Surname	Centre Number	Candidate Number
Other Names		2

GCE A Level – LEGACY

1144/01

S18-1144-01

ELECTRONICS – ET4

WEDNESDAY, 6 JUNE 2018 – AFTERNOON

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**4**	
2.	**8**	
3.	**13**	
4.	**8**	
5.	**6**	
6.	**4**	
7.	**7**	
Total	**50**	

1144 010001

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

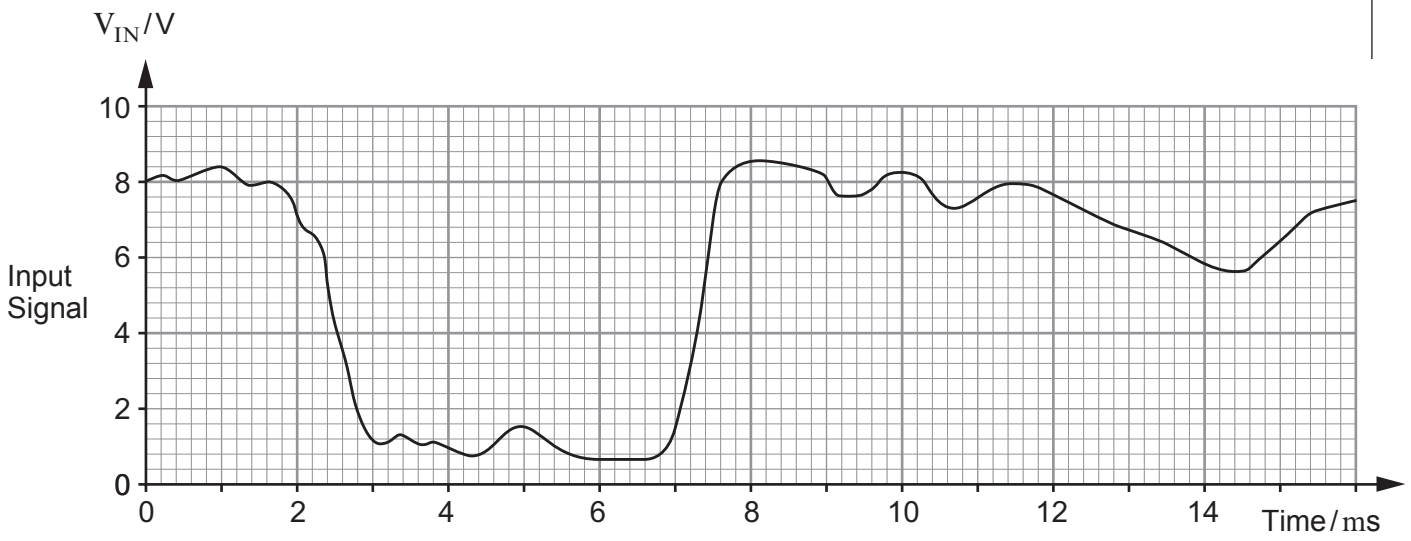
$$C = \frac{1}{4\pi^2 f_0^{\,2} L}$$

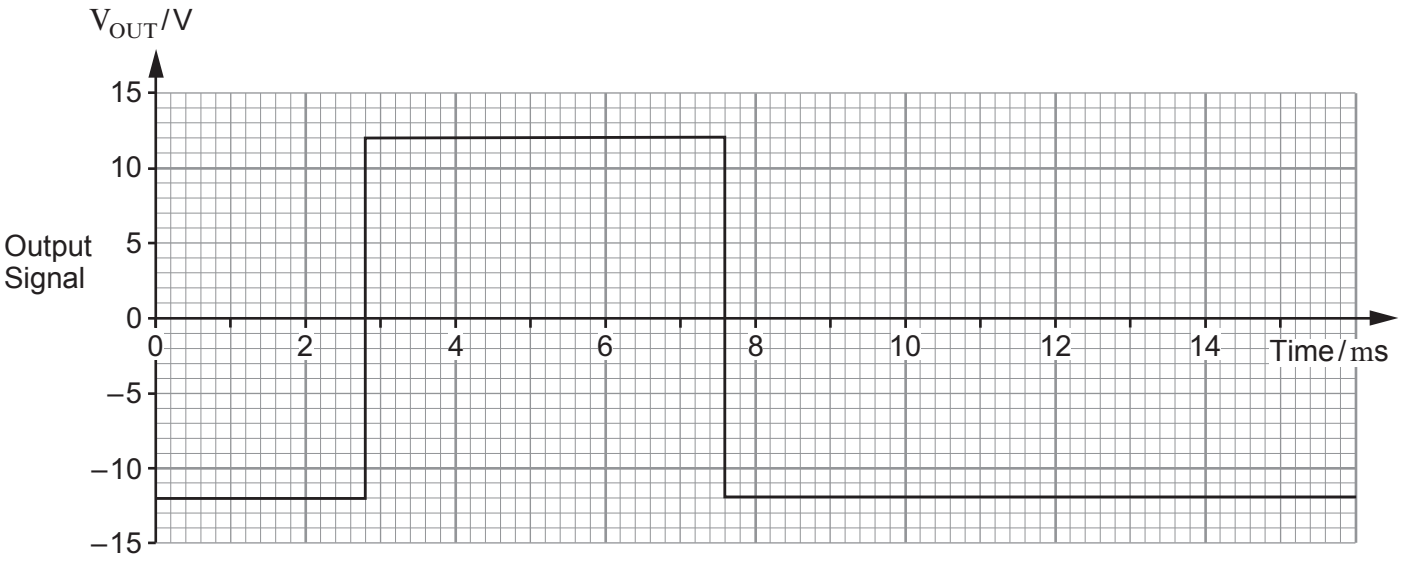
BLANK PAGE

Examiner only

Answer **all** *questions.*

1. The input and output signals for a Schmitt trigger circuit are shown below.



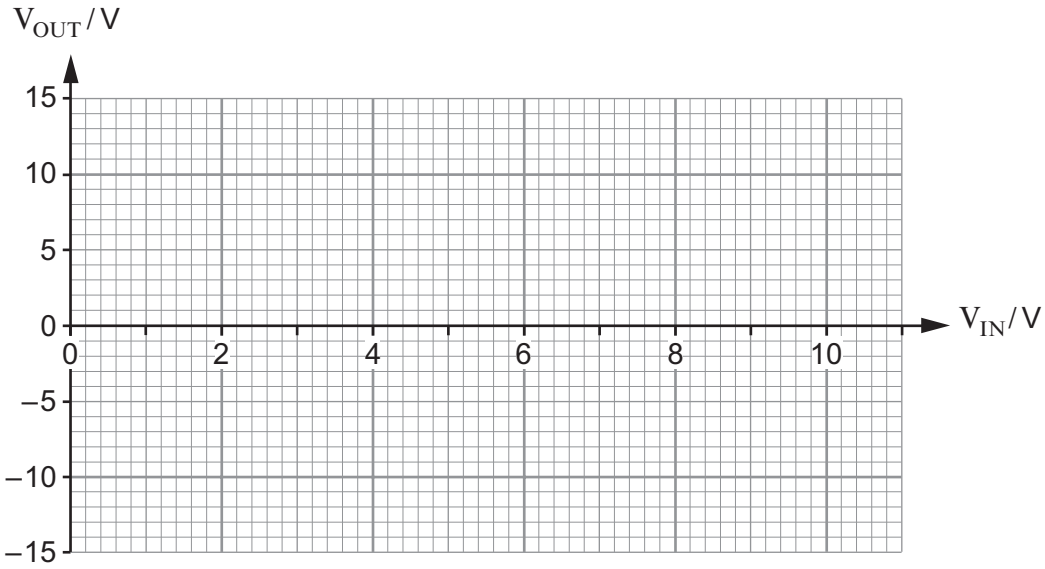


(a) What type of Schmitt trigger would be required to produce this output? [1]

.....

Examiner only

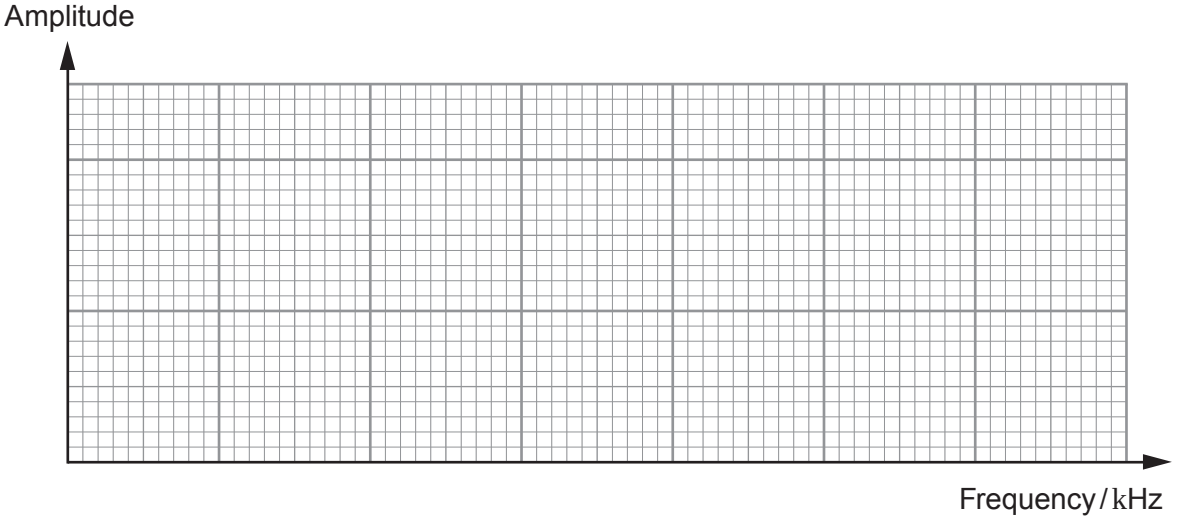
(b) Use the information provided in the graphs to draw the switching characteristic for the Schmitt trigger. [3]



1144 010005

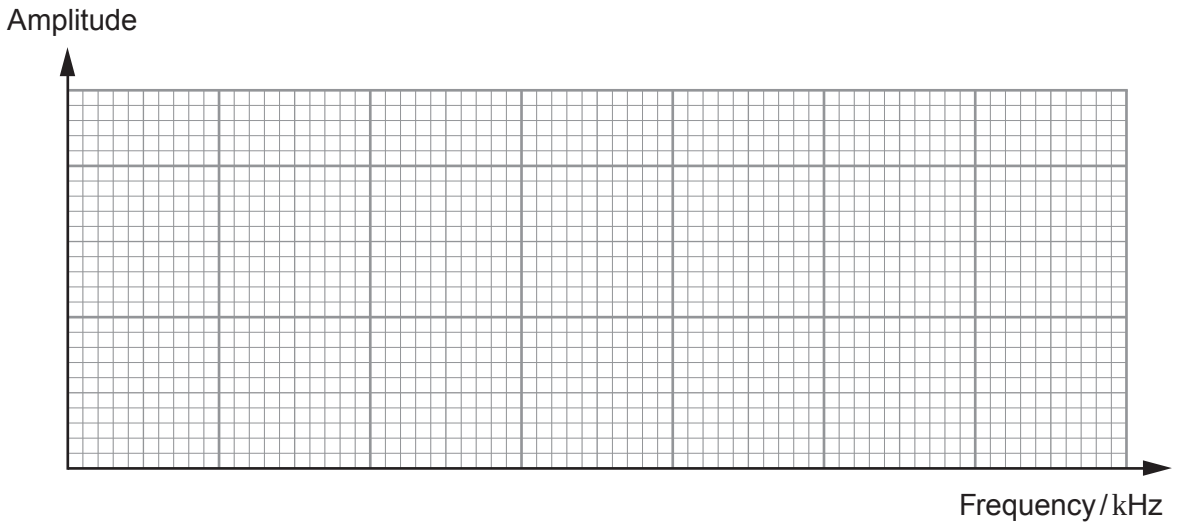
Examiner only

2. *(a)* A 12 kHz sinusoidal wave is amplitude modulated onto a 250 kHz carrier wave. On the axes below, draw the frequency spectrum of the transmitted wave. Label **all** significant frequencies. [3]



(b) The 12 kHz sinusoidal wave is replaced with an audio signal containing frequencies in the range 150 Hz – 17 kHz. The carrier signal frequency remains at 250 kHz.

(i) On the axes below, draw the frequency spectrum of the transmitted wave. [1]

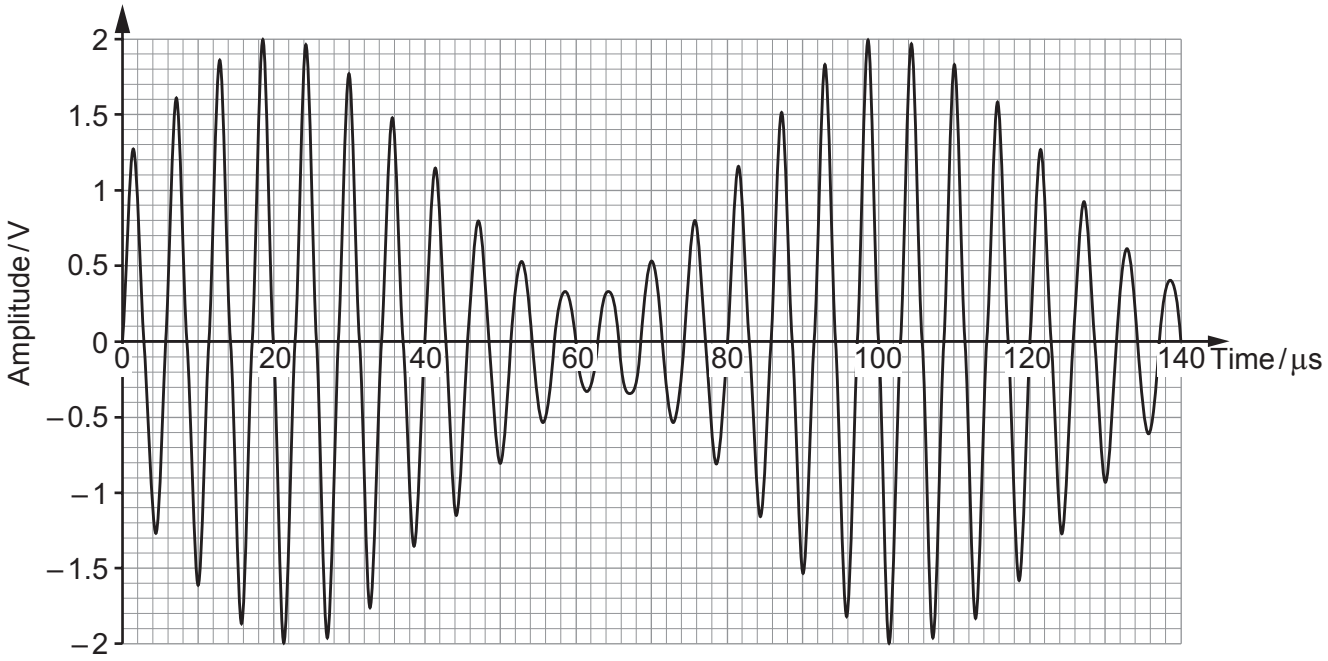


(ii) What is the broadcast bandwidth of the signal? [1]

.....

Examiner only

(c) The following diagram shows a **different** amplitude modulated signal.



Determine

(i) the frequency of the sinusoidal signal used to modulate the carrier. [1]

.....

.....

(ii) the carrier frequency. [1]

.....

.....

(iii) the depth of modulation. [1]

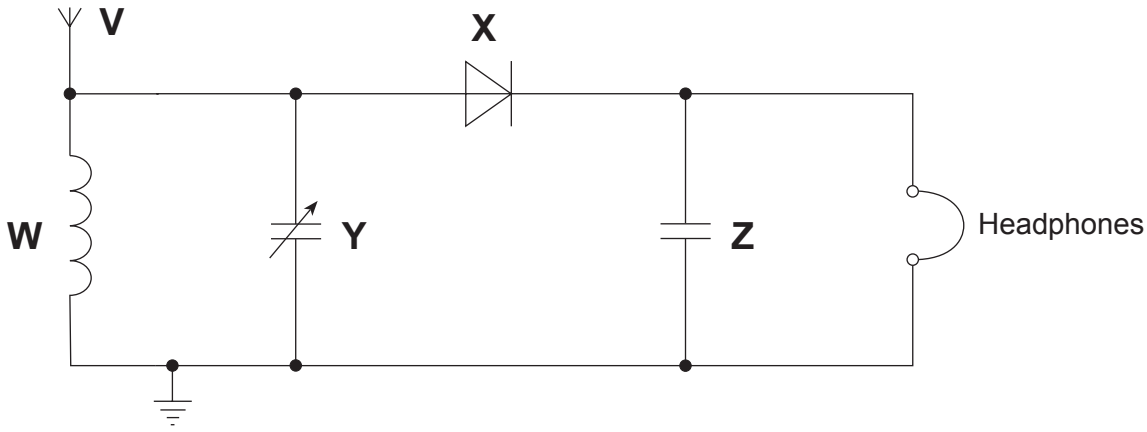
.....

.....

1144 010007

Examiner only

3. *(a)* The circuit diagram for a simple radio receiver is shown below.



Use the letters **V**, **W**, **X**, **Y** and **Z** to answer the following questions.

(i) Which component removes the RF carrier to leave the audio signal?

..... [1]

(ii) Which component carries many RF signals at all times?

..... [1]

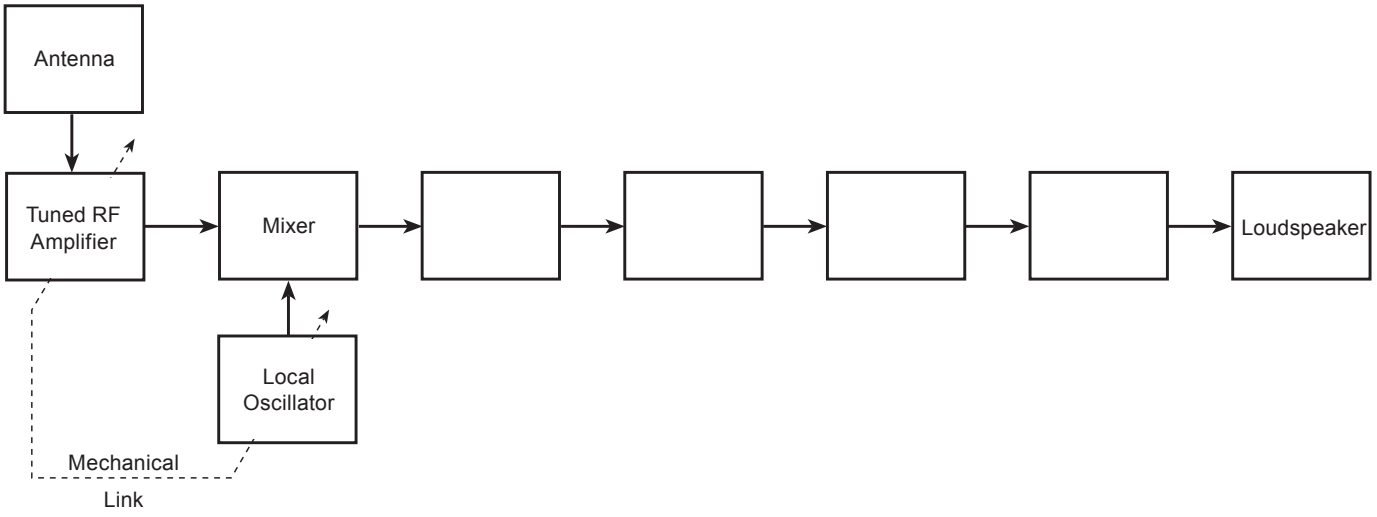
(iii) Which components select the required RF signal?

..... [1]

(iv) Which component changes the RF signal to give a non-zero average signal?

..... [1]

(b) (i) The superheterodyne receiver offers significant improvements over the simple radio receiver. Complete the following block diagram of the full superheterodyne receiver. [4]



Examiner only

(ii) Which block(s) in the superheterodyne receiver improve(s): [2]

I. sensitivity?

.....

II. selectivity?

.....

(iii) The tuned RF amplifier has been tuned to a frequency of 1.430 MHz. The local oscillator output is measured at 1.885 MHz. What **four** frequency signals will be present at the output of the mixer? [2]

1. .....

2. .....

3. .....

4. .....

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

.....

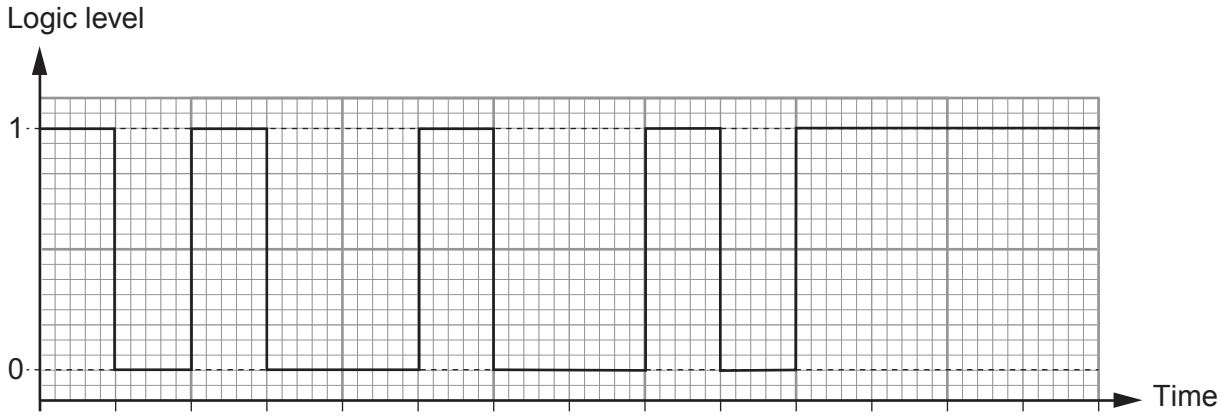
Examiner only

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
A	1000001
E	1000101
I	1001001
O	1001111
U	1010101

(a) The diagram below shows the transmitted signal for one of these characters using **odd** parity.



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

(ii) Identify the transmitted **character**.

Character = ... [1]

Examiner only

(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 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	0	1	1	0	1	1	0					

Complete the table with the values of the parity bits P_4 – P_0 for an **odd** parity system. [2]

(ii) The following data and parity bits are received from the system using **odd** parity.

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	0	1	0	0	0	1	1	1	0	0

There is a **single** error.

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

(II) Locate the error and write down the corrected data and parity bits. [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

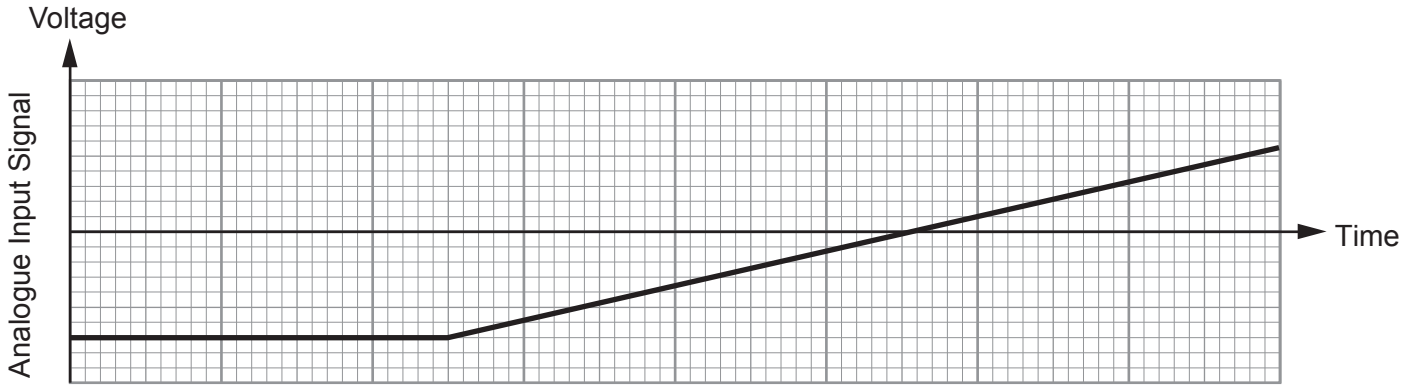
Examiner only

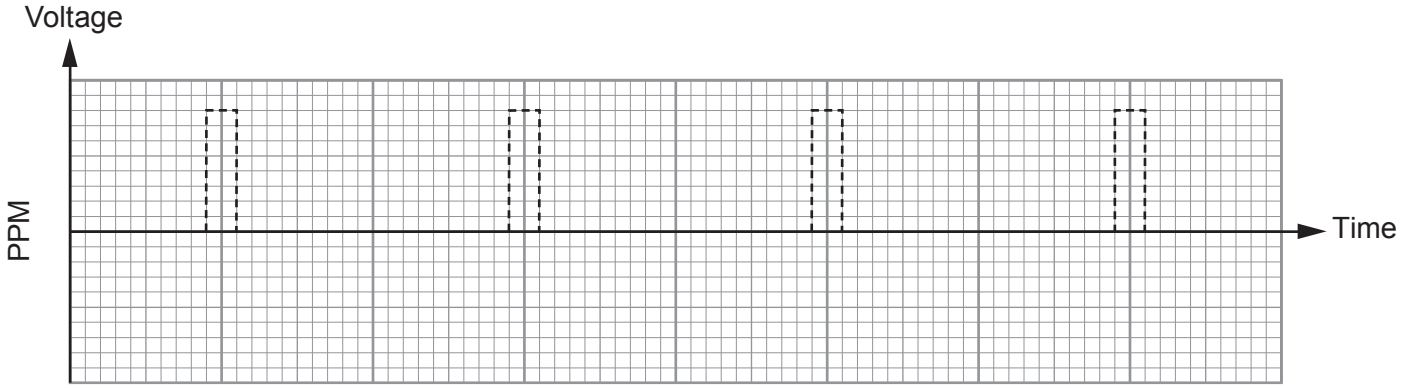
5. Pulse Position Modulation (PPM), Pulse Width Modulation (PWM) and Pulse Code Modulation (PCM) are three methods of modulating information.

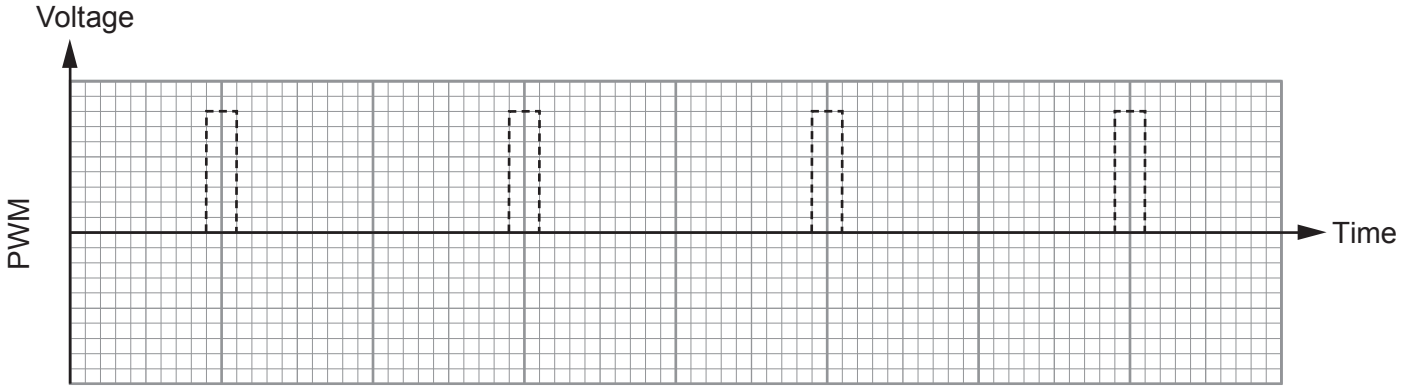
(a) On each of the following graphs, illustrate what would happen to the unmodulated clock pulse train (shown dotted) if the signal below was transmitted using:

(i) PPM;

(ii) PWM. [4]







Examiner only

(b) A PCM transmitter requires an ADC with a **minimum** resolution of 300 μV. The input voltage range is 6 V.

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

.....

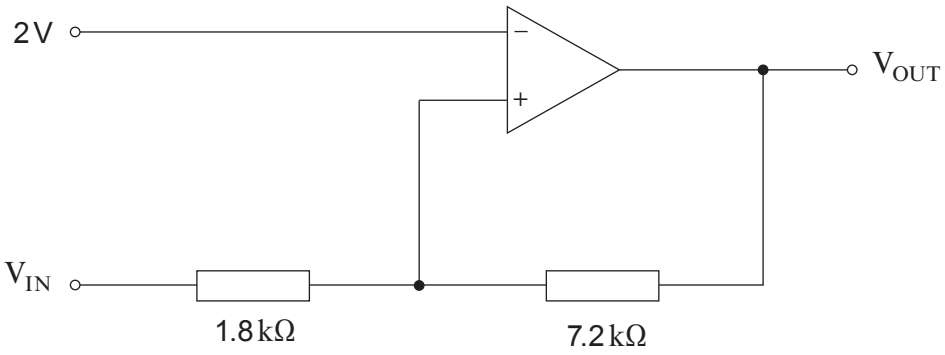
.....

.....

Turn over.

Examiner only

6. In the following Schmitt trigger circuit the op-amp saturates at ± 14 V.

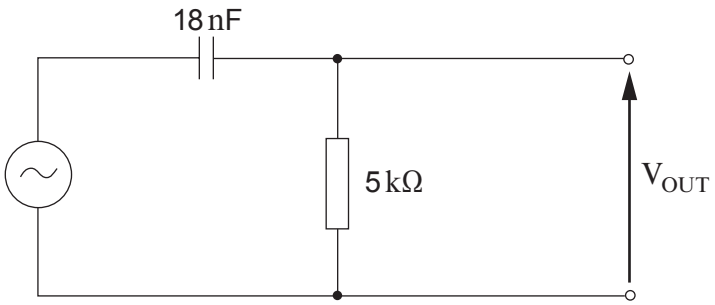


(a) Calculate the value of V_{IN} which causes V_{OUT} to change from +14 V to −14 V. [2]

(b) Calculate the value of V_{IN} which causes V_{OUT} to change from −14 V to +14 V. [2]

Examiner only

7. The following circuit is to be used as a filter.



(a) Calculate the reactance of the capacitor at 400 Hz. [2]

.....

.....

.....

(b) What is the reactance of the capacitor at 40 kHz? [1]

.....

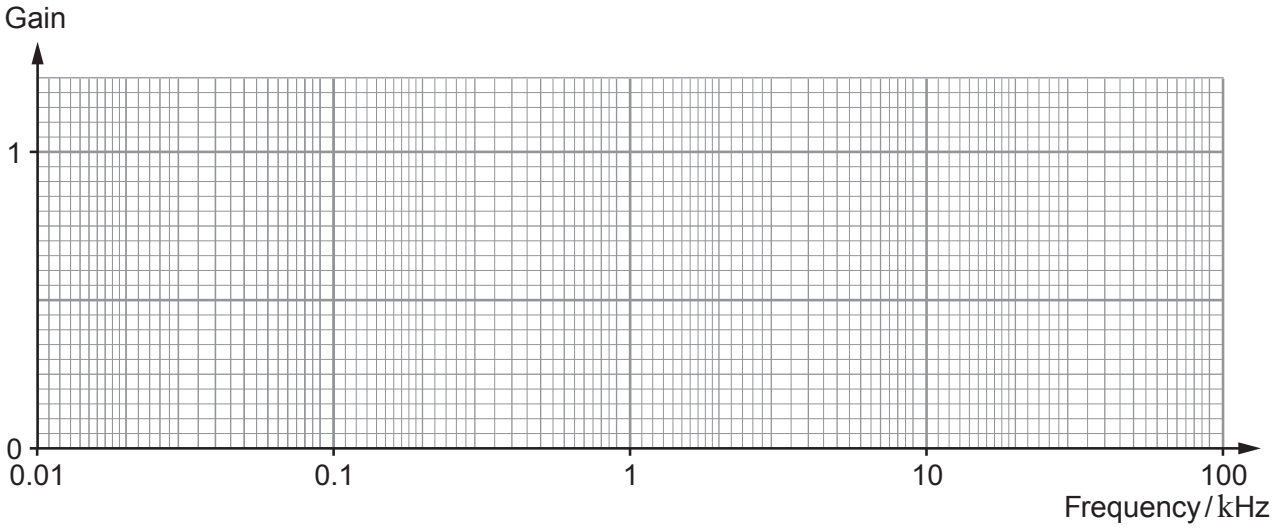
(c) Calculate the break frequency for this filter. [2]

.....

.....

.....

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



END OF PAPER