Surname	Centre Number	Candidate Number
Other Names		2

GCE A Level – LEGACY

1144/01

S19-1144-01

ELECTRONICS – ET4

WEDNESDAY, 5 JUNE 2019 – AFTERNOON

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**3**	
2.	**3**	
3.	**9**	
4.	**8**	
5.	**8**	
6.	**5**	
7.	**14**	
Total	**50**	

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ADDITIONAL MATERIALS

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

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

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

$$X_L = 2\pi fL$$ Inductive reactance

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

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

$$R_D = \frac{L}{r_L C}$$ Dynamic resistance

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

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

Modulation

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

$$\beta = \frac{\Delta f_c}{f_i}$$ Modulation index

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

$$\text{Bandwidth} = 2(\Delta f_c + f_i)$$

$$\text{Bandwidth} = 2(1+\beta)f_i$$

} Transmitted FM Bandwidth

Radio receivers

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

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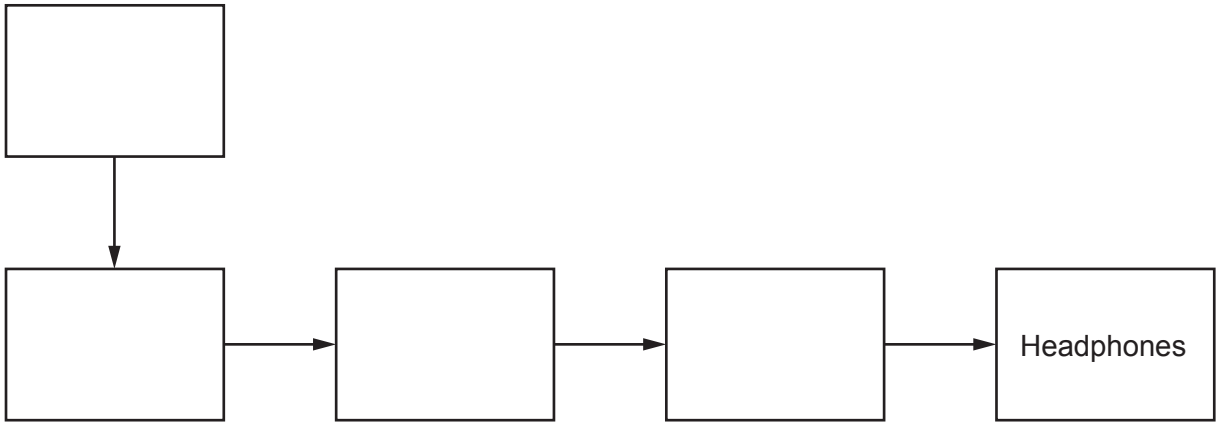
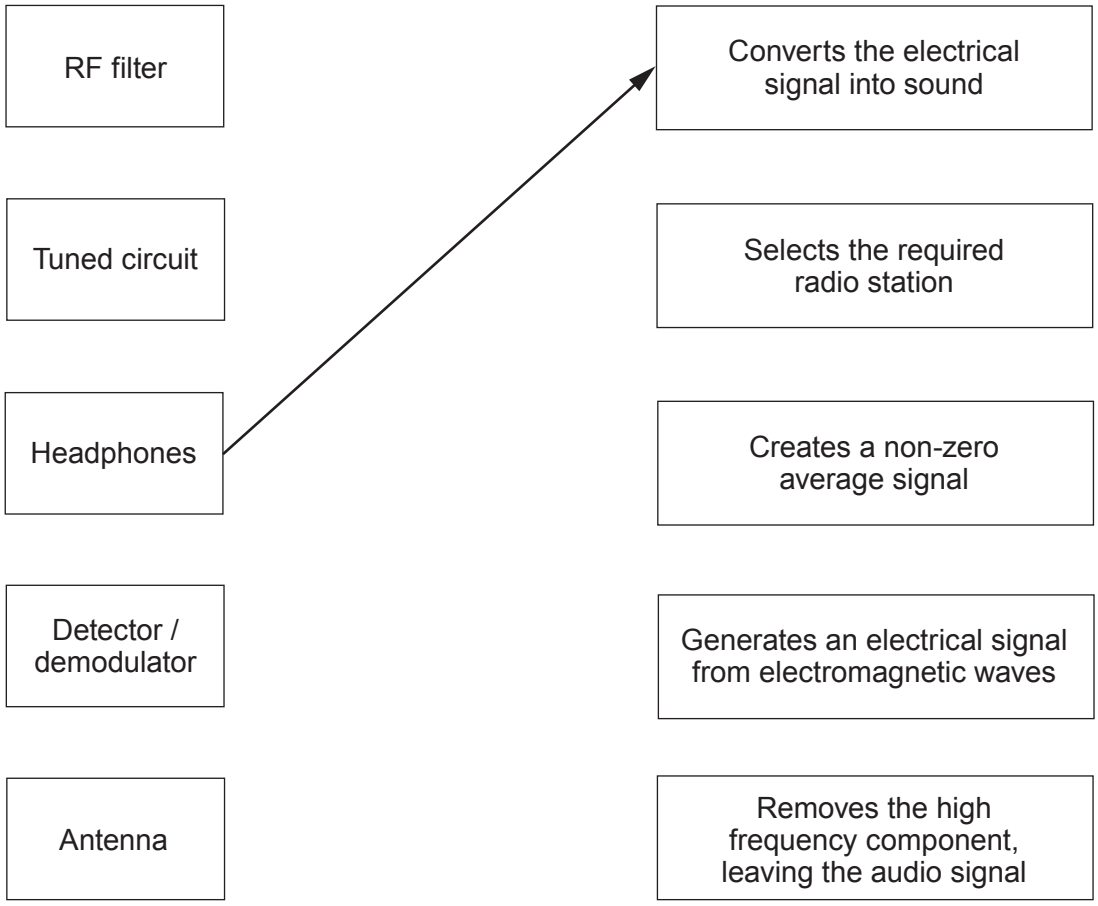
Answer **all** *questions.*

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 the part of the simple radio receiver with its function. One has been done for you. [2]



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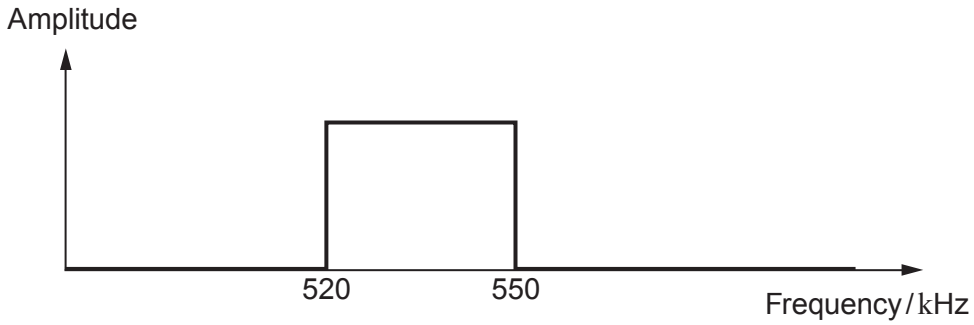
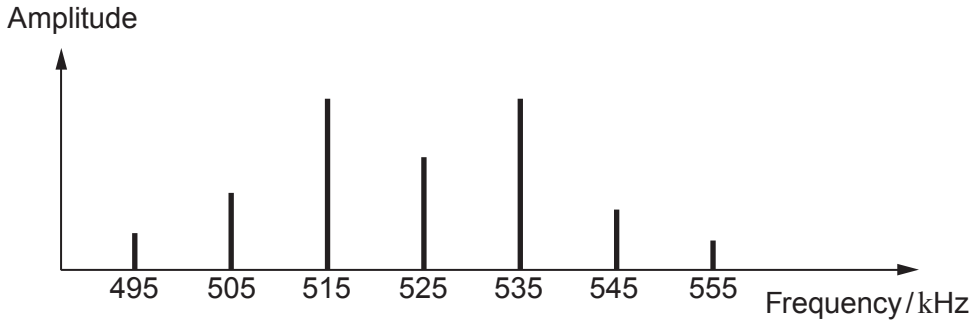
2. An engineer investigated the behaviour of a filter in response to different input signals. A block diagram of the test system is shown below.

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



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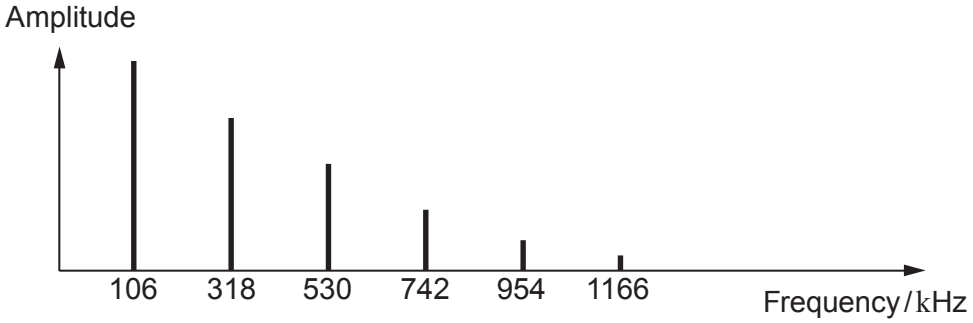
(b) A square wave signal having the following frequency spectrum is connected to the input of the filter.



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

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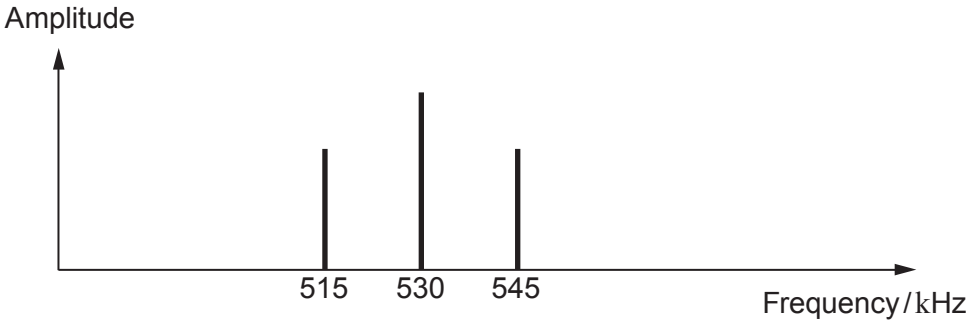
(c) An Amplitude Modulated signal having the following frequency spectrum is connected to the input of the filter.



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

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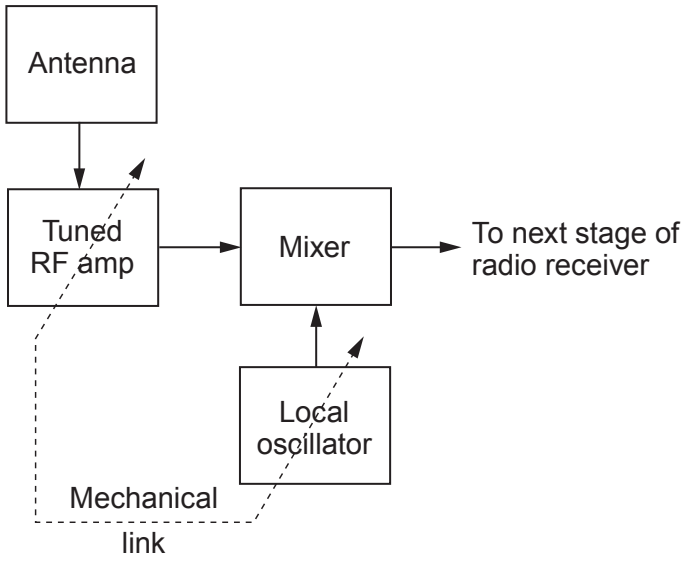
3. *(a)* The superheterodyne radio receiver offers considerable improvement compared to the simple radio receiver. **Part** of the superheterodyne receiver is shown below:



(i) The tuned RF amplifier has been tuned to a frequency of 1.680 MHz. The local oscillator output is measured at 2.140 MHz. What **four** frequency signals will be present at the output of the mixer? [2]

1. .....

2. .....

3. .....

4. .....

(ii) Which of these frequencies is the intermediate frequency of the receiver? [1]

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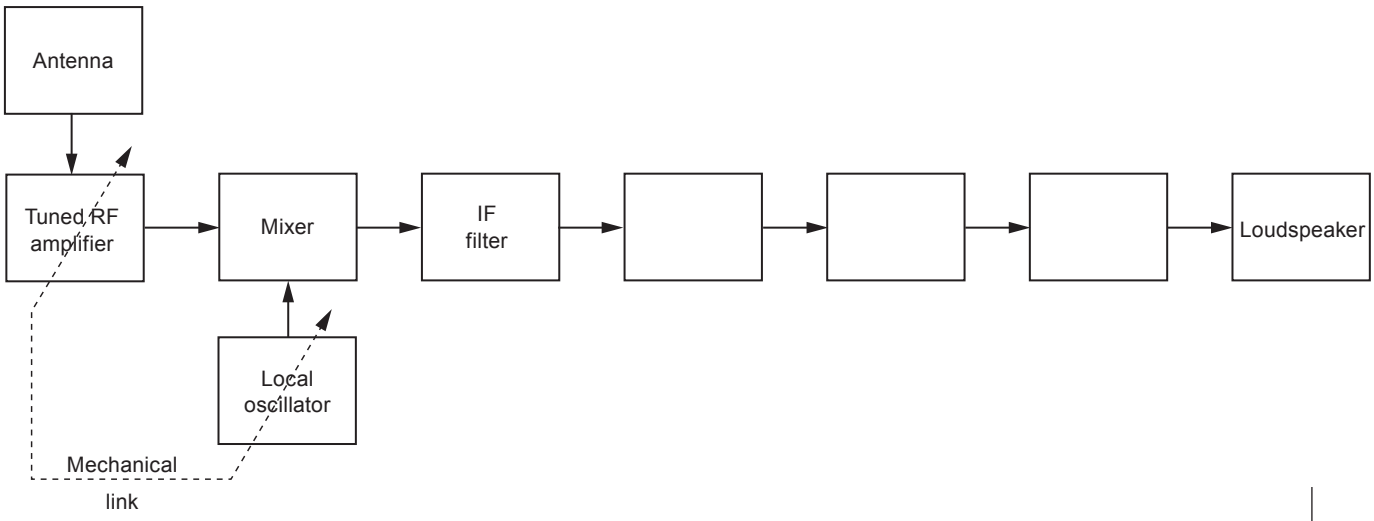
(b) Complete the following block diagram of the superheterodyne receiver. [3]



(c) A 250 MHz carrier is frequency modulated by an audio signal in the range 100 Hz to 20 kHz. The frequency deviation is 100 kHz. Calculate:

(i) the modulation index. [1]

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

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4. The ASCII code is an internationally agreed method of coding alphanumeric characters in computer systems.

The following table gives the ASCII code for a number of different characters.

Character	ASCII Code
V	1010110
W	1010111
X	1011000
Y	1011001
Z	1011010

(a) A computer system uses **odd** parity. Start, stop and parity bits have to be added before the signal can be transmitted.

(i) What is the purpose of the parity bit? [1]

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(ii) What is the value of the parity bit when character, 'Z' is transmitted? [1]

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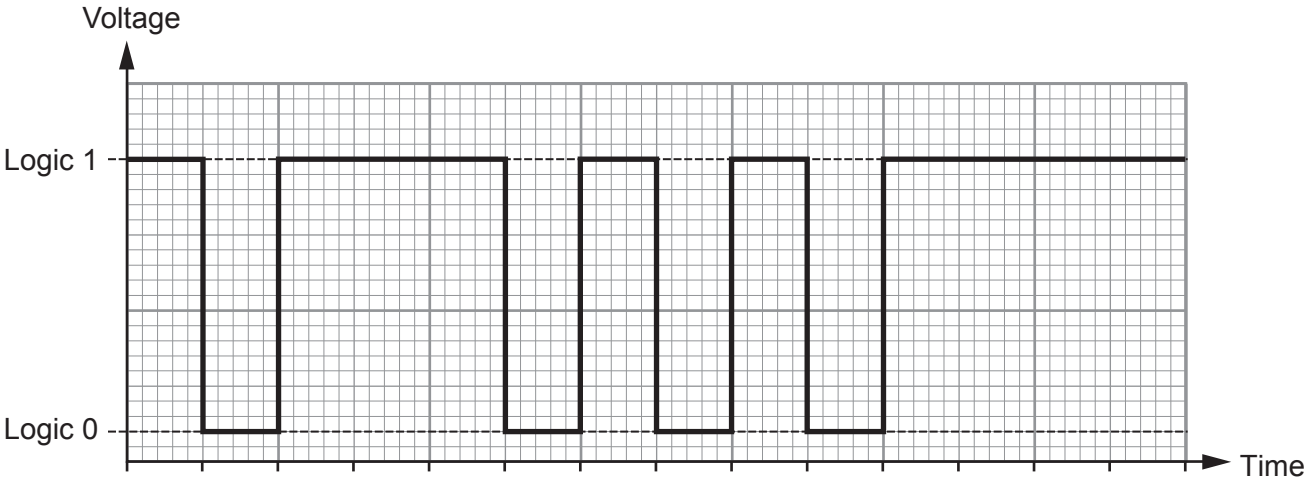
(b) The graph below shows the signal for a character, received at the end of the transmission link.



(i) **Label** the start, stop and parity bits. [3]

(ii) Using the table above, determine what character was transmitted to the receiver. [1]

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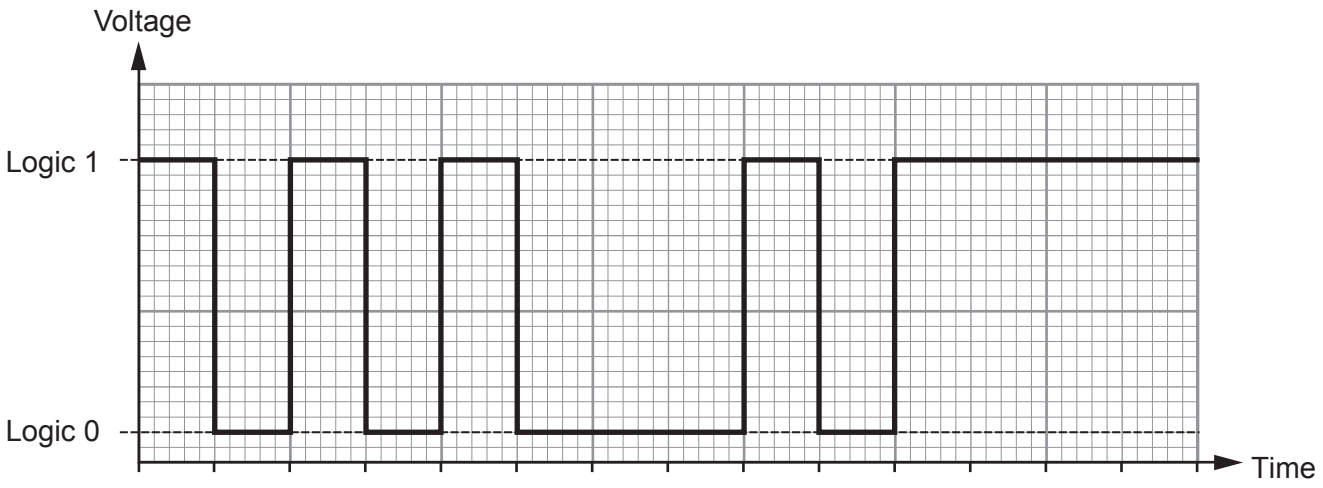
(c) The **same** character was transmitted again, and the information received is shown in the graph below.



(i) Given that an attempt was made to transmit the **same** character, as in part *(b)*. Explain why the receiving equipment would not have rejected the data as being incorrect. [1]

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(ii) How can this system be improved? [1]

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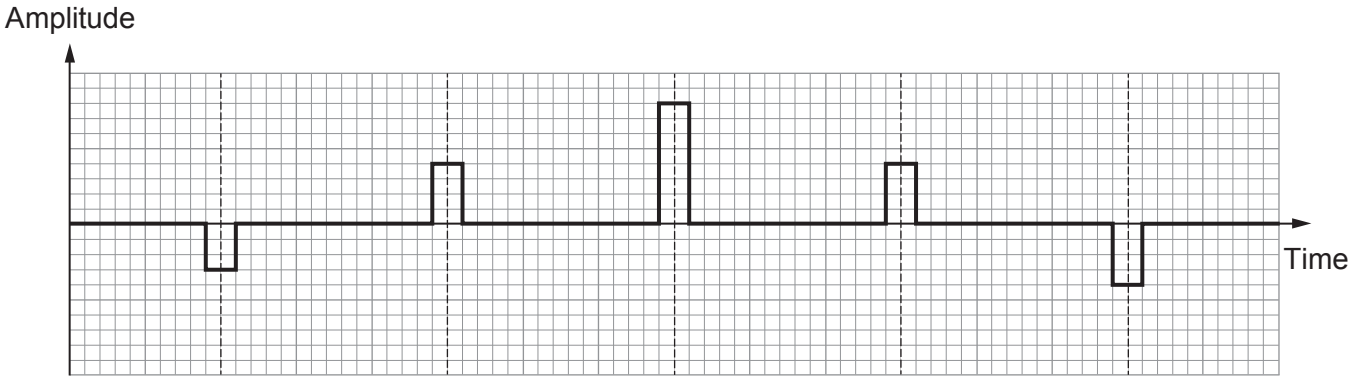
Examiner only

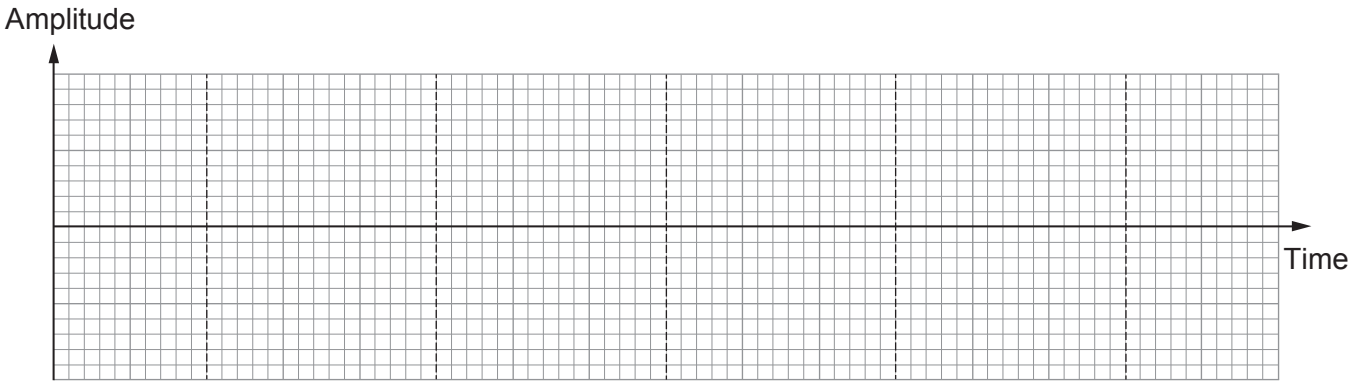
5. The following graphs show different ways in which Pulse Modulation can be used in a communication system. For each case:

- state which method is being used, either PPM, PWM or PAM.
- sketch the original modulating signal.

(a) (i) Type of Pulse Modulation used ..... [3]



(ii) Sketch the original modulating signal below.



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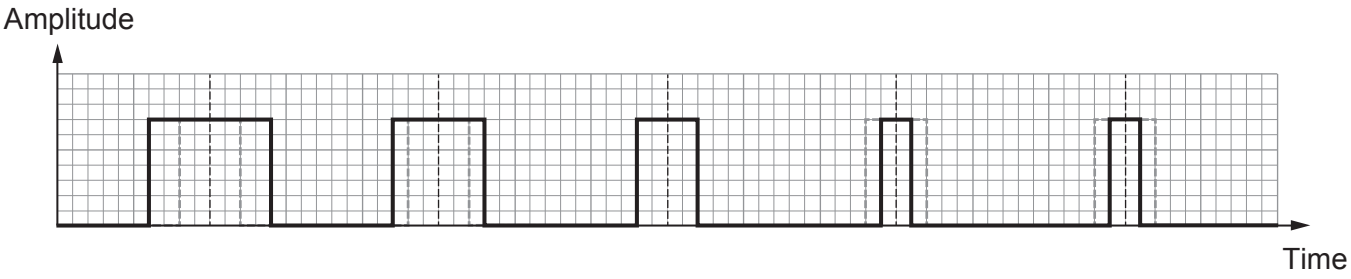
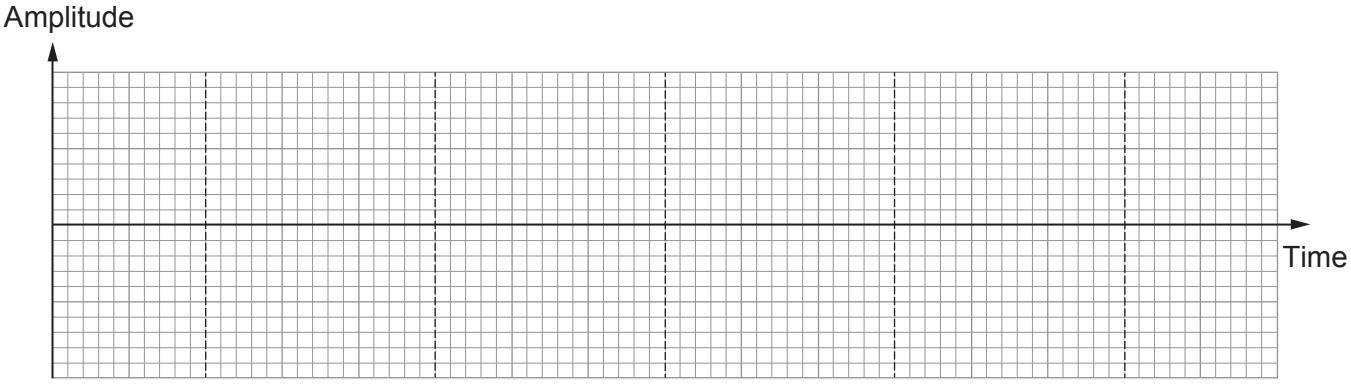
(b) (i) Type of Pulse Modulation used ..... [3]



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



(c) A PCM transmitter requires an ADC with a **minimum** resolution of 200 μV. The input voltage range is 5 V.

What is the minimum number of bits needed for the ADC output to provide this resolution? [2]

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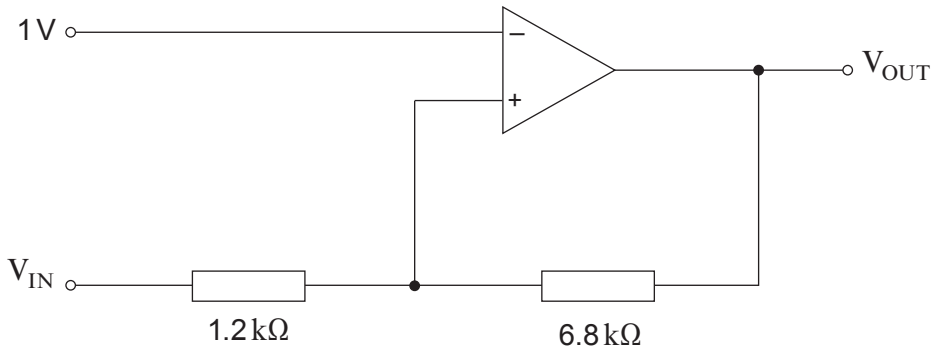
6. In the following Schmitt trigger circuit the op-amp saturates at ±10 V.



(a) Calculate the value of V_{IN} which causes V_{OUT} to change from +10 V to −10 V. [2]

(b) Calculate the value of V_{IN} which causes V_{OUT} to change from −10 V to +10 V. [2]

(c) What is the Schmitt trigger used for in a communication system? [1]

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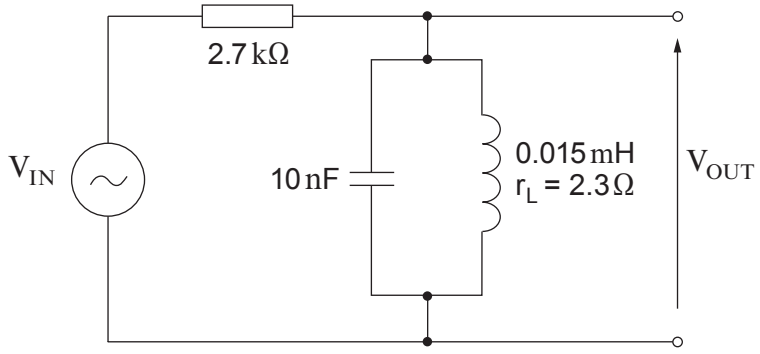
7. The following circuit diagram shows the IF filter from a Superhet receiver connected to a signal generator.

- The inductor has a resistance r_L of $2.3\,\Omega$
- The frequency is varied to find the maximum value of V_{OUT}.
- The amplitude of V_{IN} remains at 12 V throughout.



(a) Calculate the frequency at which V_{OUT} is a maximum. [2]

(b) Calculate the Dynamic Resistance R_D of the filter. [2]

(c) Use your answer to part *(b)* to calculate the maximum value of the voltage V_{OUT} with V_{IN} set to 12 V. [2]

(d) Calculate the 'Q factor' of this circuit. [2]

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(e) Calculate the bandwidth of this filter. [2]

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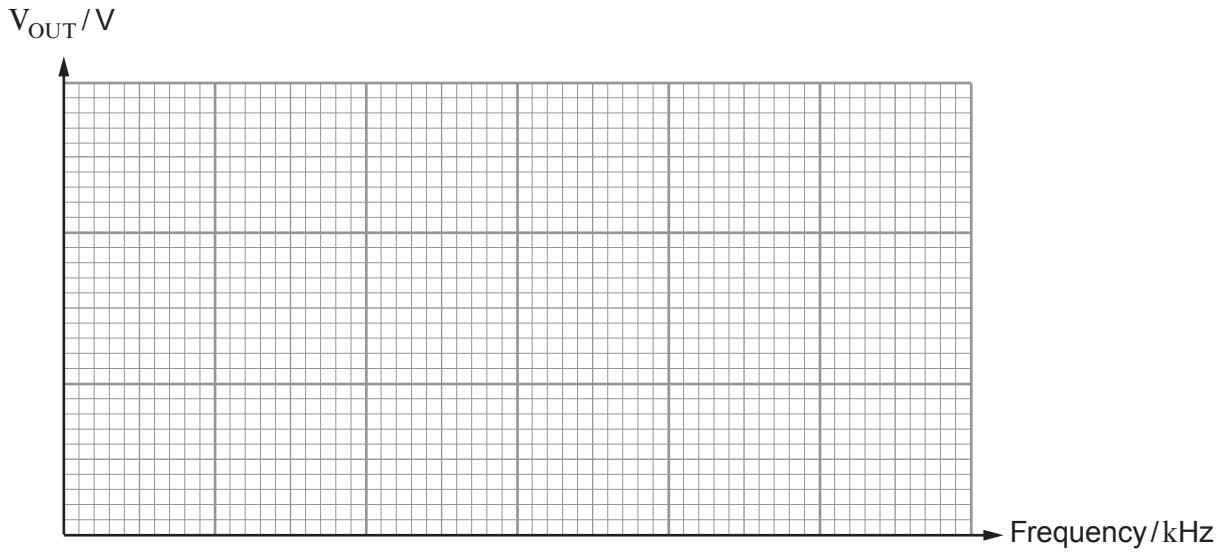
(f) Sketch the frequency response of the filter using the axes below.

Label the graph with **numerical values** for:

(i) Peak output voltage;
(ii) Resonant frequency;
(iii) Bandwidth.



[4]

END OF PAPER