PapaCambridge

Cambridge International AS & A Level

PHYSICS

Paper 4

Topical Past Paper Questions
+ Answer Scheme

2016 - 2021

PapaCambridge

Chapter 7

Communication

137. 9702_m21_qp_42 Q: 5

(a) **(i)** State what is meant by the *amplitude modulation* (*AM*) of a radio wave.

....

....

.... [2]

(ii) State **two** advantages of AM transmissions when compared with frequency modulation (FM) transmissions.

1. ....

....

2. ....

....
[2]

(b) The variation with frequency *f* of the amplitude *A* of a transmitted radio wave after amplitude modulation by an audio signal is shown in Fig. 5.1.

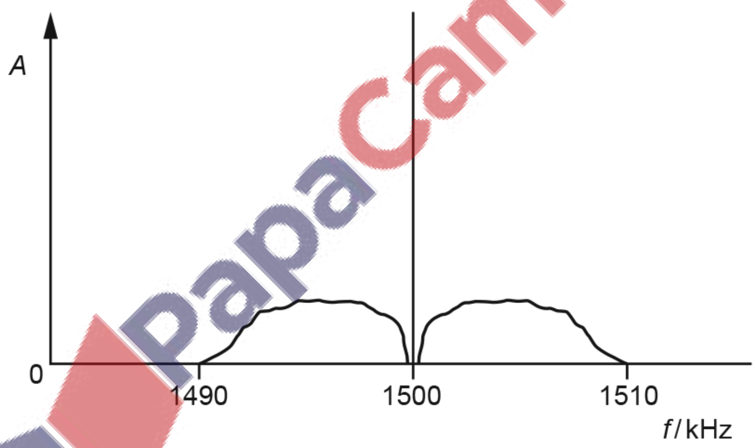

Fig. 5.1

For this transmission, determine:

(i) the wavelength of the carrier wave

wavelength = ... m [1]

(ii) the maximum frequency of the transmitted audio signal.

frequency = ... kHz [1]

(c) Another audio signal with the same maximum frequency is transmitted using a different carrier wave frequency. The lowest frequency of this modulated wave is equal to the highest frequency of the modulated wave in **(b)**.

Determine the frequency of this carrier wave.

frequency = ... kHz [1]

[Total: 7]

---

138. 9702_s21_qp_42 Q: 4

(a) A sinusoidal carrier wave has a constant amplitude and a frequency of 1.2 MHz. The carrier wave is modulated by a signal wave such that a 1.0 V displacement of the signal wave causes a change in frequency of 25 kHz.

The signal wave has frequency 8.0 kHz and amplitude 2.0 V.

(i) State the name of this type of modulation of the carrier wave.

.... [1]

(ii) For this modulated carrier wave, determine the variation, if any, in:

1. its amplitude

....

....

2. its frequency.

....

....

.... [3]

(b) An audio signal is transmitted by means of a modulated radio wave.

The variation with frequency of the amplitude of the radio wave is shown in Fig. 4.1.

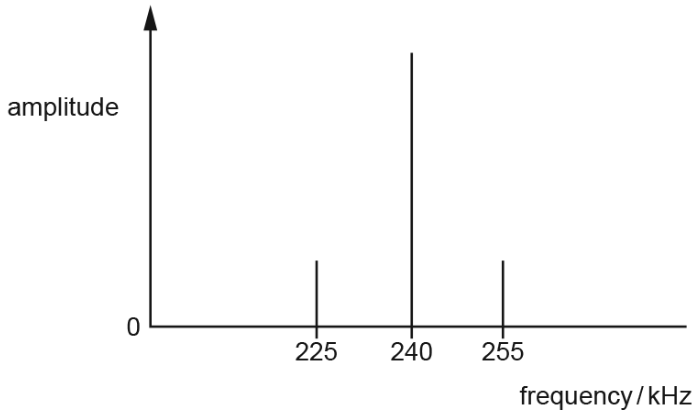

Fig. 4.1

For this transmission, determine:

(i) the wavelength, in km, of the carrier wave

wavelength = ... km [2]

(ii) the bandwidth

bandwidth = ... kHz [1]

(iii) the frequency of the audio signal.

frequency = ... kHz [1]

[Total: 8]

139. 9702_w21_qp_42 Q: 5

(a) **(i)** When audio signals are transmitted over long distances, modulation of radio waves is used.

Suggest a reason why modulation is used.

....

.... [1]

(ii) State a technical advantage and a technical disadvantage of using frequency modulation rather than amplitude modulation.

advantage: ....

....

disadvantage: ....

....
[2]

(b) An audio signal of amplitude 2.0 μV and frequency 4.2 kHz is to be transmitted using a carrier wave of amplitude 10.0 mV and frequency 100 kHz.

Either amplitude modulation or frequency modulation may be used.

The amplitude modulation is at a rate of $1\,mV\,\mu V^{-1}$.
The frequency modulation is at a rate of $5\,kHz\,\mu V^{-1}$.

Complete Table 5.1 to show the maximum and minimum values of the amplitude and of the frequency of the modulated wave for each type of modulation.

Table 5.1

	amplitude / mV		frequency / kHz	
	minimum	maximum	minimum	maximum
amplitude modulation				
frequency modulation				

[4]

(c) For the amplitude modulated wave in **(b)**, determine the bandwidth.

bandwidth = ... kHz [1]

[Total: 8]

140. 9702_w19_qp_42 Q: 6

The variation with time of the displacement of an amplitude-modulated (AM) wave is shown in Fig. 6.1.

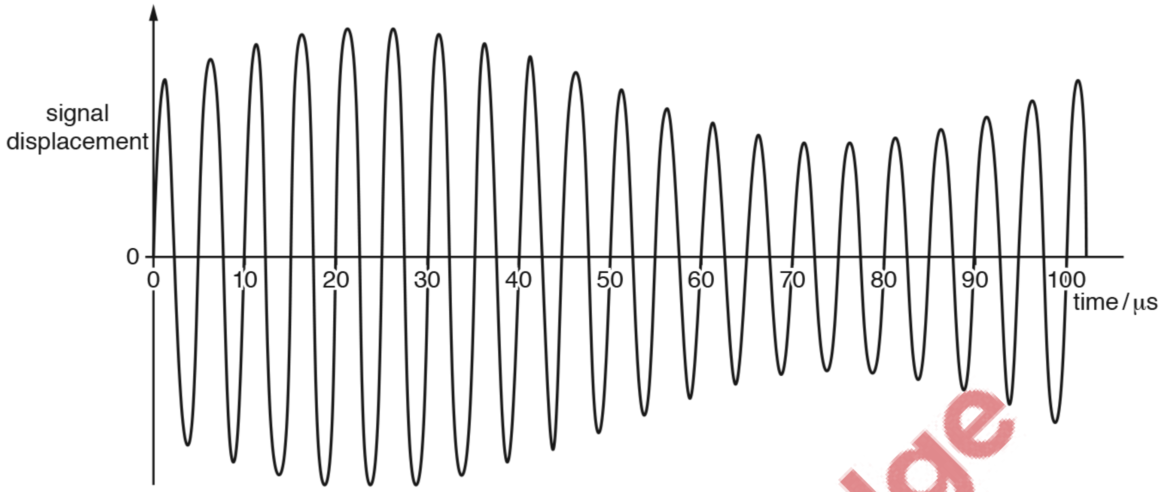

Fig. 6.1

The sinusoidal information signal has frequency 10 kHz.

(a) Determine the frequency of the carrier wave.

frequency = ... Hz [1]

(b) On the axes of Fig. 6.2, sketch the frequency spectrum of the modulated wave.

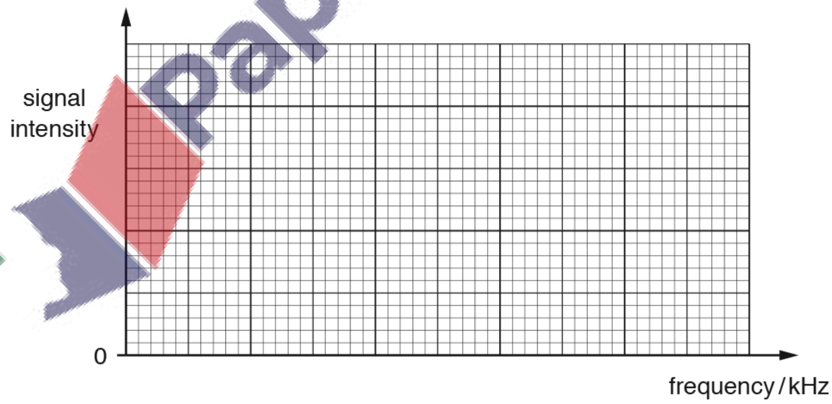

Fig. 6.2

[3]

[Total: 4]

141. 9702_s18_qp_42 Q: 5

(a) In radio communication, the bandwidth of an FM transmission is greater than the bandwidth of an AM transmission.

State

(i) what is meant by *bandwidth*,

....

....[1]

(ii) one advantage and one disadvantage of a greater bandwidth.

advantage: ....

....

disadvantage: ....

....
[2]

(b) A carrier wave has a frequency of 650 kHz and is measured to have an amplitude of 5.0 V.

The carrier wave is frequency modulated by a signal of frequency 10 kHz and amplitude 3.0 V. The frequency deviation of the carrier wave is 8.0 kHz V^{-1}.

Determine, for the frequency modulated carrier wave,

(i) the measured amplitude,

amplitude = ... V [1]

(ii) the maximum and the minimum frequencies,

maximum frequency = ... kHz

minimum frequency = ... kHz
[2]

(iii) the minimum time between a maximum and a minimum transmitted frequency.

time = ... s [1]

[Total: 7]

---

142. 9702_w18_qp_42 Q: 5

(a) In radio communication, the radio wave is usually modulated.

State what is meant by *amplitude modulation* (*AM*).

....

....

....[2]

(b) A sinusoidal radio carrier wave has a frequency of 900 kHz and an unmodulated amplitude measured to be 4.0 V.

The carrier wave is amplitude modulated by a signal of frequency 5.0 kHz.

For the amplitude modulated wave,

(i) determine the wavelength,

wavelength = ... m [1]

(ii) describe the amplitude variation,

....

....

....[2]

(iii) state the bandwidth.

bandwidth = ... Hz [1]

(c) Communication is sometimes made using satellites in geostationary orbits that have a period of rotation about the Earth of 24 hours.

(i) State two other features, apart from the period, of a geostationary orbit.

1. ....

....

2. ....

....

[2]

(ii) Suggest why

1. frequencies of the order of gigahertz are used for satellite communication,

....

....[1]

2. the uplink frequency to the satellite is different from the downlink frequency.

....

....

....[2]

[Total: 11]

143. 9702_w21_qp_41 Q: 5

An analogue signal is to be transmitted to a receiver. Before transmission, the signal passes through an analogue-to-digital converter (ADC). After transmission it passes through a digital-to-analogue converter (DAC) before finally reaching the receiver, as shown in Fig. 5.1.

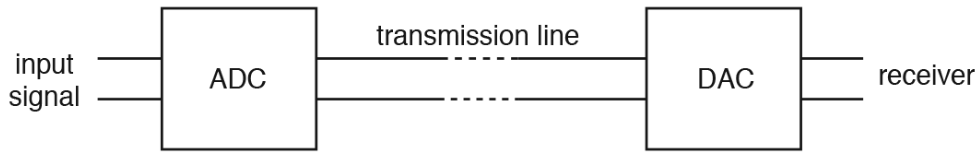

Fig. 5.1

(a) State **two** advantages of converting the signal into digital form for transmission.

1. ....

....

2. ....

....
[2]

(b) The variation with time of the potential difference (p.d.) of the input signal is shown in Fig. 5.2.

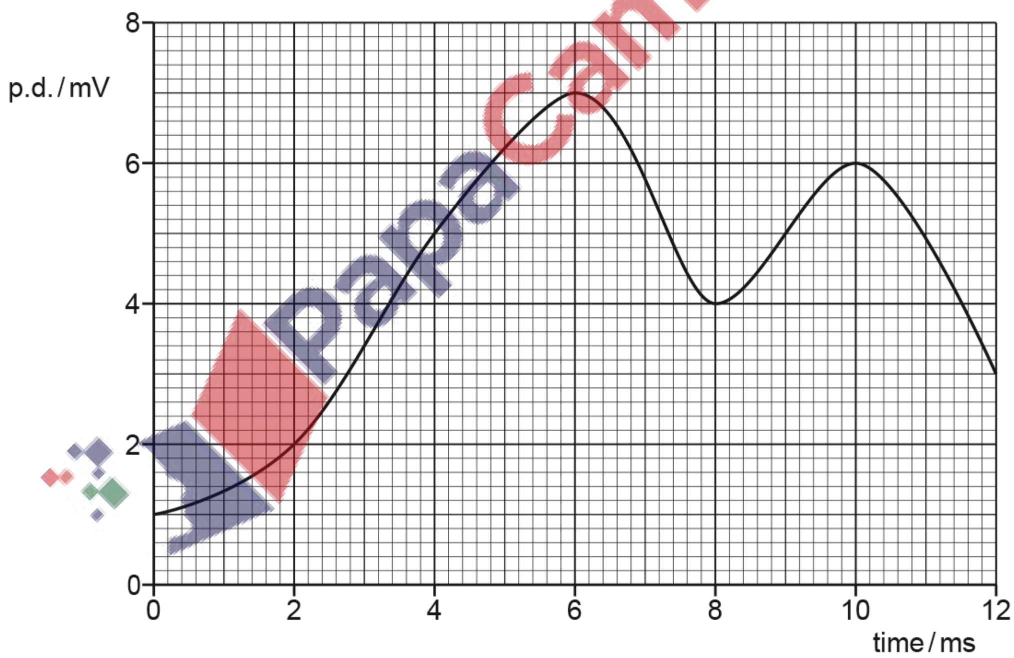

Fig. 5.2

The ADC has a sampling frequency of 250 Hz and uses 4-bit sampling, with the least significant bit corresponding to 1 mV. The signal is first sampled at time 0, when the sampled bits are 0001.

(i) State the sampled bits at time 4 ms and time 8 ms.

4 ms: .... 8 ms: .... [1]

(ii) Part of the signal received by the receiver, after the sampled signal has passed through the DAC, is shown in Fig. 5.3.

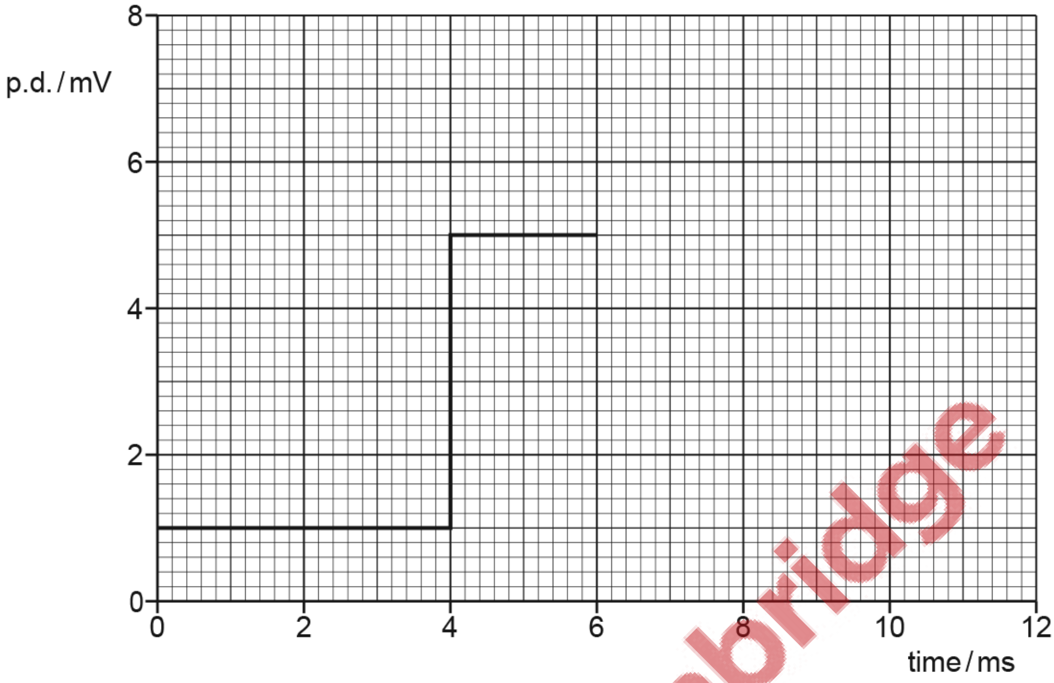

Fig. 5.3

On Fig. 5.3, complete the line to show the received signal for time 0 to time 12 ms. [2]

(c) The ADC in **(b)** is replaced with one that has a sampling frequency of 500 Hz and uses 3-bit sampling, with the least significant bit corresponding to 2 mV.

On Fig. 5.4, sketch the signal that is now received, after passing through the DAC, from time 0 to time 12 ms.

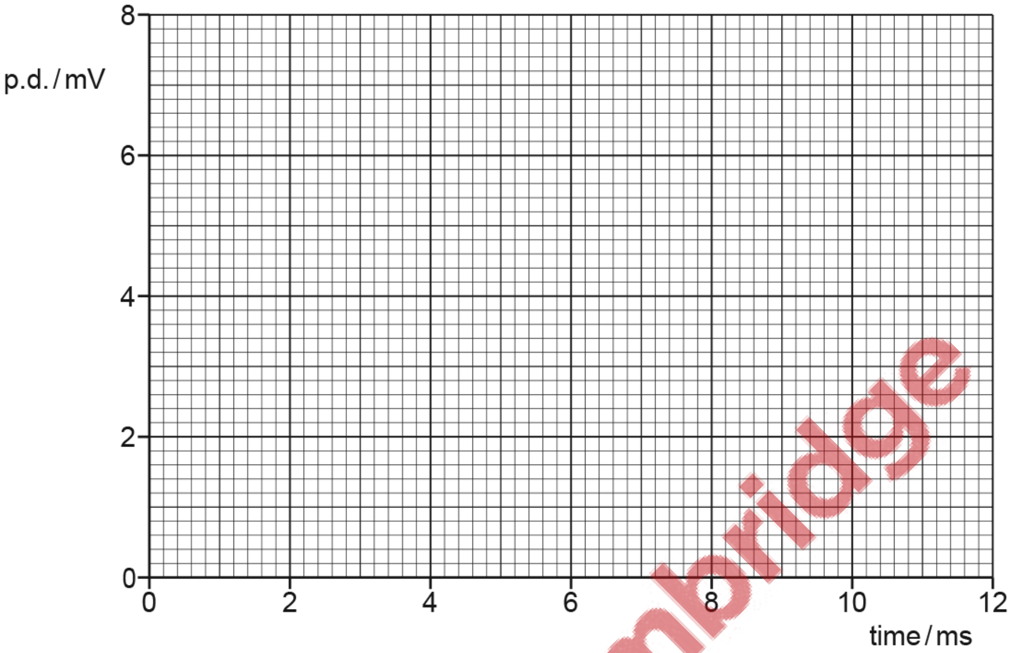

Fig. 5.4

[3]

[Total: 8]

144. 9702_w21_qp_43 Q: 5

An analogue signal is to be transmitted to a receiver. Before transmission, the signal passes through an analogue-to-digital converter (ADC). After transmission it passes through a digital-to-analogue converter (DAC) before finally reaching the receiver, as shown in Fig. 5.1.

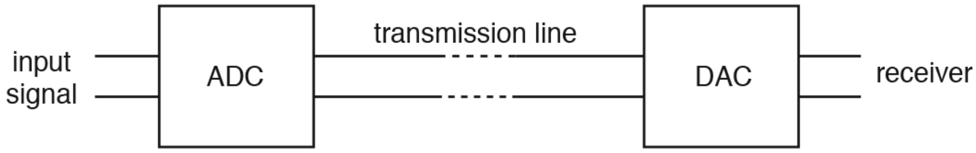

Fig. 5.1

(a) State **two** advantages of converting the signal into digital form for transmission.

1. ....

....

2. ....

.... [2]

(b) The variation with time of the potential difference (p.d.) of the input signal is shown in Fig. 5.2.

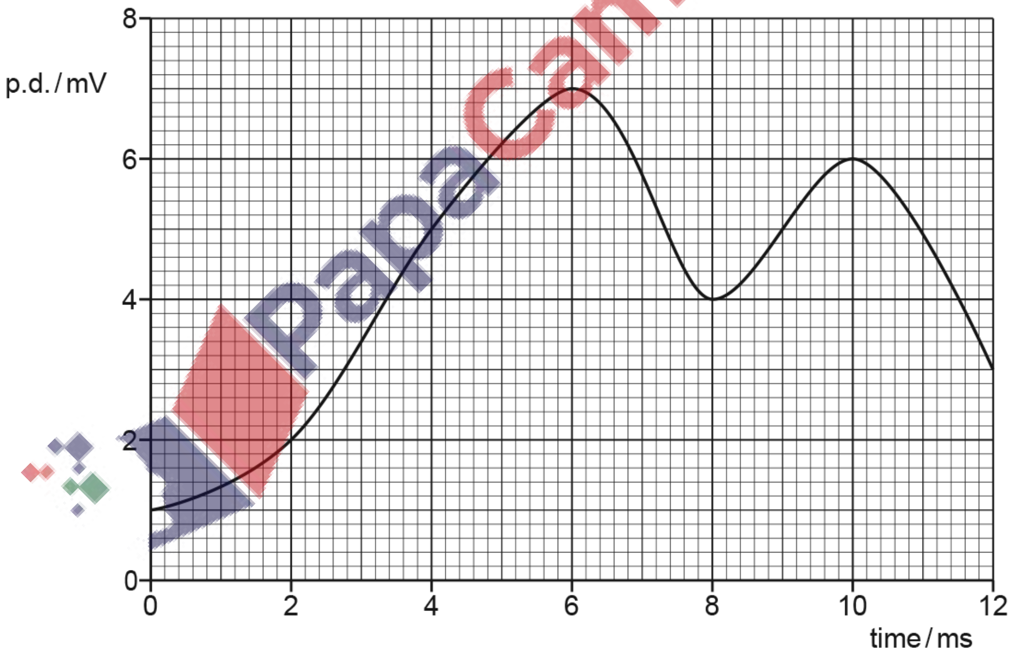

Fig. 5.2

The ADC has a sampling frequency of 250 Hz and uses 4-bit sampling, with the least significant bit corresponding to 1 mV. The signal is first sampled at time 0, when the sampled bits are 0001.

(i) State the sampled bits at time 4 ms and time 8 ms.

4 ms: .... 8 ms: .... [1]

(ii) Part of the signal received by the receiver, after the sampled signal has passed through the DAC, is shown in Fig. 5.3.

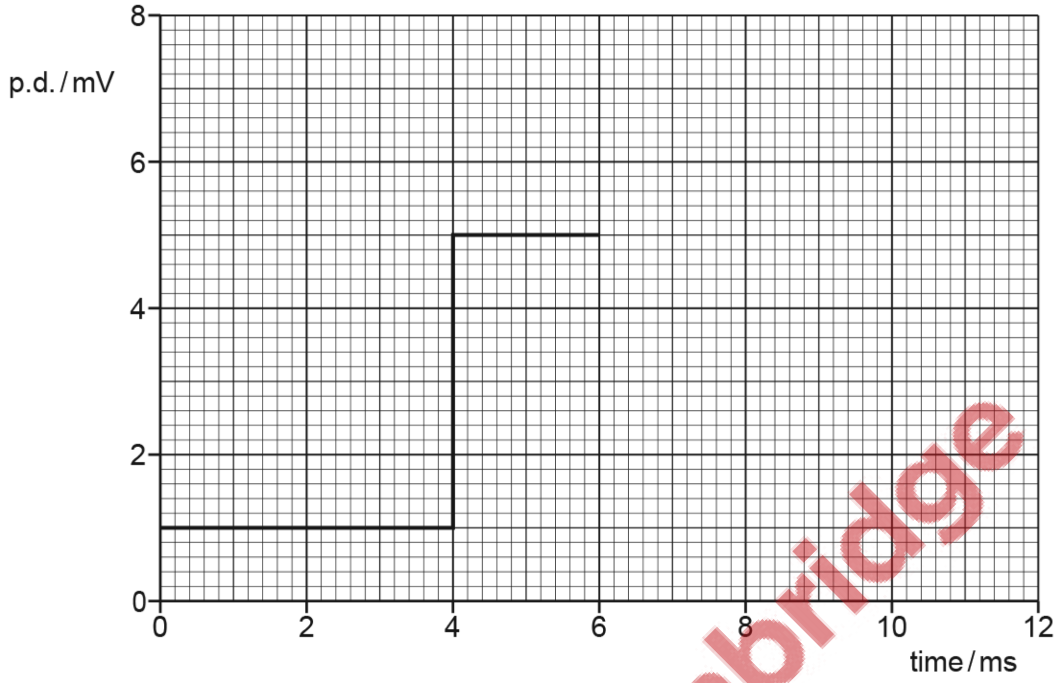

Fig. 5.3

On Fig. 5.3, complete the line to show the received signal for time 0 to time 12 ms. [2]

(c) The ADC in **(b)** is replaced with one that has a sampling frequency of 500 Hz and uses 3-bit sampling, with the least significant bit corresponding to 2 mV.

On Fig. 5.4, sketch the signal that is now received, after passing through the DAC, from time 0 to time 12 ms.

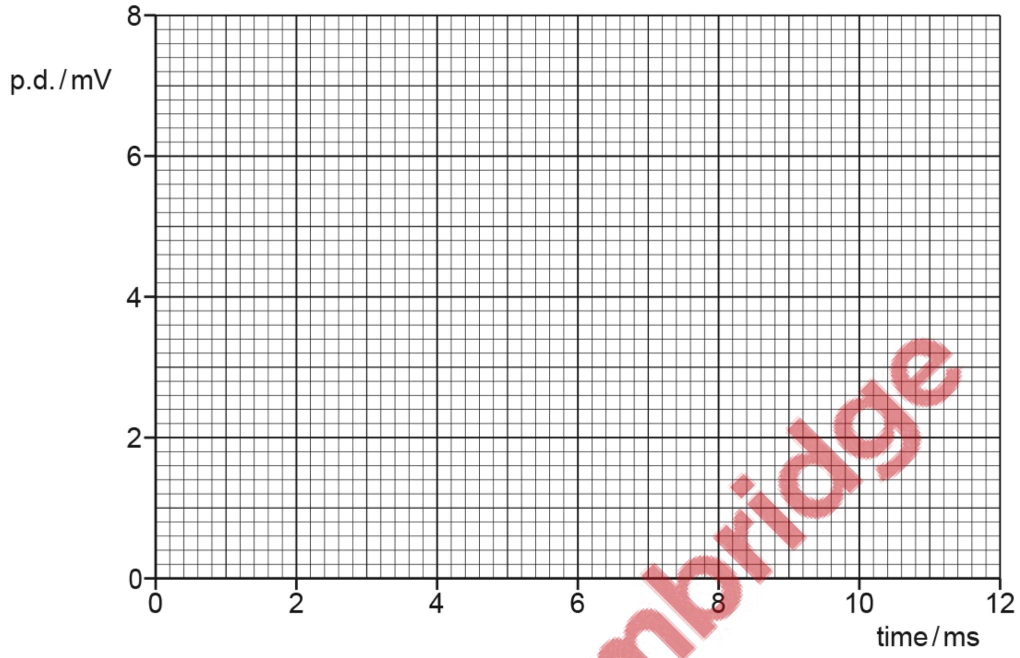

Fig. 5.4

[3]

[Total: 8]

145. 9702_m18_qp_42 Q: 6

The digital transmission of speech may be represented using the block diagram of Fig. 6.1.

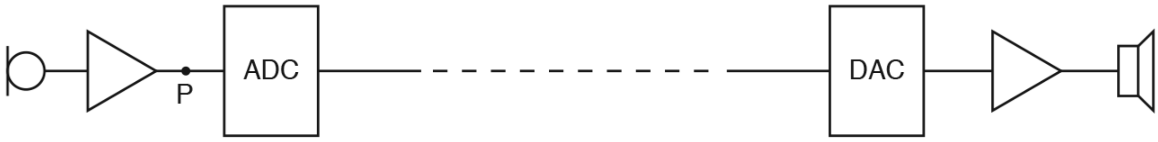

Fig. 6.1

(a) Part of the signal at point P on Fig. 6.1 is shown in Fig. 6.2.

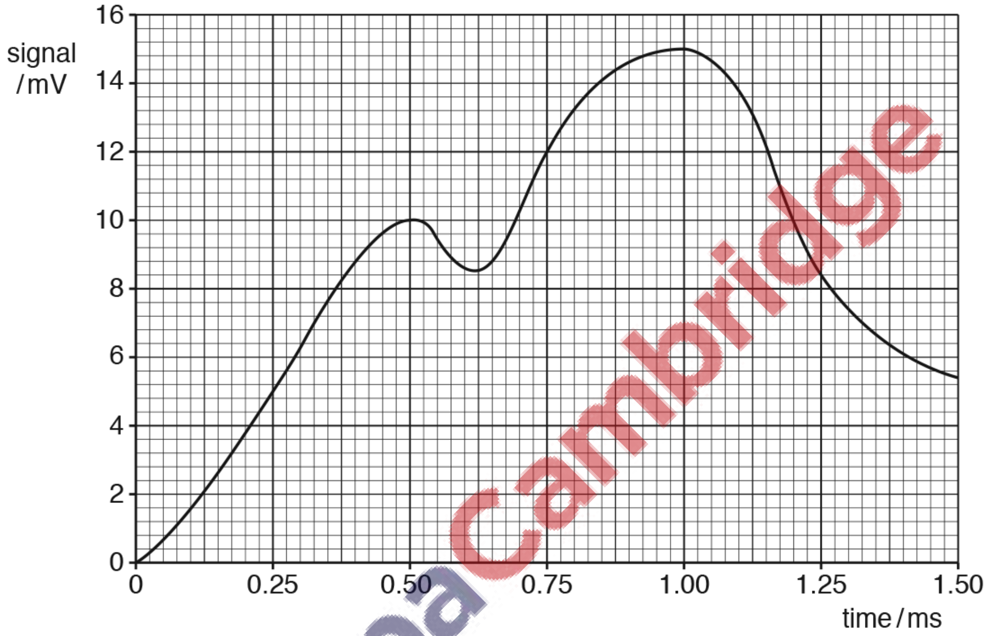

Fig. 6.2

The analogue-to-digital converter (ADC) samples the signal at time intervals of 0.25 ms. Each sample is converted into a four-bit number with the smallest bit representing 1.0 mV.

Use Fig. 6.2 to determine the four-bit number produced by the ADC at time

(i) 0.25 ms,

number ....

(ii) 1.25 ms.

number ....
[2]

(b) The digital number is transmitted and then converted to an analogue form by the digital-to-analogue converter (DAC).

Use data from Fig. 6.2 to draw, on the axes of Fig. 6.3, the output level of the DAC for time $t = 0$ to time $t = 1.50$ ms.
Assume that there is no time delay of the transmission of the signal between point P and the output of the DAC.

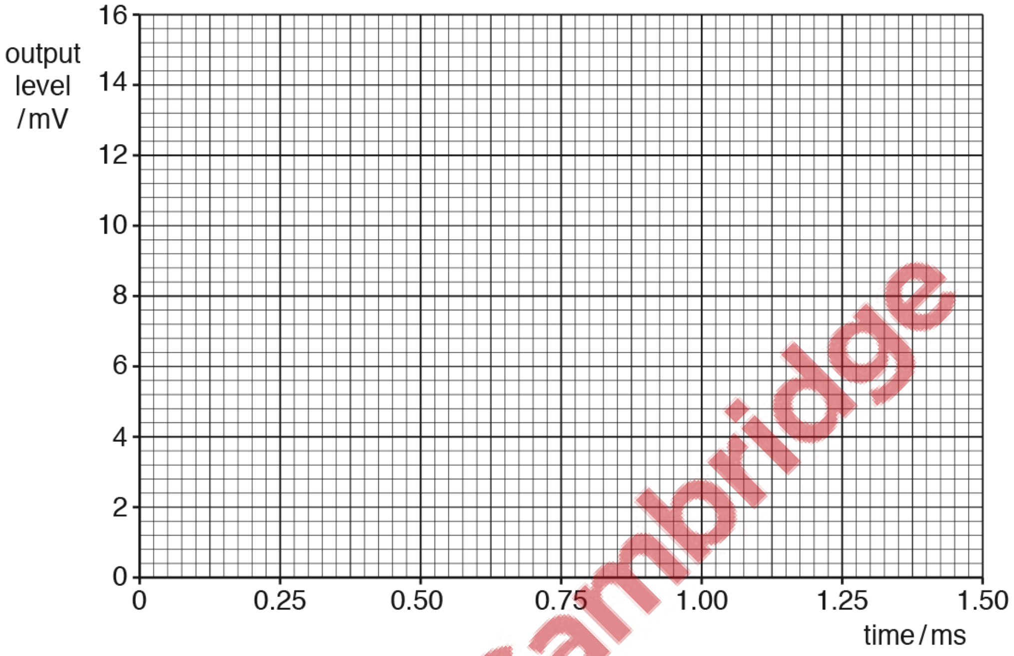

Fig. 6.3

[4]

[Total: 6]

146. 9702_w18_qp_41 Q: 5

(a) State two advantages of the transmission of data in digital form, compared with the transmission in analogue form.

1. ....

....

2. ....

.... [2]

(b) The digital numbers shown in Fig. 5.1 are transmitted at a sampling rate of 500 Hz.

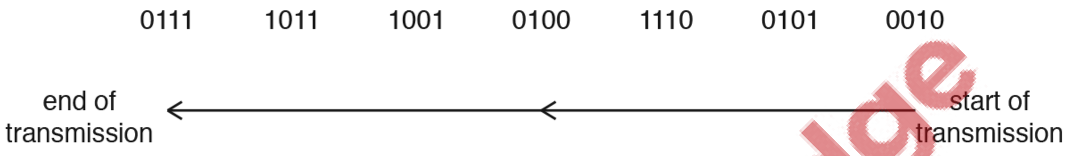

Fig. 5.1

The digital numbers are received, after transmission, by a digital-to-analogue converter (DAC).

On Fig. 5.2, complete the graph to show the variation with time *t* of the signal level from the DAC.

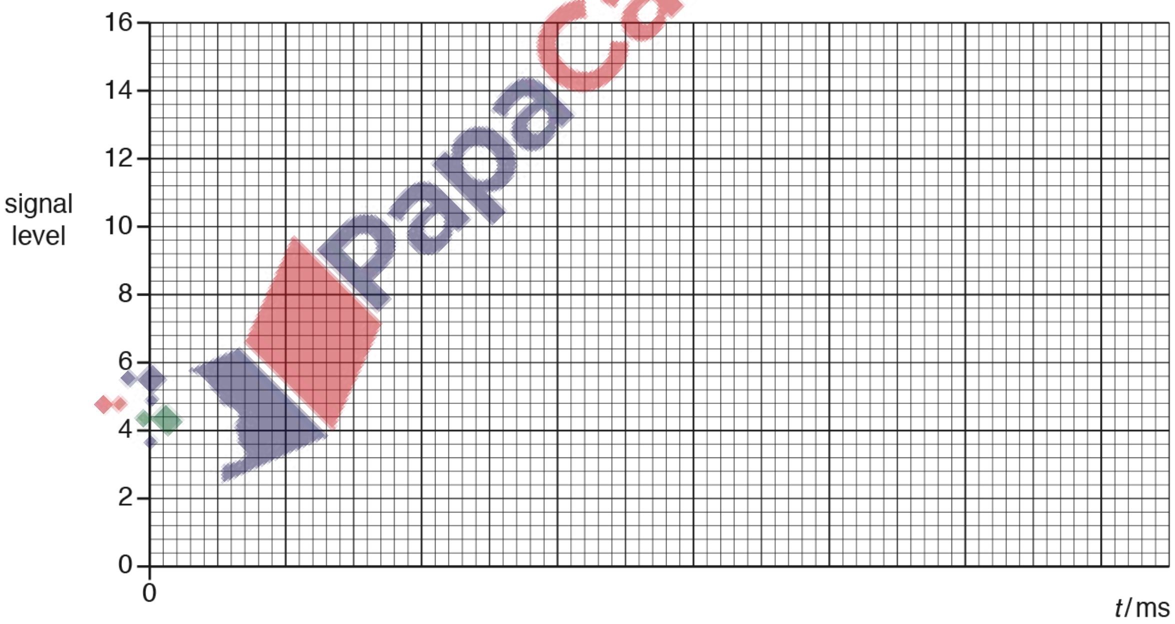

Fig. 5.2

[4]

(c) State the effect on the transmitted analogue signal when

(i) the sampling rate of the analogue-to-digital converter (ADC) and of the DAC is increased,

....

....[1]

(ii) the number of bits in each sample is increased.

....

....[1]

[Total: 8]

147. 9702_w18_qp_43 Q: 5

(a) State two advantages of the transmission of data in digital form, compared with the transmission in analogue form.

1. ....

....

2. ....

.... [2]

(b) The digital numbers shown in Fig. 5.1 are transmitted at a sampling rate of 500 Hz.

0111 1011 1001 0100 1110 0101 0010

end of transmission ←——————←—————— start of transmission

Fig. 5.1

The digital numbers are received, after transmission, by a digital-to-analogue converter (DAC).

On Fig. 5.2, complete the graph to show the variation with time *t* of the signal level from the DAC.

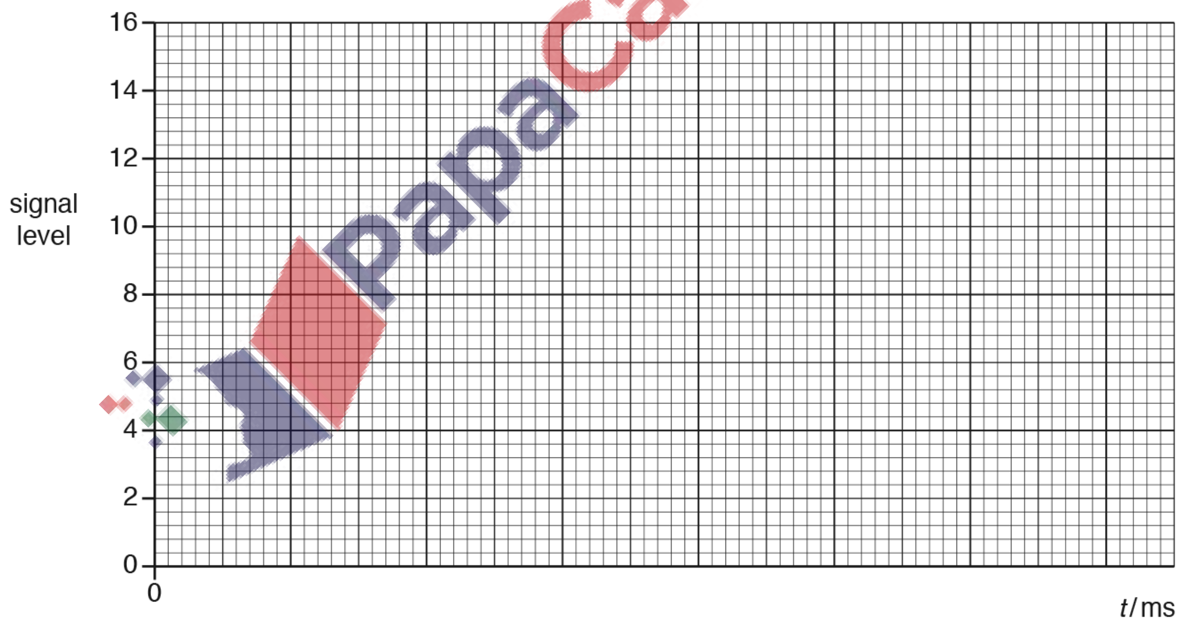

Fig. 5.2

[4]

(c) State the effect on the transmitted analogue signal when

(i) the sampling rate of the analogue-to-digital converter (ADC) and of the DAC is increased,

....

....[1]

(ii) the number of bits in each sample is increased.

....

....[1]

[Total: 8]

148. 9702_s17_qp_42 Q: 5

(a) State two advantages of the transmission of data in digital form rather than in analogue form.

1. ....

....

2. ....

....
[2]

(b) An analogue signal S_I is converted into a digital signal D using an analogue-to-digital converter (ADC). After transmission of the digital signal, it is converted back to an analogue signal S_T using a digital-to-analogue converter (DAC), as illustrated in Fig. 5.1.

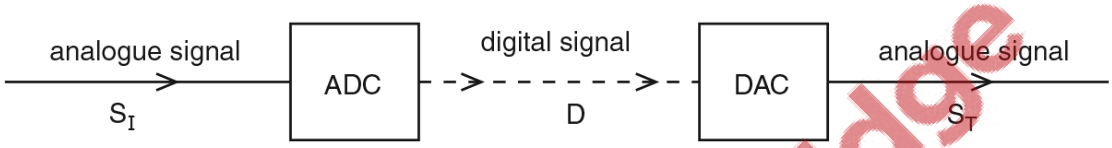

Fig. 5.1

(i) Outline the process by which the ADC converts the analogue signal S_I into the digital signal D.

....

....

....[2]

(ii) The ADC and the DAC operate with the same sampling rate and the same number of bits in each digital number.

State the effect on the transmitted analogue signal S_T when, for the ADC and the DAC,

1. the sampling rate is increased,

....

....

2. the number of bits in each digital number is increased.

....

....
[2]

[Total: 6]

149. 9702_w17_qp_42 Q: 5

The analogue signal from a microphone is to be transmitted in digital form.
The variation with time t of part of the signal from the microphone is shown in Fig. 5.1.

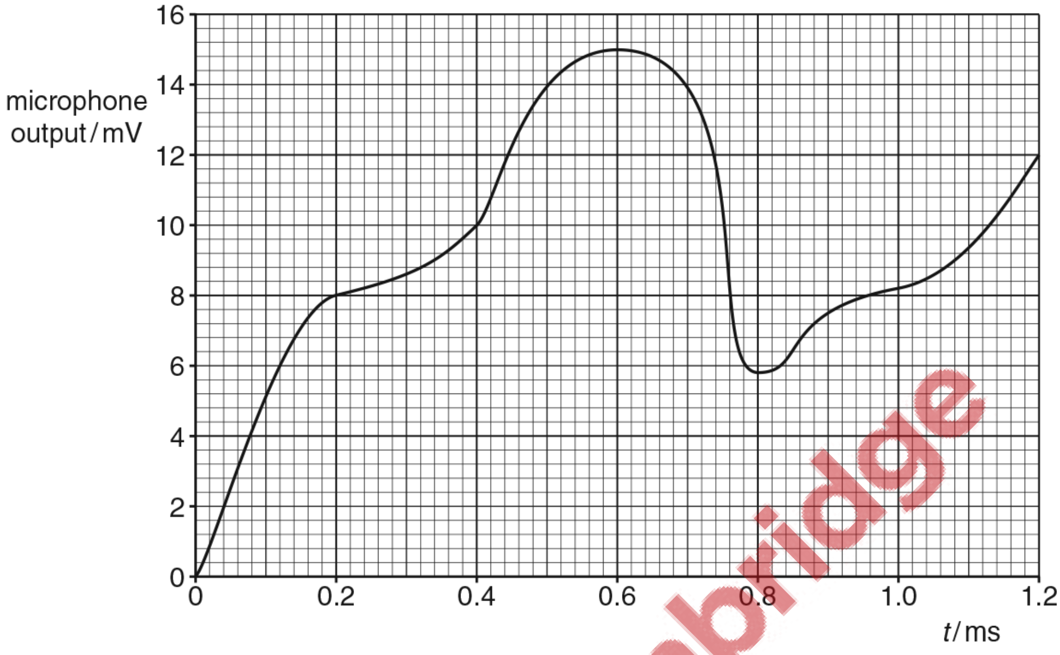

Fig. 5.1

The microphone output is sampled at a frequency of 5.0 kHz by an analogue-to-digital converter (ADC).
The output from the ADC is a series of 4-bit numbers. The smallest bit represents 1.0 mV.
The first sample is taken at time $t = 0$.

(a) Use Fig. 5.1 to complete Fig. 5.2.

time t / ms	microphone output / mV	ADC output
0.2	....	....
0.8	....	....

Fig. 5.2 [2]

(b) After transmission of the digital signal, it is converted back to an analogue signal using a digital-to-analogue converter (DAC).
Using data from Fig. 5.1, draw, on the axes of Fig. 5.3, the output level from the DAC for the transmitted signal from time $t = 0$ to time $t = 1.2$ ms.

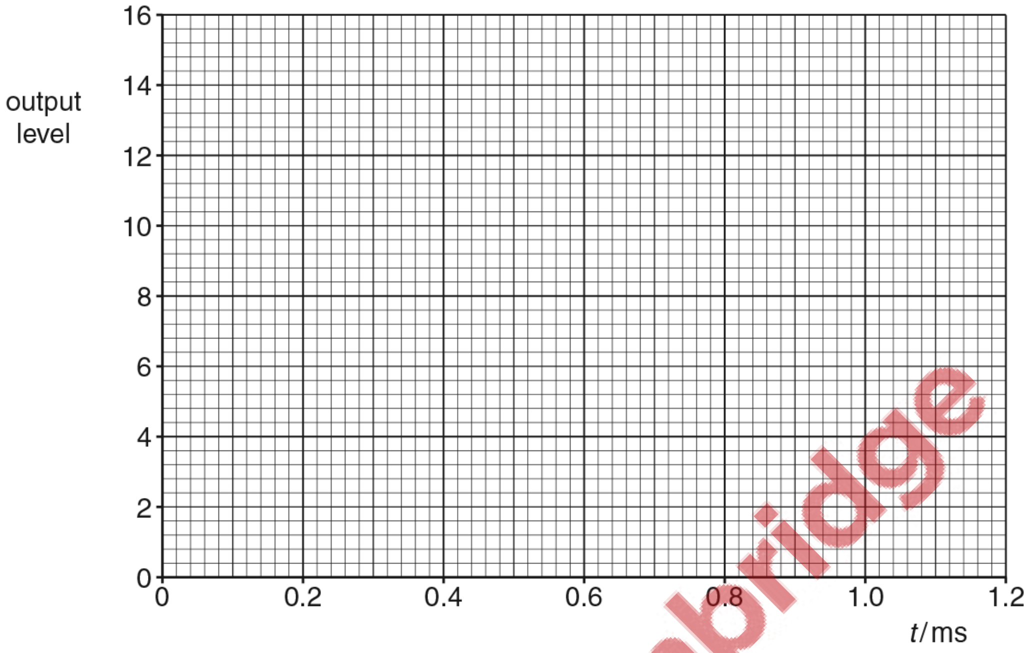

Fig. 5.3

[4]

(c) It is usual in modern telecommunication systems for the ADC and the DAC to have more than four bits in each sample.
State and explain the effect on the transmitted analogue signal of such an increase.

....

....

....

....[2]

[Total: 8]

150. 9702_m16_qp_42 Q: 5

(a) A digital signal is produced by sampling an analogue signal and passing the samples through an analogue-to-digital converter (ADC).

(i) State what is meant by a *digital signal*.

....

....

....[2]

(ii) State one change to the sampling or to the ADC that will improve the accuracy of reproduction of the original analogue signal.

....

....[1]

(b) The least significant bit of the four-bit digital number 1100 represents a signal voltage of 2.5 mV. Determine the signal voltage, in mV, represented by this digital number.

voltage = ... mV [1]

[Total: 4]

151. 9702_s19_qp_41 Q: 4

(a) During the transmission of a signal, attenuation occurs and noise is picked up.

State what is meant by:

(i) *attenuation*

....

.... [1]

(ii) *noise.*

....

....

.... [2]

(b) By reference to **(a)(ii)**, explain the advantage of the transmission of the signal in digital form rather than in analogue form.

....

.... [1]

(c) Part of an analogue signal is shown in Fig. 4.1.

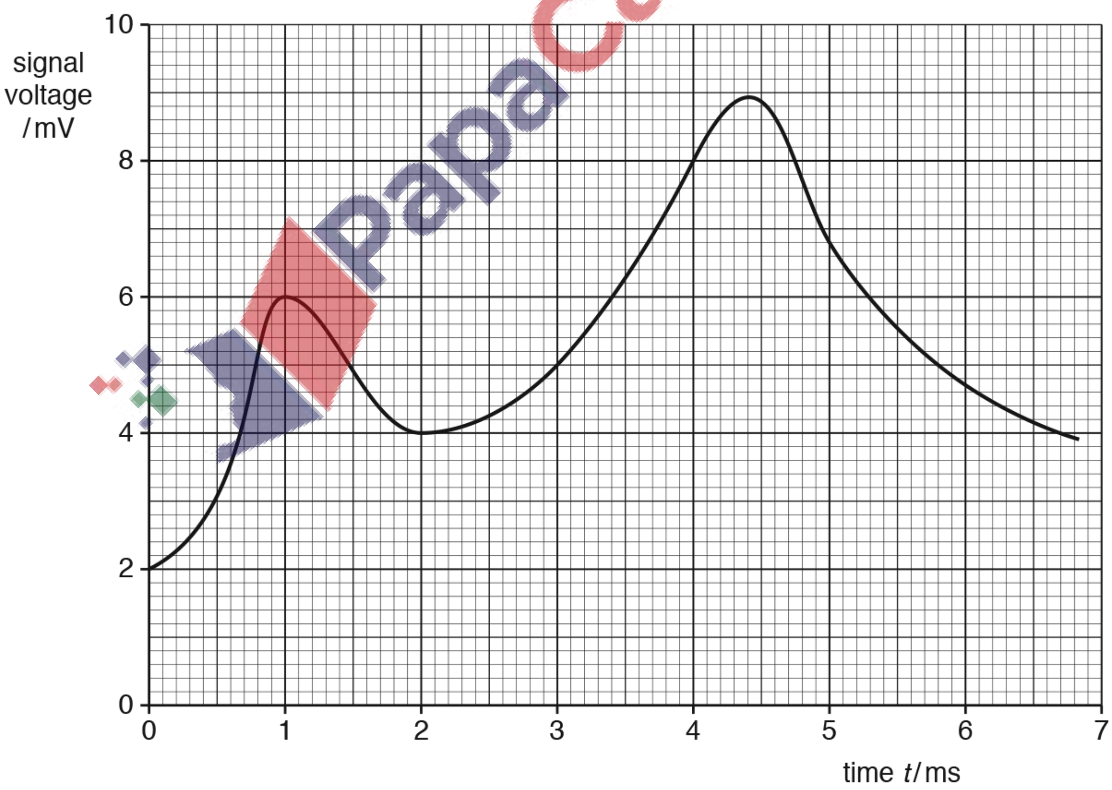

Fig. 4.1

The signal is to be transmitted in digital form.

The analogue signal is sampled at a frequency of 1.0×10^3 Hz using an analogue-to-digital converter (ADC). The ADC produces 4-bit numbers.

The times t at which the analogue signal is sampled are shown in Fig. 4.2.

time t/ms	0	1.0	2.0	3.0	4.0	5.0	6.0
digital number	0010	0110	0100	0101	....	....	....

Fig. 4.2

On Fig. 4.2:

(i) for the digital number at time t = 3.0 ms, underline the least significant bit (LSB) [1]

(ii) state the digital numbers corresponding to the sampling times between time t = 4.0 ms and time t = 6.0 ms. [2]

(d) The transmitted digital signal is converted back to an analogue signal using a digital-to-analogue converter (DAC).

On Fig. 4.3, show the variation with time t of the output levels of the DAC for time t = 0 to time t = 4.0 ms. Assume that there is negligible time delay in the transmission line.

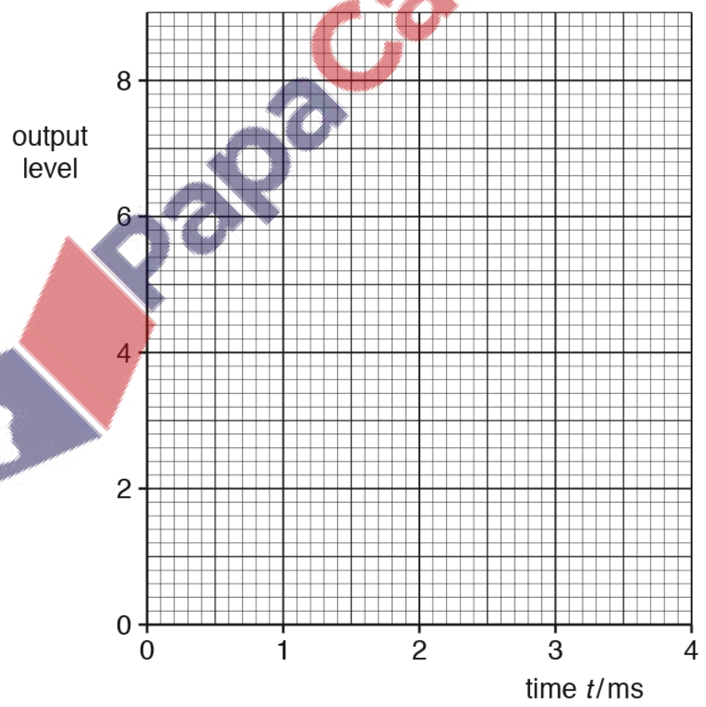

Fig. 4.3

[3]

[Total: 10]

152. 9702_s21_qp_41 Q: 5

(a) State what is meant by the *amplitude modulation* (*AM*) of a radio wave.

....

....

.... [2]

(b) A radio wave is modulated by an audio signal.

The variation with frequency *f* of the amplitude of the modulated wave is shown in Fig. 5.1.

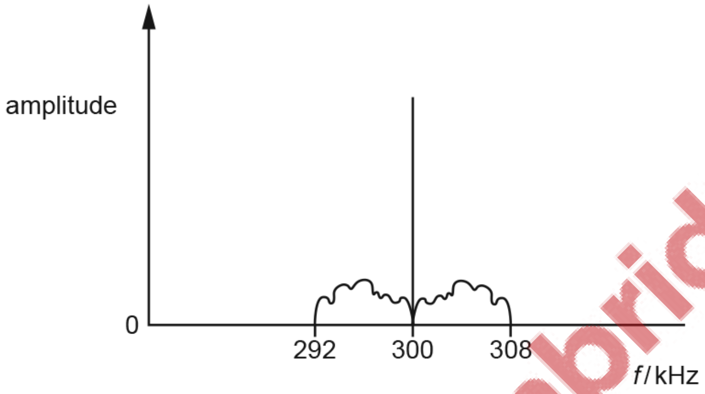

Fig. 5.1

Determine:

(i) the wavelength of the carrier wave

wavelength = ... m [1]

(ii) the bandwidth of the modulated wave

bandwidth = ... kHz [1]

(iii) the maximum frequency of the audio signal.

maximum frequency = ... kHz [1]

(c) The power of a radio signal at a transmitter is P_T.
At a receiver, the received power P_R is given by the expression

$$P_R = \frac{0.082\,P_T}{x^2}$$

where x is the distance, in metres, between the transmitter and the receiver.

For the transmission of this signal, the attenuation is 73 dB.

Determine the distance x.

x = ... m [3]

[Total: 8]

153. 9702_s21_qp_43 Q: 5

(a) State what is meant by the *amplitude modulation* (*AM*) of a radio wave.

....

....

.... [2]

(b) A radio wave is modulated by an audio signal.

The variation with frequency *f* of the amplitude of the modulated wave is shown in Fig. 5.1.

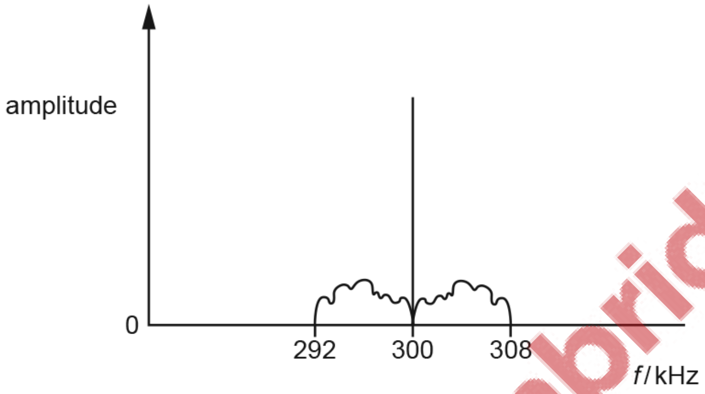

Fig. 5.1

Determine:

(i) the wavelength of the carrier wave

wavelength = ... m [1]

(ii) the bandwidth of the modulated wave

bandwidth = ... kHz [1]

(iii) the maximum frequency of the audio signal.

maximum frequency = ... kHz [1]

(c) The power of a radio signal at a transmitter is P_T.
At a receiver, the received power P_R is given by the expression

$$P_R = \frac{0.082\,P_T}{x^2}$$

where x is the distance, in metres, between the transmitter and the receiver.

For the transmission of this signal, the attenuation is 73 dB.

Determine the distance x.

x = ... m [3]

[Total: 8]

154. 9702_m20_qp_42 Q: 5

(a) State **two** advantages of the transmission of data in digital form, rather than analogue form.

1. ....

....

2. ....

.... [2]

(b) Optic fibres are used for the transmission of data.

(i) A signal in an optic fibre is carried by an electromagnetic wave of frequency 1.36×10^{14} Hz. The speed of the wave in the fibre is $2.07 \times 10^{8}\,\mathrm{m\,s^{-1}}$.

For this electromagnetic wave, determine the ratio:

$$\frac{\text{wavelength in free space}}{\text{wavelength in fibre}}.$$

ratio = ... [2]

(ii) The attenuation per unit length of the signal in the fibre is $0.40\,\mathrm{dB\,km^{-1}}$. The input power is 1.5 mW and the output power is 0.060 mW.

Calculate the length of the fibre.

length = ... km [3]

[Total: 7]

155. 9702_s20_qp_41 Q: 6

(a) The transmission of signals using optic fibres has, to a great extent, replaced the use of coaxial cables.

Advantages of optic fibres include greater bandwidth and very little crosslinking.

(i) Suggest an advantage of greater bandwidth.

....

.... [1]

(ii) State what is meant by *crosslinking*.

....

....

.... [2]

(b) In telecommunications, a signal power of 1.0 mW is used as a reference power. Signal powers relative to this reference power and expressed in dB are said to be measured in 'dBm'.

Show that a signal power of 13 dBm is equivalent to 20 mW.

[2]

(c) A signal of input power 20 mW is transmitted along an optic fibre for an uninterrupted distance of 45 km.

The optic fibre has an attenuation per unit length of 0.18 dB km^{-1}.

Calculate the output power P from the optic fibre.

P = ... mW [2]

[Total: 7]

156. 9702_s20_qp_42 Q: 6

(a) Telephone signals may be transmitted either by means of an optic fibre or by means of a wire pair.

State **three** advantages of the use of an optic fibre rather than a wire pair.

1. ....

....

2. ....

....

3. ....

....
[3]

(b) It is proposed to transmit a signal over a distance of 4.5×10^3 km by means of an optic fibre.

The input signal has a power of 9.8 mW.

The minimum signal that can be detected at the output has a power of 6.3×10^{-17} W. For this signal power, the signal-to-noise ratio is 21 dB.

Calculate:

(i) the power of the background noise

power = ... W [2]

(ii) the maximum attenuation per unit length of the optic fibre that allows for uninterrupted transmission of the signal.

attenuation per unit length = ... dB km^{-1} [2]

[Total: 7]

157. 9702_s20_qp_43 Q: 6

(a) The transmission of signals using optic fibres has, to a great extent, replaced the use of coaxial cables.

Advantages of optic fibres include greater bandwidth and very little crosslinking.

(i) Suggest an advantage of greater bandwidth.

....

.... [1]

(ii) State what is meant by *crosslinking*.

....

....

.... [2]

(b) In telecommunications, a signal power of 1.0 mW is used as a reference power. Signal powers relative to this reference power and expressed in dB are said to be measured in 'dBm'.

Show that a signal power of 13 dBm is equivalent to 20 mW.

[2]

(c) A signal of input power 20 mW is transmitted along an optic fibre for an uninterrupted distance of 45 km.

The optic fibre has an attenuation per unit length of 0.18 dB km^{-1}.

Calculate the output power *P* from the optic fibre.

P = ... mW [2]

[Total: 7]

158. 9702_m19_qp_42 Q: 4

(a) State **three** features of the orbit of a geostationary satellite.

1. ....

....

2. ....

....

3. ....

.... [3]

(b) A signal is transmitted from Earth to a geostationary satellite. Initially, the signal has power 3.2 kW. The signal is attenuated by 194 dB.

Calculate the signal power received by the satellite.

power = ... W [2]

(c) Suggest one advantage and one disadvantage of the use of geostationary satellites compared with polar-orbiting satellites for communication between points on the Earth's surface.

advantage: ....

....

disadvantage: ....

.... [2]

[Total: 7]

159. 9702_s19_qp_42 Q: 5

(a) For a signal transmitted along an optic fibre, state what is meant by:

(i) *attenuation*

....

....[1]

(ii) *noise*.

....

....

....[2]

(b) The initial section of the transmission line for a signal from a telephone exchange is illustrated in Fig. 5.1.

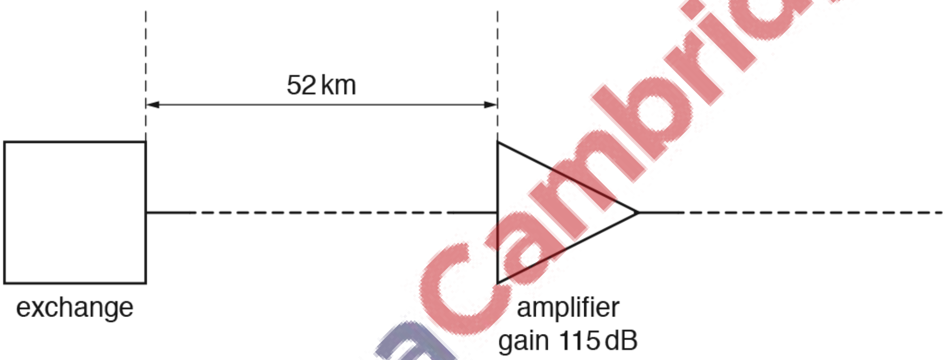

Fig. 5.1

At the exchange, the input signal to the transmission line has a power of 2.5×10^{-3} W.

After the signal has travelled a distance of 52 km along the transmission line, the power of the signal is 7.8×10^{-16} W. The signal is then amplified.

(i) Calculate the attenuation per unit length, in dB km^{-1}, in the transmission line.

attenuation per unit length = ... dB km^{-1} [3]

(ii) The gain of the amplifier is 115 dB.

Calculate the power of the signal at the output of the amplifier.

power = ... W [2]

[Total: 8]

160. 9702_s19_qp_43 Q: 4

(a) During the transmission of a signal, attenuation occurs and noise is picked up.

State what is meant by:

(i) *attenuation*

....

.... [1]

(ii) *noise*.

....

....

.... [2]

(b) By reference to **(a)(ii)**, explain the advantage of the transmission of the signal in digital form rather than in analogue form.

....

.... [1]

(c) Part of an analogue signal is shown in Fig. 4.1.

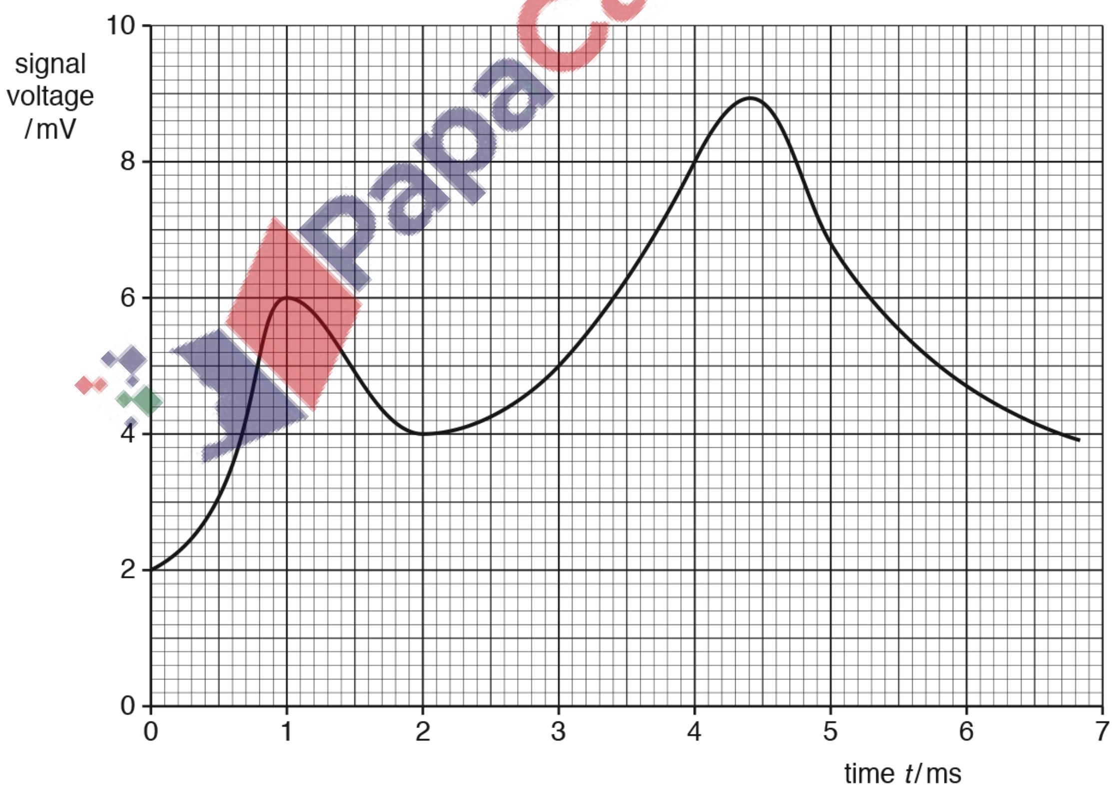

Fig. 4.1

The signal is to be transmitted in digital form.

The analogue signal is sampled at a frequency of 1.0×10^3 Hz using an analogue-to-digital converter (ADC). The ADC produces 4-bit numbers.

The times *t* at which the analogue signal is sampled are shown in Fig. 4.2.

time t/ms	0	1.0	2.0	3.0	4.0	5.0	6.0
digital number	0010	0110	0100	0101	………	………	………

Fig. 4.2

On Fig. 4.2:

(i) for the digital number at time $t = 3.0$ ms, underline the least significant bit (LSB) [1]

(ii) state the digital numbers corresponding to the sampling times between time $t = 4.0$ ms and time $t = 6.0$ ms. [2]

(d) The transmitted digital signal is converted back to an analogue signal using a digital-to-analogue converter (DAC).

On Fig. 4.3, show the variation with time *t* of the output levels of the DAC for time $t = 0$ to time $t = 4.0$ ms. Assume that there is negligible time delay in the transmission line.

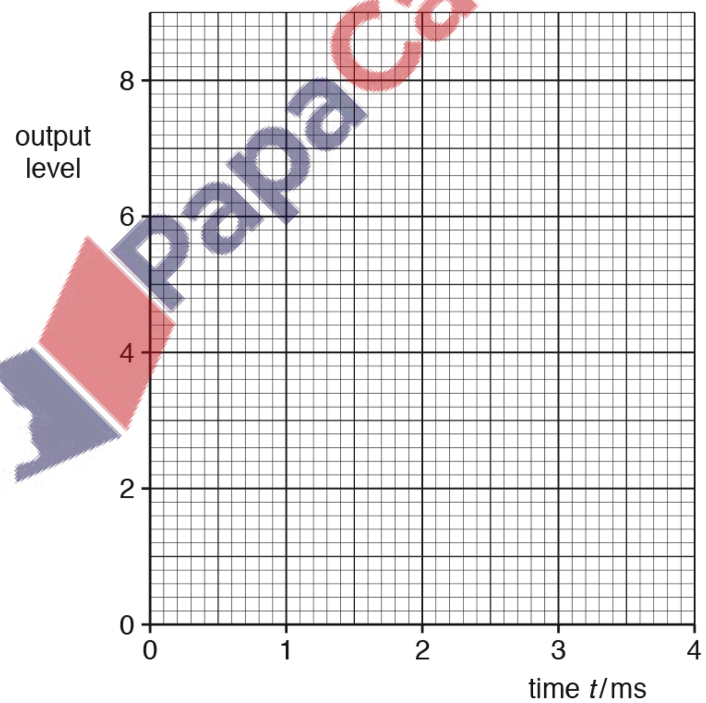

Fig. 4.3

[3]

[Total: 10]

161. 9702_w19_qp_41 Q: 5

(a) A section of a coaxial cable is shown in Fig. 5.1.

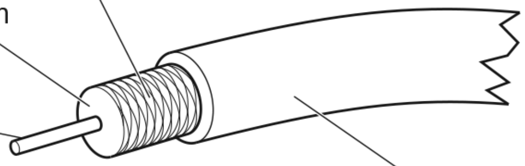

Fig. 5.1

(i) Suggest **two** functions of the copper braid.

1. ....

....

2. ....

.... [2]

(ii) Suggest **one** application of a coaxial cable for the transmission of electrical signals.

....

.... [1]

(b) **(i)** The constant noise power in a transmission cable is 7.6 μW. The minimum acceptable signal-to-noise ratio is 32 dB.

Calculate the minimum acceptable signal power P_{MIN} in the cable.

P_{MIN} = ... W [2]

(ii) The input power of the signal to the transmission cable is 2.6 W. The attenuation per unit length of the cable is 6.3 dB km^{-1}.

Use your answer in **(i)** to determine the maximum uninterrupted length L of cable along which the signal may be transmitted.

L = ... km [2]

[Total: 7]

162. 9702_w19_qp_43 Q: 5

(a) A section of a coaxial cable is shown in Fig. 5.1.

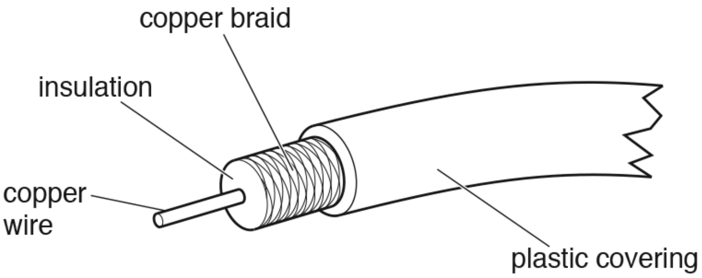

Fig. 5.1

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....

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Calculate the minimum acceptable signal power P_{MIN} in the cable.

P_{MIN} = ... W [2]

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Use your answer in **(i)** to determine the maximum uninterrupted length L of cable along which the signal may be transmitted.

L = ... km [2]

[Total: 7]

163. 9702_s18_qp_41 Q: 5

A geostationary satellite orbits the Earth with a period of 24 hours.

(a) State

(i) the direction of the orbit about the Earth,

....[1]

(ii) the position of the satellite relative to the Earth's surface,

....[1]

(iii) a typical frequency for communication between the satellite and Earth.

frequency = ... Hz [1]

(b) A signal transmitted from Earth to a satellite has an initial power of 3.0 kW.
The signal power received by the satellite is attenuated by 195 dB.

(i) Calculate the signal power received by the satellite.

power = ... W [3]

(ii) By reference to your answer in **(i)**, explain why different frequencies are used for the up-link and the down-link in communication with the satellite.

....

....

....

....[2]

[Total: 8]

164. 9702_s18_qp_43 Q: 5

A geostationary satellite orbits the Earth with a period of 24 hours.

(a) State

(i) the direction of the orbit about the Earth,

....[1]

(ii) the position of the satellite relative to the Earth's surface,

....[1]

(iii) a typical frequency for communication between the satellite and Earth.

frequency = ... Hz [1]

(b) A signal transmitted from Earth to a satellite has an initial power of 3.0 kW.
The signal power received by the satellite is attenuated by 195 dB.

(i) Calculate the signal power received by the satellite.

power = ... W [3]

(ii) By reference to your answer in **(i)**, explain why different frequencies are used for the up-link and the down-link in communication with the satellite.

....

....

....

....[2]

[Total: 8]

165. 9702_m17_qp_42 Q: 5

(a) State **three** advantages of an optic fibre compared to a metal wire for the transmission of a signal.

1. ....

2. ....

3. ....
[3]

(b) An optic fibre of length 57 km is connected between a transmitter and a receiver, as shown in Fig. 5.1.

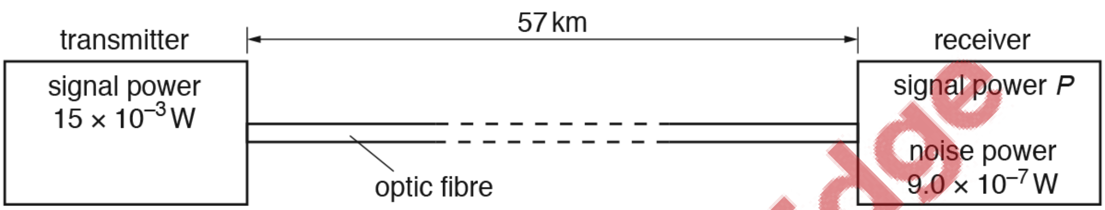


Fig. 5.1

The attenuation per unit length of the optic fibre is 0.50 dB km^{-1}. The transmitter provides an input signal of power 15×10^{-3} W to the fibre. The noise power at the receiver is 9.0×10^{-7} W.

(i) Show that the signal power *P* entering the receiver from the optic fibre is 2.1×10^{-5} W.

[2]

(ii) A minimum signal-to-noise ratio of 24 dB is needed at the receiver in order for it to be able to distinguish the signal from the noise.

Determine whether the receiver is able to distinguish the signal from the noise.

[3]

[Total: 8]

166. 9702_s17_qp_41 Q: 3

The digital transmission of speech may be illustrated using the block diagram of Fig. 3.1.

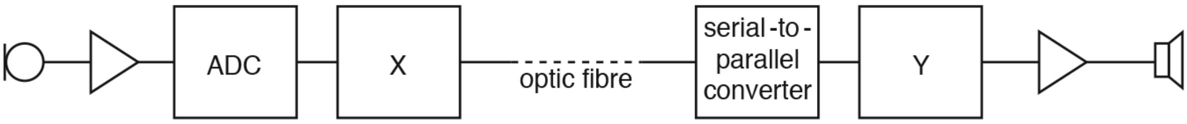


Fig. 3.1

(a) **(i)** State what is meant by a *digital signal*.

....

....[1]

(ii) State the names of the components labelled X and Y on Fig. 3.1.

X: ....

Y: ....
[2]

(iii) Describe the function of the ADC.

....

....

....[2]

(b) The optic fibre has length 84 km and the attenuation per unit length in the fibre is 0.19 dB km^{-1}.

The input power to the optic fibre is 9.7 mW. At the output from the optic fibre, the signal-to-noise ratio is 28 dB.

Calculate

(i) in dB, the ratio

$$\frac{\text{input power to optic fibre}}{\text{noise power at output of optic fibre}},$$

ratio = ... dB [2]

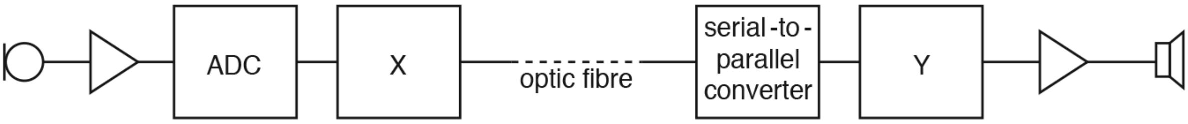
(ii) the noise power at the output of the optic fibre.

noise power = ... W [3]

[Total: 10]

167. 9702_s17_qp_43 Q: 3

The digital transmission of speech may be illustrated using the block diagram of Fig. 3.1.



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(a) **(i)** State what is meant by a *digital signal*.

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....[1]

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X: ....

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Calculate

(i) in dB, the ratio

$$\frac{\text{input power to optic fibre}}{\text{noise power at output of optic fibre}},$$

ratio = ... dB [2]

(ii) the noise power at the output of the optic fibre.

noise power = ... W [3]

[Total: 10]

---

168. 9702_w17_qp_41 Q: 4

A coaxial cable is frequently used to connect an aerial to a television receiver. Such a cable is illustrated in Fig. 4.1.

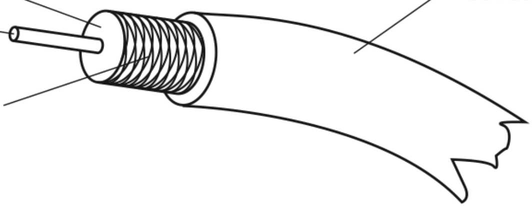

Fig. 4.1

(a) Suggest two functions of the copper braid.

1. ....

....

2. ....

.... [2]

(b) Suggest two reasons why a wire pair is not usually used to connect the aerial to the receiver.

1. ....

....

2. ....

.... [2]

(c) The coaxial cable connecting an aerial to a receiver has length 14 m.
The cable has an attenuation per unit length of 190 dB km^{-1}.

Calculate the fractional **loss** in signal power during transmission of the signal along the cable.

fractional loss = ... [4]

[Total: 8]

169. 9702_w17_qp_43 Q: 4

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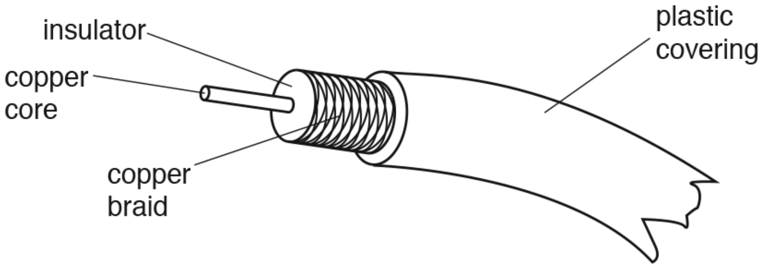

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2. ....

.... [2]

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The cable has an attenuation per unit length of 190 dB km^{-1}.

Calculate the fractional **loss** in signal power during transmission of the signal along the cable.

fractional loss = ... [4]

[Total: 8]

170. 9702_w16_qp_41 Q: 4

(a) Signals may be transmitted in either analogue or digital form. One advantage of digital transmission is that the signal can be regenerated.

Explain

(i) what is meant by *regeneration*,

....

....

.... [2]

(ii) why an analogue signal cannot be regenerated.

....

....

.... [2]

(b) Digital signals are transmitted along an optic fibre using infra-red radiation. The uninterrupted length of the optic fibre is 58 km.

The effective noise level in the receiver at the end of the optic fibre is 0.38 μW.
The minimum acceptable signal-to-noise ratio in the receiver is 32 dB.

(i) Calculate the minimum acceptable power P_{MIN} of the signal at the receiver.

P_{MIN} = ... W [2]

(ii) The input signal power to the optic fibre is 9.5 mW. The output power is P_{MIN}.
Calculate the attenuation per unit length of the optic fibre.

attenuation per unit length = ... dB km^{-1} [2]

[Total: 8]

171. 9702_w16_qp_43 Q: 4

(a) Signals may be transmitted in either analogue or digital form. One advantage of digital transmission is that the signal can be regenerated.

Explain

(i) what is meant by *regeneration*,

....

....

.... [2]

(ii) why an analogue signal cannot be regenerated.

....

....

.... [2]

(b) Digital signals are transmitted along an optic fibre using infra-red radiation. The uninterrupted length of the optic fibre is 58 km.

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(i) Calculate the minimum acceptable power P_{MIN} of the signal at the receiver.

P_{MIN} = ... W [2]

(ii) The input signal power to the optic fibre is 9.5 mW. The output power is P_{MIN}.
Calculate the attenuation per unit length of the optic fibre.

attenuation per unit length = ... dB km^{-1} [2]

[Total: 8]