Candidate Name	Centre Number	Candidate Number
		2

General Certificate of Education
Advanced

384/01

ELECTRONICS
ET4

P.M. WEDNESDAY, 23 January 2008
(1¼ hours)

For Examiner's use only.	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

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 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.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

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.

RC networks	$V_C = V_O (1 - e^{-t/RC})$	for a charging capacitor
	$V_C = V_O e^{-t/RC}$	for a discharging capacitor
	$t = -RC \ln\left(1 - \frac{V_c}{V_o}\right)$	for a charging capacitor
	$t = -RC \ln\left(\frac{V_c}{V_o}\right)$	for a discharging capacitor
Alternating Voltages	$V_o = V_{rms}\sqrt{2}$	
	$X_C = \frac{1}{2\pi fC}$	Capacitive reactance
	$X_L = 2\pi fL$	Inductive reactance
	$f_0 = \frac{1}{2\pi\sqrt{LC}}$	Resonant frequency
	$f_{co} = \frac{1}{2\pi RC}$	Cut-off frequency for high pass and low pass filters
	$\phi = \tan^{-1}\frac{R}{X_C}$	Phase shift between V_R and V_c.
Silicon Diode	$V_F \approx 0{\cdot}7V$	
Bipolar Transistor	$h_{FE} = \frac{I_C}{I_B}$	Current gain
	$V_{BE} \approx 0{\cdot}7V$	in the on state
MOSFETs	$I_D = g_M V_{GS}$	

Operational amplifier	$G = -\frac{R_F}{R_{IN}}$	Inverting amplifier
	$G = 1 + \frac{R_F}{R_1}$	Non-inverting amplifier
	$V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$	Summing amplifier
	$\text{Slew Rate} = \frac{\Delta V_{OUT}}{\Delta t}$	Slew rate
	$V_{OUT} = V_{DIFF}\left(\frac{R_F}{R_1}\right)$	Difference amplifier
	$V_L \approx V_Z\left(1 + \frac{R_F}{R_1}\right)$	Stabilised power supply
Power Amplifier	$P_{MAX} = \frac{V_S^2}{8R_L}$	where V_S is rail-to-rail voltage
555 Monostable	$T = 1 \cdot 1\ RC$	
555 Astable	$t_H = 0 \cdot 7\ (R_A + R_B)C$	
	$t_L = 0 \cdot 7\ R_B C$	
	$f = \frac{1 \cdot 44}{(R_A + 2R_B)C}$	
Schmitt Astable	$f \approx \frac{1}{RC}$	

1. *(a)* Noise and distortion are two undesirable effects in a communications system. Explain what is meant by

(i) noise,

....

....

....

(ii) distortion.

....

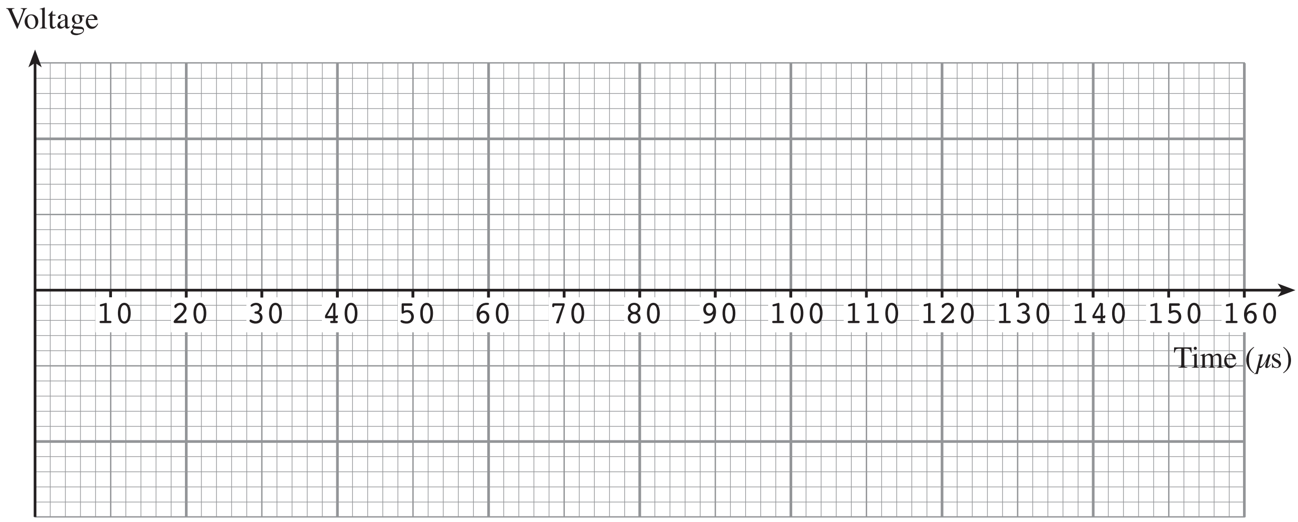
....

....

[2]

(b) A radio station broadcasts its programs using amplitude modulation (AM).

(i) A 10 kHz test signal is to be broadcast on a 100 kHz carrier wave, with 50% depth of modulation. Use the axes below to draw the resulting Amplitude Modulated Carrier. [4]



(ii) What advantage would be gained if the radio station broadcast its programs using frequency modulation instead of amplitude modulation.

....

....

....

[1]

Examiner only

2. The internet currently uses a 32 bit binary address to identify each website. The following binary number is an example of one such address.

10101100 00001110 00110100 11010100

(a) A shorthand way of writing this binary number is to use *dotted decimal notation*. Convert the binary number given above into *dotted decimal notation*.

....

[2]

(b) Here are five dotted decimal notation numbers.

A. 255.207.93.130 B. 127.89.45.259

C. 16.87.190.22 D. 156.99.160.204

E. 122.55.255.31

(i) Which of these cannot represent an IP address ? .... [1]

(ii) Explain why you have chosen your answer to part (i).

....

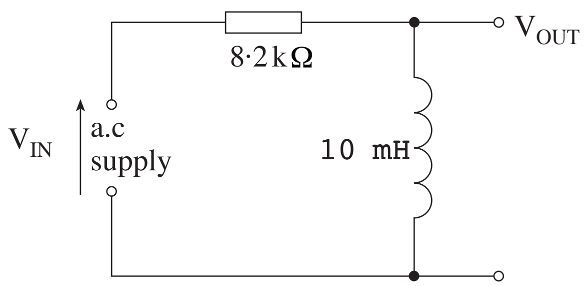
....

....

....

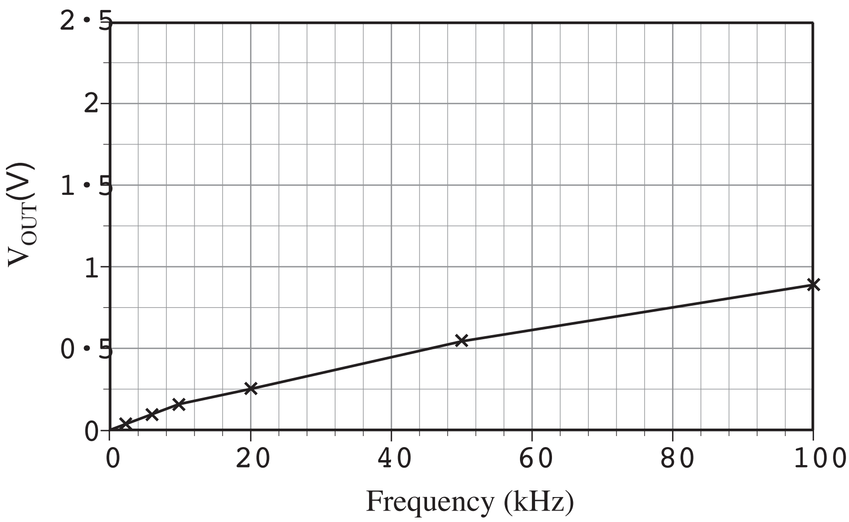
[1]

3. A student investigates the effect of inductors and capacitors in a.c. circuits. The circuit used is shown below with a resistor and an inductor.



The voltage V_{OUT} was measured at six different frequencies with V_{IN} kept constant at 2 V. The results are shown on the graph.

A graph to show how Output Voltage changes with frequency



Examiner only

(a) The inductor in the circuit is then replaced with a 0·47 nF capacitor. The following results are obtained.

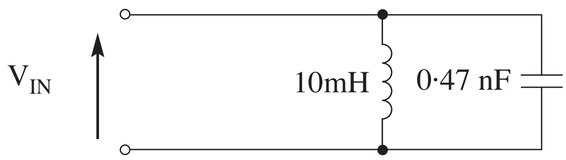
Capacitor Results		
V_{IN}(V)	f(kHz)	V_{OUT}(V)
2	1	1·95
2	2	1·91
2	5	1·78
2	10	1·61
2	20	1·35
2	50	0·90
2	100	0·58

(i) **On the same axes**, plot the results for the capacitor. [2]

(ii) At what frequency is the output voltage the same for the two circuits?

.... [1]

(b) The inductor and capacitor are now joined together to make a tuned circuit as shown below.



Calculate the resonant frequency of this circuit (Use the appropriate formula from the information page).

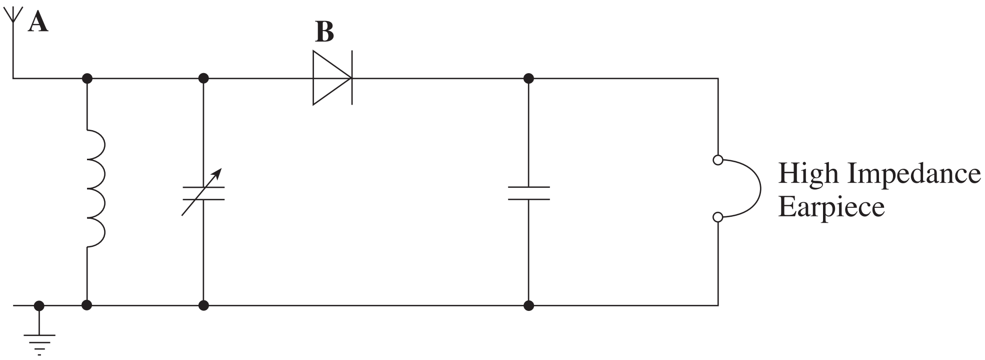
....

....

.... [2]

Examiner only

(c) This tuned circuit is modified and used in the simple radio receiver as shown in the circuit diagram below.



(i) What is the purpose of the modification made to the tuned circuit?

....

.... [1]

(ii) What is the purpose of the part of the circuit labelled **A** ?

....

.... [1]

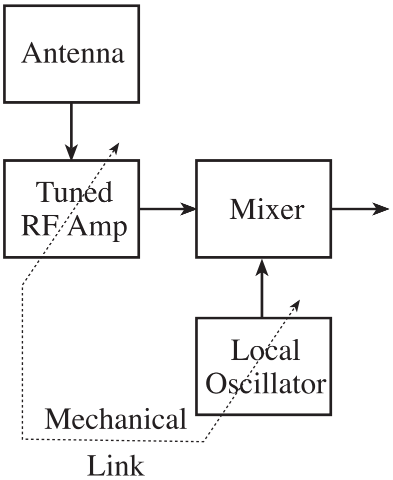
(iii) What is the purpose of the part of the circuit labelled **B** ?

....

.... [1]

Examiner only

4. The superheterodyne radio receiver offers improved selectivity and sensitivity compared with the radio receiver. The front end of the superheterodyne receiver is shown below:



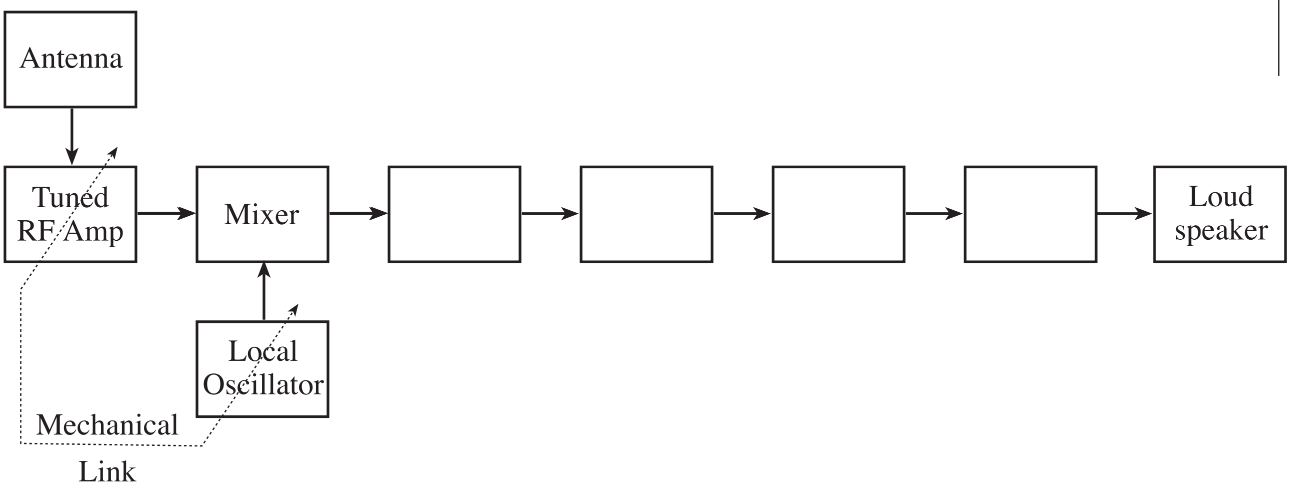
(a) The tuned RF amplifier has been tuned to a frequency of 1·4 MHz. The local oscillator output is measured at 1·87 MHz. What **four** frequency signals will be present at the output of the mixer? [2]

....

....

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

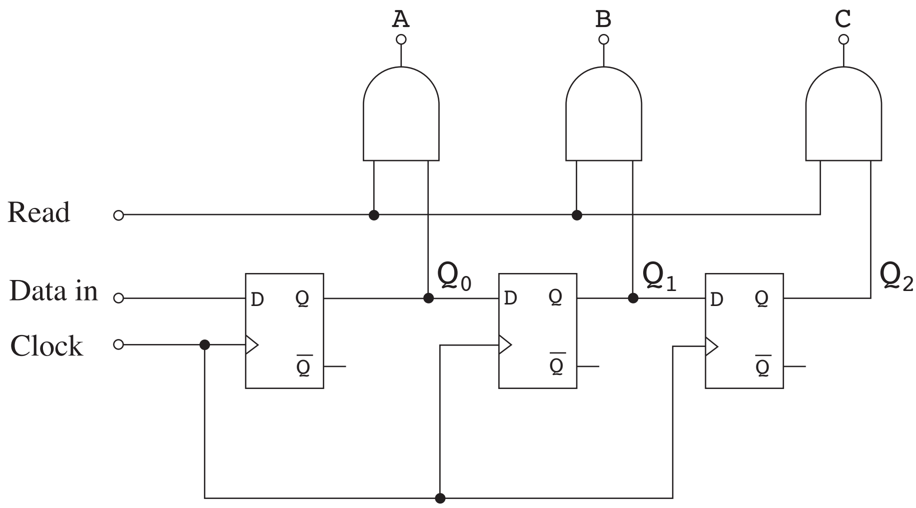
(c) Complete the following block diagram of the full superheterodyne receiver. [4]



Turn over.

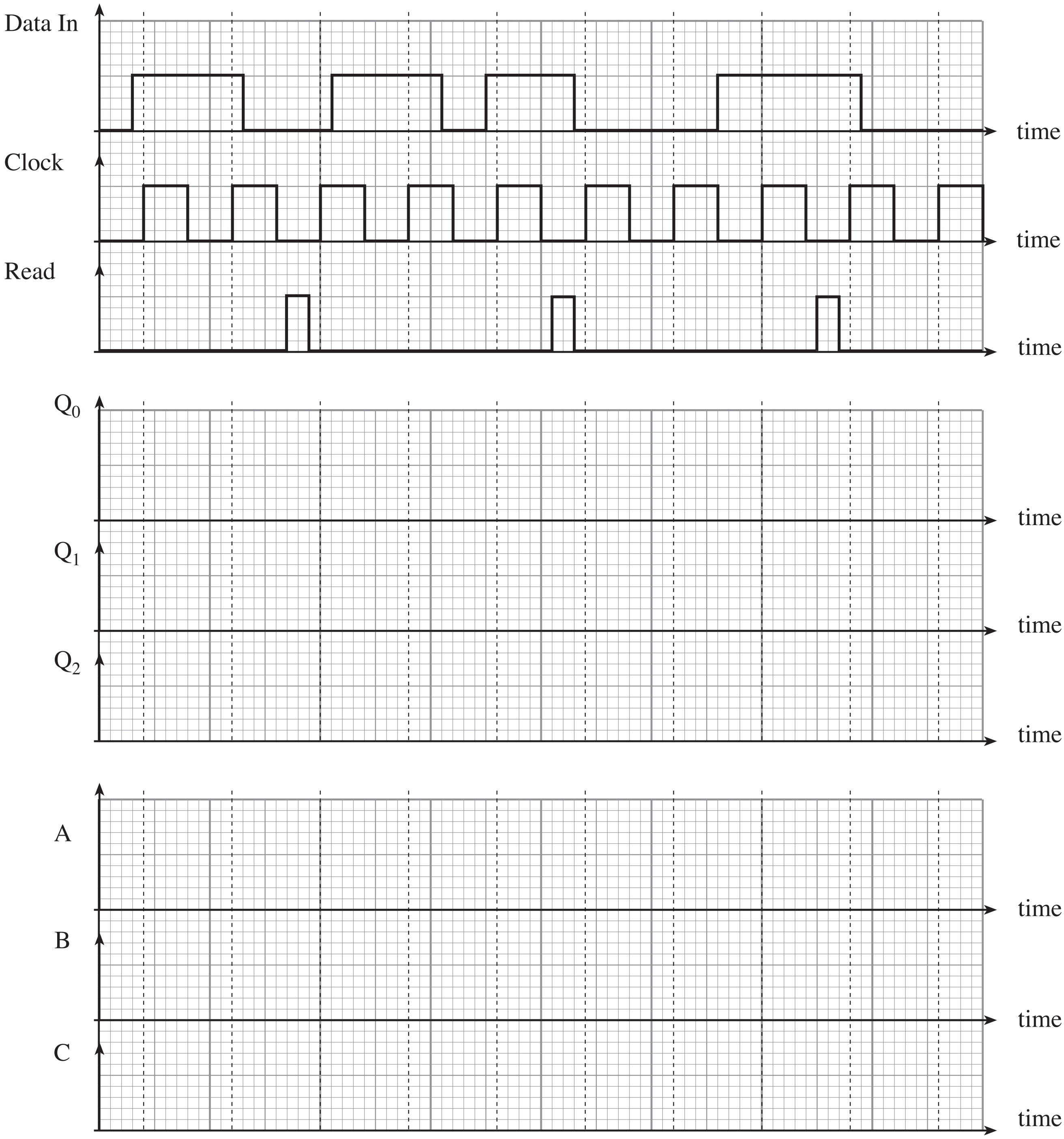
Examiner only

5. The following diagram shows a 3-bit Serial-In-Parallel-Out (SIPO) shift register. It is made from *rising-edge-triggered* D-Type flip flops. Initially **all** inputs and outputs are at Logic 0.



Examiner only

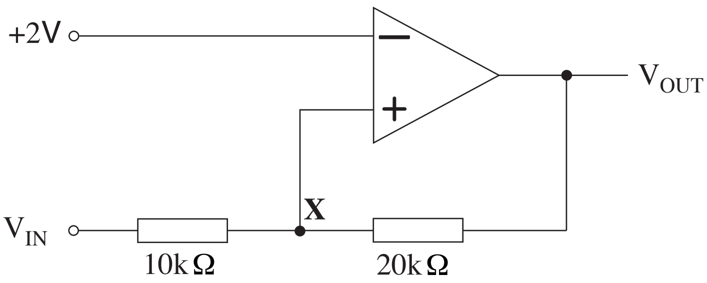
Complete the following graphs to show the outputs Q_0 - Q_2, and A-C in response to the given 'Clock', 'Data In' and 'Read' signals.



[6]

Turn over.

6. The following circuit diagram shows an op-amp connected as a Schmitt trigger. The op-amp saturates at +10 V and 0 V.



(a) Calculate the voltage at **X** when V_{IN} = +7 V and V_{OUT} = +10 V. [2]

....

....

....

....

(b) Calculate the value of V_{IN} that causes V_{OUT} to change from 0 V to 10 V. [2]

....

....

....

....

(c) Calculate the value of V_{IN} that causes V_{OUT} to change from 10 V to 0 V. [2]

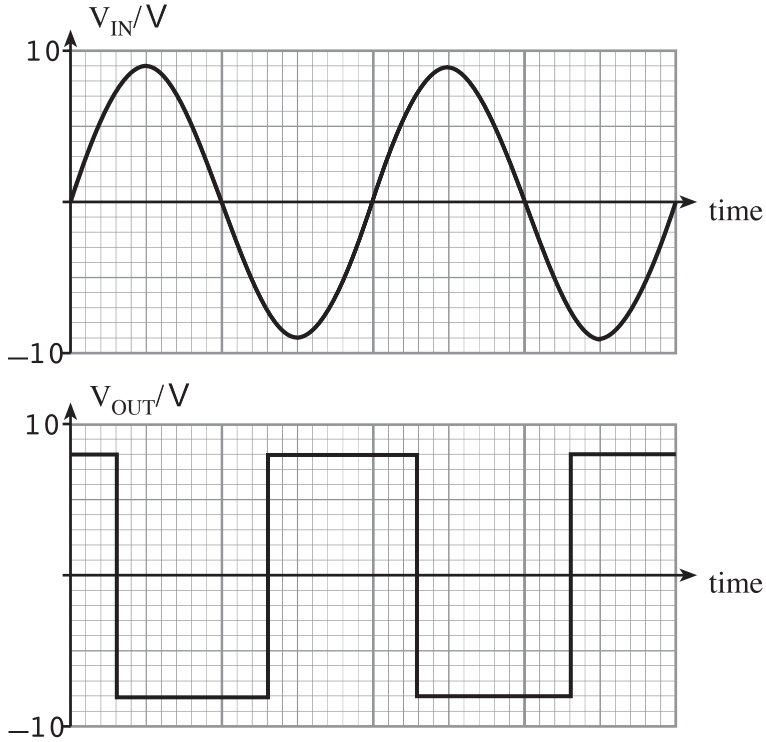
....

....

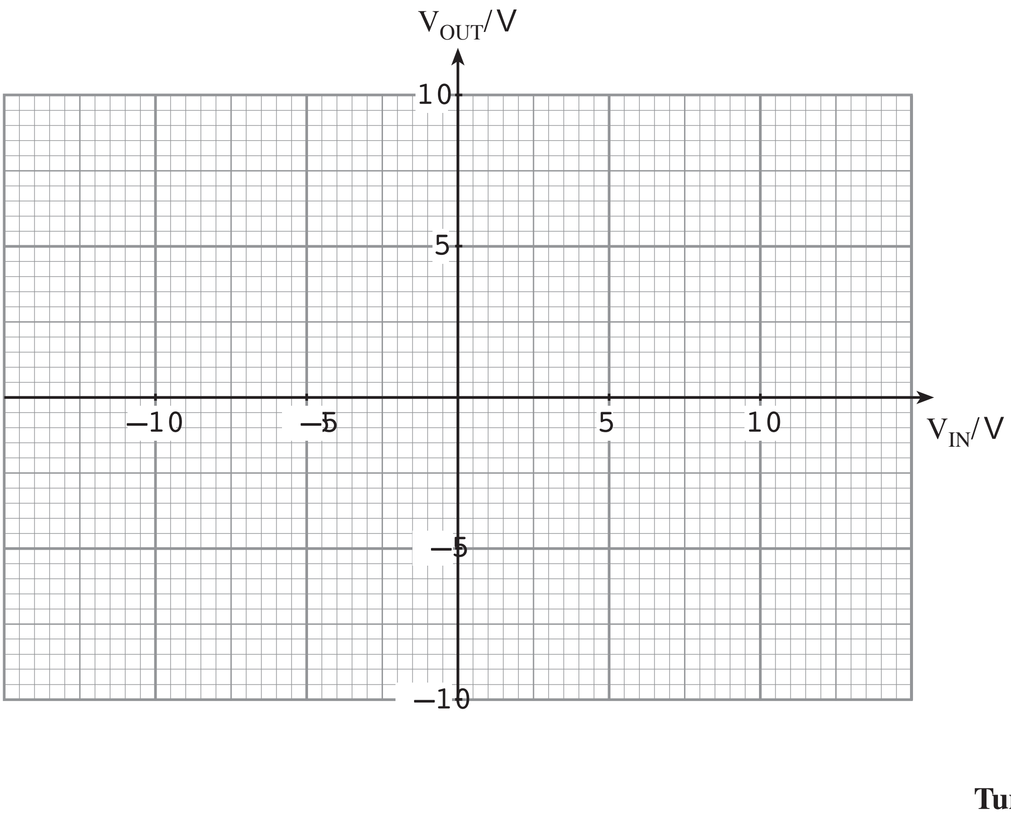
....

....

(d) A **different** Schmitt trigger is used as a regenerator for a transmission line. A sinusoidal waveform used as a test signal gives the output shown on the graph below.

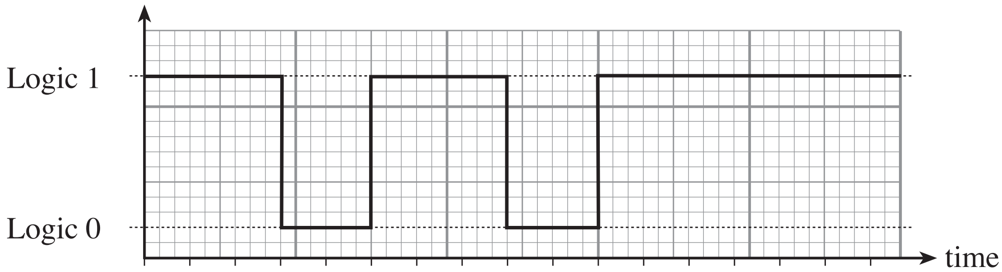


Sketch the characteristic for V_{OUT} against V_{IN} for this Schmitt trigger using the axes provided. [3]



7. The graph shows the waveform of a signal transmitted from a computer.

The signal carries the ASCII code for an alphanumeric character.



The signal includes a start bit, a stop bit, a parity bit, and 7 data bits corresponding to the ASCII character.

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

(ii) Write down the 7 bit character code. .... [2]

(iii) There is no error in the transmitted signal. Use the graph to work out if the system used odd or even parity.

The system uses .... parity. [1]

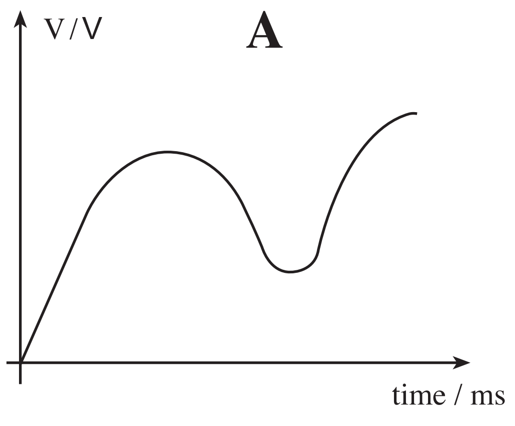
Examiner only

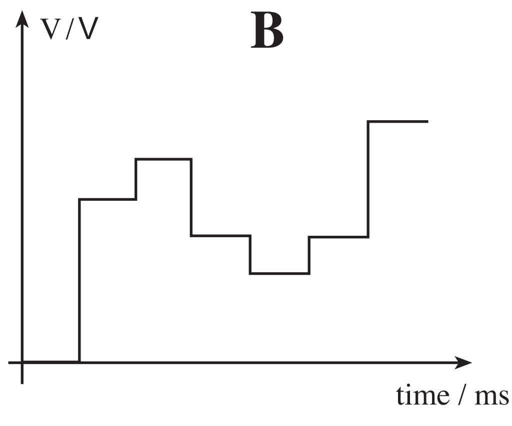
8. The receiver of a Pulse Code Modulation system is constructed from the following subsystems:

SIPO shift register *2 MHz Clock* *Schmitt Trigger*
Low pass filter *Digital to Analogue Converter (DAC)*

(a) Draw the block diagram for this receiver, using **only** these sub-systems. [2]

(b) The following graphs show the output of two subsystems in the PCM receiver.





(i) Which subsystem produces the output shown by Graph **A**?

....

(ii) Which subsystem produces the output shown by Graph **B**?

....

[2]

FOR USE ONLY IF YOU HAVE MADE SUBSTANTIAL DELETIONS IN PARTS OF YOUR ANSWERS OR NEED MORE SPACE TO COMPLETE THEM. BE SURE TO INDICATE THE QUESTIONS CONCERNED.