For Examiner's Use

1 An analogue signal is sampled at a frequency of 5.0 kHz. Each sample is converted into a four-bit number and transmitted as a digital signal.
Fig. 10.1 shows part of the digital signal.

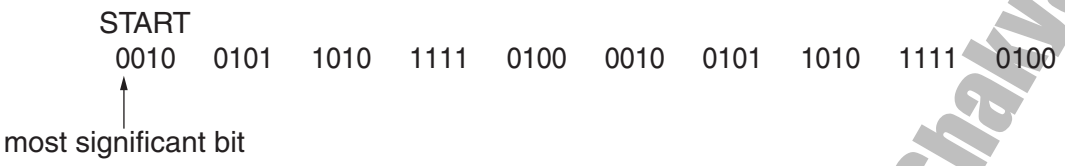
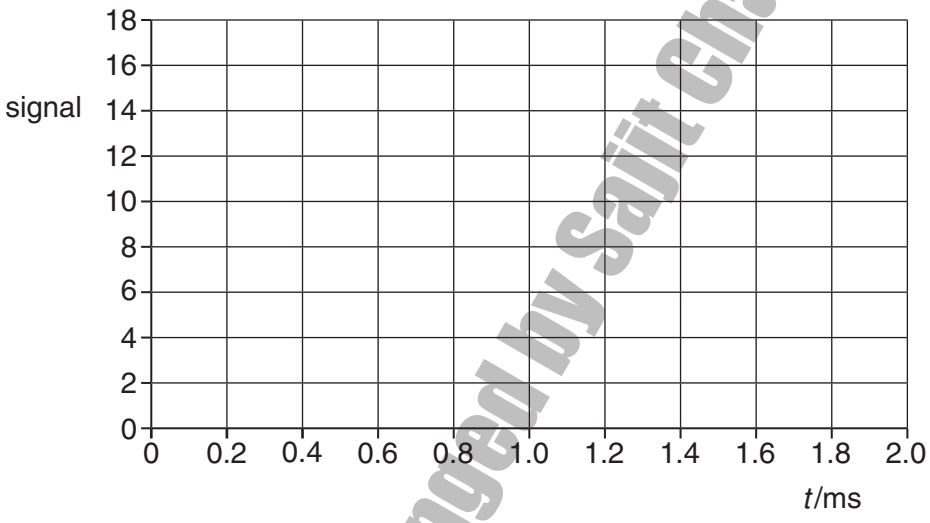


Fig. 10.1

The digital signal is transmitted and is finally converted into an analogue signal.

(a) On the axes of Fig. 10.2, sketch a graph to show the variation with time *t* of this final analogue signal.



[4]

Fig. 10.2

(b) Suggest two ways in which the reproduction of the original analogue signal could be improved.

1. .....

.....

2. .....

..... [2]

2 (a) Fig. 11.1 is a block diagram showing part of a mobile phone handset used for sending a signal to a base station.

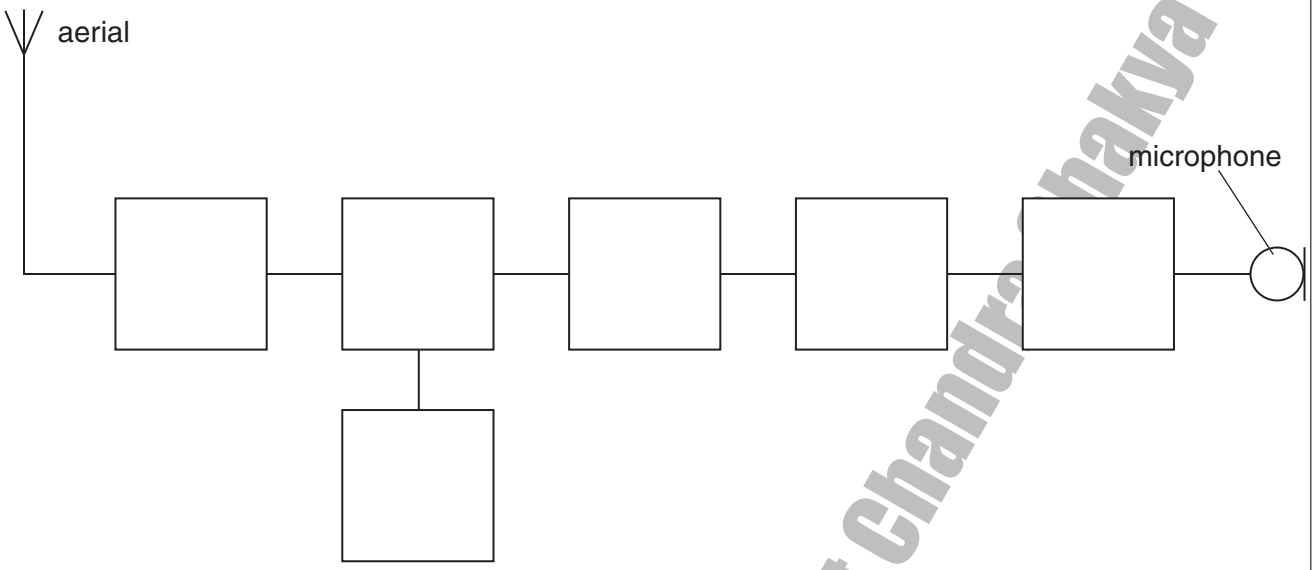


Fig. 11.1

Complete Fig. 11.1 by labelling each of the blocks. [3]

(b) Whilst making a call using a mobile phone fitted into a car, a motorist moves through several different cells. Explain how reception of signals to and from the mobile phone is maintained.

.....

.....

.....

.....

.....

.....

..... [4]

3 (a) (i) Describe what is meant by *frequency modulation*.

For Examiner's Use

.....

.....

.....[2]

(ii) A sinusoidal carrier wave has frequency 500 kHz and amplitude 6.0 V. It is to be frequency modulated by a sinusoidal wave of frequency 8 kHz and amplitude 1.5 V. The frequency deviation of the carrier wave is 20 kHz V^{-1}.
Describe, for the carrier wave, the variation (if any) of

1. the amplitude,

.....

.....[1]

2. the frequency.

.....

.....

.....

.....[3]

(b) State two reasons why the cost of FM broadcasting to a particular area is greater than that of AM broadcasting.

1 .....

.....

2 .....

.....[2]

For Examiner's Use

4 (a) Optic fibre transmission has, in some instances, replaced transmission using co-axial cables and wire pairs.
Optic fibres have negligible cross-talk and are less noisy than co-axial cables.
Explain what is meant by

(i) cross-talk,

.....

.....

.....[2]

(ii) noise.

.....

.....

.....[2]

(b) An optic fibre has a signal attenuation of 0.20 dB km^{-1}.
The input signal to the optic fibre has a power of 26 mW. The receiver at the output of the fibre has a noise power of 6.5 μW.
Calculate the maximum uninterrupted length of optic fibre given that the signal-to-noise ratio at the receiver must not be less than 30 dB.

length = ... km [5]

5 A signal is to be transmitted along a cable system of total length 125 km.
The cable has an attenuation of 7 dB km^{-1}. Amplifiers, each having a gain of 43 dB, are placed at 6 km intervals along the cable, as illustrated in Fig. 12.1.

For Examiner's Use

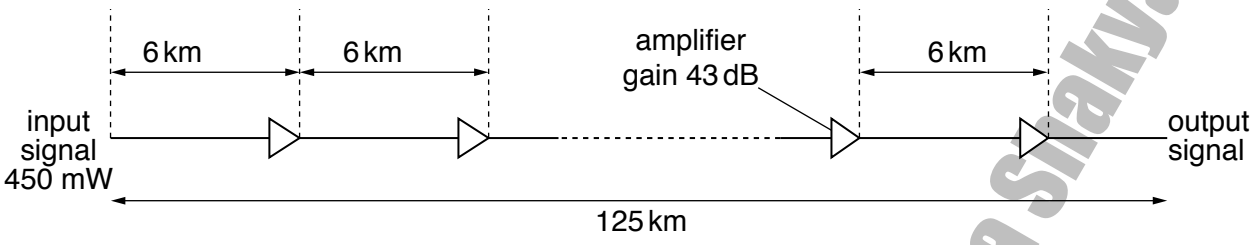


Fig. 12.1

(a) State what is meant by the *attenuation* of a signal.

.....

..... [1]

(b) Calculate

(i) the total attenuation caused by the transmission of the signal along the cable,

attenuation = ... dB [1]

(ii) the total signal gain as a result of amplification by all of the amplifiers along the cable.

gain = ... dB [1]

(c) The input signal has a power of 450 mW. Use your answers in **(b)** to calculate the output power of the signal as it leaves the cable system.

For Examiner's Use

power = ... mW [3]

6 (a) Fig. 13.1 is a block diagram illustrating part of a mobile phone handset used for receiving a signal from a base station.

For Examiner's Use

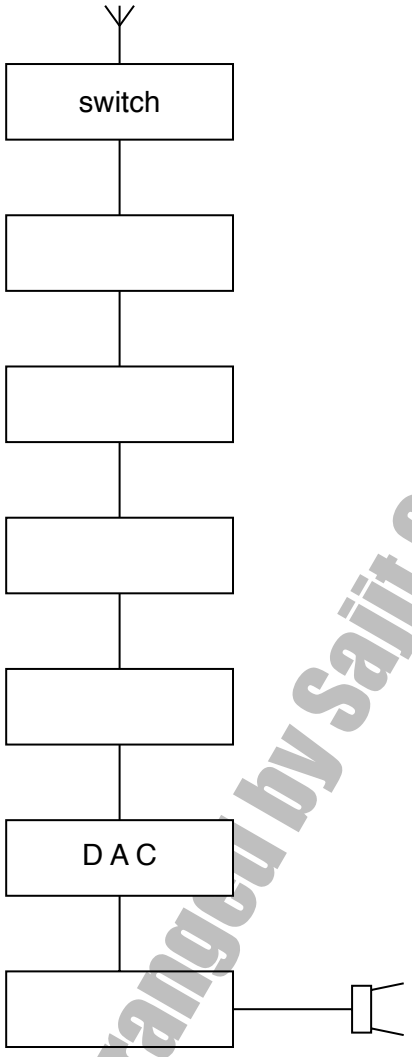


Fig. 13.1

Complete Fig. 13.1 by labelling each of the blocks. [4]

(b) Explain the role of the base station and the cellular exchange when a mobile phone is switched on and before a call is made or received.

.....

.....

.....

.....

.....

.....

.....

..... [4]

7 Fig. 10.1 shows the variation with frequency f of the power P of a radio signal.

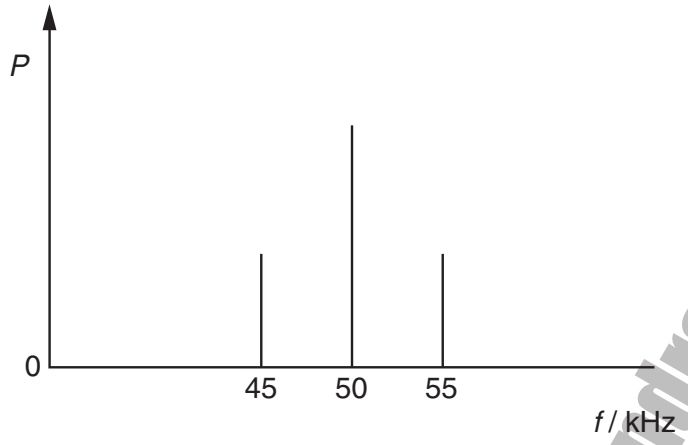


Fig. 10.1

(a) State the name of

(i) the type of modulation of this radio signal,

.....[1]

(ii) the component of frequency 50 kHz,

.....[1]

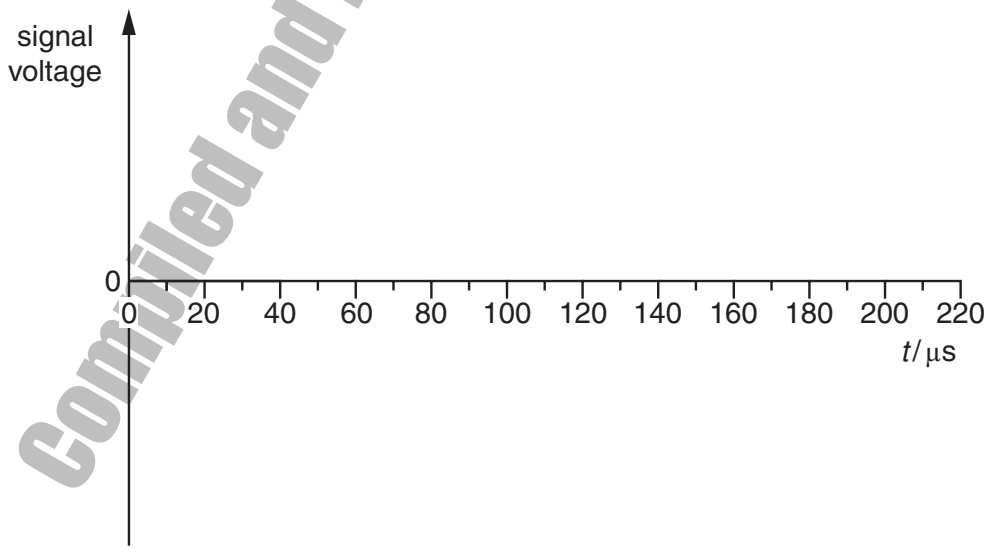
(iii) the components of frequencies 45 kHz and 55 kHz.

.....[1]

(b) State the bandwidth of the radio signal.

bandwidth = ...kHz [1]

(c) On the axes of Fig. 10.2, sketch a graph to show the variation with time t of the signal voltage of Fig. 10.1.



[3]

Fig. 10.2

8 In a cellular phone network, a country is divided into a number of cells, each with its own base station.
Fig. 11.1 shows a number of these base stations and their connection to a cellular exchange.

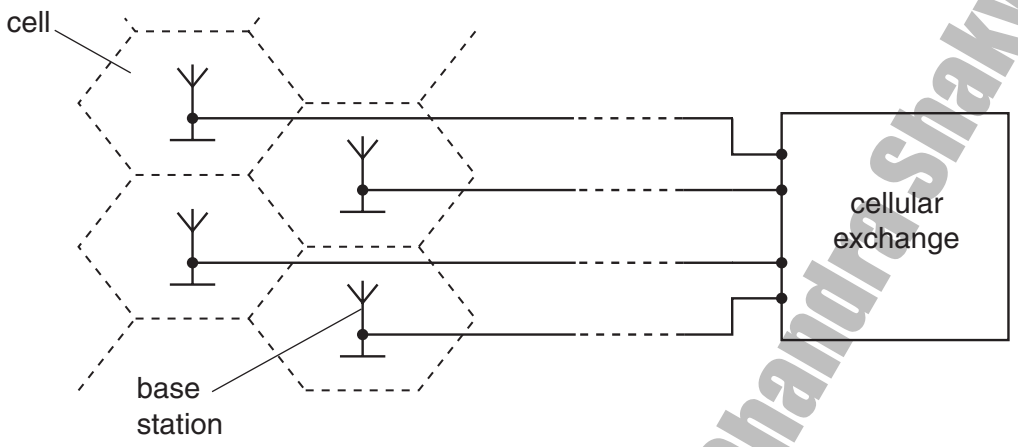


Fig. 11.1

(a) Suggest and explain why the country is divided into a number of cells.

.....

.....

.....

.....[2]

(b) Outline what happens at the base station and the cellular exchange when a mobile phone handset is switched on, before a call is made.

.....

.....

.....

.....

.....

.....

.....[4]

For Examiner's Use

9 Different frequencies and wavelengths are used in different channels of communication. Suggest why

(a) infra-red radiation rather than visible light is usually used with optic fibres,

.....

.....

.....[2]

(b) the base stations in mobile phone networks operate on UHF,

.....

.....

.....[2]

(c) for satellite communication, frequencies of the order of GHz are used, with the uplink having a different frequency to the downlink.

.....

.....

.....[2]

For Examiner's Use

10 **(a)** State and explain two advantages of the transmission of information in digital, rather than analogue, form.

1. .....

.....

.....

2. .....

.....

..... [4]

(b) Convert

(i) the decimal number 13 to a four-bit digital number,

..... [1]

(ii) the digital number 0101 to a decimal number.

..... [1]

(c) An analogue signal is to be transmitted digitally. A block diagram for part of the transmission system is shown in Fig. 12.1.

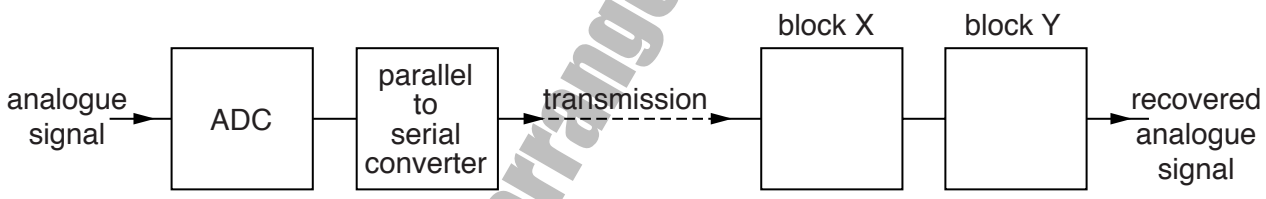


Fig. 12.1

(i) Complete Fig. 12.1 by labelling block X and block Y. [2]

(ii) State the purpose of the parallel-to-serial converter.

.....

.....

..... [2]

(d) The original analogue signal is shown in Fig. 12.2. The recovered signal after transmission is shown in Fig. 12.3.

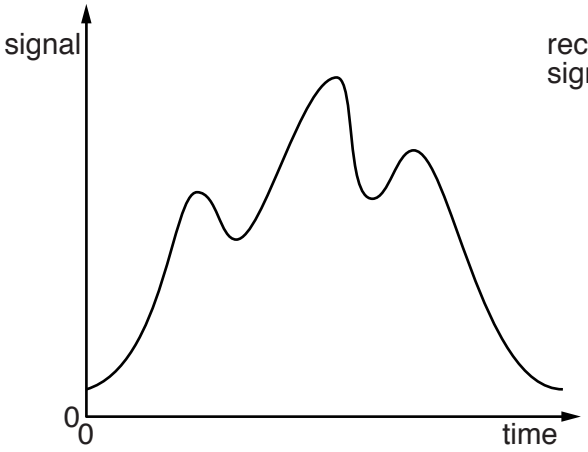


Fig. 12.2

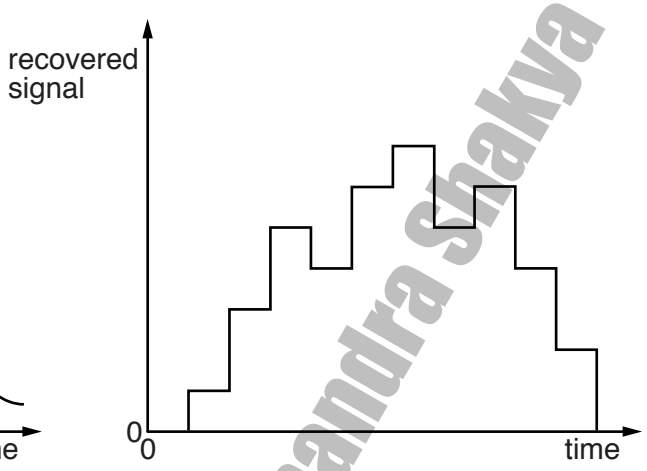


Fig. 12.3

Suggest and explain two ways in which the reproduction of the input signal may be improved.

1. .....

.....

.....

2. .....

.....

.....

[4]

11 The variation with time of the signal transmitted from an aerial is shown in Fig. 11.1.

For Examiner's Use

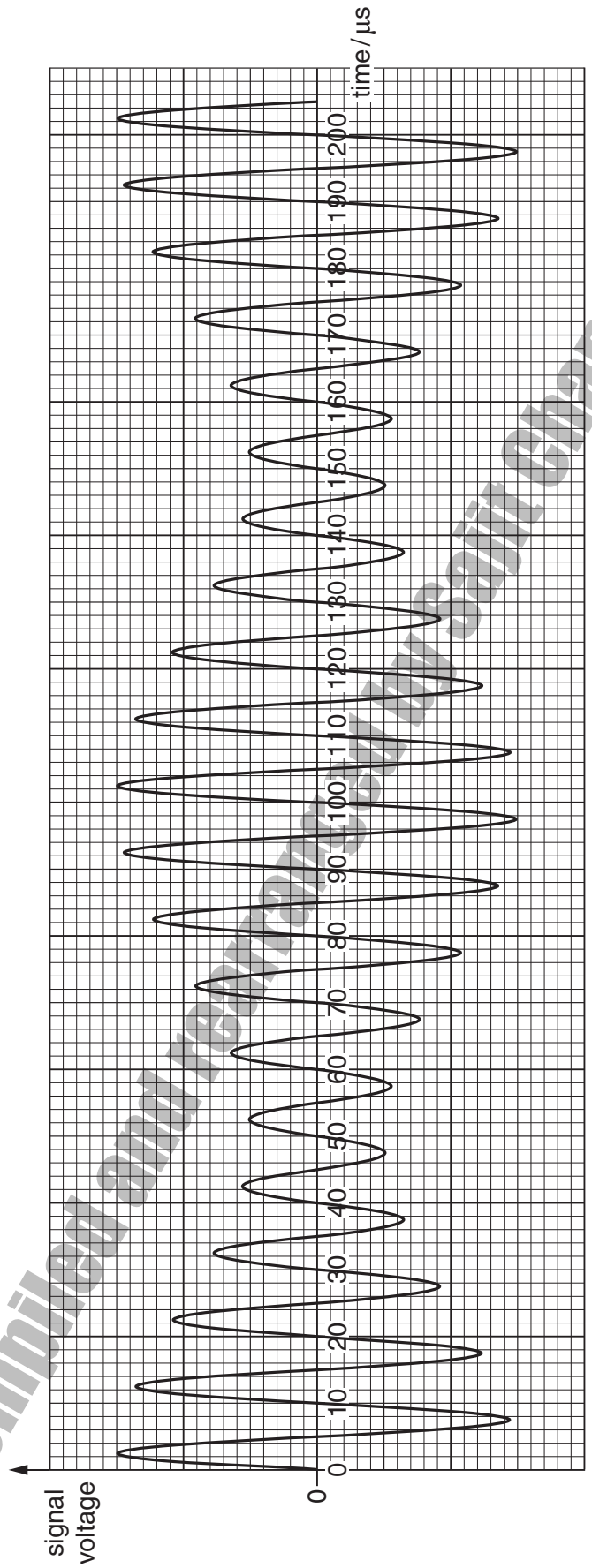


Fig. 11.1

(a) State the name of this type of modulated transmission.

..... [1]

(b) Use Fig. 11.1 to determine the frequency of

(i) the carrier wave,

frequency = ... Hz [2]

(ii) the information signal.

frequency = ... Hz [1]

(c) **(i)** On the axes of Fig. 11.2, draw the frequency spectrum (the variation with frequency of the signal voltage) of the signal from the aerial. Mark relevant values on the frequency axis.

Fig. 11.2

[3]

(ii) Determine the bandwidth of the signal.

bandwidth = ... Hz [1]

12 A block diagram representing part of a mobile phone network is shown in Fig. 12.1.

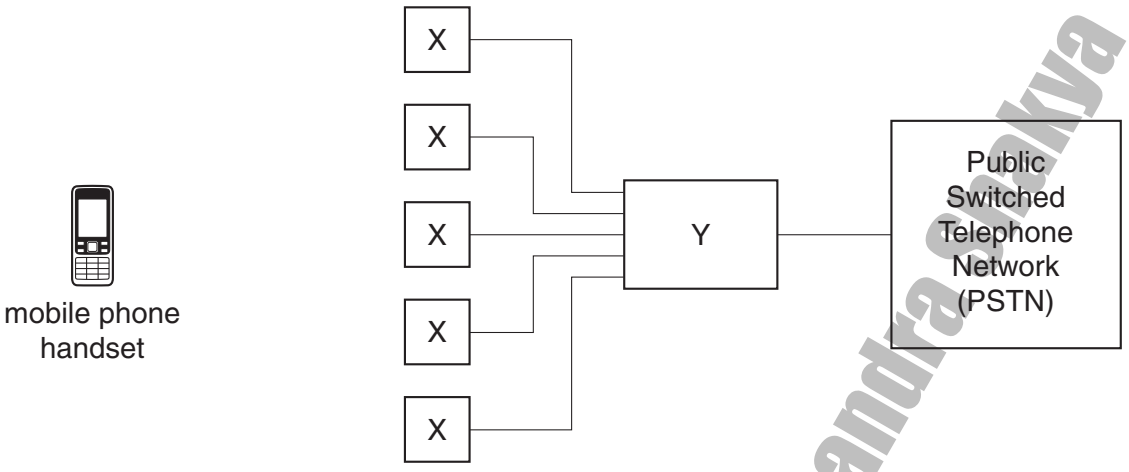


Fig. 12.1

(a) State what is represented by

(i) the blocks labelled X,

..... [1]

(ii) the block labelled Y.

..... [1]

(b) A user of a mobile phone is making a call.

Explain the role of the components in the boxes labelled X and Y during the call.

.....

.....

.....

.....

.....

.....

.....

..... [5]

13 A telephone link between two towns is to be provided using an optic fibre. The length of the optic fibre between the two towns is 75 km.

For Examiner's Use

(a) State two changes that occur in a signal as it is transmitted along an optic fibre.

1. .....

.....

2. .....

.....

[2]

(b) The optic fibre has an attenuation per unit length of 1.6 dB km^{-1}. The minimum permissible signal-to-noise power ratio in the fibre is 25 dB. The average noise power in the optic fibre is 6.1×10^{-19} W.

(i) Suggest one reason why power ratios are expressed in dB.

.....

..... [1]

(ii) The signal input power to the optic fibre is designed to be 6.5 mW.
Determine whether repeater amplifiers are necessary in the optic fibre between the two towns.

[5]

14 Many radio stations now broadcast on FM rather than on AM. In general, FM is broadcast at much higher frequencies than AM.

For Examiner's Use

(a) Explain what is meant by *FM* (*frequency modulation*).

.....

.....

.....

.....[2]

(b) State two advantages and two disadvantages of FM transmissions when compared with AM transmissions.

advantages of FM transmissions

1. .....

.....

2. .....

.....

disadvantages of FM transmissions

1. .....

.....

2. .....

.....

[4]

15 A ground station on Earth transmits a signal of frequency 14 GHz and power 18 kW towards a communications satellite orbiting the Earth, as illustrated in Fig. 12.1.

For Examiner's Use

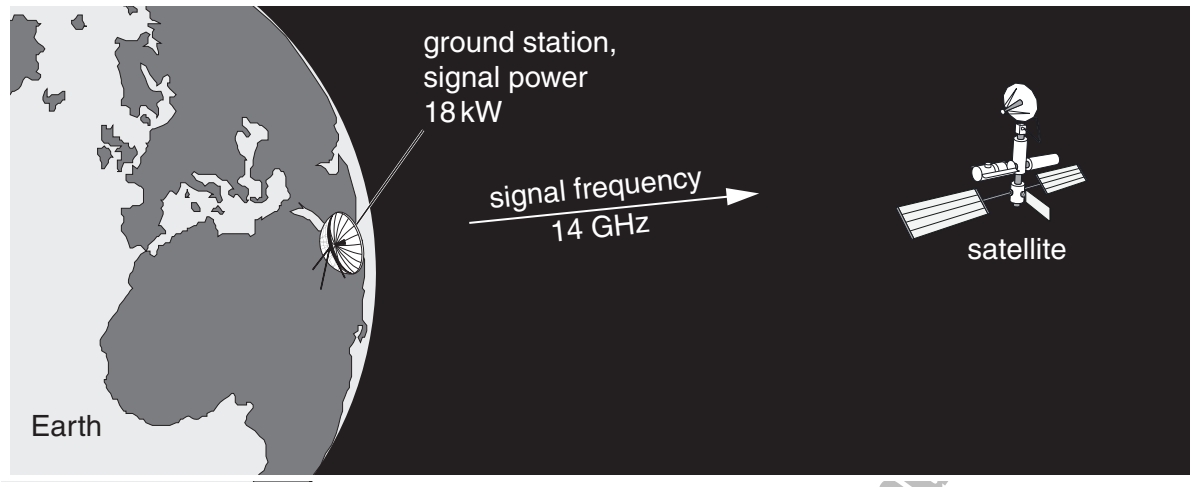


Fig. 12.1

The loss in signal power between the ground station and the satellite is 190 dB.

(a) Calculate the power of the signal received by the satellite.

power = ... W [3]

(b) The signal received by the satellite is amplified and transmitted back to Earth.

(i) Suggest a frequency for the signal that is sent back to Earth.

frequency = ... GHz [1]

(ii) Give a reason for your answer in **(i)**.

.....

.....[1]

For Examiner's Use

11 **(a)** Wire pairs provide one means of communication but they are subject to high levels of noise and attenuation.
Explain what is meant by

(i) *noise*,

.....

..... [1]

(ii) *attenuation*.

.....

..... [1]

(b) A microphone is connected to a receiver using a wire pair, as shown in Fig. 11.1.

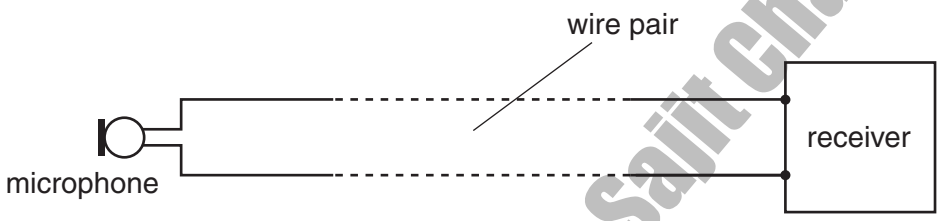


Fig. 11.1

The wire pair has an attenuation per unit length of 12 dB km^{-1}. The noise power in the wire pair is 3.4×10^{-9} W.
The microphone produces a signal power of 2.9 μW.

(i) Calculate the maximum length of the wire pair so that the minimum signal-to-noise ratio is 24 dB.

length = ... m [4]

(ii) Communication over distances greater than that calculated in **(i)** is required.
Suggest how the circuit of Fig. 11.1 may be modified so that the minimum signal-to-noise ratio at the receiver is not reduced.

.....

.....

..... [2]

12 (a) Outline the principles of the use of a geostationary satellite for communication on Earth.

For Examiner's Use

.....

.....

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.....

.....

.....

.....[4]

Question 12 continues on the next page.

(b) Polar-orbiting satellites are also used for communication on Earth.
State and explain one advantage and one disadvantage of polar-orbiting satellites as compared with geostationary satellites.

For Examiner's Use

advantage: .....

.....

.....

.....

disadvantage: .....

.....

.....

.....

[4]

For Examiner's Use

12 (a) Data may be transmitted as an analogue signal or as a digital signal.

(i) Explain what is meant by

1. an *analogue* signal,

.....

.....

.....

2. a *digital* signal.

.....

.....

.....

[3]

(ii) State two advantages of the transmission of data in digital form.

1. .....

.....

2. .....

.....

[2]

(b) The block diagram of Fig. 12.1 represents a system for the digital transmission of analogue data.

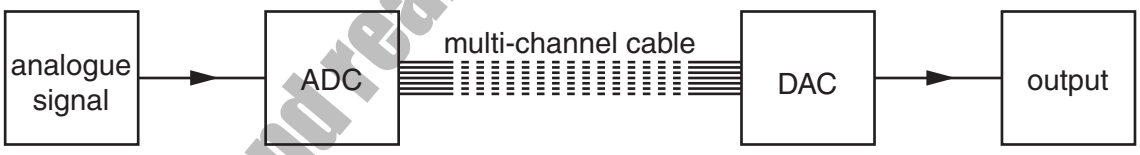

Fig. 12.1

(i) Describe the function of the ADC (analogue-to-digital converter).

.....

.....

.....[2]

(ii) Suggest why the transmission cable has a number of channels.

.....

..... [1]

11 **(a)** Describe what is meant by *frequency modulation* (*FM*).

For Examiner's Use

.....

.....

.....[2]

(b) A sinusoidal carrier wave has a frequency of 600 kHz and an amplitude of 5.0 V.
The carrier wave is frequency modulated by a sinusoidal wave of frequency 7.0 kHz and amplitude 2.0 V.
The frequency deviation of the carrier wave is 20 kHz V^{-1}.

Determine, for the modulated carrier wave,

(i) the amplitude,

amplitude = ... V [1]

(ii) the maximum frequency,

maximum frequency = ... Hz [1]

(iii) the minimum frequency,

minimum frequency = ... Hz [1]

(iv) the number of times per second that the frequency changes from maximum to minimum and then back to maximum.

number = ...[1]

12 Many television receivers are connected to an aerial using a coaxial cable. Such a cable is illustrated in Fig. 12.1.

For Examiner's Use

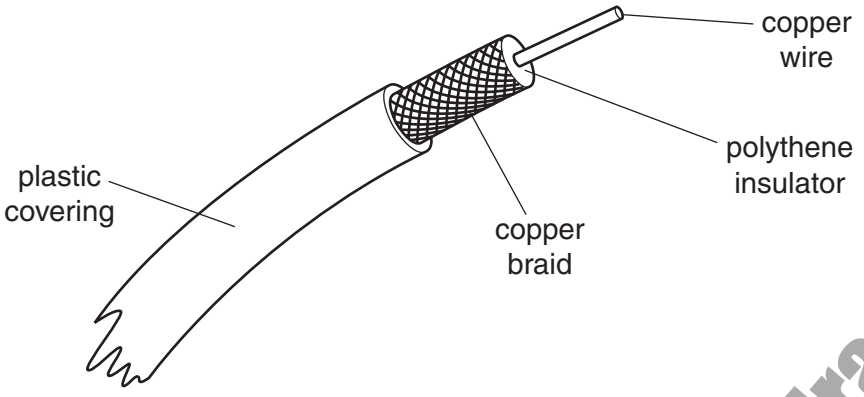

Fig. 12.1

(a) State two functions of the copper braid.

1. .....

.....

2. .....

.....

[2]

(b) Suggest two reasons why a coaxial cable is used, rather than a wire pair, to connect the aerial to the receiver.

1. .....

.....

2. .....

.....

[2]

(c) A coaxial cable has an attenuation per unit length of 200 dB km^{-1}.
The length of the co-axial cable between an aerial and the receiver is 12 m.
Calculate the ratio

$$\frac{\text{input signal power to coaxial cable}}{\text{output signal power from coaxial cable}}.$$

ratio = ...[3]

11 The use of ionospheric reflection of radio waves for long-distance communication has, to a great extent, been replaced by satellite communication.

For Examiner's Use

(a) State and explain two reasons why this change has occurred.

1. .....

.....

.....

2. .....

.....

.....

[4]

(b) The radio link between a geostationary satellite and Earth may be attenuated by as much as 190 dB.
Suggest why, as a result of this attenuation, the uplink and downlink frequencies must be different.

.....

.....

.....

..... [2]

12 (a) The signal-to-noise ratio in an optic fibre must not fall below 24 dB. The average noise power in the fibre is 5.6×10^{-19} W.

For Examiner's Use

(i) Calculate the minimum effective signal power in the optic fibre.

power = ... W [3]

(ii) The fibre has an attenuation per unit length of 1.9 dB km^{-1}. Calculate the maximum uninterrupted length of fibre for an input signal of power 3.5 mW.

length = ... km [3]

(b) Suggest why infra-red radiation, rather than ultraviolet radiation, is used for long-distance communication using optic fibres.

.....

..... [1]