Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1144/01

ELECTRONICS – ET4

P.M. THURSDAY, 5 June 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**7**	
3.	**7**	
4.	**4**	
5.	**4**	
6.	**6**	
7.	**7**	
8.	**10**	
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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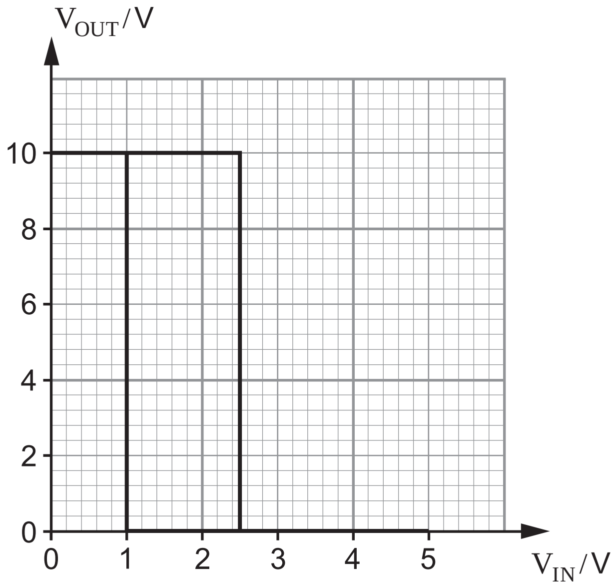
1. A Schmitt trigger circuit has the following characteristic.



(a) (i) What type of Schmitt trigger has this characteristic? .... [1]

(ii) What are the switching thresholds for this Schmitt trigger?

.... and .... [1]

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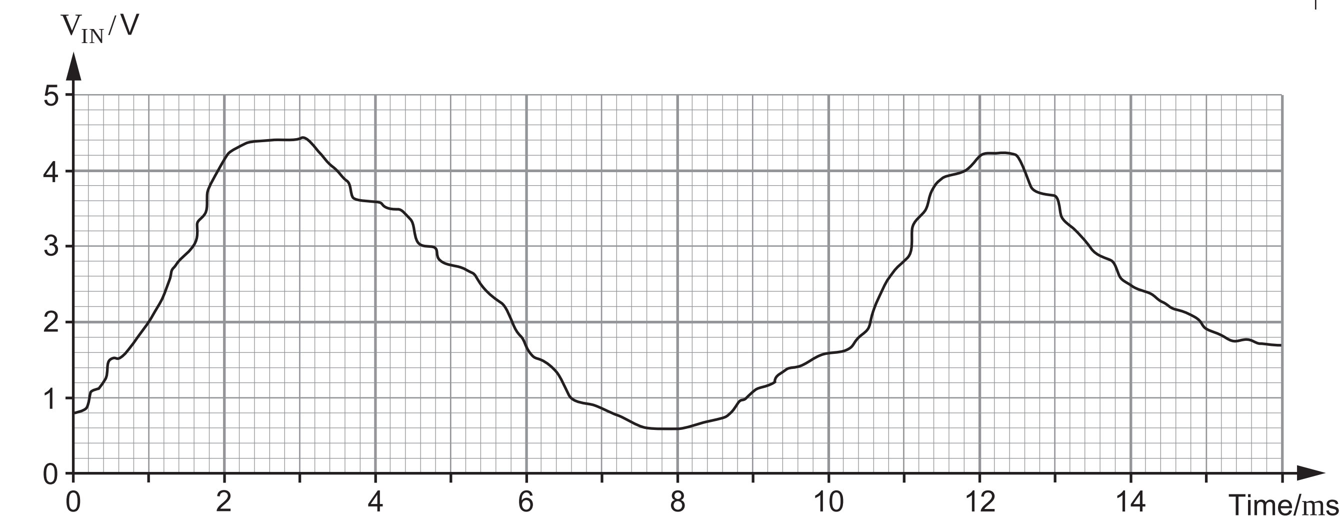
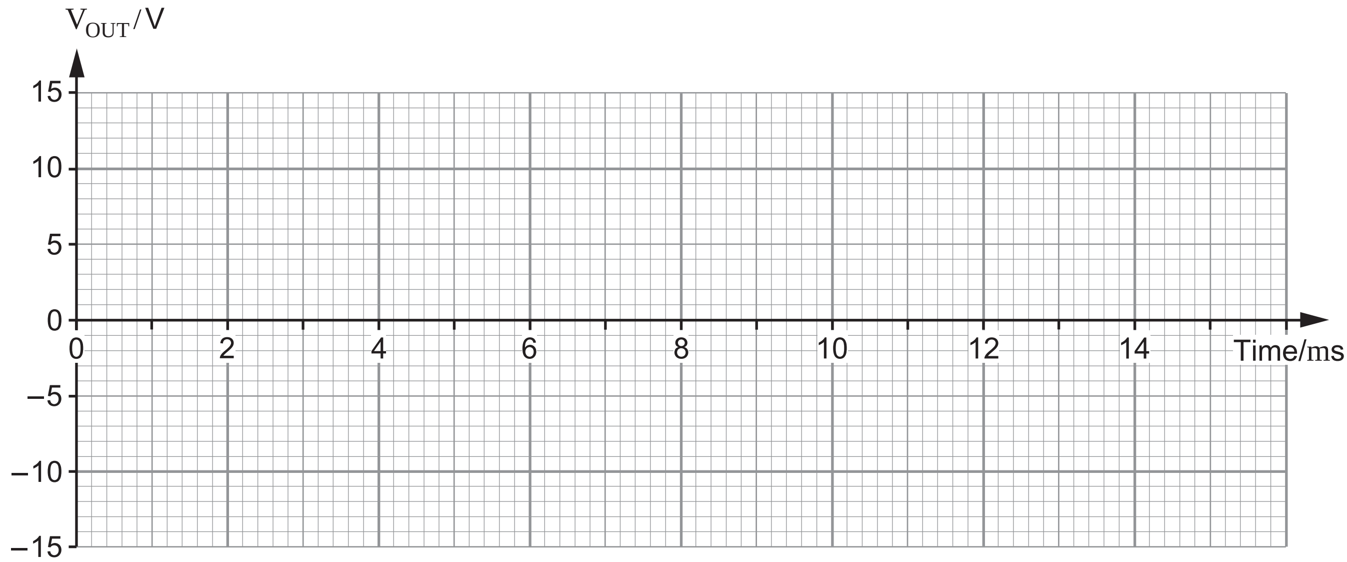
(b) Draw the output for this Schmitt trigger when the following analogue signal is applied to the input. [3]





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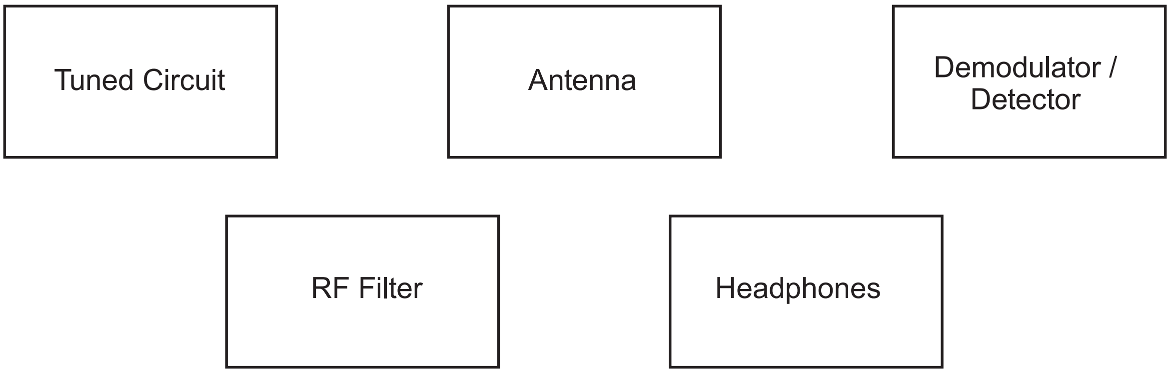
2. The simple radio receiver is made from five functional blocks. The blocks are shown below.



(a) Draw a block diagram to show how these blocks are connected to make a simple radio receiver. [1]

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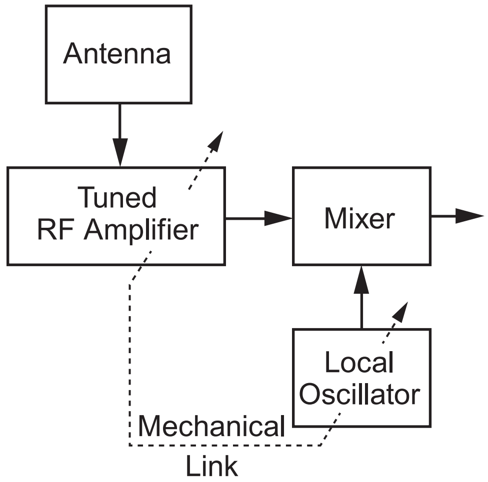
(b) The superheterodyne radio receiver offers considerable improvement compared to the simple radio receiver. **Part** of the superheterodyne receiver is shown below.



(i) The tuned RF amplifier has been tuned to a frequency of 1.4 MHz. The local oscillator output is measured at 1.88 MHz. What **additional** frequency signals will be present at the output of the mixer? [2]

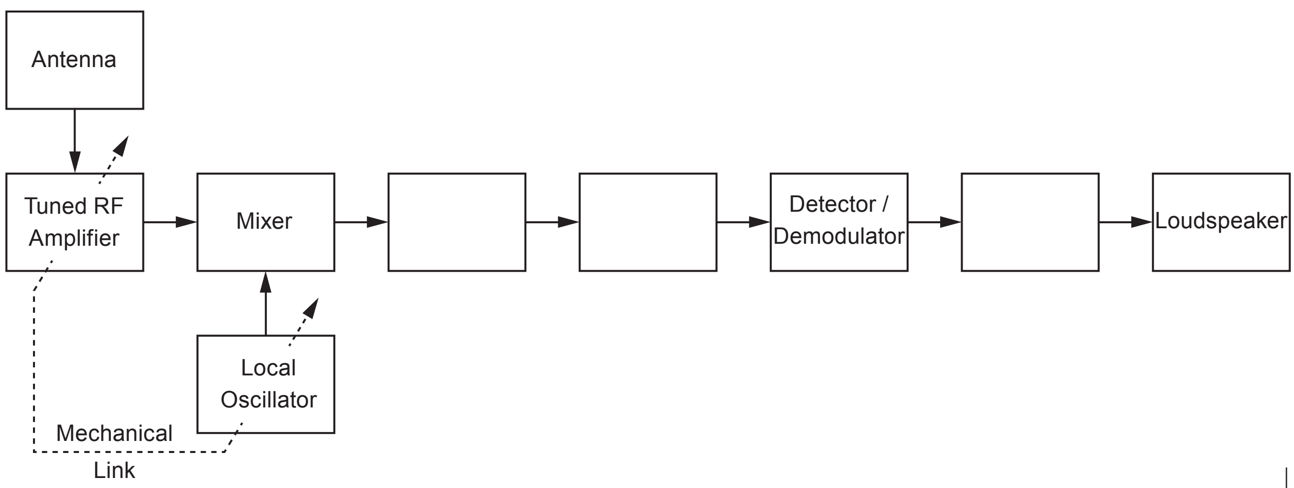
1. ....

2. ....

(ii) Which of these frequencies is the intermediate frequency?

.... [1]

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



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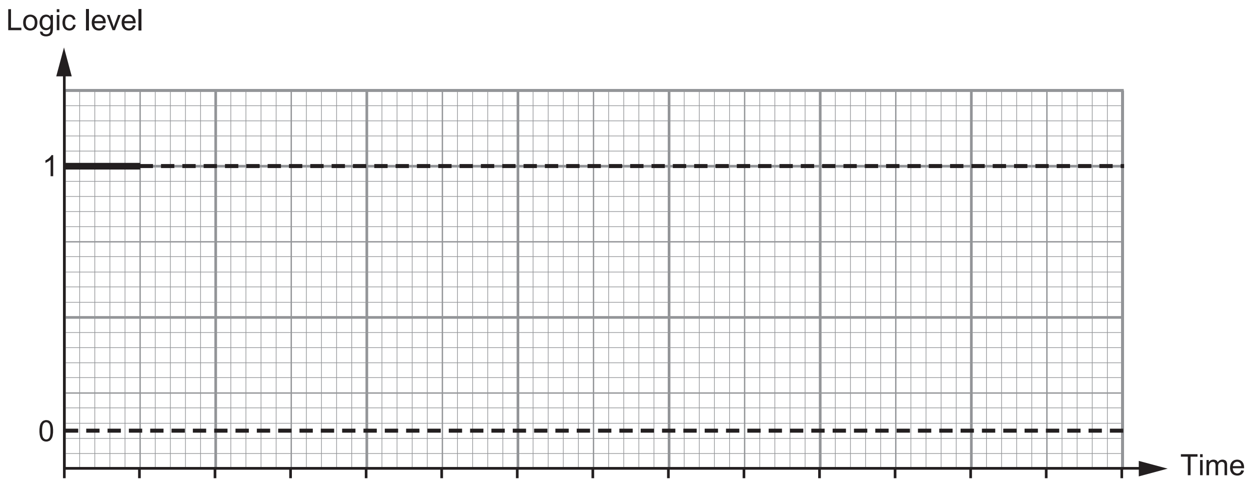
3. The ASCII code is an internationally agreed method of coding alphanumeric characters in computer systems.

The following table gives the ASCII code for some characters.

Character	ASCII Code
f	0110110
g	0110111
h	0111000
i	0111001
j	0111010

(a) Complete the graph below to show the transmitted signals for character **h** using **even** parity. **Label** the start, stop and parity bits. [3]



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(b) An asynchronous data transmission system uses a five bit parity system, with the parity bits assigned to the data bits as shown in the following table.

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_4	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			
x	x			x	x			x				

(i) The following data is to be **transmitted**.

Determine the values of the parity bits P_4 - P_0 that should be transmitted with this data for an **odd** parity system. Complete the table. [2]

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_4	P_3	P_2	P_1	P_0
1	0	1	1	0	1	1	0					

(ii) The following data and parity bits are **received** from this system when different data is transmitted.

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_4	P_3	P_2	P_1	P_0
1	1	1	0	1	1	0	0	1	0	1	0	1

There is a **single** error.

(I) Which parity bit(s) fail the parity test? .... [1]

(II) Determine where the error is located and therefore write down the correct version. [1]

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	P_4	P_3	P_2	P_1	P_0

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4. In national radio broadcasts using FM, the frequency deviation of the carrier, Δf_c is chosen to be 60 kHz. The range of the audio baseband is 20 Hz to 20 kHz.

(a) Calculate the modulation index, β, for the transmission. [2]

....

....

....

....

(b) Calculate the broadcast bandwidth of the signal. [2]

....

....

....

....

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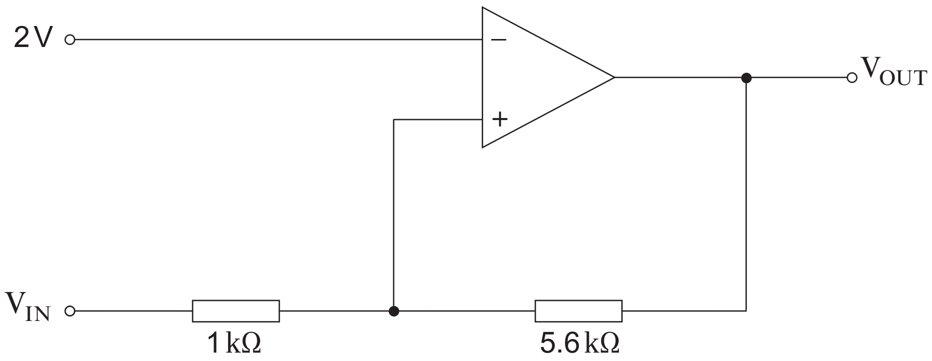
5. A Schmitt trigger is shown in the following circuit diagram.



The op-amp saturates at ±9 V.

(a) Calculate the value of V_{IN} which causes V_{OUT} to change from +9 V to –9 V. [2]

....

....

....

....

....

....

(b) Calculate the value of V_{IN} which causes V_{OUT} to change from –9 V to +9 V. [2]

....

....

....

....

....

....

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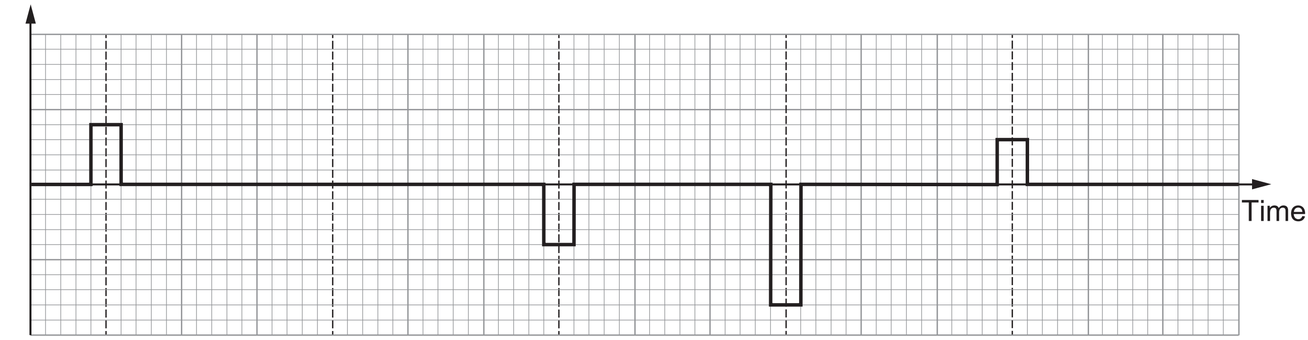
6. The following graphs show different ways in which Pulse Modulation can be used in a communication system. For each case state:

(i) which method is being used, either PPM, PWM or PAM;

(ii) sketch the original modulating signal.

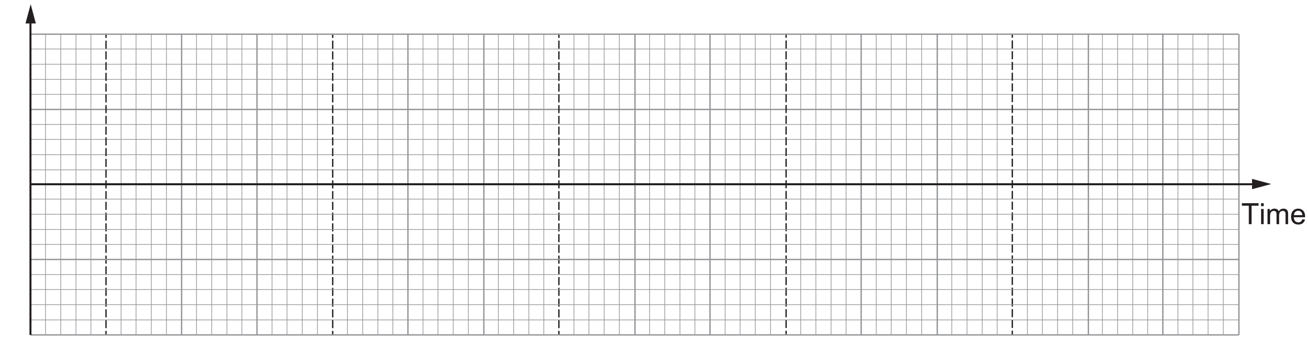
(a) (i) Type of Pulse Modulation used ....

Amplitude



(ii) Sketch the modulating signal below.

Amplitude



[3]

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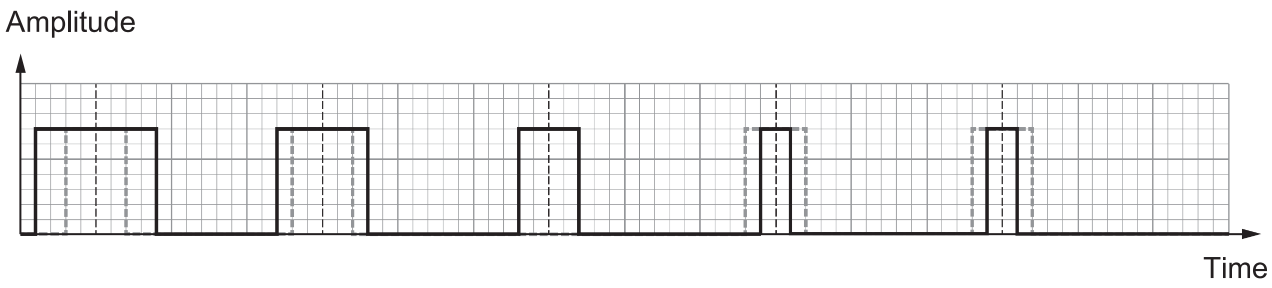
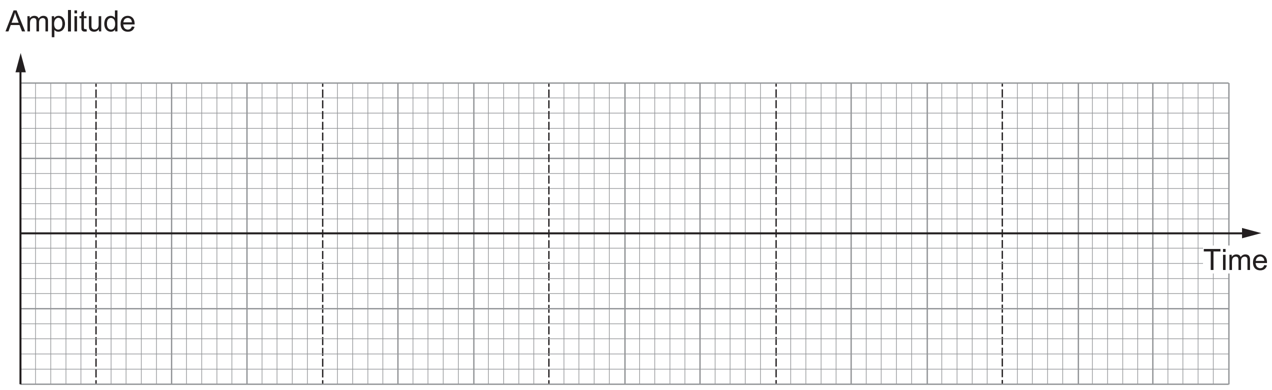
(b) (i) Type of Pulse Modulation used ....



(ii) Sketch the modulating signal below.



[3]

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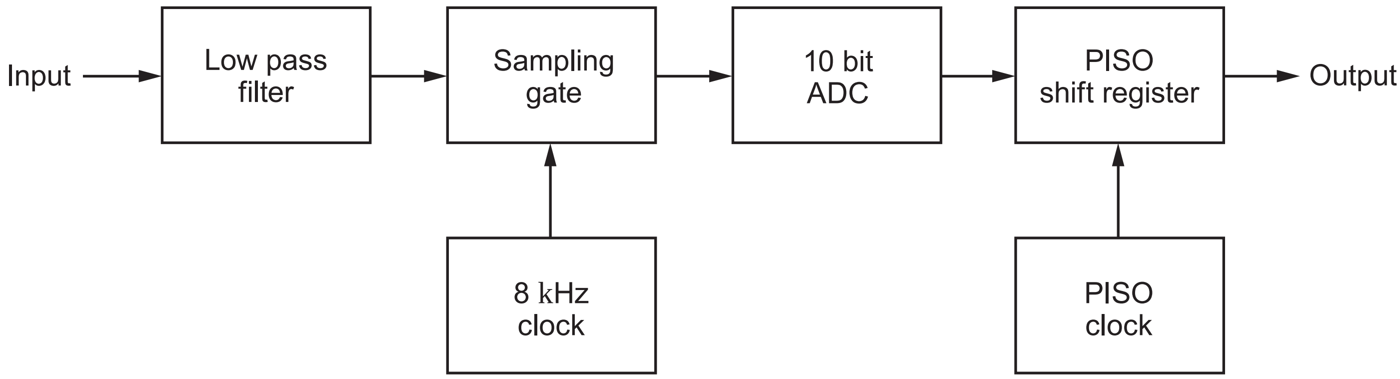
7. The following block diagram shows a *Pulse Code Modulation* (PCM) transmitter used in the telephone system, transmitting speech information in the range 50 Hz to 3.9 kHz.



(a) What is the minimum frequency for the PISO Clock for this PCM transmitter? Give a reason for your answer. [2]

Minimum Frequency = ...

Reason ....

....

....

(b) The 10-bit Analogue to Digital Converter (ADC) has an input voltage range of 0 to 6 V. What is the resolution of the system? [2]

....

....

....

....

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(c) Draw a block diagram of a PCM receiver using the following functional blocks. [3]

Low pass filter *SIPO clock* *DAC* *SIPO shift register* *Schmitt trigger*

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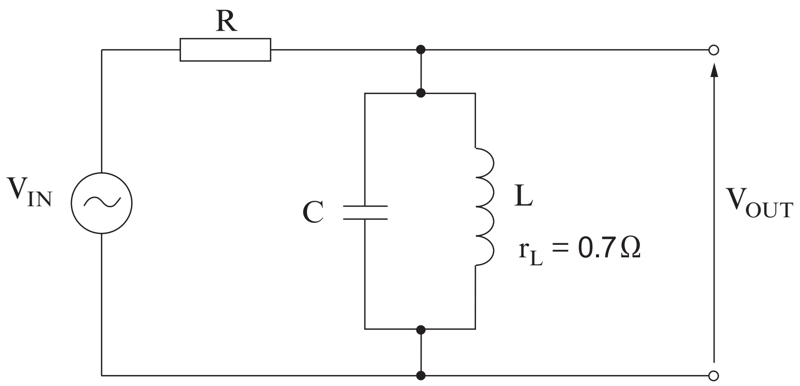
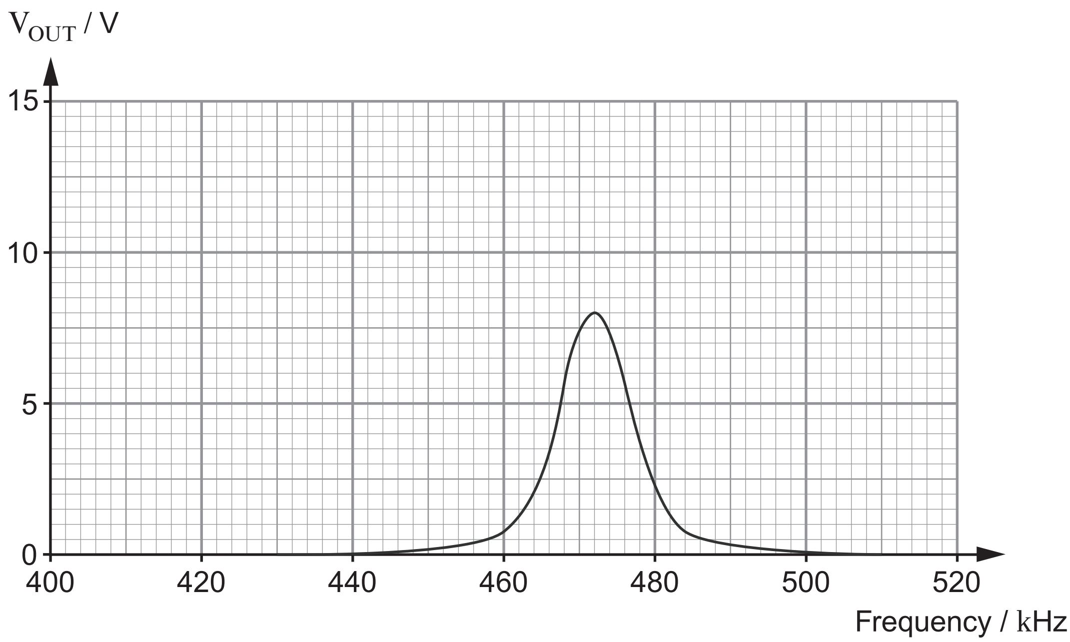
8. A student has built an intermediate frequency filter for a superheterodyne receiver. The circuit is shown below. The inductor resistance r_L is 0.7 Ω. The circuit is tested with a signal generator which is set to provide a constant amplitude of 10 V.



The graph shows the characteristic for the filter.



(a) Determine and **show** on the graph:

(i) the resonant frequency; .... [1]

(ii) the bandwidth. .... [2]

(b) Use your answers from *(a)* to show by calculation that the Q factor of the filter is approximately 60. [1]

....

....

....

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(c) Use your answers from parts *(a)* and *(b)* to **show by calculation** that the ideal value of the inductor is approximately 14 µH.
(Note: If your value of Q *is not between* 58 *and* 61 *use a value of* Q = 60 *from here on.)* [2]

....

....

....

....

(d) **Show by calculation** that the value of C required to achieve the resonant frequency for this filter is approximately 8 nF. *(Note: If your value of* L *is not between* 13 µH *and* 15 µH *use a value of* L = 14 µH *from here on.)* [1]

....

....

....

....

(e) (i) Calculate the dynamic resistance for this filter, showing all working.
(Note: If your value of C *is not between* 7 nF *and* 9 nF *use a value of* C = 8 nF.*)* [1]

....

....

....

....

(ii) Use your answer from *(e)*(i) to determine the value of R. [2]

....

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....

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