1. Nov/2021/Paper_41/No.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.

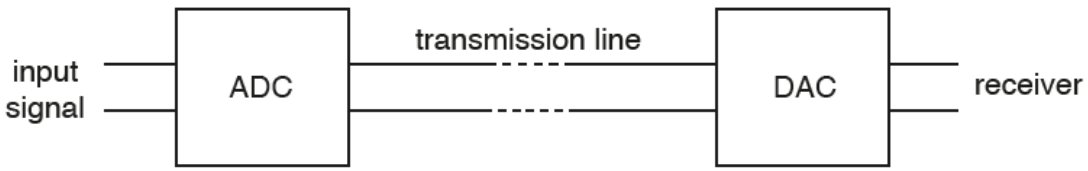

Fig. 5.1

(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.

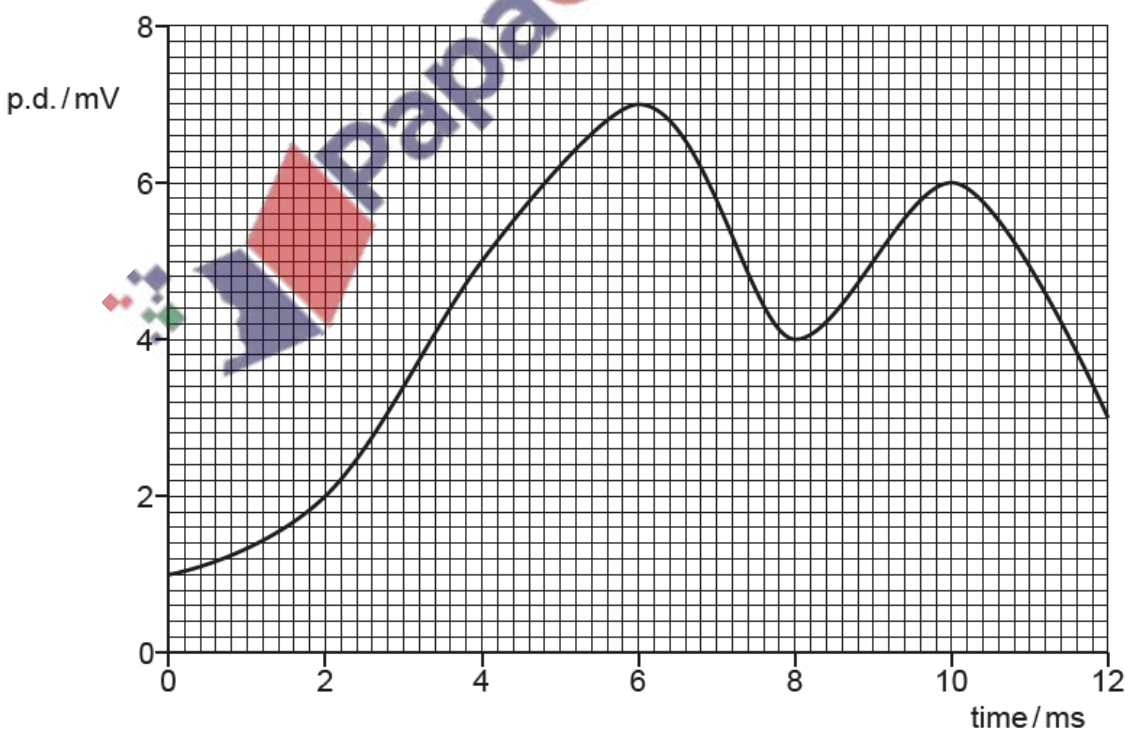

Fig. 5.2

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.

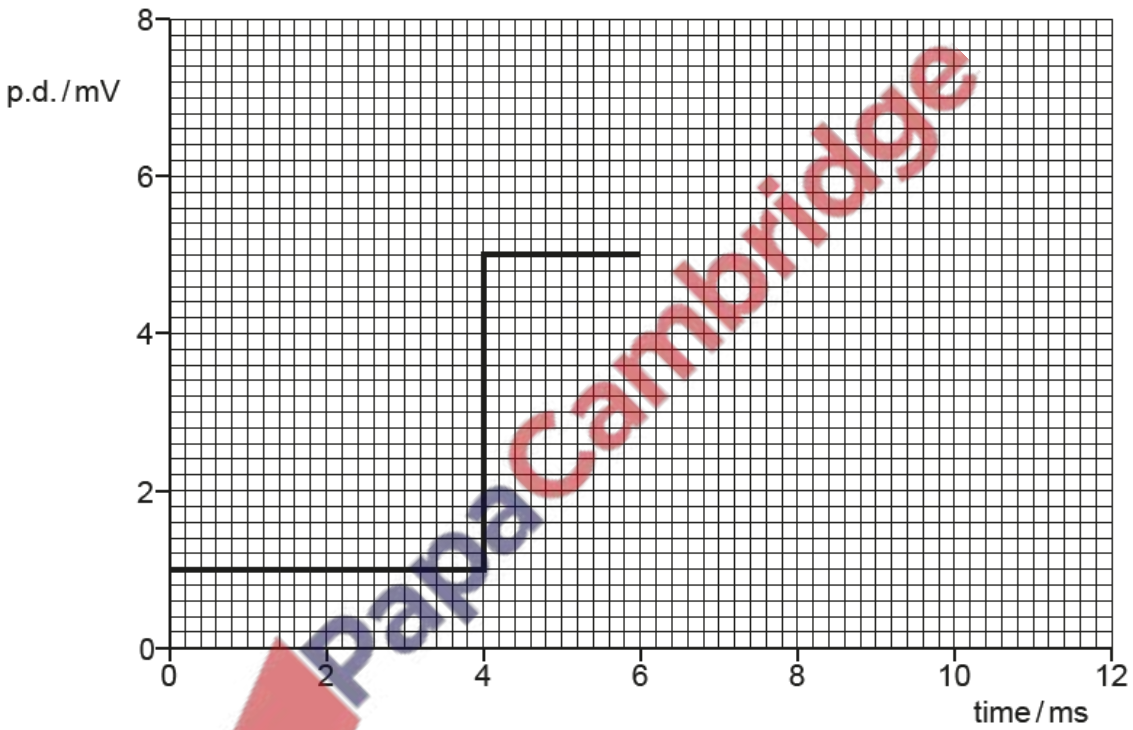

Fig. 5.3

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.

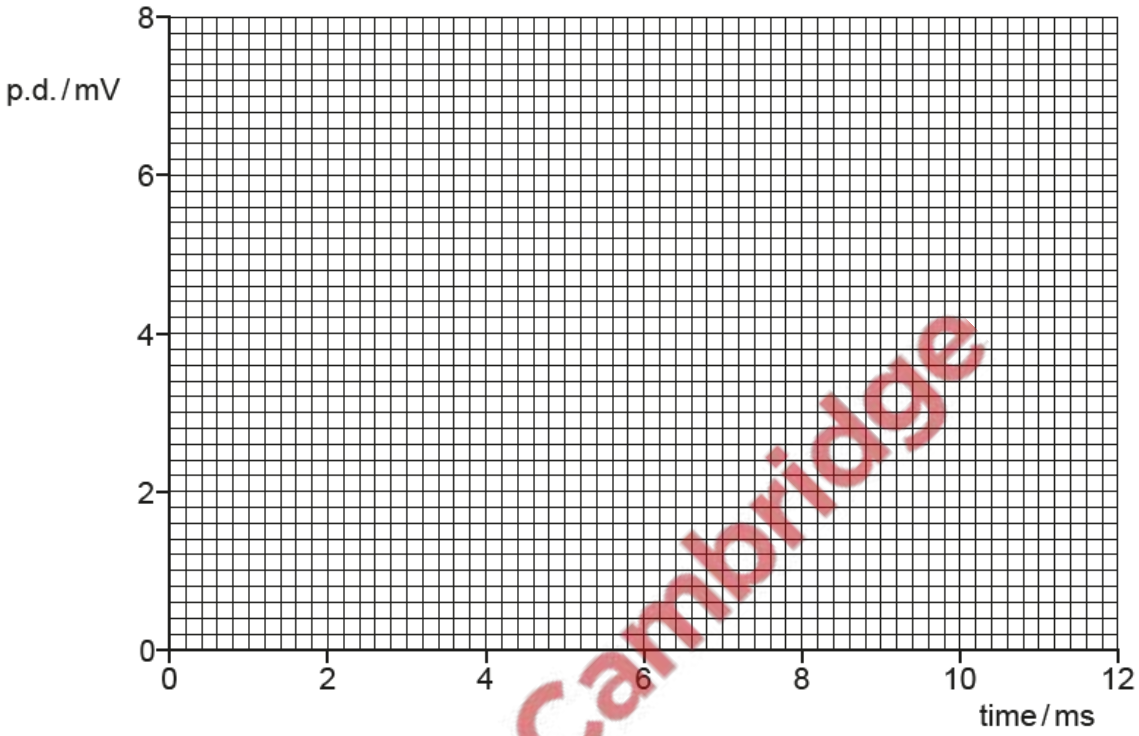

Fig. 5.4

[3]

[Total: 8]

2. Nov/2021/Paper_42/No.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 μV^{-1}.
The frequency modulation is at a rate of 5 kHz μV^{-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]

3. June/2021/Paper_41/No.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.

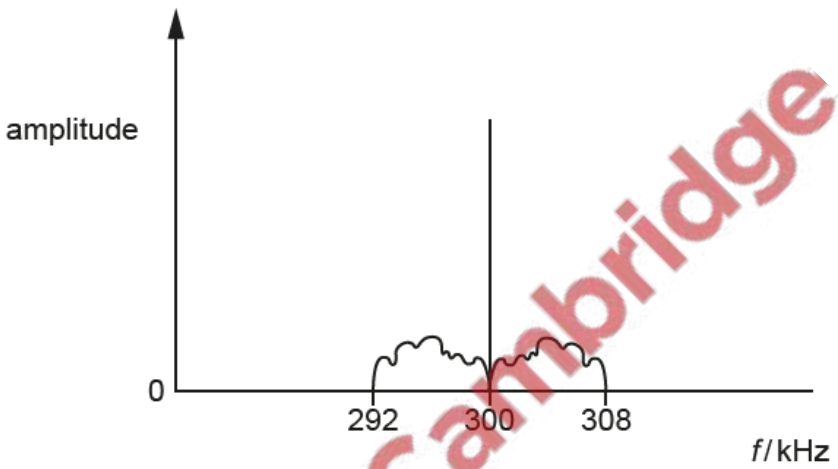

Fig. 5.1

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]

4. June/2021/Paper_42/No.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.

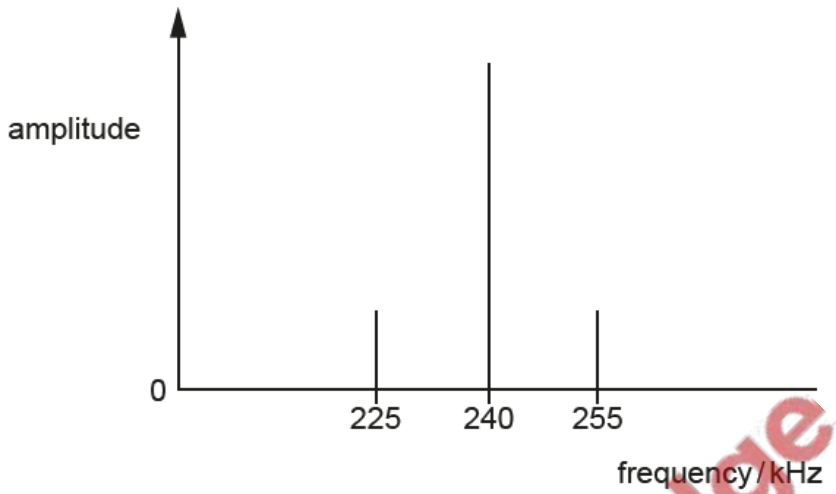

Fig. 4.1

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]

5. March/2021/Paper_42/No.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.

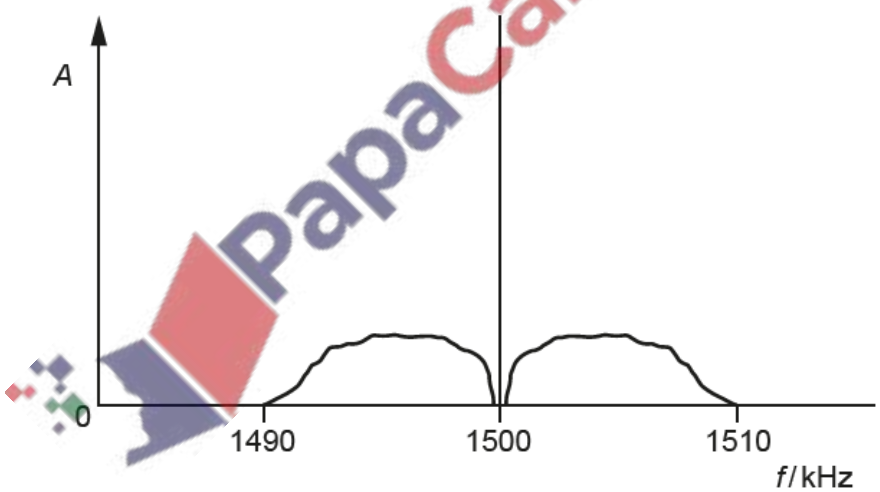

Fig. 5.1

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]