Surname	Centre Number	Candidate Number
Other Names		

GCE A level

1144/01

ELECTRONICS – ET4

A.M. FRIDAY, 24 January 2014

1 hour

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

$$f_b = \frac{1}{2\pi RC}$$ 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

$$\text{Bandwidth} = 2(\Delta f_c + f_i)$$
$$\text{Bandwith} = 2(1+\beta)f_i$$
} Transmitted FM Bandwidth

Radio receivers

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

Examiner only

1. Communication systems use a number of different types of filters.

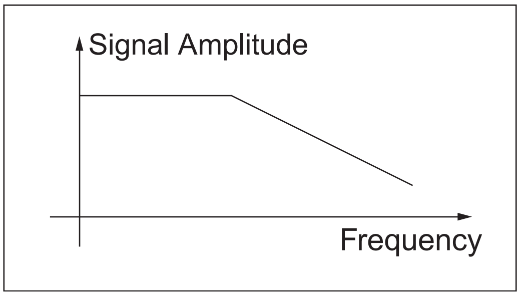
Draw a line to match the name of the filter to its characteristic. [3]

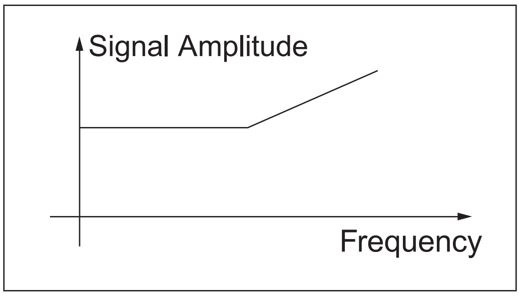
Name of Filter | **Filter Characteristic**

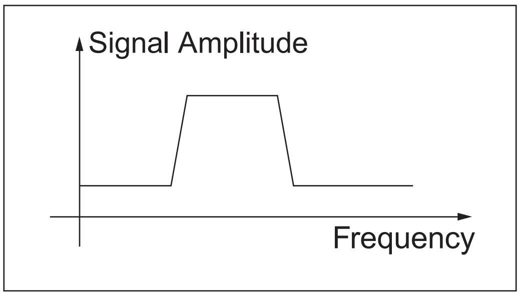
Band pass filter

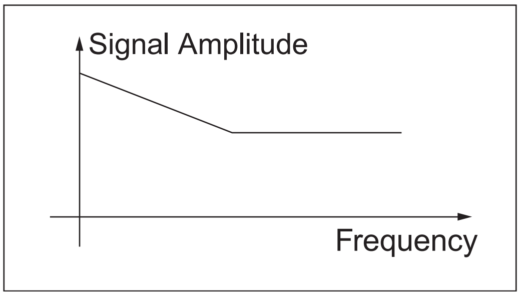
Low pass filter

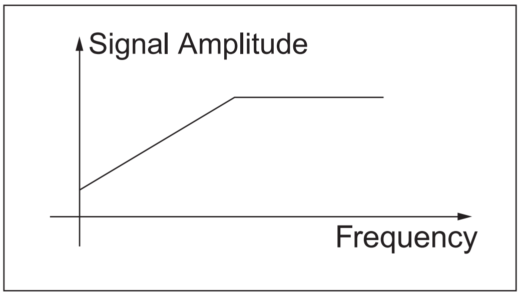
High pass filter











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2. *(a)* The following table contains some statements about AM and FM transmissions. Complete the table by writing True or False after each statement. [4]

Statement	True / False
The modulators and demodulators for AM are more complex than for FM.	
The AM bandwidth needed for a given information baseband is greater than that required for FM.	
All communication systems pick up noise. This has the effect of degrading the output signal of the AM receiver.	
In an FM signal with a modulation index $\beta=3$, the amplitude of the carrier is smaller than the sideband signals.	

(b) In national radio broadcasts using FM, the frequency deviation of the carrier, Δf_c is chosen to be 90 kHz. The range of the audio baseband is 20 Hz to 18 kHz.

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

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

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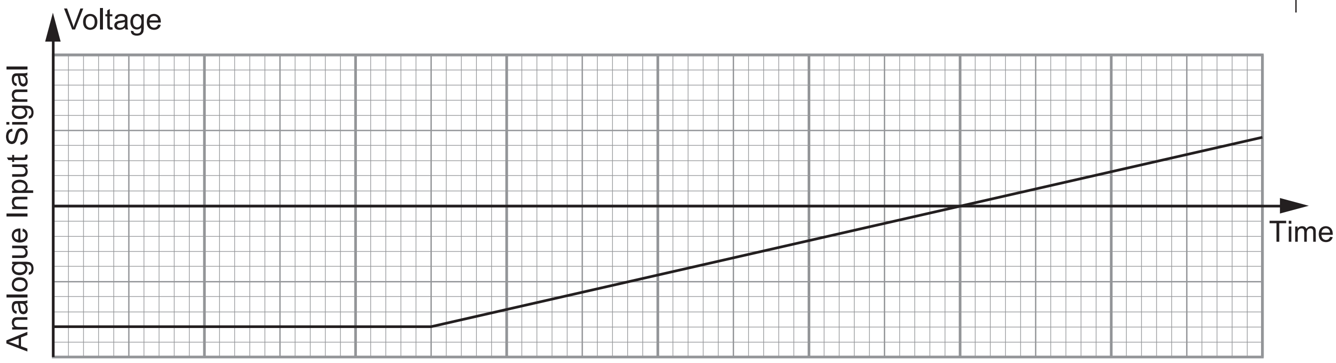
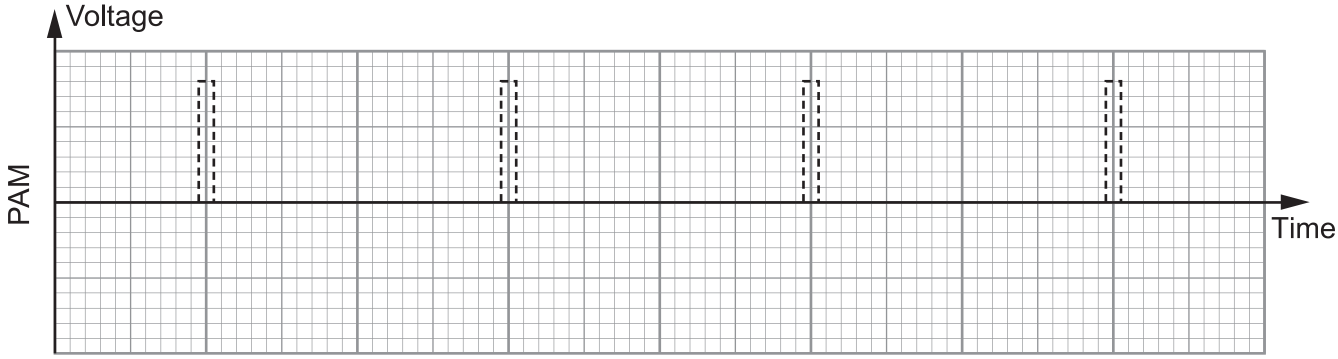
3. Pulse Amplitude Modulation (PAM), and Pulse Position Modulation (PPM), are two methods of modulating information.

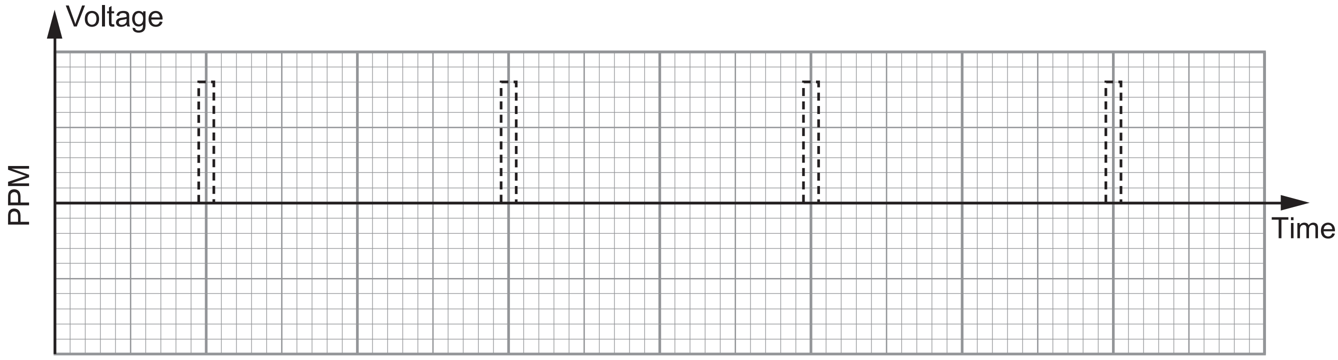
Use the grids below to draw the output observed when the analogue input signal is transmitted using:

(i) PAM

(ii) PPM [4]







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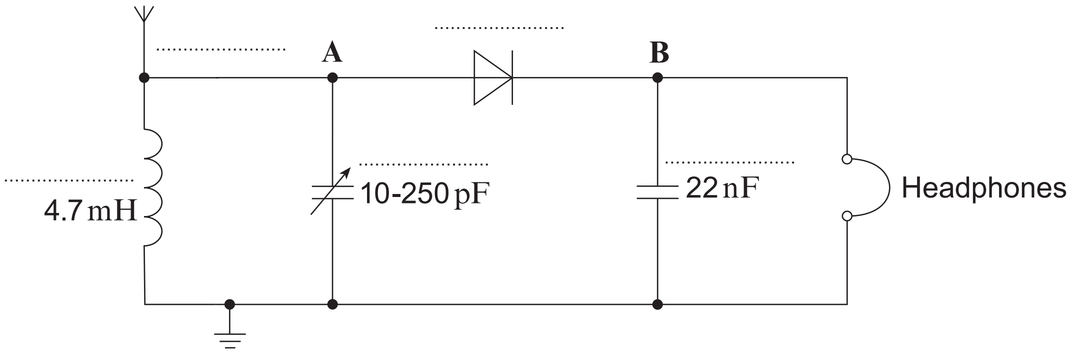
4. The circuit diagram for a simple radio receiver is shown below.



(a) Complete the circuit diagram by labelling the:

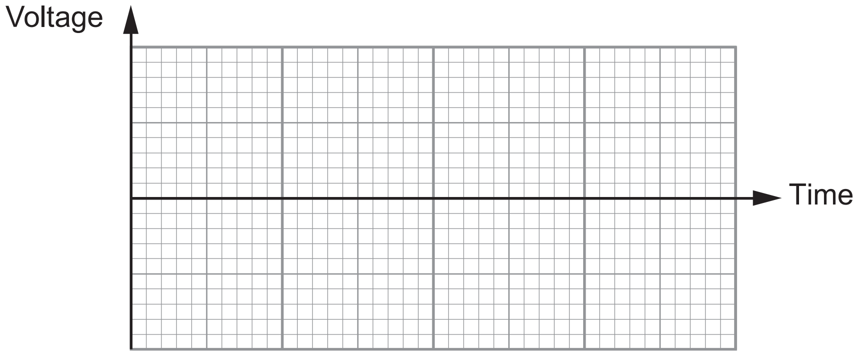
(i) component that separates the high frequency carrier signal from the audio signal, with the letter **S**; [1]

(ii) component that carries multiple high frequency carrier signals at all times, with the letter **M**; [1]

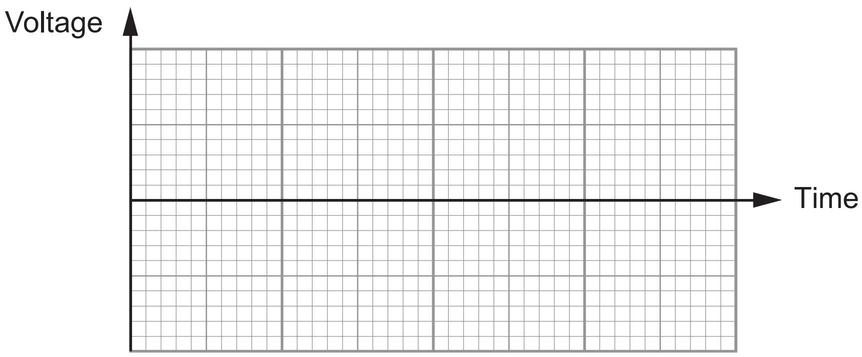
(iii) two components that pick out a single RF carrier signal, with the letters **P** & **Q**. [1]

(b) The receiver is tuned to a radio station.

(i) On the axes below sketch the signal at point **A**. [1]



(ii) On the axes below sketch the signal at point **B**. [1]



(c) Show by calculation whether or not this radio circuit would be suitable for someone to listen to Radio 5 Live, transmitting at a frequency of 909 kHz. [3]

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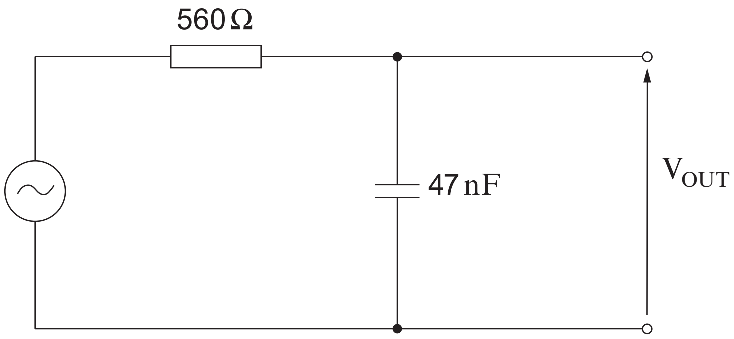
5. The following circuit diagram shows a passive RC filter.



(a) What is the name of this type of passive RC filter? .... [1]

(b) Calculate the reactance of the capacitor at 100 Hz. [2]

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(c) Estimate the reactance of the capacitor at 10 kHz. [1]

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

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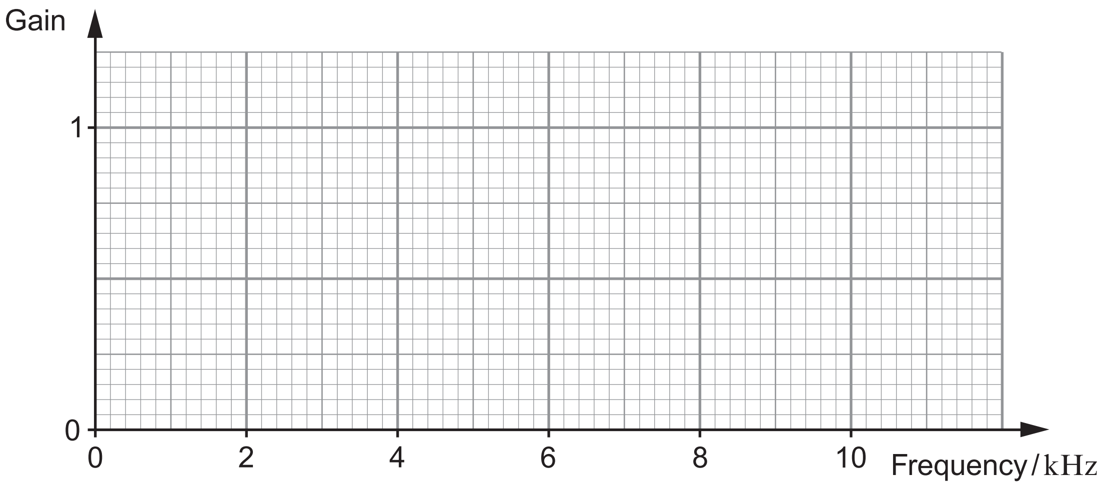
(e) Draw the characteristic of this filter. [2]



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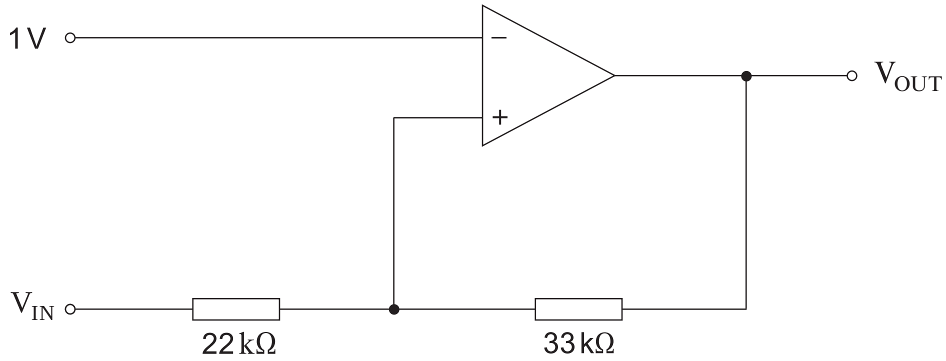
6. A Schmitt trigger is shown in the following circuit diagram.



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]

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(c) Give a use of a Schmitt trigger in a communications system. [1]

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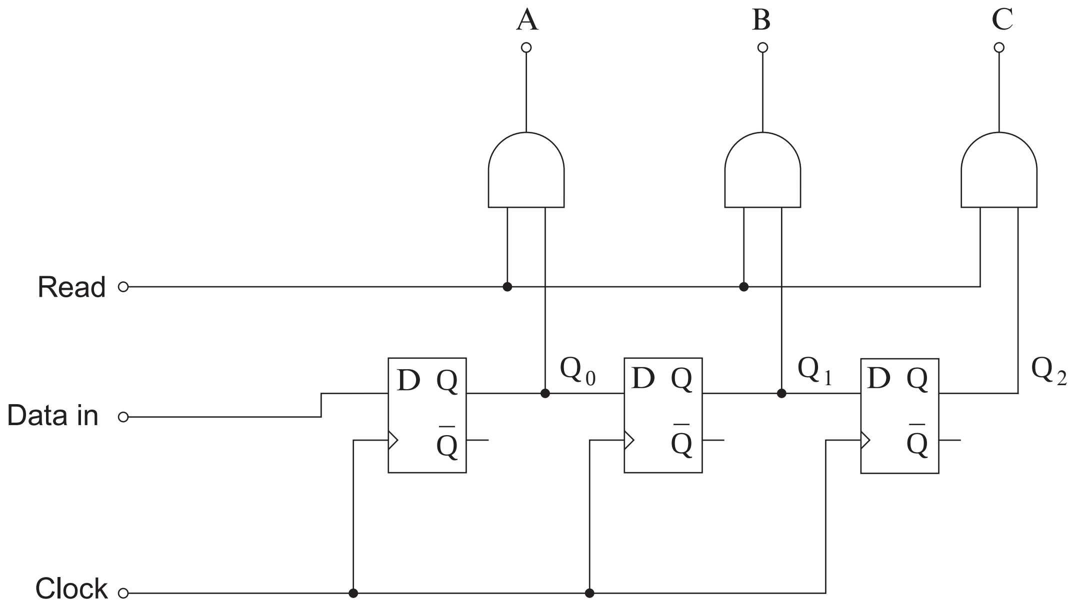
7. The following diagram shows a 3-bit *Serial-In-Parallel-Out* shift register. It is made from *rising-edge-triggered* D-Type flip flops. Initially **all** inputs and outputs are at Logic 0.



Complete the graphs opposite to show the outputs Q_0-Q_2, and A-C in response to the given 'Clock', 'Data in' and 'Read' signals. [6]

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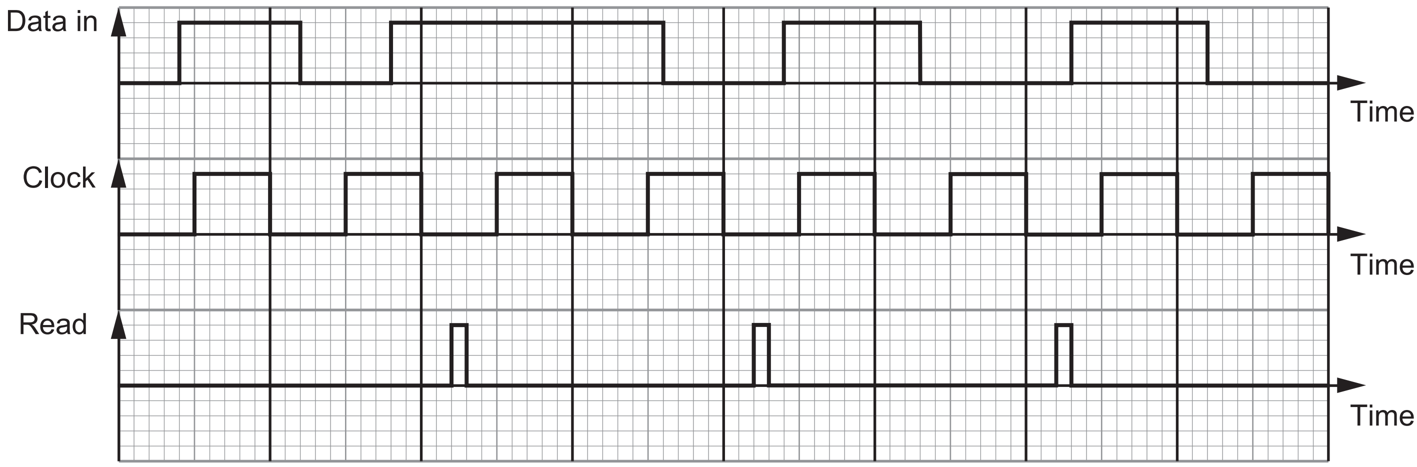

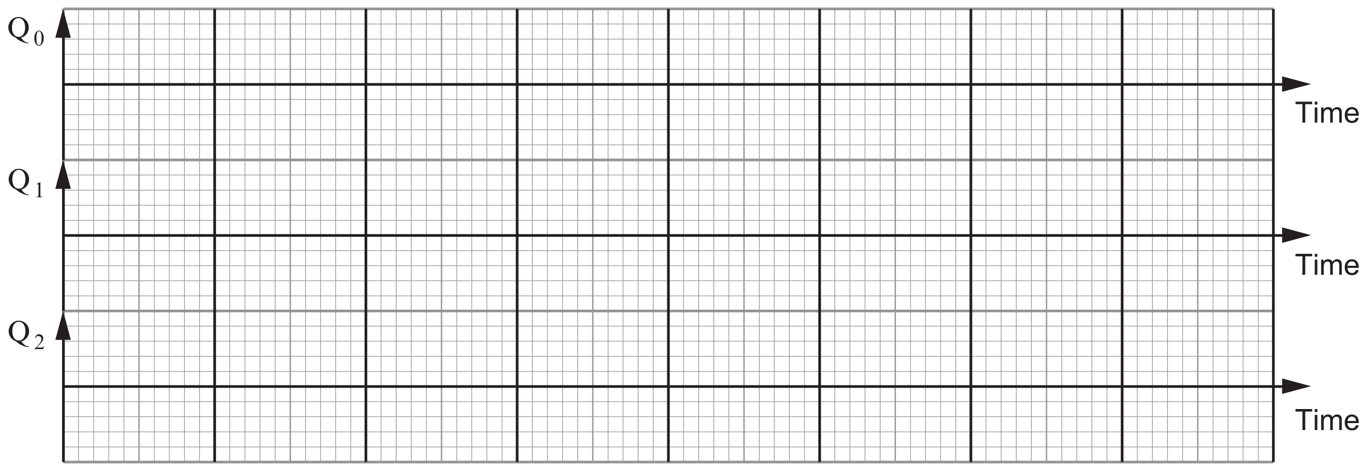

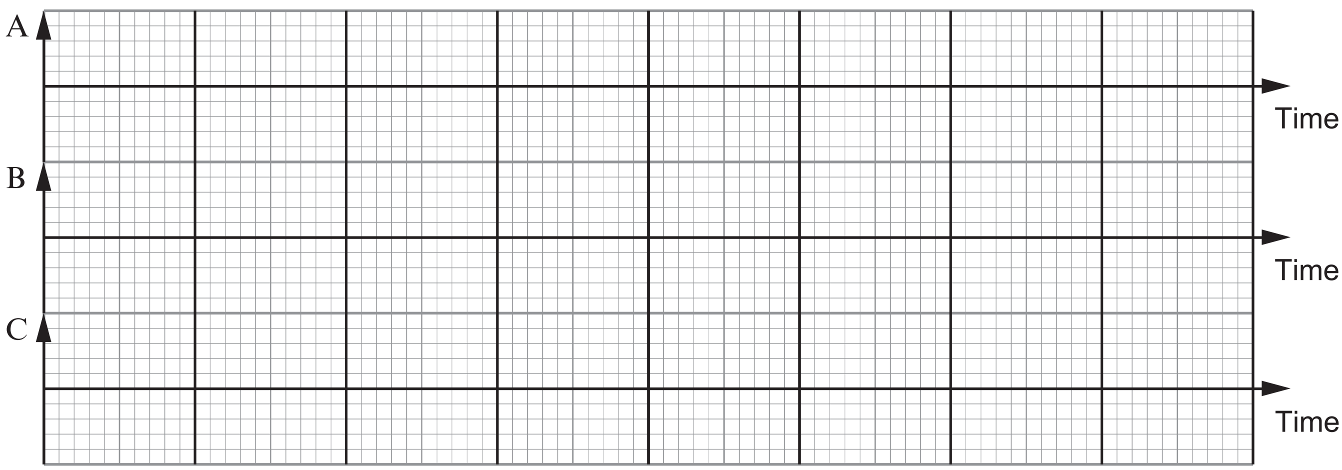

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8. An asynchronous data transmission system uses a four bit parity system, with the parity bits assigned to the data bits in accordance with the following table.

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	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			

(a) The following data will be transmitted.

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

Determine the values of the parity bits P_3 - P_0 that should be transmitted with this data for an **even** parity system. Complete the table. [2]

(b) The following data and parity bits are received from a transmission line of a system using **even** parity.

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

There is a **single** error in the received data.

(i) Which parity bits fail the parity test? .... [1]

(ii) Determine where the error is located and write down the corrected version of the received data. [1]

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

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(c) The following data and parity bits are received from a system using **even** parity.

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

There is **still** a **single** error in the received data.

(i) In this case the received data **cannot** be reconstructed with any certainty. Use the information provided in the received signal to explain why this is the case. [2]

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(ii) How could the system be modified so that this error could be both detected and corrected? [2]

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END OF PAPER

