Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level

1144/01

S17-1144-01

ELECTRONICS – ET4

WEDNESDAY, 7 JUNE 2017 – AFTERNOON

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**3**	
2.	**6**	
3.	**4**	
4.	**7**	
5.	**5**	
6.	**13**	
7.	**12**	
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

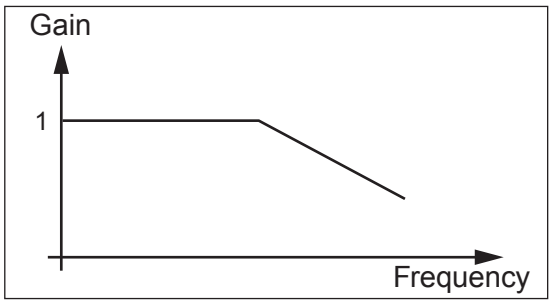
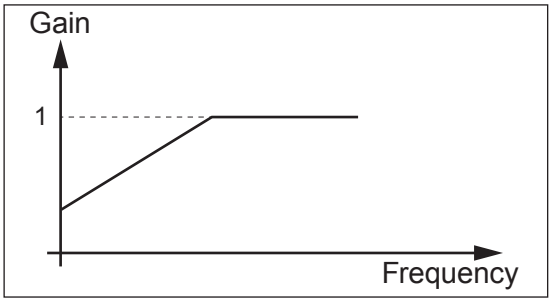
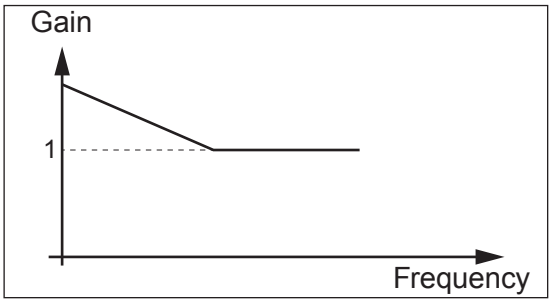
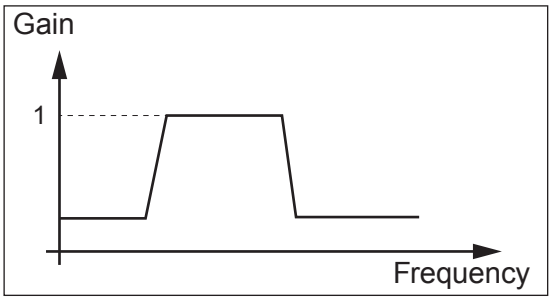
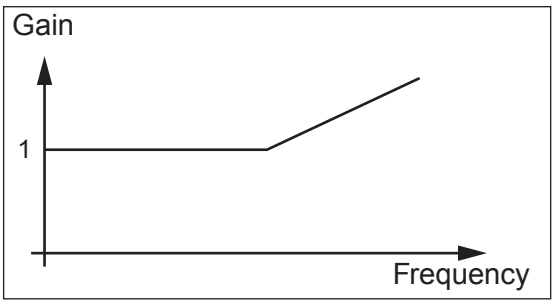
$$C = \frac{1}{4\pi^2 f_0^{\,2} L}$$

Examiner only

Answer **all** *questions.*

1. Modern communications systems use different types of signal filters.

Match the type of filter to its characteristic by drawing a line between them. [3]

Type of Filter	**Filter Characteristic**
Band Pass Filter	
	
High Pass Filter	
	
Low Pass Filter	

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Turn over.

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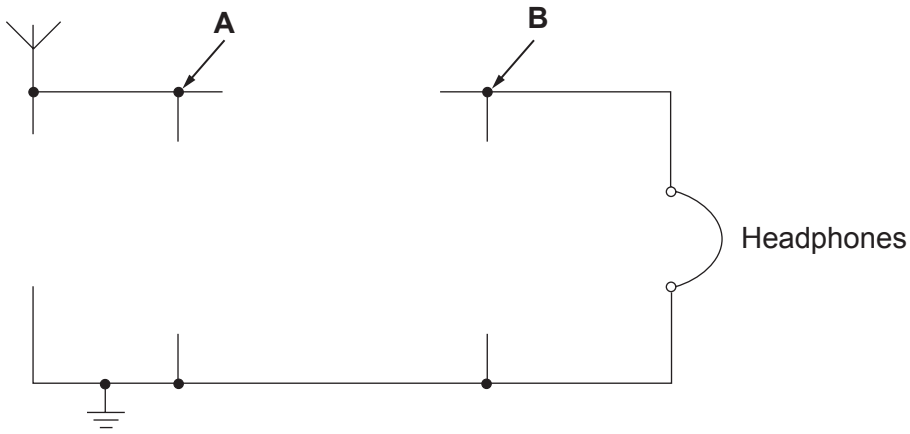
2. *(a)* Complete the circuit diagram for a simple radio receiver. [4]



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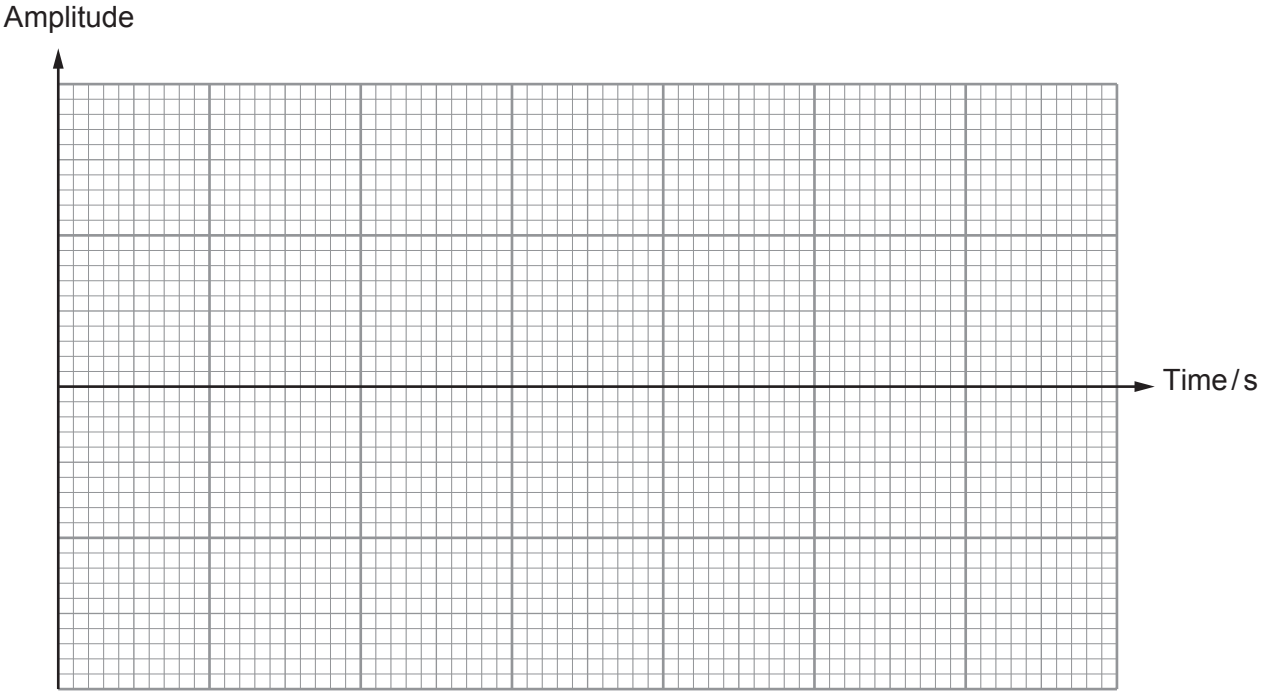
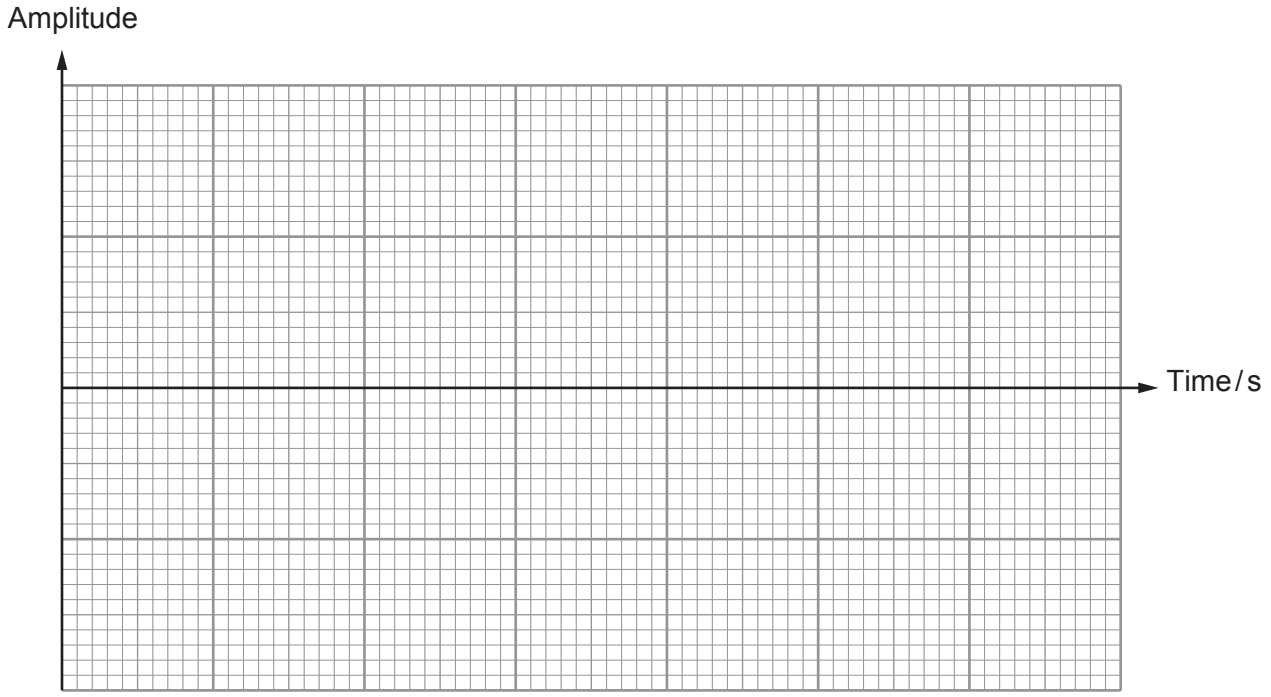
(b) (i) On the axes below, draw the signal you would see at point **A** on the completed circuit diagram of the simple radio receiver. [1]



(ii) On the axes below, draw the corresponding signal you would see at point **B** on the completed circuit diagram of the simple radio receiver. [1]



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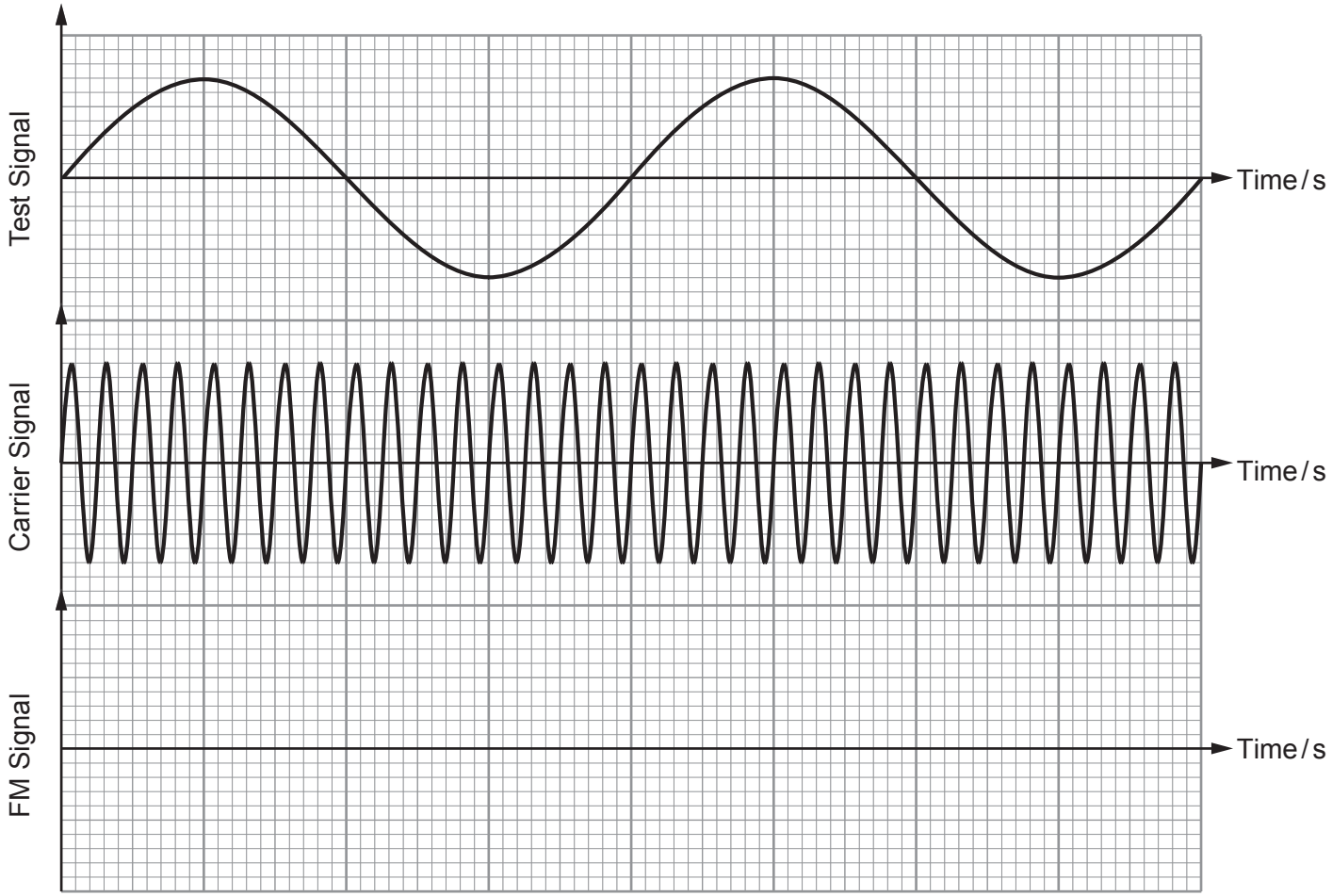
3. Frequency modulation (FM) is a very popular way of modulating radio signals.

(a) The test signal below is used to frequency modulate the carrier. Use the axis provided to draw the FM Signal. [2]



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(b) A 600 MHz carrier is frequency modulated by a 25 kHz sinusoidal test signal using a modulation index β = 5. Determine:

(i) the frequency deviation of the carrier Δf_c; [1]

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(ii) the bandwidth of the resulting FM waveform. [1]

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Turn over.

Examiner only

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
1	0110001
2	0110010
3	0110011
4	0110100
5	0110101

(a) A computer system uses **even** 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, '4' is transmitted? [1]

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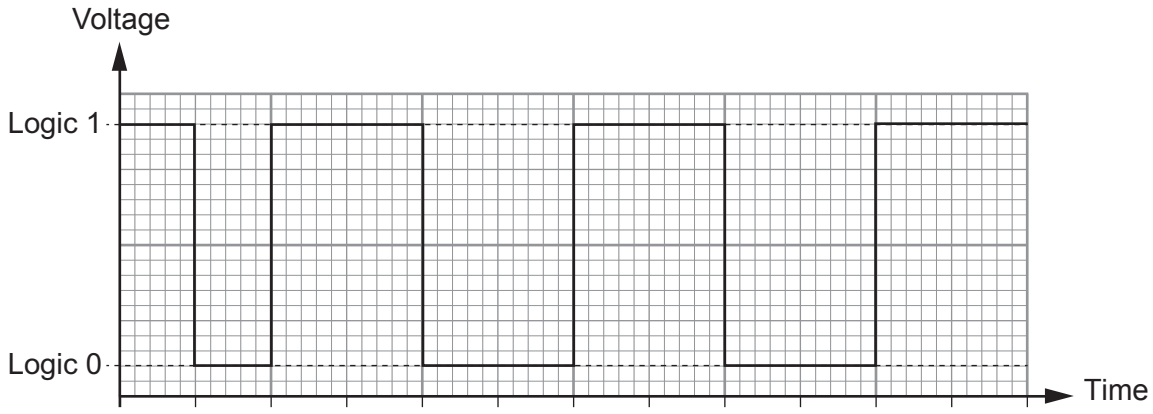
(b) The graph below shows the signal for a character, received at the end of the transmission link using even parity.



(i) **Label** the start, stop and parity bits. [2]

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

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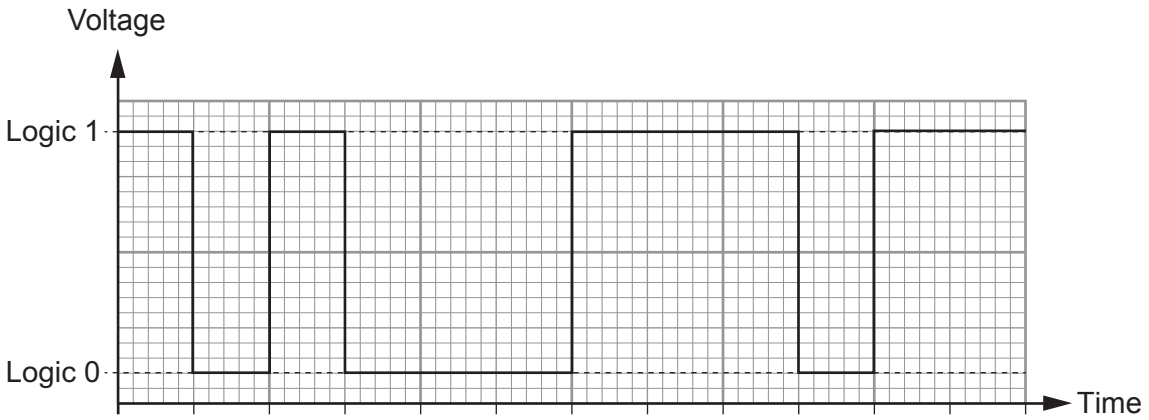
(c) The **same** character was transmitted again, and the information received is shown in the graph below.



(i) Explain why the receiving equipment would have accepted the data as being correct. [1]

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(ii) Describe how the system could be improved to eliminate this limitation. [1]

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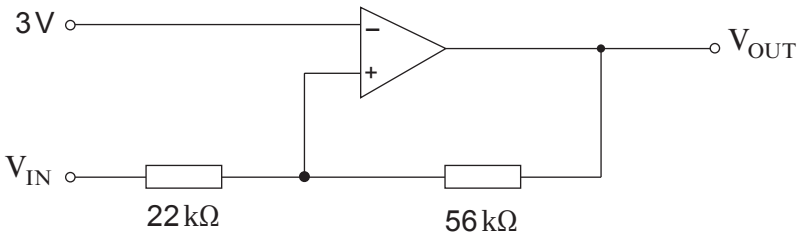
5. *(a)* A Schmitt trigger circuit is shown in the following circuit diagram.



The op-amp saturates at ± 10 V.

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

Examiner only

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

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(b) A Schmitt trigger can be used to restore a digital signal to its original state after the signal degrades as it travels along a transmission line. Name **two** causes of signal degradation that can be restored by the Schmitt trigger. [1]

1. .....

.....

2. .....

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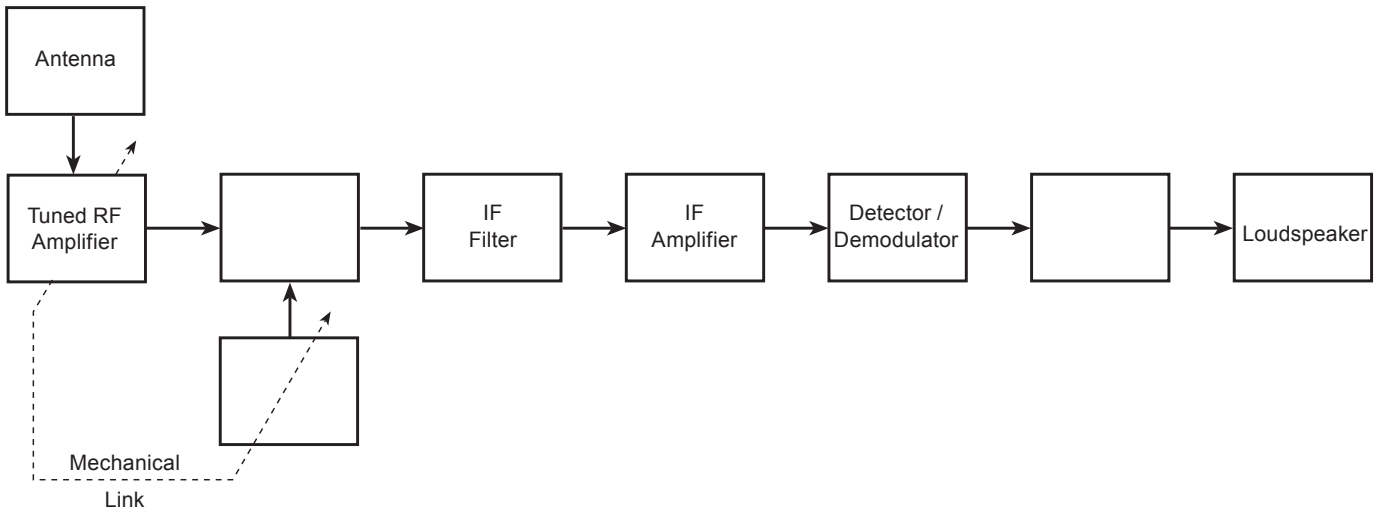
Examiner only

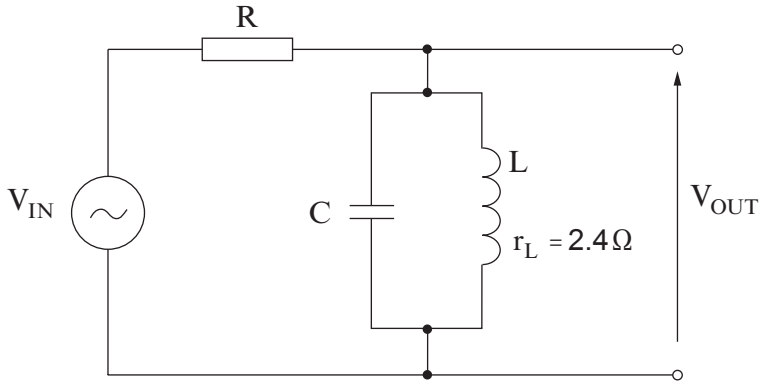
6. The superhet radio receiver is an advanced radio receiver.

(a) **Complete** the following block diagram of the superhet receiver. [3]



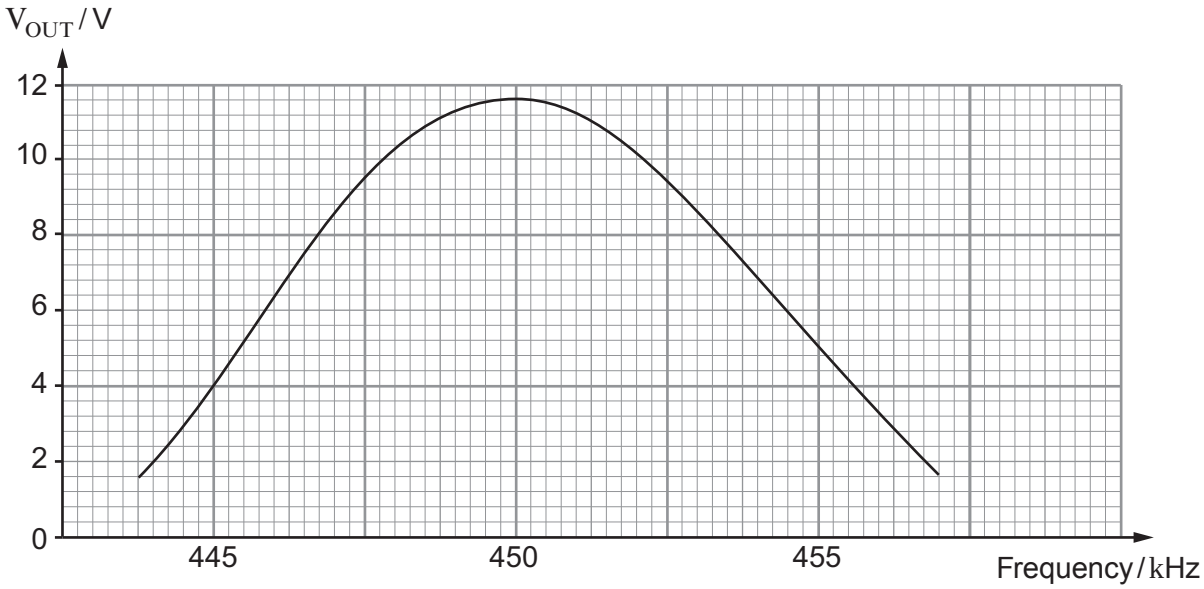
(b) An engineer has designed an IF filter for a Superhet receiver.

The following circuit diagram shows the IF filter connected to a signal generator with V_{IN} set to provide a constant 12 V. The inductor resistance r_L is 2.4 Ω.



Examiner only

The graph shows the characteristic for the filter.



Determine and **show** on the graph:

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

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

(c) Use your answers from *(b)* to **show by calculation** that the Q factor of the filter is approximately 70. [1]

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(d) Use your answers from parts *(b)* and (*c*) to **show by calculation** that the ideal value of the inductor is approximately 60 μH. [2]
(Note: If your value of Q *is not between 68 and 71 use a value of* Q *= 70 from here on.)*

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Examiner only

(e) **Show by calculation** that the value of C required to achieve the resonant frequency for this filter is approximately 2 nF. *(Note: If your value of* L *is not between* 57 μH *and* 61 μH *use a value of* L = 60 μH *from here on.)* [1]

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(f) (i) Calculate the dynamic resistance for this filter, showing all working.
(Note: If your value of C *is not between* 1.5 nF *and* 2.8 nF *use a value of* C = 2 nF*.)* [1]

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

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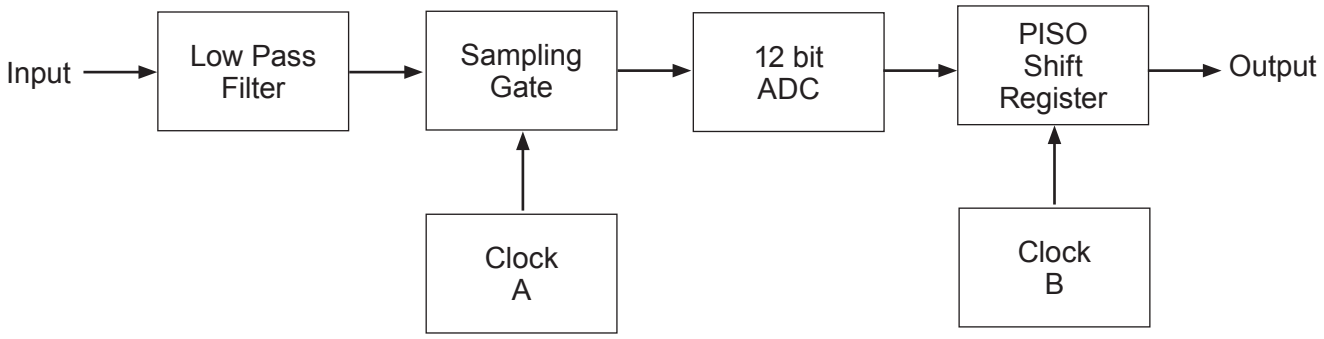
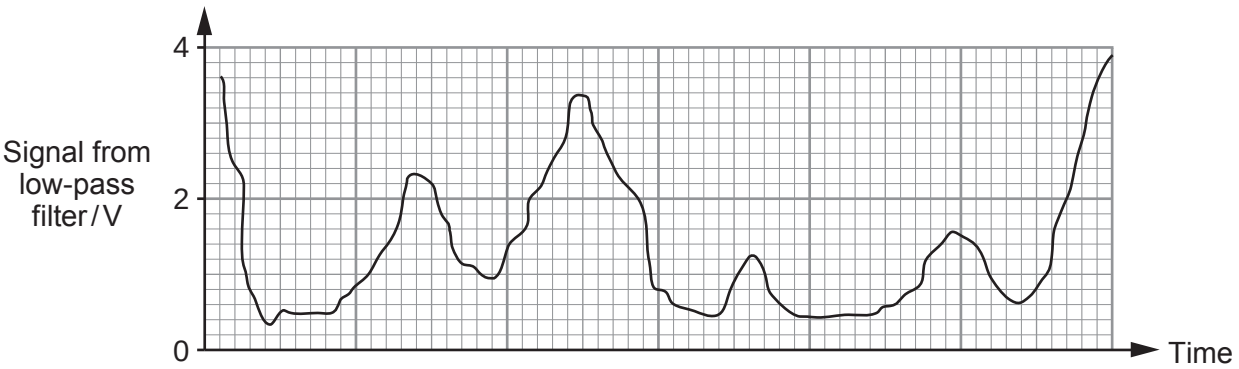
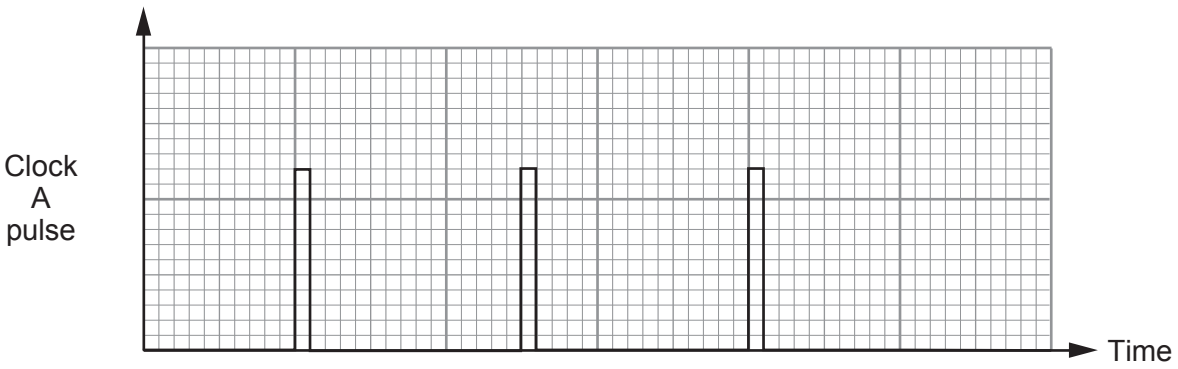
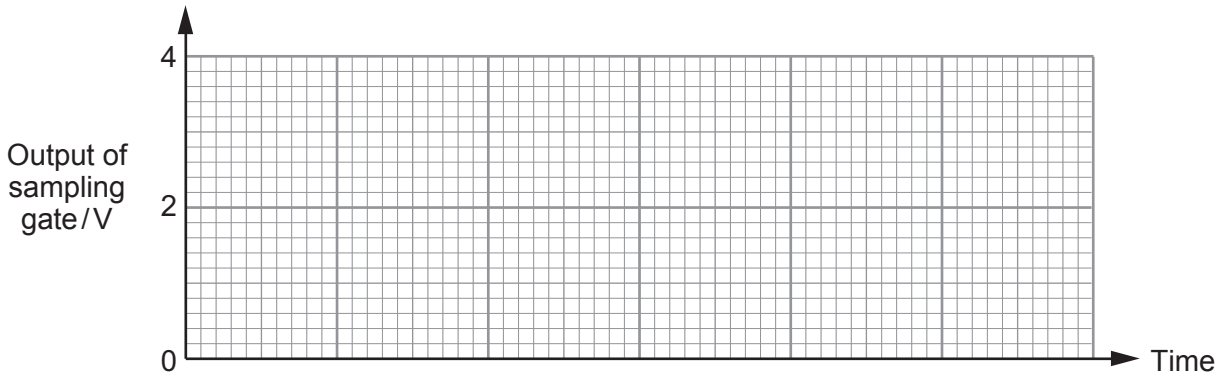
7. The following block diagram shows a Pulse Code Modulation (PCM) Transmitter.



(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. [2]







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(b) The signal from the low pass filter contains frequencies in the range 20 Hz to 19 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]

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(ii) What is the minimum frequency that can be used for clock A in this transmitter? [1]

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(c) (i) 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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(ii) State the minimum frequency of clock B to ensure this system operates correctly. [1]

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(d) The 12-bit Analogue to Digital Converter (ADC) has an input voltage range of 0 to 9 V. What is the resolution of the system? [2]

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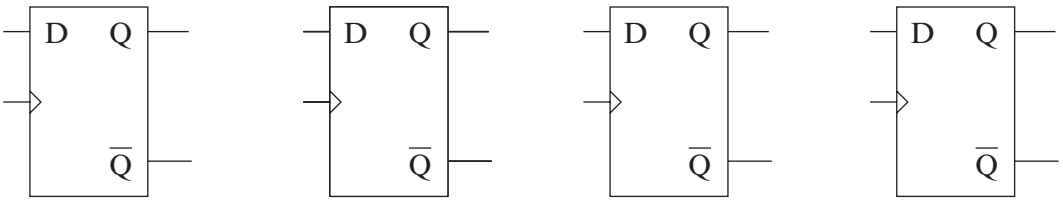
Examiner only

(e) A PCM **receiver** requires a serial-in-parallel-out shift register (SIPO) which can be constructed using D-Type flip-flops.



On the diagram above:

(i) draw the connections needed to make the first 4-bits of a SIPO shift register; [2]

(ii) label the signal input; [1]

(iii) label the signal outputs. [1]

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