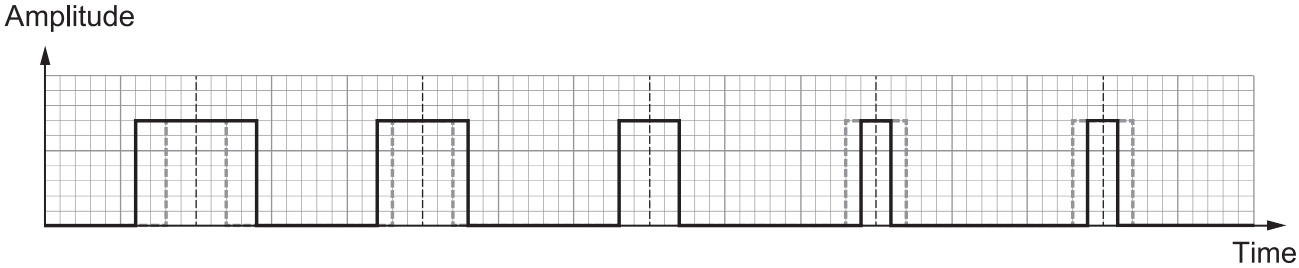
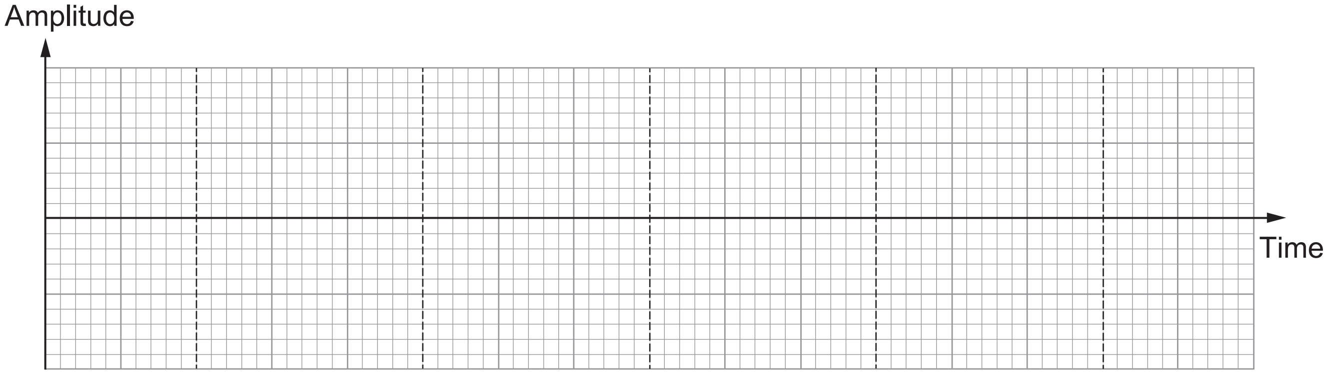
4. The following graphs show different ways in which Pulse Modulation can be used in a communication system. For each case:

(i) state which method is being used, either PPM, PWM or PAM;
(ii) sketch the original modulating signal.

(a) (i) Type of Pulse Modulation used .... [1]



(ii) Sketch the modulating signal below. The unmodulated signal is shown as a dashed line. [2]



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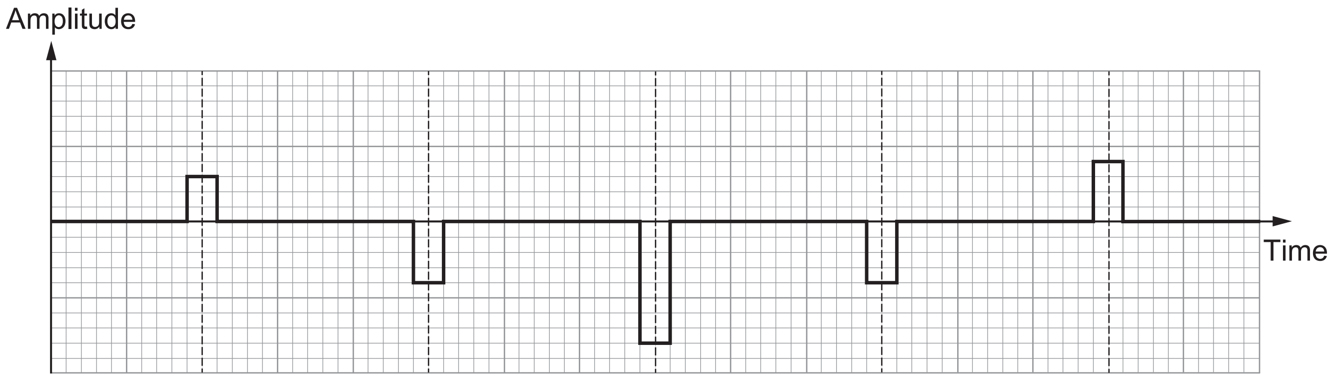
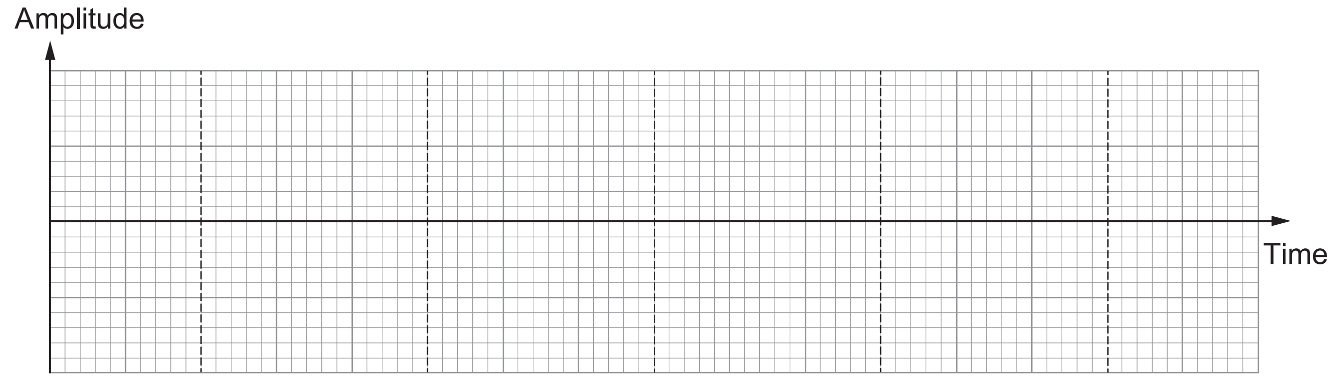
(b) (i) Type of Pulse Modulation used .... [1]



(ii) Sketch the modulating signal below. [2]



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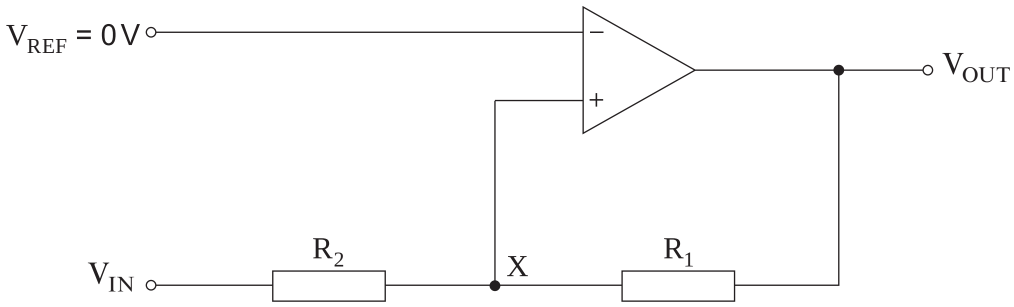
5. A non-inverting Schmitt trigger has saturation values of ± 11 V, and switching thresholds of ± 4 V.



(a) Why are the switching thresholds for this circuit symmetrical? [1]

....

....

(b) Determine the values of R_1 and R_2. [3]

....

....

....

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....

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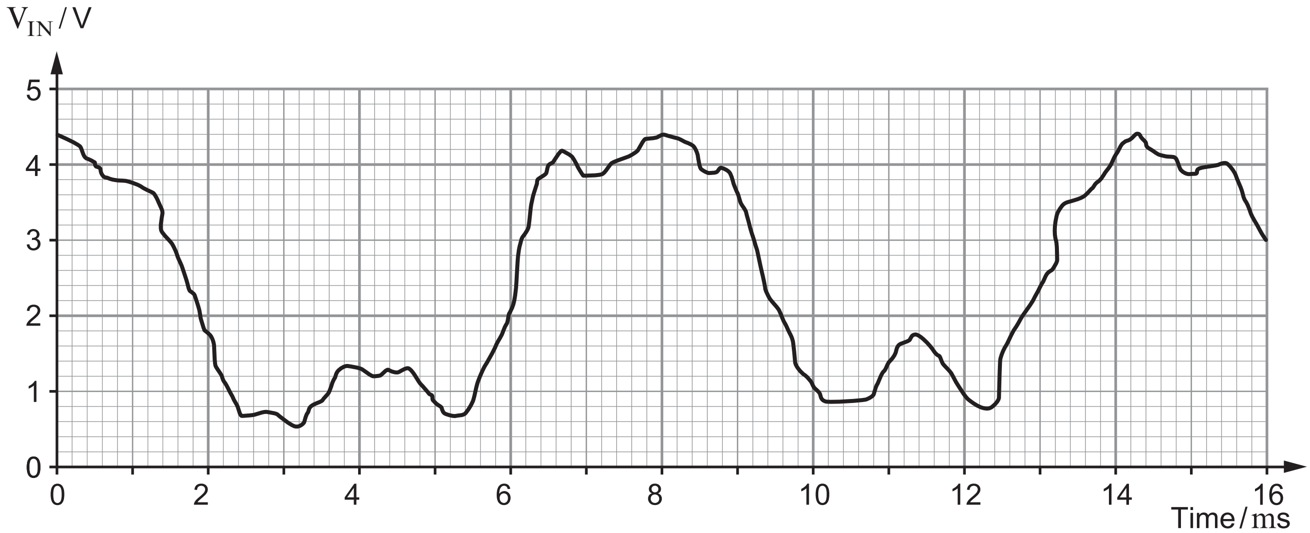
....

....

R_1 = ... R_2 = ...

Examiner only

(c) Suggest the input threshold voltages for a different Schmitt trigger that would allow the regeneration of the original digital signal from the noisy signal shown below. [2]



Lower switching threshold ....

Upper switching threshold ....

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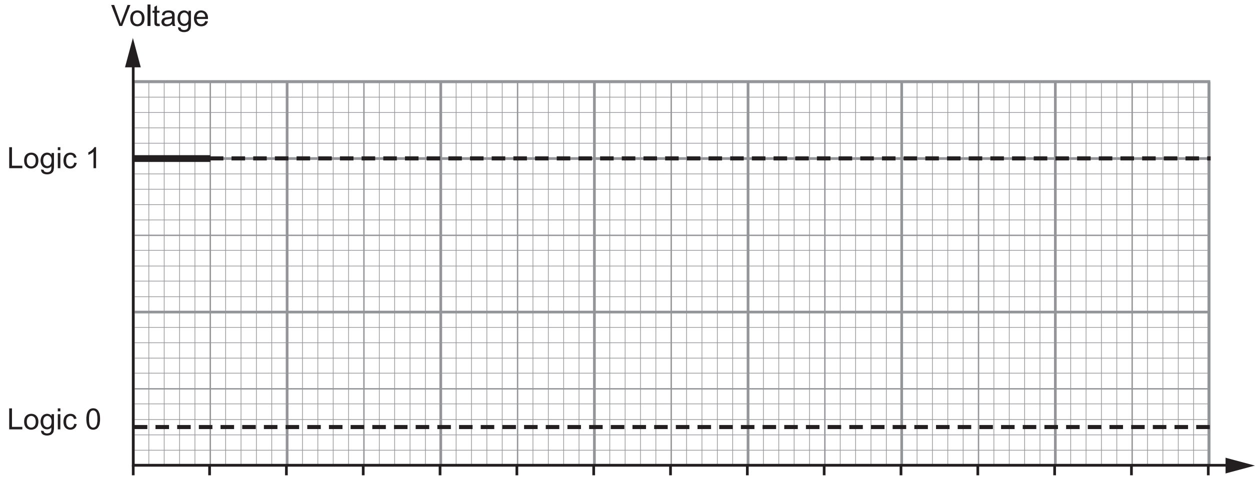
6. *(a)* A computer system uses **odd** parity. Start, stop and parity bits have to be added before a signal can be transmitted.
The computer system transmits the character ‘Y’. The ASCII code for the character ‘Y’ is 1011001.

(i) What is the logic state of the parity bit? .... [1]

(ii) Complete the graph to show the transmitted signal for the character ‘Y’. Label the start, stop and parity bits. [3]



(b) An improved transmission system uses a four bit parity system. The parity bits are assigned to the data bits in accordance with the following table. The transmission system uses **odd** parity.

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_3	P_2	P_1	P_0
				x	x	x	x				x
x	x	x	x							x	
		x	x			x	x		x		
	x	x			x	x		x			

(i) The data in the table below is transmitted along a transmission line. Complete the table showing the values of the parity bits $P_3 – P_0$. [1]

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_3	P_2	P_1	P_0
1	0	0	0	1	1	0	1				

Examiner only

(ii) In a second transmission the following data and parity bits are received from a distant source.

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_3	P_2	P_1	P_0
1	1	1	1	0	1	0	0	1	0	1	1

There is a **single** error in the received transmission. Determine where the error is located and therefore write down the correct version of the received data. [1]

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_3	P_2	P_1	P_0

(iii) In a third transmission the following data and parity bits are received from a distant source.

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_3	P_2	P_1	P_0
1	0	1	1	1	1	0	0	1	1	1	1

There is still only a **single** error in the received transmission. Explain why it is not possible to reconstruct the correct version of the received data. [1]

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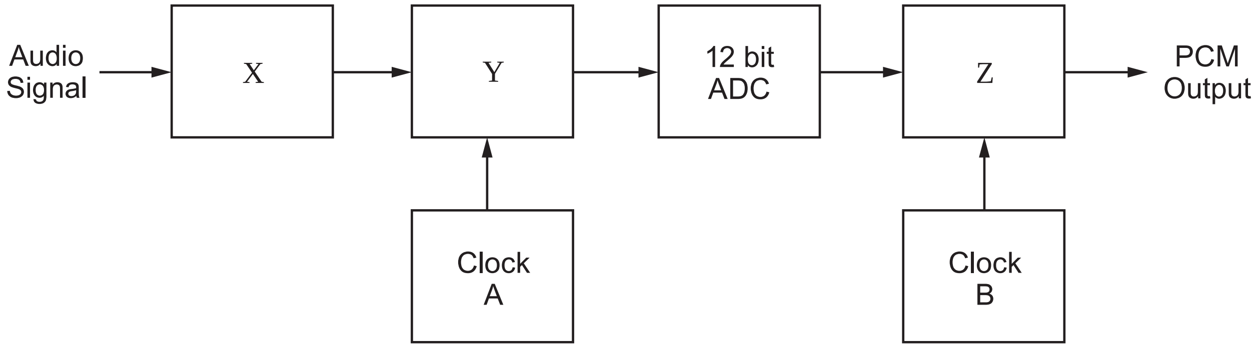
7. The block diagram shows a Pulse Code Modulation **transmitter**.



(a) Identify the blocks labelled X, Y and Z.

(i) Block X = ... [1]

(ii) Block Y = ... [1]

(iii) Block Z = ... [1]

(b) (i) How many sampling levels are available using a 12-bit code? [1]

....

(ii) What is the minimum input voltage range required for the ADC to achieve a resolution of at least 2 mV? [1]

....

....

(iii) The audio signal contains frequencies in the range 150 Hz to 19.5 kHz.
For each of clocks A and B, state the minimum frequency and explain why you have selected that particular frequency.

I. Clock A frequency .... [2]

Explanation

....

....

....

....

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II. Clock B frequency .... [2]

Explanation

....

....

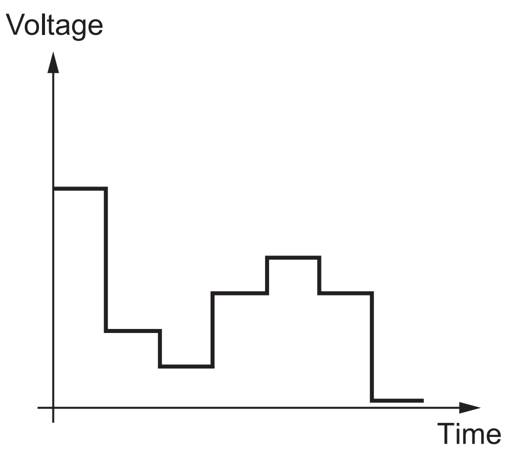
....

....

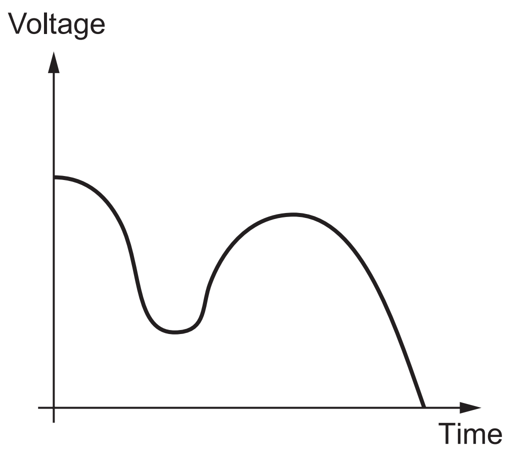
(c) The **receiver** of a **different** Pulse Code Modulation system is constructed from the following sub-systems:

- 2 MHz clock
- Schmitt trigger
- Low pass filter
- SIPO shift register
- Digital to Analogue Converter (DAC).

The following graphs show the output of two sub-systems in the PCM receiver.



Graph A



Graph B

(i) What is the name of the sub-system that has the form of output shown by Graph **A**? [1]

....

(ii) What is the name of the sub-system that has the form of output shown by Graph **B**? [1]

....

TURN OVER FOR THE LAST QUESTION

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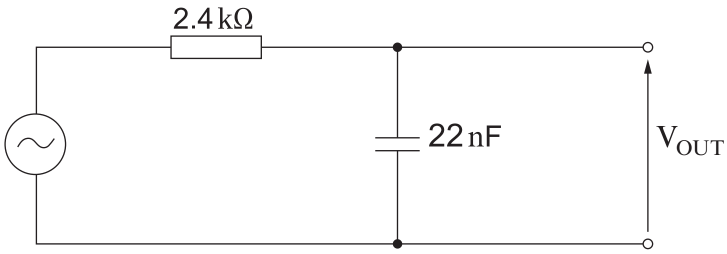
8. The following circuit is used as a filter.



(a) What is the name of this type of passive RC filter? .... [1]

(b) Calculate the reactance of the capacitor at 50 Hz. [2]

....

....

....

(c) What is the reactance of the capacitor at 50 kHz? [1]

....

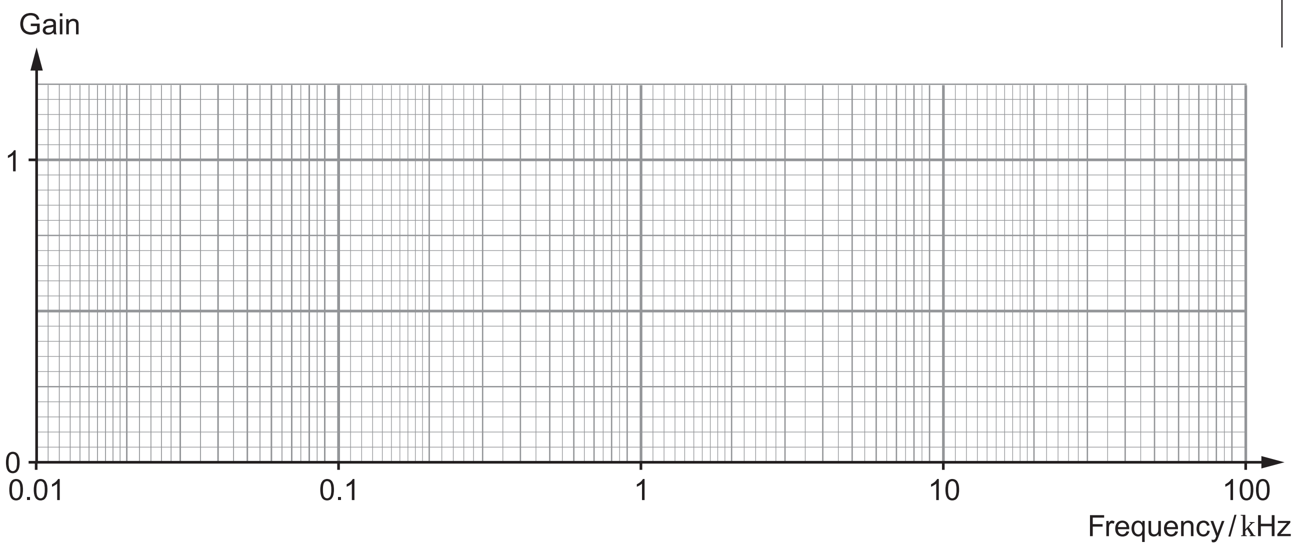
(d) Calculate the break frequency for this filter. [2]

....

....

....

(e) Sketch the frequency response of this filter. [2]



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