Candidate forename		Candidate surname	

Centre number						Candidate number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED GCE

F615

ELECTRONICS

Communication Systems

FRIDAY 10 JUNE 2011: Afternoon
DURATION: 1 hour 40 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the question paper.

OCR SUPPLIED MATERIALS:

Loose sheets containing a Datasheet and Boolean Algebra
Loose sheets for questions 4, 6 and 7

OTHER MATERIALS REQUIRED:

Scientific calculator

READ INSTRUCTIONS OVERLEAF

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INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).**
- **Answer all the questions.**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **The total number of marks for this paper is 110.**
- **You will be awarded marks for the quality of your written communication where this is indicated in the question.**
- **You are advised to show all the steps in any calculations.**
-

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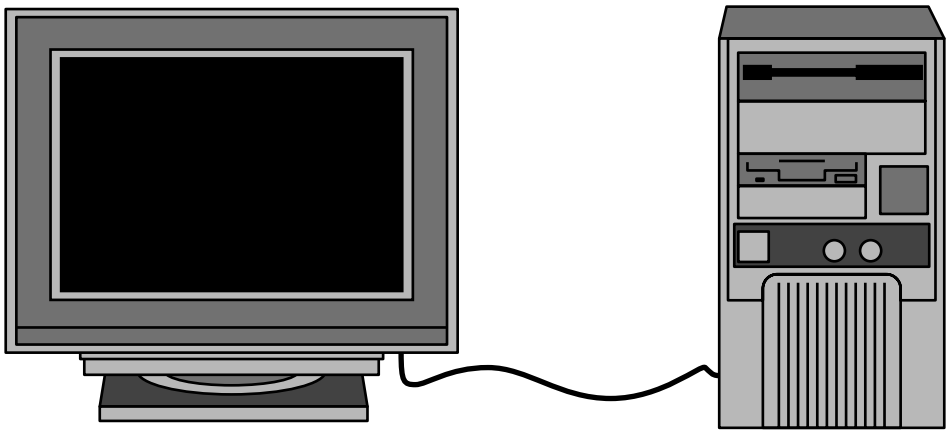
Answer ALL questions.

1 A computer transfers signals along a cable to a video screen.



(a) The cable carries five different signals along parallel wires.

(i) State the names of the five signals.

_____

_____

_____ **[3]**

(ii) Some of the wires carry information as analogue signals.

They could carry digital signals instead.

Explain the advantages of sending information as digital signals.

_____

_____

_____

_____

_____ **[4]**

(b) A single wire can carry the same information from the computer to the screen using digital signals. One method transmits pictures with a grey scale using five-bit words to determine the brightness of the pixels on the screen.

(i) How many different brightness levels can each pixel have?

number of levels = _____ **[1]**

(ii) The video screen contains 600 lines of pixels, with 850 pixels in each line.

Calculate the number of bits of information required for a single picture.

information = _____ bits [2]

(iii) The frame refresh rate is 40 Hz. This is above the minimum value for video systems.

State and explain a value for the MINIMUM frame refresh rate for video systems.

_____

_____

_____ **[2]**

(c) For the method described in (b), do a calculation to estimate the minimum bandwidth required for the cable connecting the computer to the screen.

bandwidth = _____MHz [2]

(d) Another method of carrying information from the computer to the screen requires the computer to compress the information before transmitting it to the screen.

(i) Explain an advantage of compressing the information.

_____

_____

_____ **[2]**

(ii) Suggest a disadvantage of using compression.

_____

_____ **[1]**

[Total: 17]

2 Fig. 2.1 is an incomplete block diagram for a simple AM radio receiver.

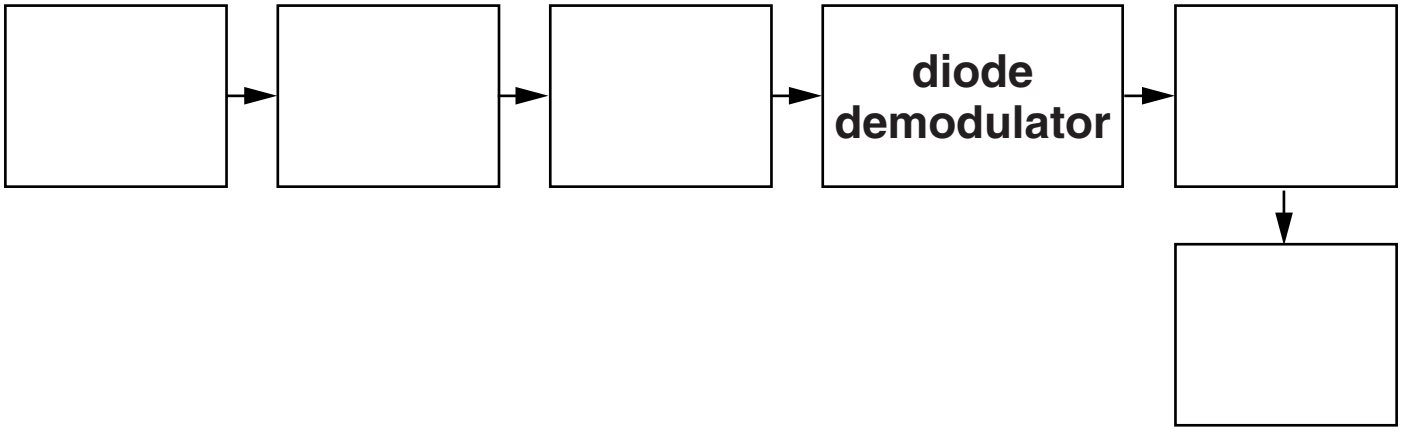


Fig. 2.1

(a) Complete the diagram. Choose words from the list below.

aerial

af amplifier

loudspeaker

rf amplifier

tuned circuit

[4]

(b) The af amplifier is required to have a gain of –50.

Draw on Fig. 2.2 below to show how the amplifier can be made from an op-amp.

State component values and justify them.

[4]

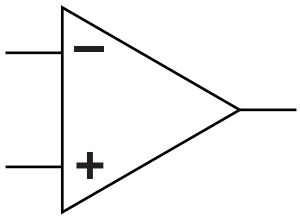


Fig. 2.2

(c) The radio system contains a tuned circuit.

(i) Describe the function of the tuned circuit.

_____

_____ **[1]**

(ii) The tuned circuit determines the selectivity of the system.

Explain what is meant by selectivity.

_____

_____

_____ **[2]**

(iii) **Another important property of a radio receiver is its sensitivity.**

Explain ONE change to the system of Fig. 2.1 which would improve its sensitivity.

_____

_____

_____

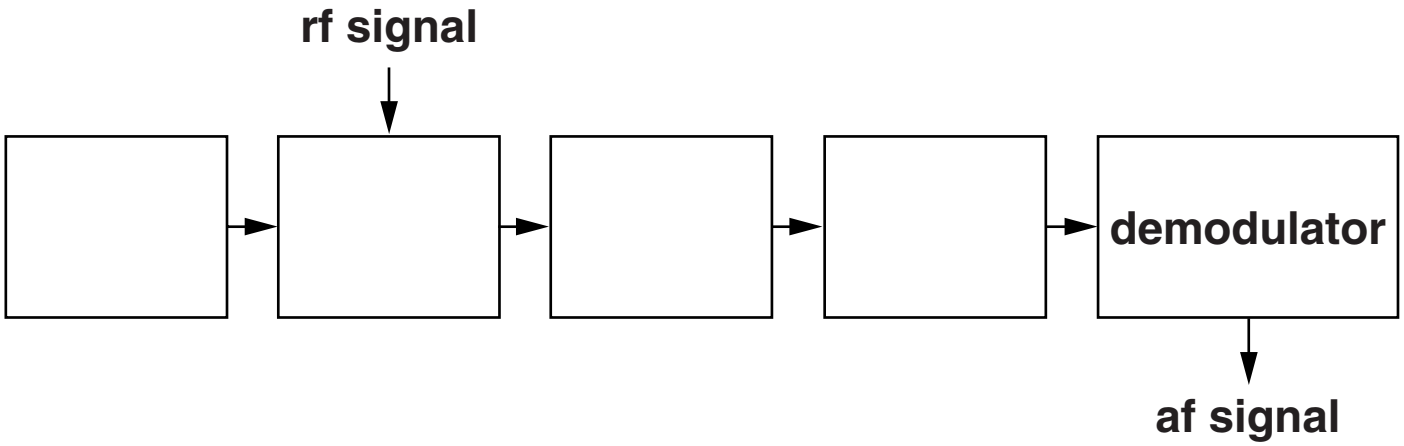
_____ **[3]**

(d) A superhet radio receiver performs better than a simple AM receiver.

(i) **Complete the block diagram below for a superhet receiver below.**

Choose words from this list.

if amplifier
if filter
local oscillator
mixer



[3]

(ii) The bandpass filter in the superhet receiver is centred on 350 kHz.

By describing the flow of signals through the receiver, explain how it can be tuned to receive a channel at 870 kHz.

_____

_____

_____

_____

_____

_____ **[4]**

[Total: 21]

3 Fig. 3.1 is the block diagram of a pulse-width modulator.

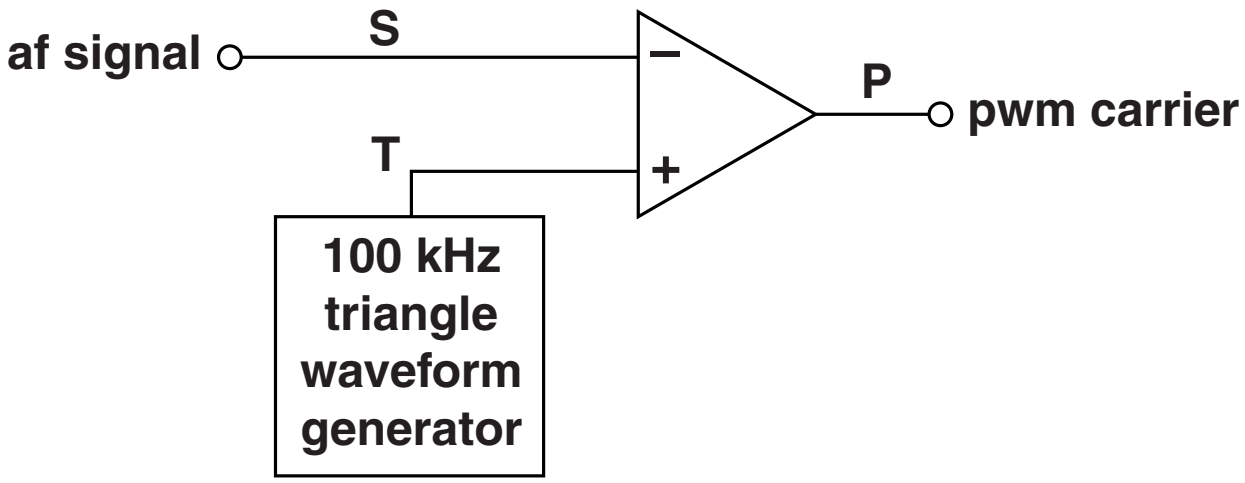


Fig. 3.1

(a) The signal at T is a triangle waveform with an amplitude of 7.5V and a frequency of 100 kHz.

(i) Calculate the period of the waveform.

period = _____ μs [1]

Fig. 3.2 shows a steady signal of +2.5V at S.

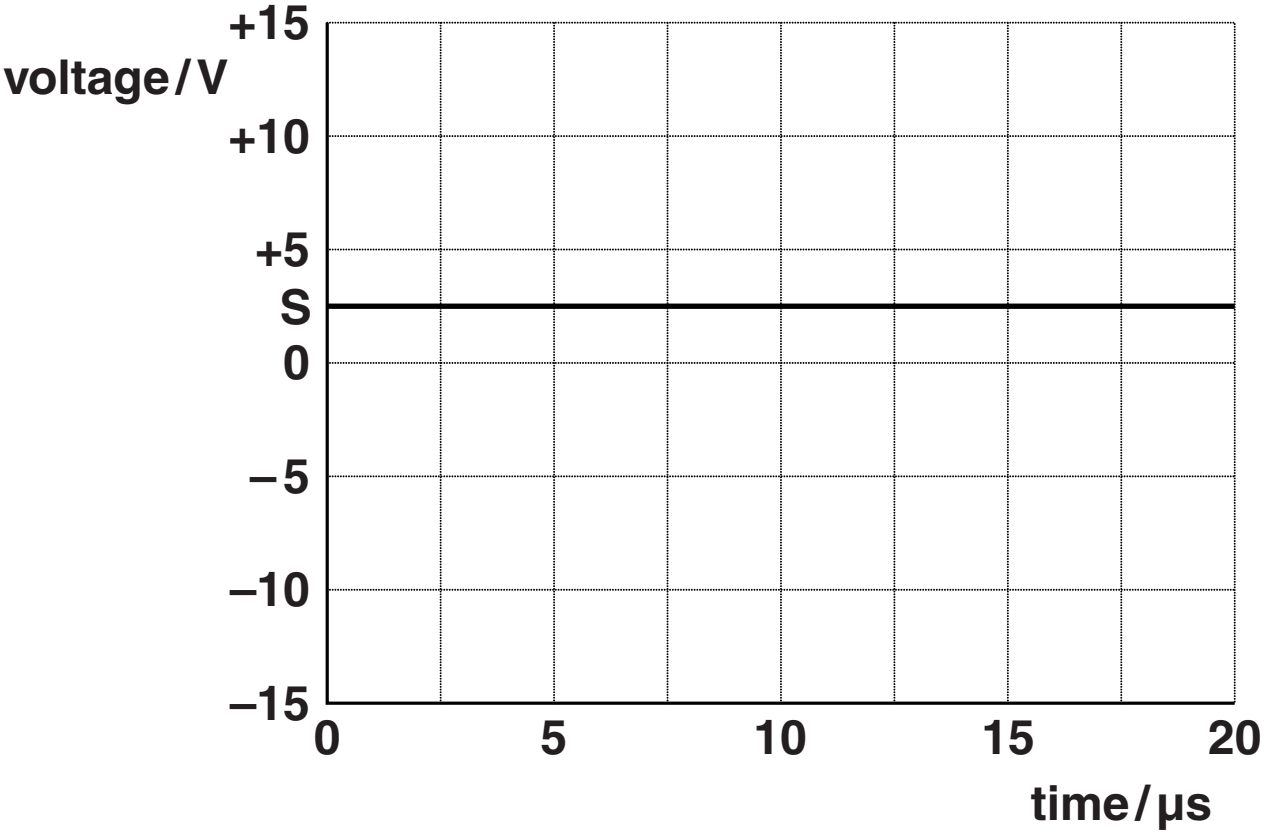


Fig. 3.2

(ii) On the axes of Fig. 3.2, sketch the waveform of the signal at T. [3]

(iii) On the axes of Fig. 3.2, sketch the waveform of the signal at P. [3]

(b) The pwm carrier at P in Fig. 3.1 can be demodulated by a filter with the transfer characteristic of Fig. 3.3.

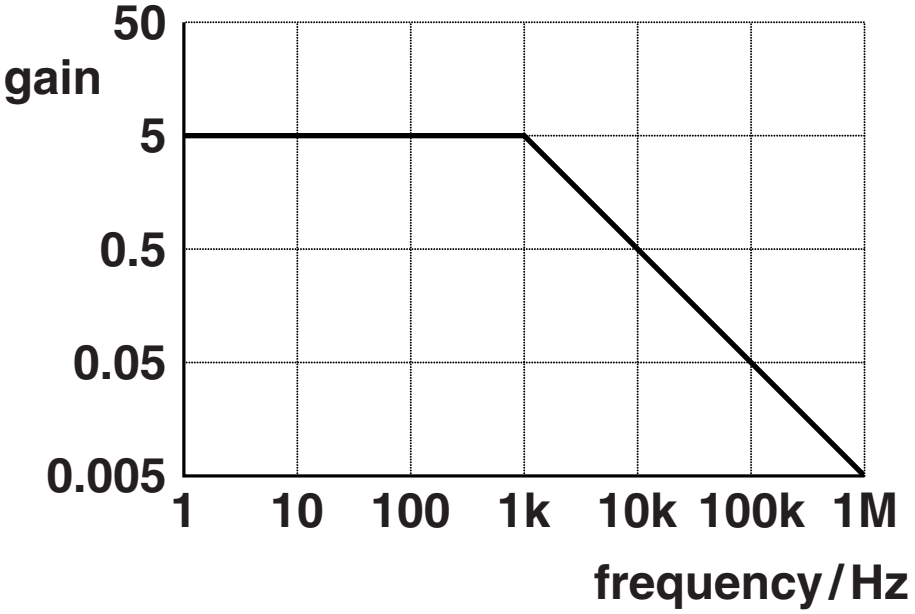


Fig. 3.3

(i) Draw on Fig. 3.4 below to show how the filter can be made with an op-amp.

Show all component values and justify them.

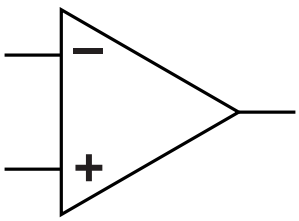


Fig. 3.4

[5]

(ii) Explain the factors that limit the range of af signals at S in Fig. 3.1 which can be transmitted by this pulse-width modulation system.

_____

_____

_____

_____

_____

_____ **[3]**

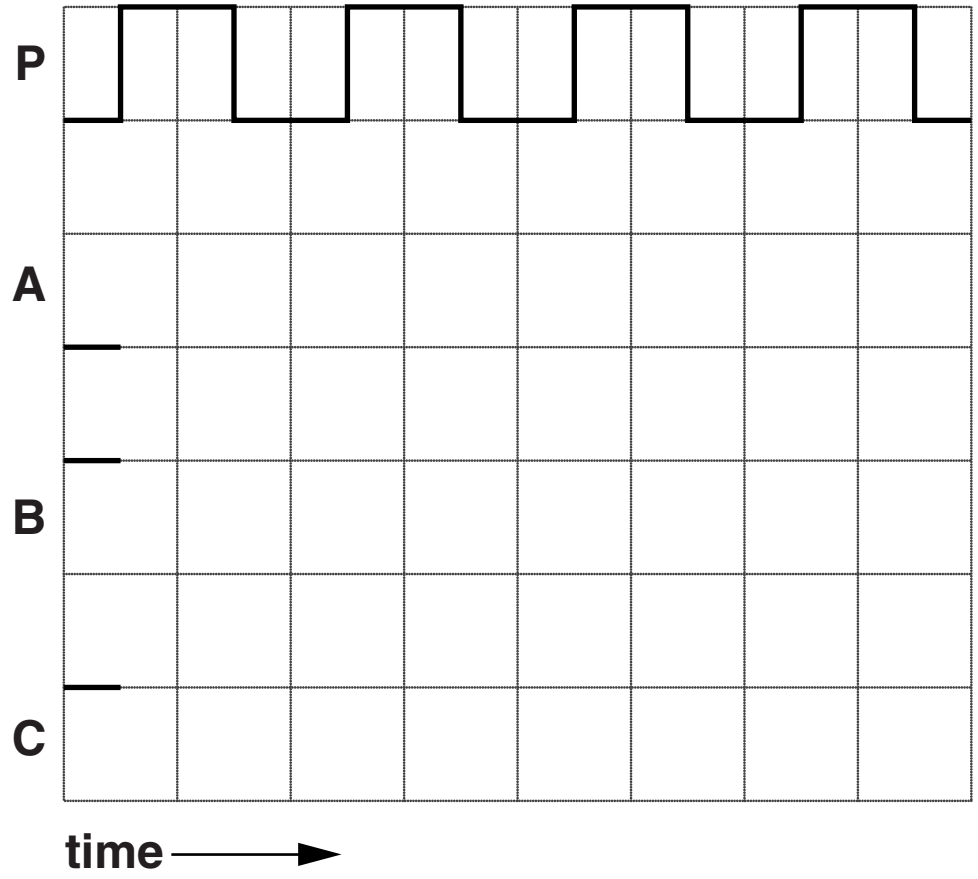
[Total: 15]

4 The circuit of Fig. 4.1 on a loose sheet is an analogue-to-digital converter (ADC).

(a) Show that the pulses at P have a frequency of about 100 kHz.

[2]

(b) Complete the timing diagram below for the counter. CBA is initially 110.



[3]

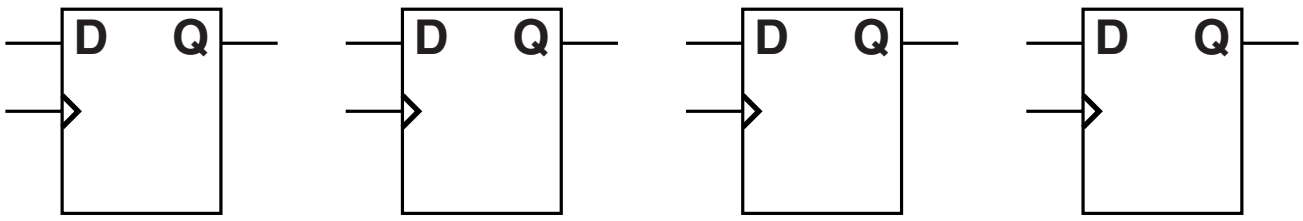
(c) The digital-to-analogue converter (DAC) of Fig. 4.1 has a resolution of 0.1V.

The lowest voltage at S is 0.0V. Calculate the highest voltage.

highest voltage = _____ V [2]

(d) Draw on the diagram below to show how the latch of Fig. 4.1 can be made from D flip-flops.

Label all inputs and outputs.



[3]

(e) Explain how the analogue-to-digital converter of Fig. 4.1 operates.

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

(f) Explain why the signal at U should have a frequency of less than 4 kHz.

_____

_____

_____

_____

_____

_____ **[3]**

[Total: 17]

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5 Fig. 5.1 shows a variable frequency oscillator (VFO) and its transfer characteristic.

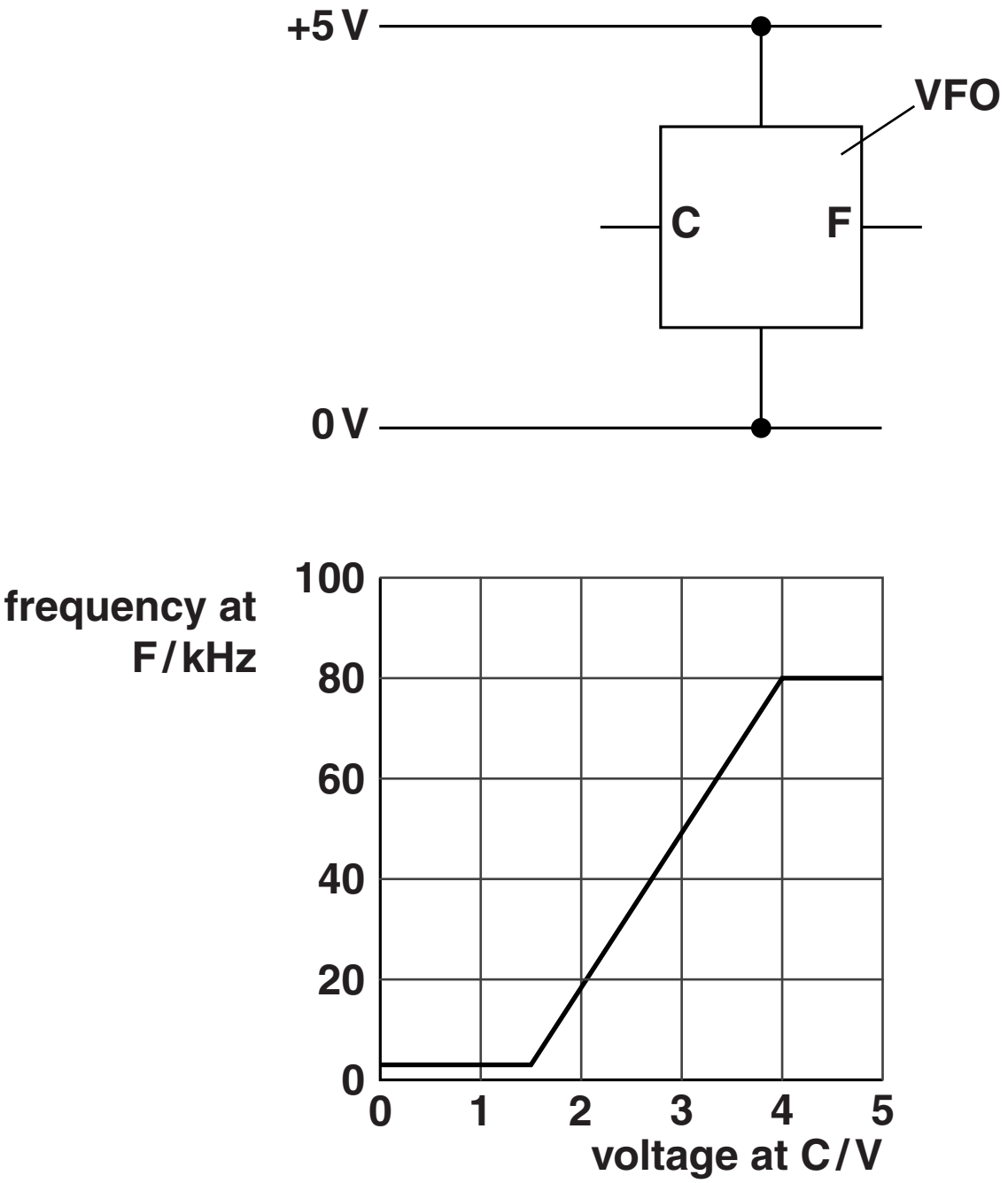

Fig. 5.1

(a) The VFO of Fig. 5.1 is part of a system which performs frequency modulation.

(i) Describe how frequency modulation carries information about an audio frequency signal.

_____

_____

_____ **[2]**

(ii) Draw on Fig. 5.1 to show how a pair of resistors can be used to set the frequency at F to 50 kHz. Show component values and justify them.

[3]

(iii) Draw on Fig. 5.1 to show how a capacitor allows the audio frequency signal to modulate the square wave at F. [1]

(b) The system of Fig. 5.1 is tested with an audio frequency (a.f.) signal whose amplitude is 1V, as shown in Fig. 5.2 below.

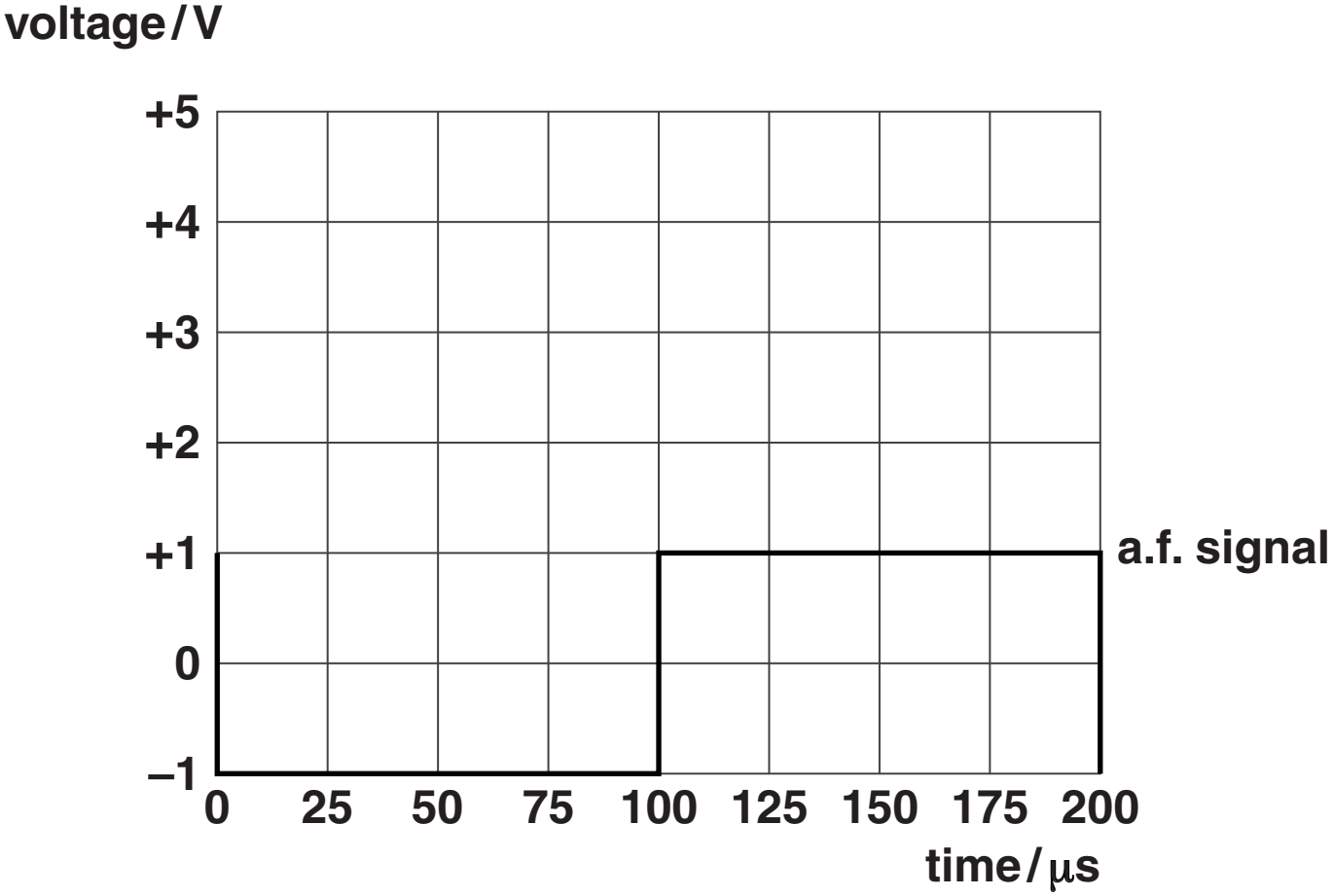

Fig. 5.2

(i) Explain why the period of the square wave at F is 50 μs when the voltage of the a.f. signal is –1 V.

[2]

(ii) Draw on Fig. 5.2 to show the square wave from F as it alternates between 5V and 0V during the 200 μs shown. [3]

[Total: 11]

6 Fig. 6.1 on a loose sheet shows computers able to communicate with each other along a single cable.

(a) Each computer is connected to the cable by two wires.

The wire OUT carries data to the cable.

The wire IN carries data from the cable.

Only the OUT wire is connected to the cable by an analogue switch.

(i) Complete the truth table for an analogue switch. Choose words from the list.

disconnected
high
low

INPUT	CONTROL	OUTPUT
low	low	
low	high	
high	low	
high	high	

[2]

(ii) Explain why only the OUT wire needs an analogue switch.

_____

_____

_____

_____ **[3]**

(iii) Although many computers can place data on the cable, only one can do so at any one time. Explain how this situation is achieved.

_____

_____

_____

_____ [3]

(b) The computers exchange data with each other using serial digital signals.

Fig. 6.2 is a timing diagram for a typical serial digital signal.

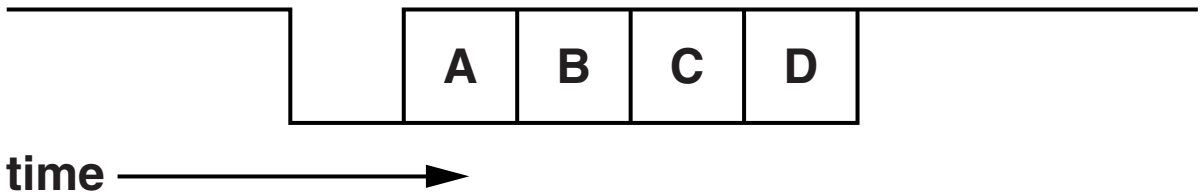

Fig. 6.2

(i) On Fig. 6.2, label the START bit and the STOP bit. [2]

(ii) Explain the function of the start and stop bits.

_____

_____

_____ [2]

(c) The system of Fig. 6.1 has the following properties:

- **each packet of data contains 512 bits**
- **the cable bandwidth is 4 MHz**

(i) Explain why each bit of a packet must be on the cable for about 130 ns.

[2]

(ii) Estimate the maximum number of packets passing through the cable in one second.

packets per second = _____ [2]

[Total: 16]

7 Fig. 7.1 on a loose sheet is the circuit diagram for a triangle waveform generator.

(a) The amplitude of the waveform at T is 7.5V.

Explain why this requires R_S to have a value of 30 kΩ.

[3]

(b) The frequency of the waveform at T is 100 kHz.

Explain why this requires R_T to have a value of 92 kΩ.

[3]

(c) Explain how the circuit of Fig. 7.1 produces a triangle waveform.

Start off with S at +13V.

_____

_____

_____

_____

_____ **[4]**

[Total: 10]

Quality of Written Communication [3]

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