# Teacher Resource Bank

GCE Electronics

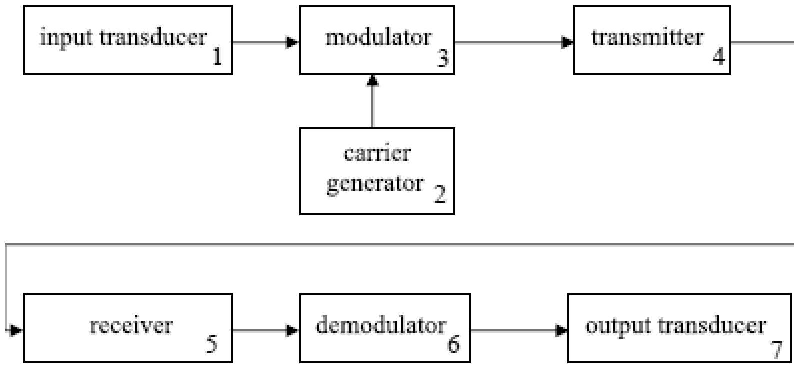
Exemplar Exam Questions

- ELEC5: Communication Systems

# ELEC5 – Communications Systems

## Communication System (ELE5, Q1, 2009)

1 A block diagram of a radio wave communication system is shown below.
Each subsystem has been numbered.




1 (a) Describe the type of signal that passes between each pair of numbered subsystems.
For example, the type of signal that passes between 1 and 3 is an information signal.

1 (a) (i) 2 and 3 ..............................

1 (a) (ii) 3 and 4 ..............................

1 (a) (iii) 4 and 5 ..............................

1 (a) (iv) 5 and 6 ..............................

1 (a) (v) 6 and 7 ..............................

*(5 marks)*

1 (b) Name a subsystem in the diagram above which could contain:

1 (b) (i) a tuned circuit ..............................

1 (b) (ii) an aerial ..............................

1 (b) (iii) a loudspeaker ..............................

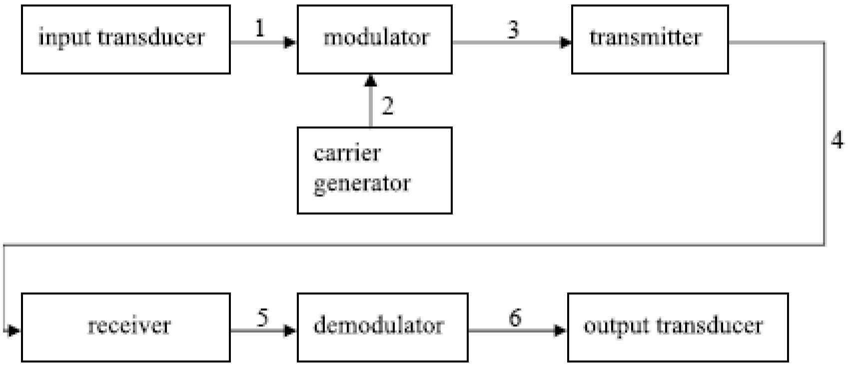
1 (b) (iv) an oscillator ..............................

1 (b) (v) a diode ..............................

*(5 marks)*

## Communication System (ELE5, Q1, 2008)

1 A block diagram of a generalized radio communication system is shown below.
The signal transfers between stages have been numbered.




Which numbered line represents:

1 (a) (i) an unmodulated radio frequency signal ..............................

1 (a) (ii) a modulated radio frequency signal in the transmitter ..............................

1 (a) (iii) a modulated radio frequency signal in the receiver ..............................

1 (a) (iv) the transmission link ..............................

1 (a) (v) the information signal in the transmitter ..............................

1 (a) (vi) the information signal in the receiver? ..............................

*(6 marks)*

1 (b) (i) Name **two** different non-wired transmission media.

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1 (b) (ii) Name **two** different wired transmission media.

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*(4 marks)*

## Communication System (ELE5, Q1, 2006)

1 (a) A radio transmitter uses the following sub-systems:

**carrier generator** **input transducer** **modulator** **transmitter**

Draw a labelled block diagram to show how these sub-systems are connected.

*(4 marks)*

(b) Electromagnetic signals can be transmitted using a variety of media.

State, with a reason in each case, which medium is best

(i) if a large bandwidth is required,

medium ..............................................................................................................

reason ..............................................................................................................

(ii) if one end of the communications link is mobile,

medium ..............................................................................................................

reason ..............................................................................................................

(iii) if a high level of security is required.

medium ..............................................................................................................

reason ..............................................................................................................

*(6 marks)*

## Active Filter (ELE2, Q5, 2008)

5 All of the electrical activity of the brain occurs at low frequencies, the alpha rhythm having the highest frequency of 8 – 13 Hz. In order to isolate this electrical activity from that of the muscles, which occurs at a higher frequency, the electrical signals are passed through a *low pass filter* with a *break point frequency* of 20 Hz.

5 (a) (i) What is meant by the term low pass filter?

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5 (a) (ii) What is meant by the term break point frequency?

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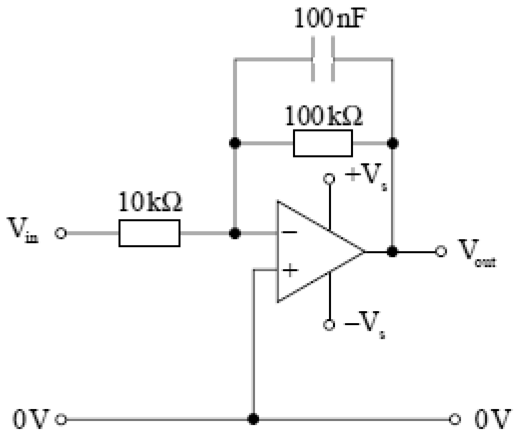
*(3 marks)*

5 (b) The circuit diagram of the low pass filter is shown below.




Calculate the reactance of the 100 nF capacitor at a frequency of 20 Hz.

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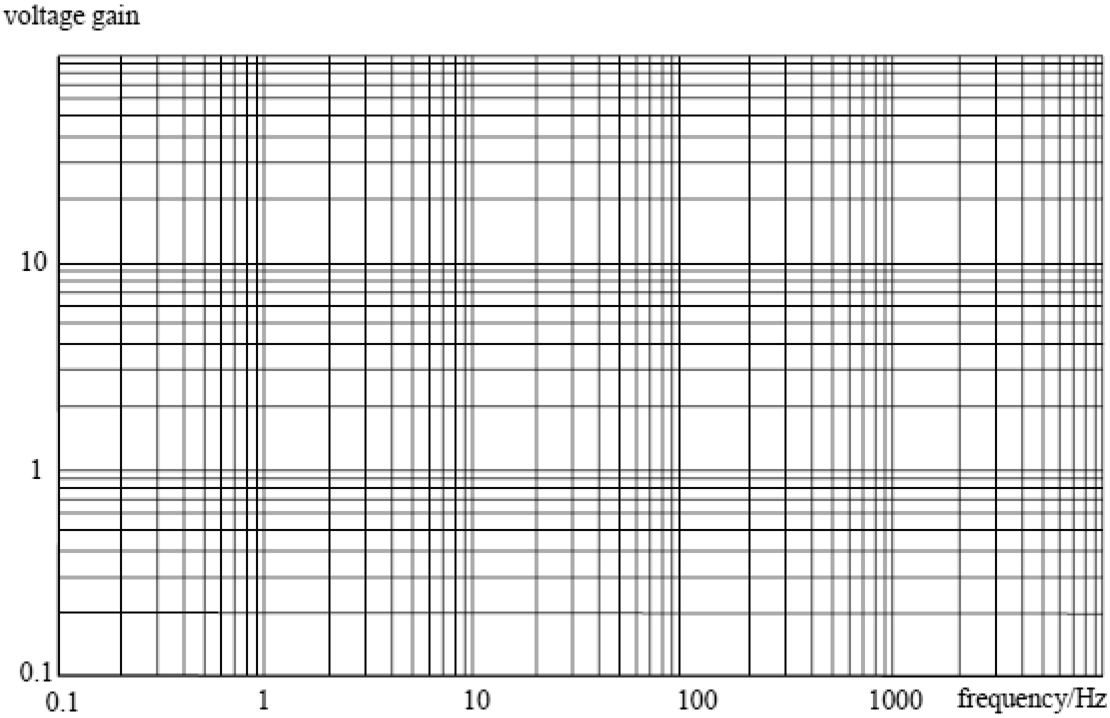
*(3 marks)*

5 (c) Sketch onto the grid below how the voltage gain of this filter circuit varies with frequency.




*(3 marks)*

## Active Filter (ELE2, Q2, 2005)

**2** A trainee electronics engineer needs to amplify and low pass filter the output of a Digital to Analogue Converter (DAC). The low pass filter break point frequency is to be 2.5 kHz.

(a) Explain what is meant by:

(i) low pass filter ..........................................................................................................

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*(1 mark)*

(ii) break point frequency ..........................................................................................................

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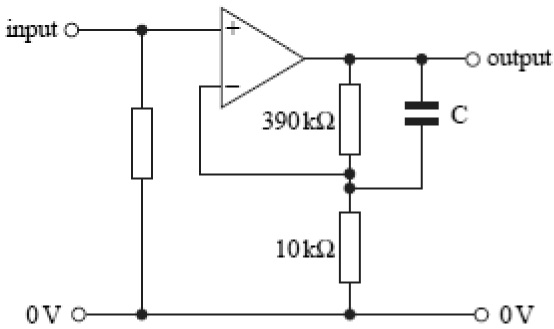
*(1 mark)*

(b) The circuit diagram used for the low pass filter is shown below.




(i) Estimate the voltage gain of the circuit well below the break point frequency, where the effect of the capacitor, C, is negligible.

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*(2 marks)*

(ii) Calculate a value for C so that the circuit has a break point frequency of 2.5 kHz.

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*(3 marks)*

(c) The engineer uses an op-amp with a gain-bandwidth product of $10^6$ Hz.
Estimate, showing your working, the maximum voltage gain that can be achieved from this op-amp at the break point frequency.

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*(2 marks)*

## Active Filter (ELE5, Q6, 2005)

6 A system using op-amp active filter circuits is designed to boost the information signal for a transmitter. The information signal should only contain frequencies from 300 Hz to 4 kHz.

(a) The op-amp used has a gain-bandwidth product of 1 MHz.
Calculate the maximum gain that could be obtained at 4 kHz.

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*(2 marks)*

(b) The system is made using a bass cut filter with a break point frequency of 300 Hz feeding a treble cut filter with a break point frequency of 4 kHz. The resulting output is then amplified by a factor of ten. Draw and label a system block diagram to show all these sub-systems. Include in your diagram the input and output.

*(3 marks)*

(c) Draw the circuit of a non-inverting amplifier that would amplify the signal by a factor of 10. Label the input and the output, give values for the components used.

*(5 marks)*

(d) (i) Draw the circuit of the active bass cut filter with $R_1$ = 10kΩ, $R_f$ = 100kΩ, and capacitor C.

(ii) Given that the reactance of C is the same as the value of $R_1$ at the break point frequency, or otherwise, calculate the value of C to give the required 300 Hz break point frequency.

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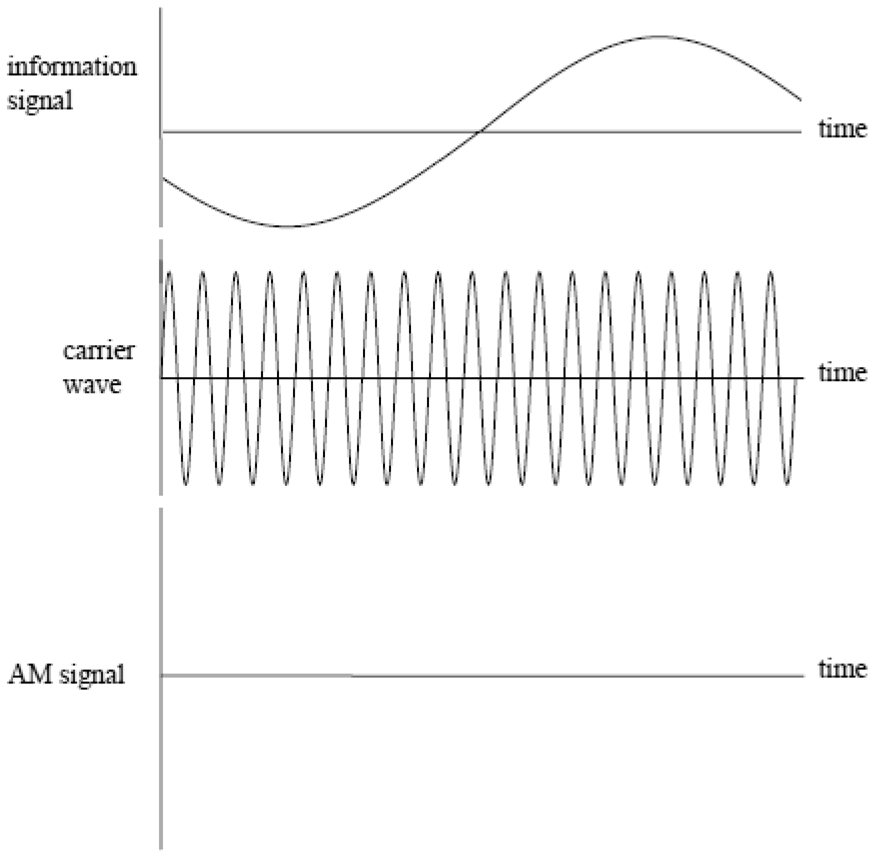
(iii) It is then realised that both filters can be made in the same circuit.
Add one capacitor to your diagram in part (d) (i) in the correct place that would also make the circuit into a treble cut filter. Label the capacitor T.

*(8 marks)*

## Amplitude Modulation (ELE5, Q3, 2009)

3 (a) An information signal and a carrier wave are shown on the axes below.
On the lowest set of axes, show how these combine to form an AM signal.




*(4 marks)*

3 (b) The information signal has a maximum frequency of 4.5 kHz and the modulated carrier is to be transmitted on the MW band.

3 (b) (i) What do the letters MW stand for?

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3 (b) (ii) Calculate the practical bandwidth of the resulting AM signal.

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3 (b) (iii) Calculate the resulting number of channels available on the MW band, which extends from 522 kHz – 1710 kHz.

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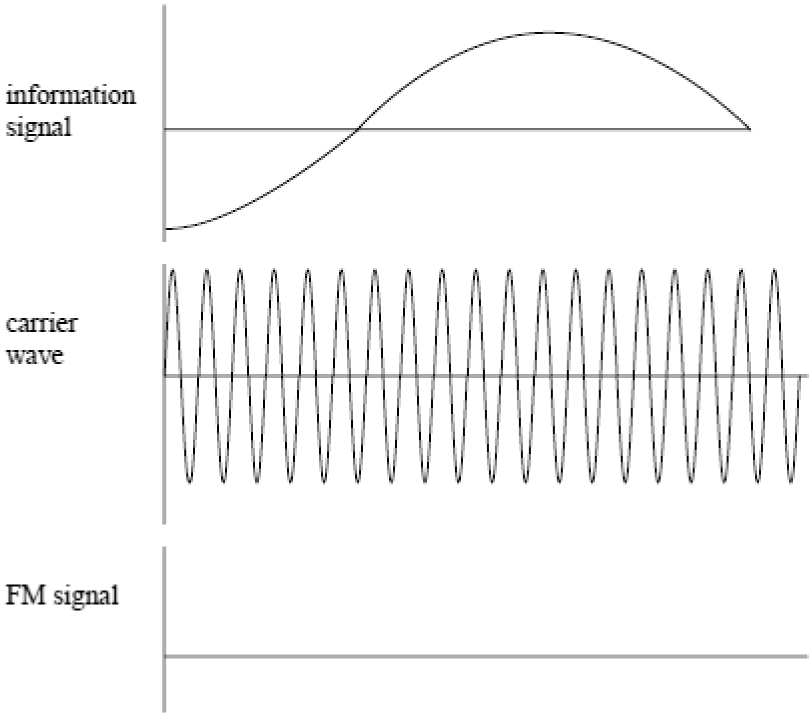
*(5 marks)*

## Amplitude Modulation, Half-Wave Dipole (ELE5, Q3, 2008)

3 (a) An information signal and a carrier wave are shown on the axes below.
On the lowest set of axes, show how these combine to form a FM signal.




*(3 marks)*

3 (b) The information signal has a maximum frequency of 15 kHz, the maximum frequency deviation of the carrier is ± 75 kHz.

3 (b) (i) Calculate the practical bandwidth of the resulting FM signal.

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3 (b) (ii) If the channel spacing is 200 kHz on the 88 – 108 MHz VHF band, calculate the number of channels available.

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3 (b) (iii) Calculate the length required for a half-wave dipole if the signal frequency is 90 MHz.

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*(6 marks)*

3 (c) Describe an advantage FM has over AM.

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*(1 mark)*

## Amplitude Modulation (ELE5, Q3, 2007)

3 A transmitter has a carrier frequency of 603 kHz and is amplitude modulated by an audio frequency signal which occupies a frequency range from 300 Hz to 3 kHz.

(a) In which broadcast waveband would the modulated signal appear?

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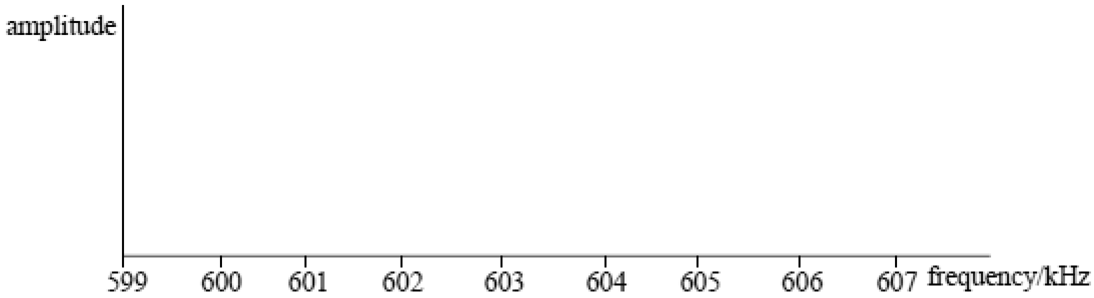
*(1 mark)*

(b) Draw a frequency spectrum diagram of the modulated signal to show the carrier and sidebands. Label all the features of the spectrum and draw all the components of the spectrum in their correct locations.




*(5 marks)*

(c) Calculate the bandwidth of the modulated signal.

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*(1 mark)*

## AM & FM (ELE5, Q2, 2006)

**2** (a) Describe how the information signal amplitude and frequency are encoded on to a carrier using amplitude modulation (AM).

amplitude ..............................................................................................................

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frequency ..............................................................................................................

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*(2 marks)*

(b) Describe how the information signal amplitude and frequency are encoded on to a carrier using frequency modulation (FM).

amplitude ..............................................................................................................

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frequency ..............................................................................................................

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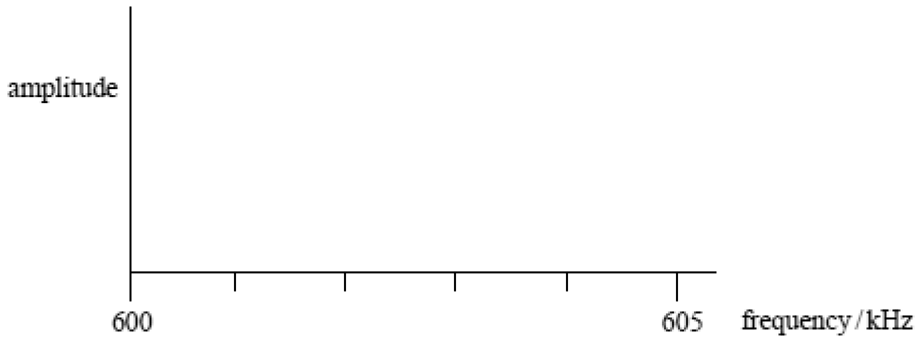
*(2 marks)*

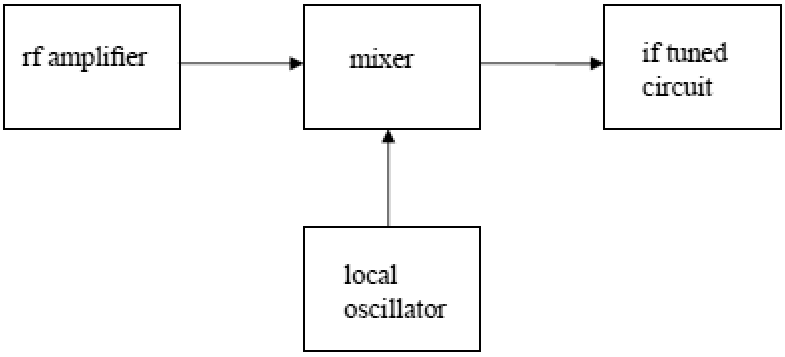
(c) An AM transmitter uses a carrier frequency of 603 kHz which is modulated with an information signal of a single frequency of 440 Hz.
Draw a complete frequency spectrum diagram of the modulated carrier.
Label all the features of your diagram and state the frequencies of all the components of the modulated signal.




*(6 marks)*

## Superhet (ELE5, Q6, 2009)

**6** The first stages of a superhet radio receiver are shown below.




**6** (a) Explain the function of the mixer and the if tuned circuit.

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*(2 marks)*

**6** (b) (i) The rf amplifier uses a tuned circuit made with a 500 μH inductor (coil) and a variable capacitor.
Show that the tuned circuit is resonant at about 1 MHz when the capacitor has a value of 50 pF.

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**6** (b) (ii) The local oscillator is set to 1.461 MHz and is higher than the resonant frequency of the tuned circuit in part (b)(i). Calculate the intermediate frequency used in the receiver.

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**6** (b) (iii) Calculate the image frequency or second channel response of the receiver.

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*(6 marks)*

## Radio Receiver (ELE5, Q1, 2007)

1 (a) A simple radio receiver uses the following subsystems:

**af amplifier, antenna, detector/demodulator, loudspeaker, tuned circuit**.

Draw a labelled block diagram to show how these subsystems are connected.

*(4 marks)*

(b) The receiver in part (a) is tuned to a carrier frequency of 600 kHz.
Calculate

(i) the wavelength of the carrier waves,
(c, speed of electromagnetic waves in vacuo, is $3 \times 10^8\,\text{m s}^{-1}$)

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(ii) the length of a half-wave dipole antenna for this frequency.

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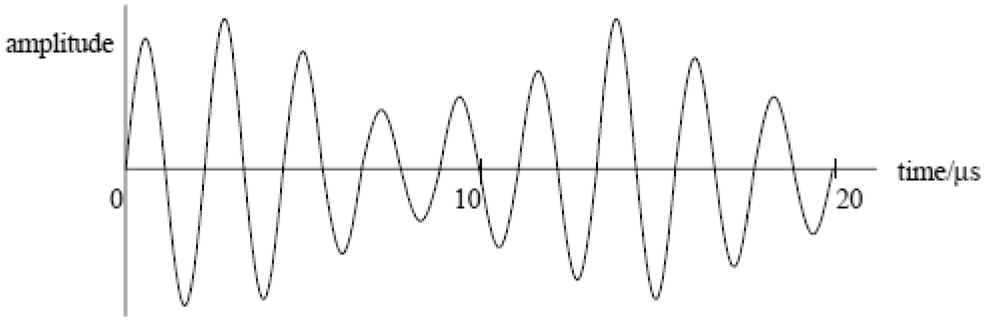
*(3 marks)*

## Superhet (ELE5, Q6, 2007)

**6** The input signal to the demodulator of a superheterodyne radio receiver is shown below.




(a) Calculate the period and frequency of the carrier wave in the input signal to the demodulator.

Period ..........................................................................................................

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Frequency ..........................................................................................................

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*(3 marks)*

(b) Draw on the graph above the output signal from the demodulator. *(2 marks)*

(c) The local oscillator of the superheterodyne radio receiver contains a 100 μH coil and a variable capacitor set to 100 pF.

Calculate

(i) the frequency of the local oscillator signal,

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(ii) a frequency to which the superheterodyne receiver would respond if it had an intermediate frequency of 455 kHz.

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*(3 marks)*

## Tuned Circuit (ELE5, Q4, 2006)

4 (a) A radio receiver contains a parallel LC circuit, where L has a value of 50 µH and C has a value of 300 pF.

(i) Suggest a use for this circuit in the receiver.

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(ii) This circuit has a high quality factor. Explain the effect this will have on the performance of the receiver.

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(iii) Calculate the resonant frequency of this circuit.

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(iv) Draw a resonance curve for this circuit. Label your axes.

*(6 marks)*

(b) The radio receiver is unable to receive weak signals.

(i) What aspect of the receiver's performance requires improvement?

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(ii) What circuit should be added to the receiver to improve this?

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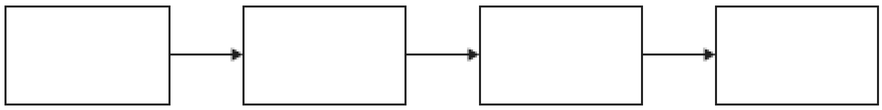
*(2 marks)*

## Radio Receiver, Half-Wave Dipole, Tuned Circuit (ELE5, Q1, 2005)

1 (a) Label the block diagram of a simple radio receiver shown below.



*(4 marks)*

(b) The receiver in part (a) is tuned to a carrier frequency of 0.6 MHz.

Calculate:

(i) the wavelength of the carrier waves;

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(ii) the length of a half-wave dipole for this frequency;

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(iii) the value of inductance, $L$, required if a 500 pF capacitor is used to tune to this frequency.

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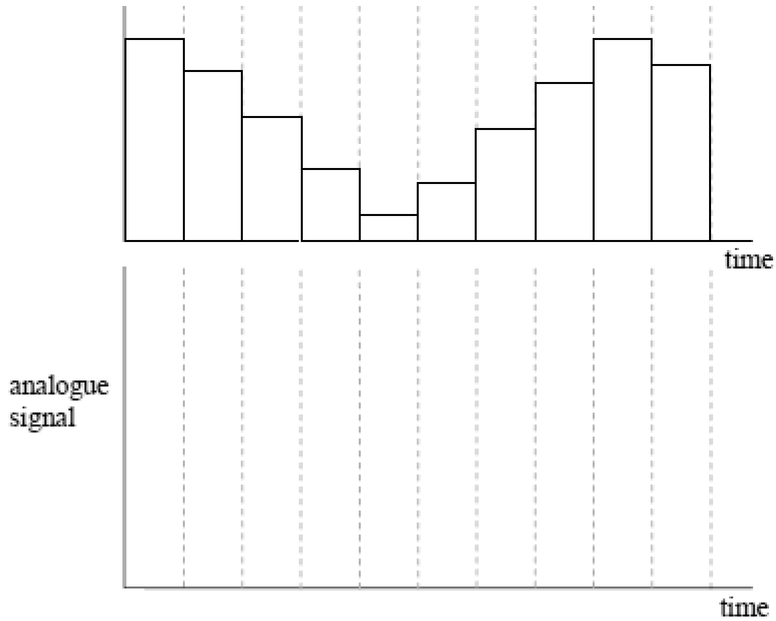
*(6 marks)*

## Pulse Modulation (ELE5, Q2, 2009)

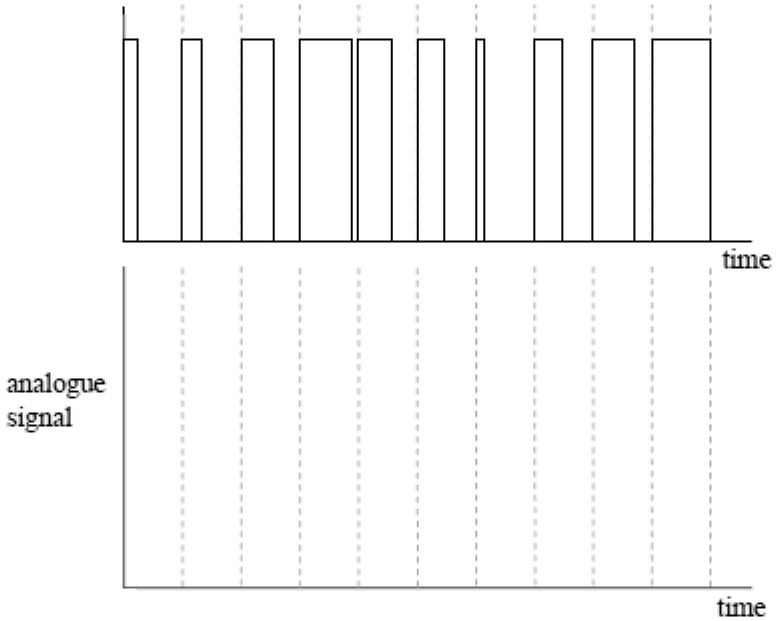
**2** Several different pulse modulated digital signals are shown below. For each one, sketch on the axes below it the analogue signal that would be obtained after it was decoded.

**2** (a) PAM signal



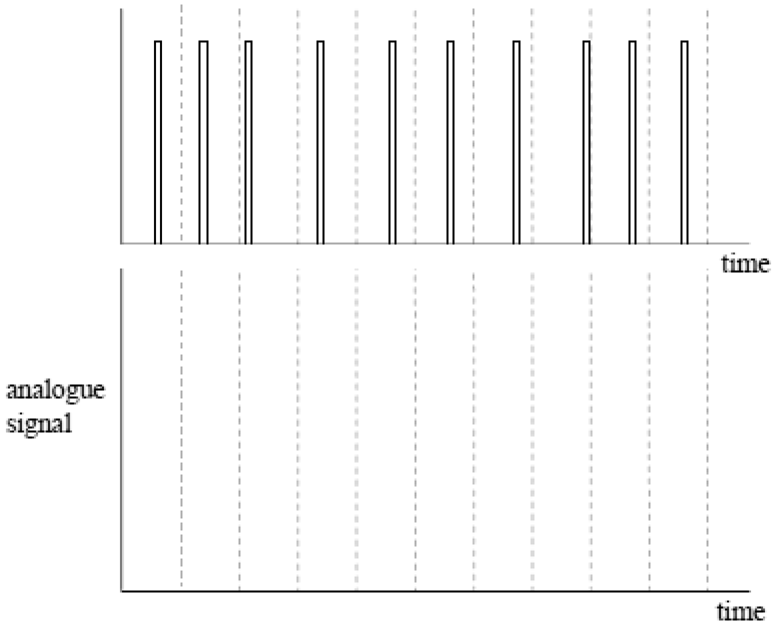

*(2 marks)*

**2** (b) PWM signal



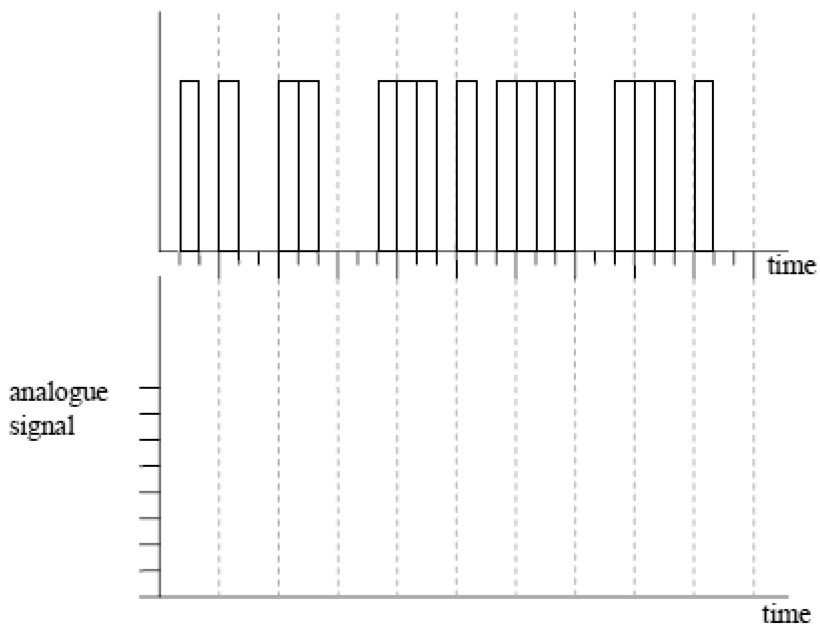

*(2 marks)*

**2** (c) PPM signal




*(3 marks)*

**2** (d) 3-bit PCM signal




*(3 marks)*

## Filter, Multiplexer, Sample Rate, Baud Rate (ELE5, Q4, 2009)

4 An ADC system is designed for signal frequencies up to 4 kHz.
A filter must be used to ensure the correct operation of the ADC.

4 (a) (i) What type of filter must be used?

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4 (a) (ii) Explain the problem that may occur if this filter is not used.

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4 (a) (iii) Calculate the minimum sampling frequency that should be used in this system.

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*(4 marks)*

4 (b) (i) The ADC produces an 8-bit parallel output. What subsystem is required to make the output suitable for a single channel transmission link?

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4 (b) (ii) Calculate the bit rate of the resulting signal using the sampling rate from your answer to part (a)(iii).

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4 (b) (iii) A start bit, two stop bits and a single parity bit are added to each byte of data from the ADC.
Calculate the baud rate of the resulting digital signal.

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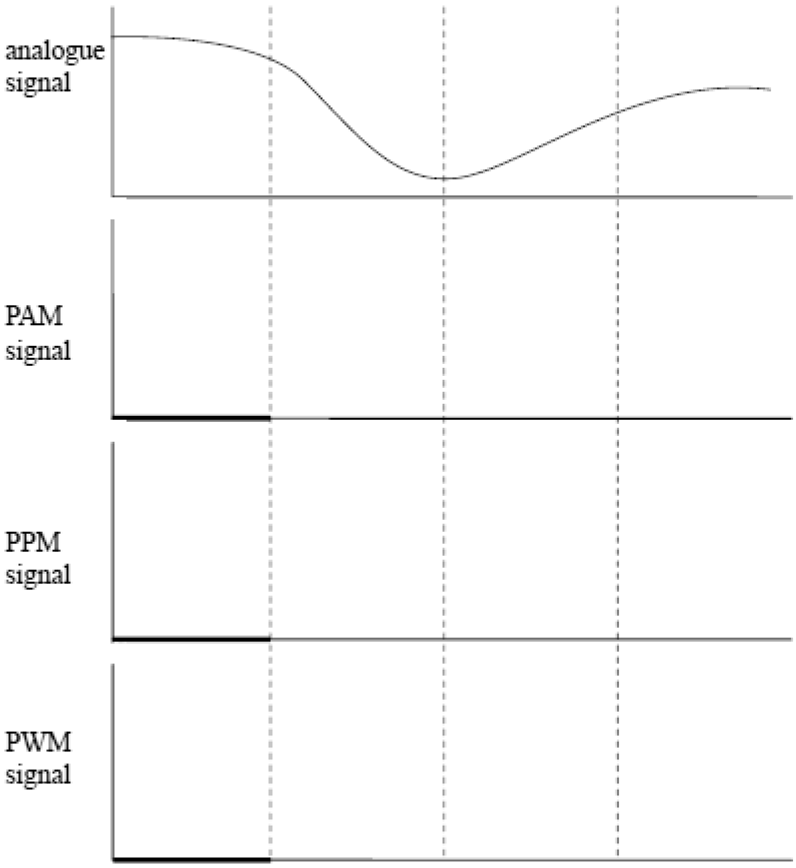
*(3 marks)*

## Pulse Modulation, Filter, Baud Rate (ELE5, Q2, 2008)

2 (a) The analogue signal shown below is to be converted into various different pulse modulated signals.

Draw on the labelled axes below the resulting digital signals when the analogue signal shown is converted at the sampling points, indicated by the dotted lines on the graphs.




*(6 marks)*

2 (b) In converting the analogue signal to a digital signal, what process or subsystem is used to retain the amplitude of the analogue signal while it is converted?

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*(1 mark)*

The sampling rate in an ADC system is 10 kHz. The analogue signal must first be filtered to ensure the correct operation of the ADC.

**2** (c) (i) What type of filter must be used?

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**2** (c) (ii) What is the maximum analogue signal frequency that should be used in this system?

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**2** (c) (iii) The ADC produces an eight-bit parallel output. What subsystem is required to make the output suitable for transmission along a co-axial cable?

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**2** (c) (iv) Calculate the bit rate of the resulting signal.

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**2** (c) (v) A start bit, two stop bits and a single parity bit are added to each byte of data from the ADC.
Explain the purpose of adding these bits.

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**2** (c) (vi) Calculate the baud rate of the resulting digital signal.

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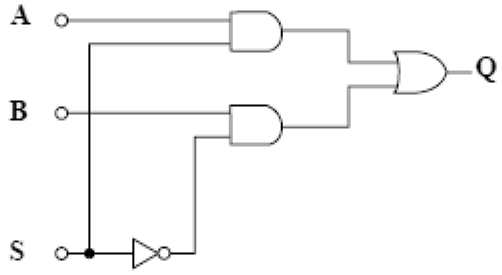
*(6 marks)*

## Multiplexer (ELE5, Q4, 2008)

**4** The diagram shows a 2 to 1 data multiplexer.




**4** (a) Complete the output column **Q** in the truth table for this logic system.

| A | B | S | Q |
|---|---|---|---|
| 0 | 0 | 0 | |
| 0 | 1 | 0 | |
| 1 | 0 | 0 | |
| 1 | 1 | 0 | |
| 0 | 0 | 1 | |
| 0 | 1 | 1 | |
| 1 | 0 | 1 | |
| 1 | 1 | 1 | |

*(4 marks)*

**4** (b) Write the simplest Boolean expression for the output **Q**, in terms of **A**, **B** and S.

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*(3 marks)*

**4** (c) Describe the function of the input signal S and explain a practical application of this system.

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*(3 marks)*

**4** (d) (i) What type of signal multiplexing does this system provide?

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**4** (d) (ii) Name another type of signal multiplexing.

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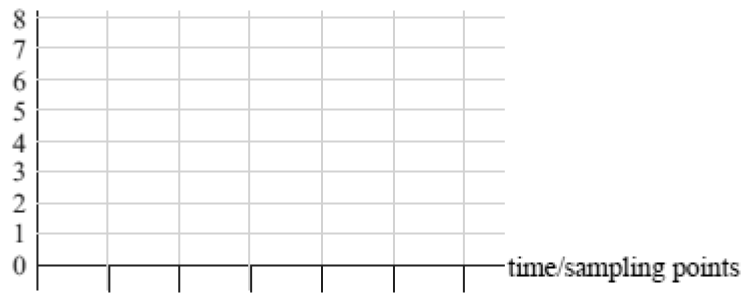
*(2 marks)*

## Pulse Modulation (ELE5, Q4, 2007)

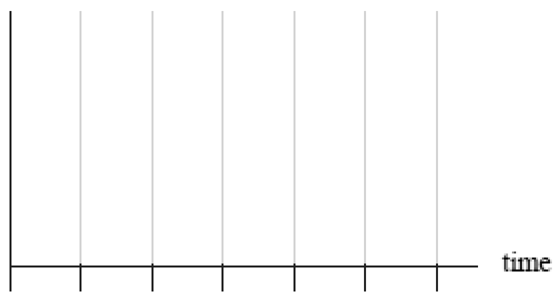
4 The analogue signal shown below is to be converted into different types of pulse modulated signal.
In each case, show how the analogue signal would be represented as the given type of pulse modulated signal.


(a) PAM signal



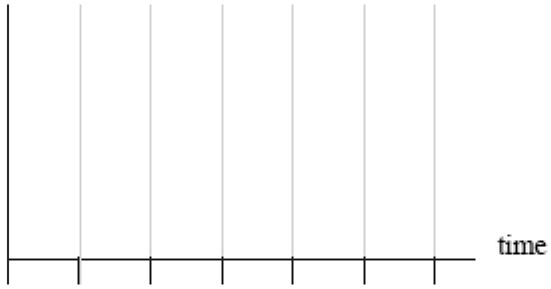

*(2 marks)*

(b) PWM signal



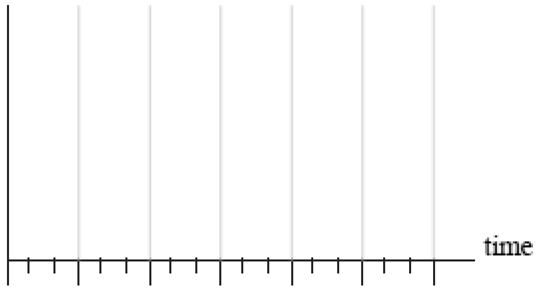

*(2 marks)*

(c) PPM signal




*(3 marks)*

(d) 3-bit PCM signal




*(3 marks)*

## Analogue/Digital Transmission (ELE5, Q5, 2006)

**5** (a) (i) State and describe **three** differences between analogue and digital communication.

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2 ..................................................................................................................

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3 ..................................................................................................................

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*(3 marks)*

(ii) Explain briefly how these differences might affect the choice of one method over the other.

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*(3 marks)*

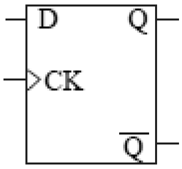
(b) Name **two** different techniques for transmitting many signals on one carrier.

1 ..................................................................................................................

2 ..................................................................................................................
*(2 marks)*

## Shift Register, Serial/Parallel Transmission (ELE5, Q7, 2006)

7 The symbol for a D-type flip-flop is shown below.




(a) Describe the function of the D-type flip-flop.

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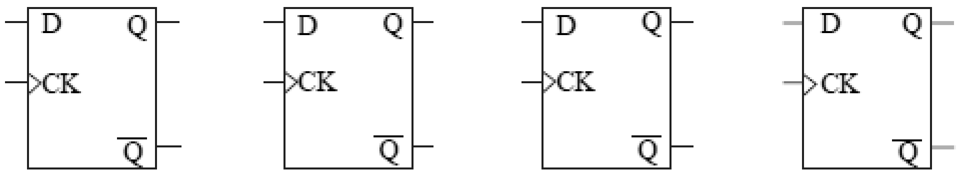
*(2 marks)*

(b) Complete the diagram below to show how a shift register is constructed from D-type flip-flops. Label the data and clock inputs, and the data output for the complete system.




*(4 marks)*

(c) Data can be communicated in serial or parallel form.

Explain which form is better for long distance communication.

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*(2 marks)*

## Mobile Phones (ELE5, Q7, 2005)

7 (a) How does the signal from a mobile telephone reach the base station?

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*(1 mark)*

(b) Each channel frequency allows eight conversations to take place at the same time.

(i) What type of multiplex system allows this?

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(ii) A base station uses sixteen channels. How many users can make calls through this base station at any one time?

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(iii) Each mobile phone channel has a bandwidth of 200 kHz.
Calculate the effective bandwidth available to each user.

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*(5 marks)*

(c) Mobile phone signals are digital. When a weak signal is received it is processed by a regenerator.
Describe the process of regeneration of a noisy digital signal.
State what type of sub-system is used and explain briefly how it operates.

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*(4 marks)*

## Optical Fibre, 555 Monostable, Logic System (ELE5, Q7, 2009)

7 A digital signal is transmitted along an optical fibre in a communication system.

7 (a) (i) State **two** different effects that limit the maximum range of the signal.

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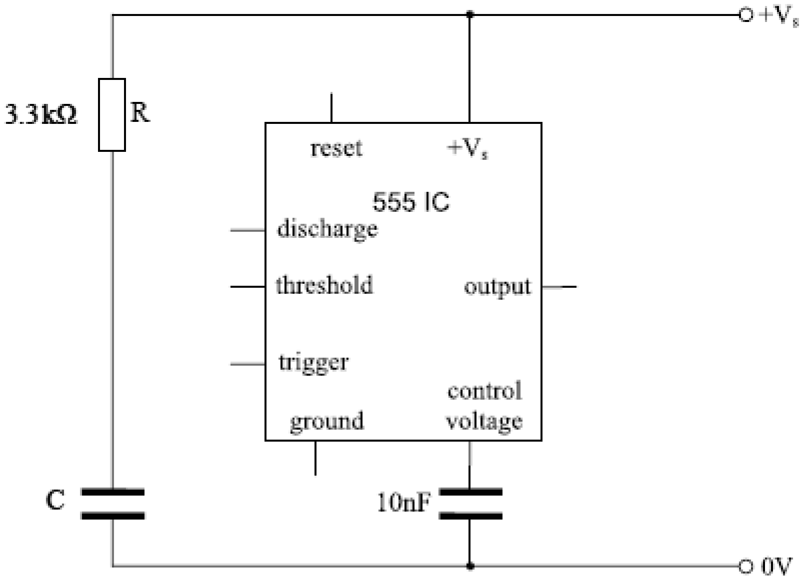
7 (a) (ii) State **one** advantage of using an optical fibre system over a wired system.

.......................................................................................................................................

*(3 marks)*

7 (b) A 555 IC is used as a monostable to control the length of PWM pulses transmitted along the fibre optic system.

7 (b) (i) Complete the circuit diagram to show how the IC is connected as a monostable. Label the connections to the input and output of the system.




7 (b) (ii) The output pulse length from the monostable is 10 µs. Calculate the value of C required for this, given the value of R marked on the diagram.

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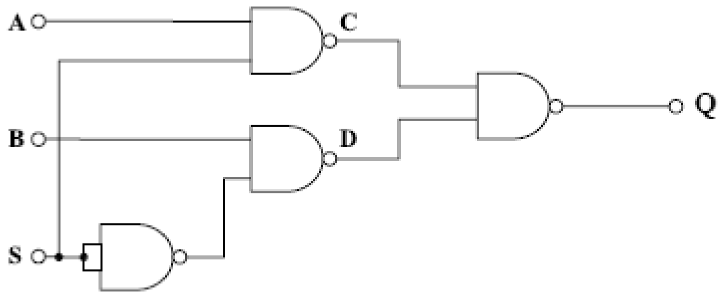
*(9 marks)*

7 (c) A logic system that could be used to process digital signals is shown below.




7 (c) (i) Complete the truth table below for this logic system.

| A | B | S | C | D | Q |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | | |
| 0 | 1 | 0 | | | |
| 1 | 0 | 0 | | | |
| 1 | 1 | 0 | | | |
| 0 | 0 | 1 | | | |
| 0 | 1 | 1 | | | |
| 1 | 0 | 1 | | | |
| 1 | 1 | 1 | | | |

7 (c) (ii) State and explain the function of this system.

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*(6 marks)*

## Optical Fibre, 555 Astable, Mobile Phones (ELE5, Q7, 2007)

7 (a) Draw a labelled diagram of a curved length of a step-index optical fibre. Include on your diagram the path of a ray of light travelling through the fibre.

*(4 marks)*

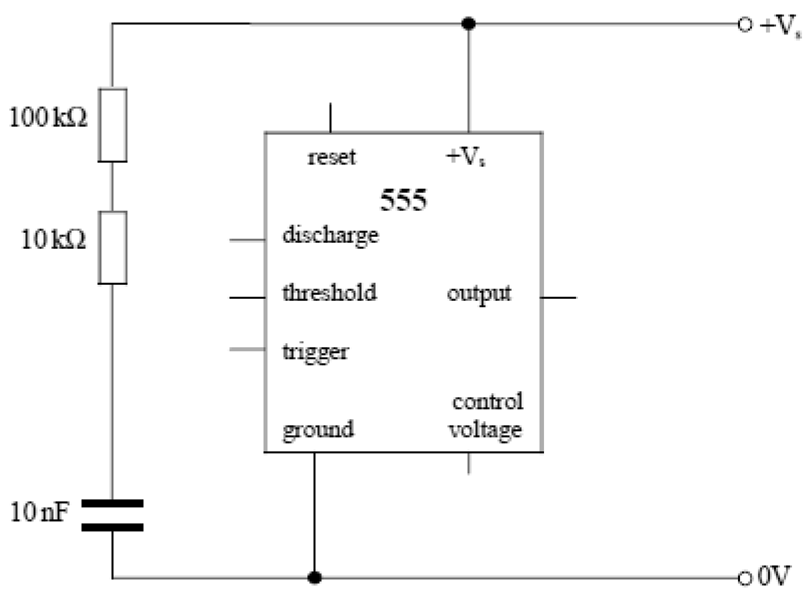
(b) Name an output device which can be used to create pulses that will travel through the fibre.

..........................................................................................................................................

*(1 mark)*

(c) A 555 timer IC is used as an astable to generate pulses for a fibre optic system.

(i) Complete the circuit diagram to show how the IC is connected as an astable and label the connection to the output device.



(ii) Calculate the frequency of the output pulses.

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(iii) Calculate the time period during which the output pulse gives a logic 0.

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*(8 marks)*

(d) An optical fibre system can be used to carry signals from a mobile telephone base station to the rest of the telephone network.

(i) How do signals from the mobile telephone travel to the base station?

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(ii) Explain how the mobile telephone network can support almost the entire population of this country using mobile telephones when only a restricted frequency allocation is available.

Credit will be given for using relevant technical terms in your answer.

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*(5 marks)*

## Optical Fibre, Filter, Sampling (ELE5, Q6, 2006)

**6** (a) (i) State a secure medium through which optical signals can travel.

.............................................................................................................................

(ii) State how optical signals can travel along paths that are not straight.

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(iii) State **two** factors that limit the range of optical signals.

1 .............................................................................................................................

2 .............................................................................................................................

(iv) An LED is used as a light source in an optical communications system.
The LED has a forward voltage drop of 2 V and operates from a power supply of 12 V. Calculate the value of the series resistor necessary to limit the LED forward current to 10 mA.

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*(6 marks)*

(b) In a mobile phone circuit, audio frequencies above 4 kHz must be removed before sampling takes place.

(i) Draw the circuit diagram of an active treble cut filter.

(ii) In the active filter circuit, the input resistor is 10 kΩ, the feedback resistor is 39 kΩ and the capacitor is 1 nF.
Show that the break point frequency is approximately 4 kHz.

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(iii) Calculate the voltage gain of this circuit at a frequency well below the break point frequency.

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(iv) What sampling rate must be used for the mobile phone system where frequencies up to 4 kHz are transmitted? Explain why this is.

Sampling rate ..........................................................................................................

Explanation ............................................................................................................

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*(12 marks)*





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**Teacher Resource Bank**

GCE Electronics

Exemplar Exam Questions – Mark Scheme

- ELEC5: Communication Systems

**Communication System (ELE5, Q1, 2009)**

**1** (a) (i) Unmodulated rf signal✓(allow carrier signal)

(ii) Modulated (rf) signal✓

(iii) Radio wave✓ (allow electromagnetic wave)

(iv) Modulated (rf) signal✓

(v) Information signal✓

(b) (i) Carrier generator or receiver✓

(ii) Transmitter or receiver✓

(iii) Output transducer✓

(iv) Carrier generator✓

(v) Demodulator✓ *(10 marks)*

**Communication System (ELE5, Q1, 2008)**

**1** (a) (i) 2✓

(ii) 3✓

(iii) 5✓

(iv) 4✓

(v) 1✓

(vi) 6✓

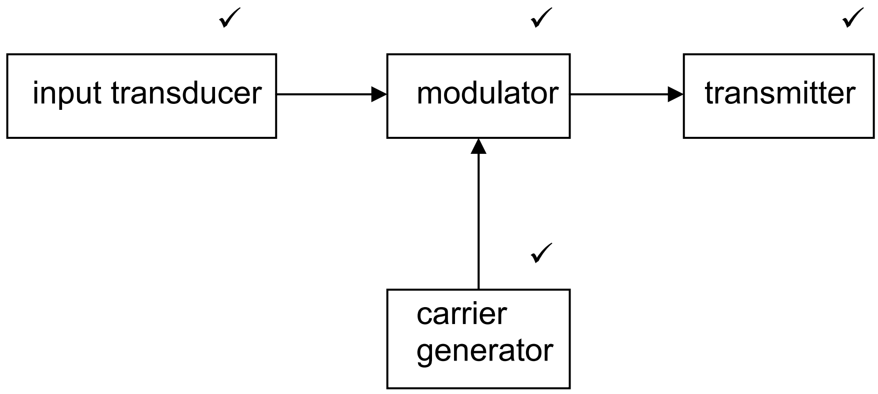
(b) (i) free space✓ optical fibre✓

(ii) any two from: open wire, twisted pair, coaxial cable✓✓

**Total – 10**

## Communication System (ELE5, Q1, 2006)

**1** (a)




*(4 marks)*

(b) (i) optic fibre✓
uses light waves as carrier, very high frequency✓

(ii) free space (allow radio)✓
no wires or fibres to move✓

(iii) optic fibre✓
cannot be tapped easily without communicators knowing✓

*(6 marks)*
*(question total 10)*

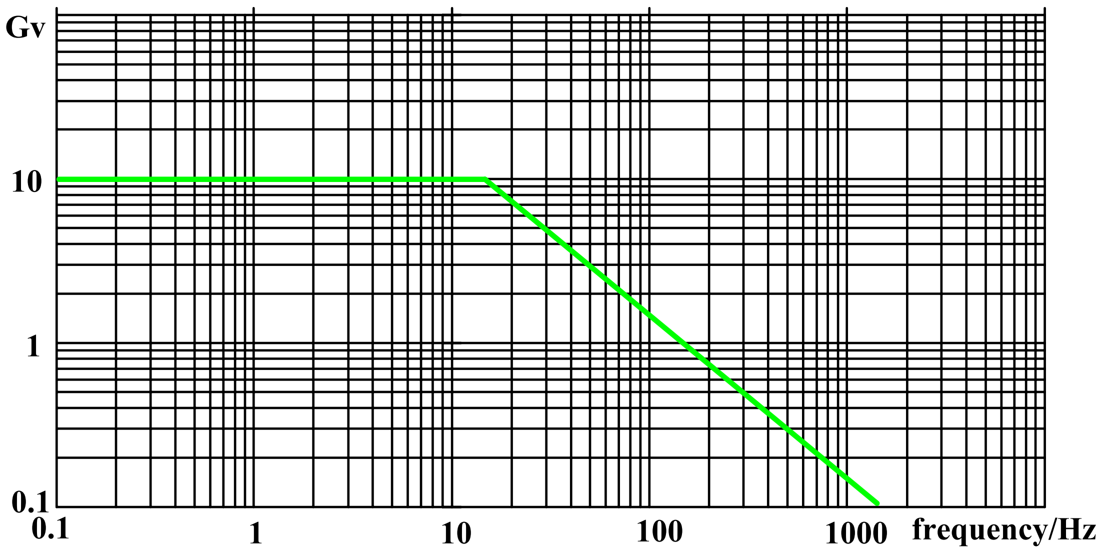
**Active Filter (ELE2, Q5, 2008)**

**5** (a) (i) Allows low frequencies to pass, ✓
but blocks high frequencies ✓

(ii) The frequency at which the output voltage (gain) is 70% of the maximum output voltage (gain) ✓

(b) $X_c = 1 / 2\pi f C$ ✓
$X_c = 1 / 2 \times 3.142 \times 20 \times 10^{-7}$ ✓
$X_c = 79.6k\Omega$ ✓

(c)




horizontal line to about 10-20Hz ✓
at a gain of 10 ✓
diagonal line - decreasing (at about 10 per decade) ✓

**Total – 9**

**Active Filter (ELE2, Q2, 2005)**

**2** (a) (i) Low pass filter - a filter that allows low frequencies to pass through with little attenuation, while high frequencies are attenuated ✓ (1 mark)

(ii) break point frequency - the frequency at which the output voltage is equal to 0.71 of its max value. ✓ (1 mark)

(b) (i) (non-inverting amplifier. At low frequencies ignore C)
$\Rightarrow G_V = 1 + 390/10 = 40$ ✓ ✓ (2 marks)

(ii) At the cut off frequency $X_C = R_f = 390k\Omega$ ✓
$C = 1/2\pi fR = 1/2\ \pi\ 2500\ 39000 = 163pF$ ✓ ✓ (3 marks)

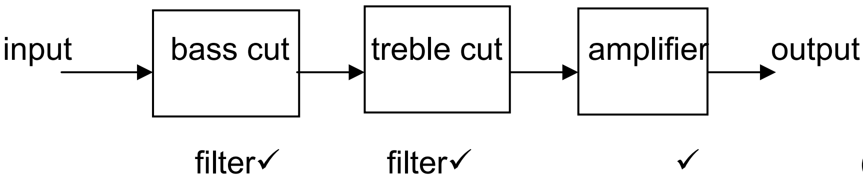
(c) $10^6$ = frequency x voltage gain => voltage gain = $10^6$ / frequency. ✓
voltage gain = $10^6 / 2.5 \times 10^3 = 400$ ✓ (2 marks)

**Total 9 marks**

**Active Filter (ELE5, Q6, 2005)**

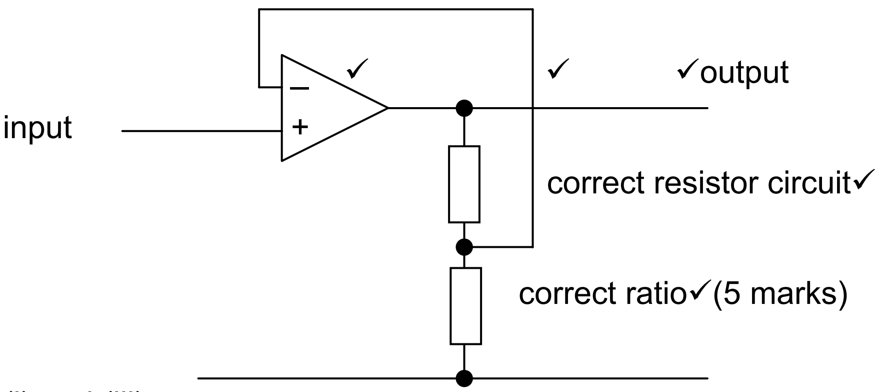
**6** (a) 1 MHz / 4 kHz =✓ 250✓ (2 marks)

(b)

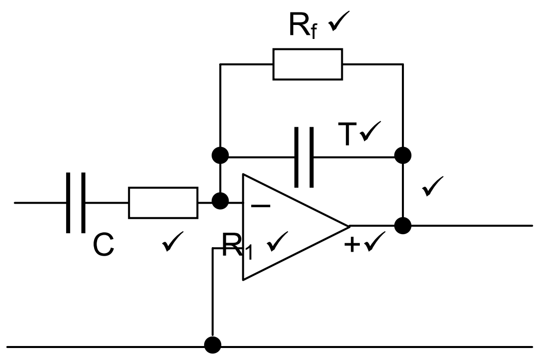



(3 marks)

(c)




(d) (i) and (iii)



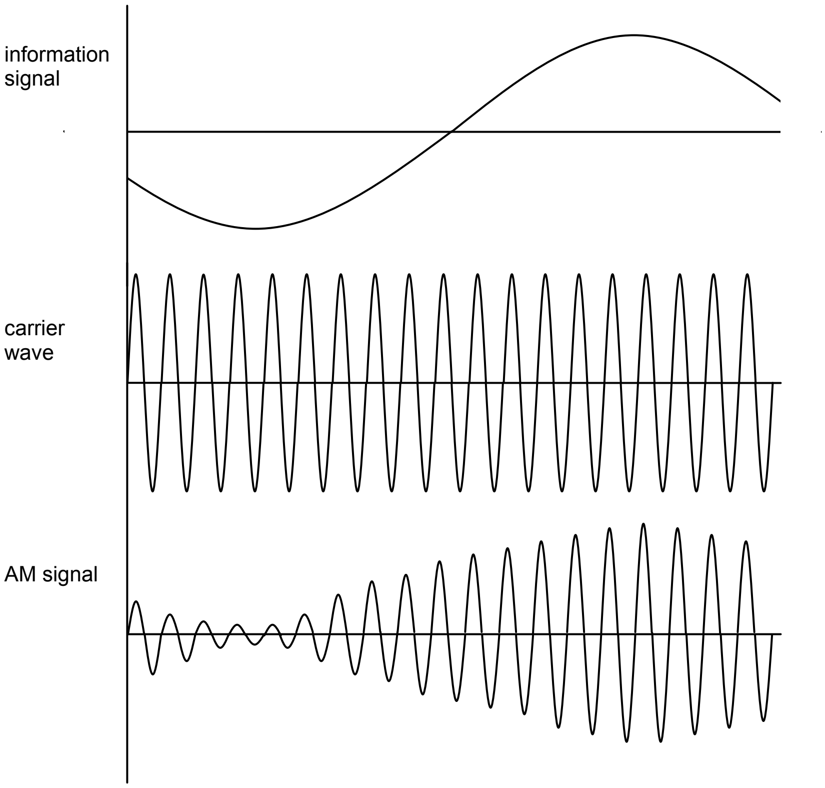

(ii) $C = 1 / 2\ \pi\ f_o\ R$
$= 1 / 2\ \pi \times 300 \times 10^4$✓

= 53 nF or $5.3 \times 10^{-8}$ F✓ (8 marks)

**Total 18 marks**

**Amplitude Modulation (ELE5, Q3, 2009)**

**3** (a)




Carrier frequency constant✓ Symmetrical about time axis✓
Amplitude variations: as info sig✓ In phase with info sig✓

(b) (i) Medium wave✓

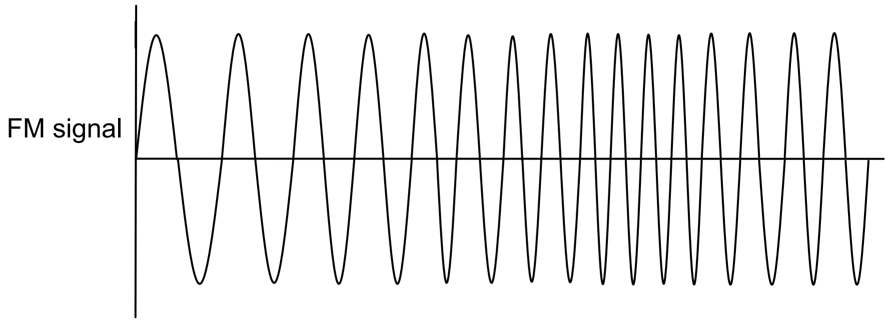
(ii) BW = 2× Fi max = 2 × 4.5✓ = 9kHz✓

(iii) 1710 − 522 = 1188kHz✓ ÷ 9 = 132 channels✓

*(9 marks)*

**Amplitude Modulation, Half-Wave Dipole (ELE5, Q3, 2008)**

**3** (a) constant amplitude✓
frequency varies✓
frequency related to info signal✓




(b) (i) 2 × (15 + 75) ✓ = 180 kHz✓

(ii) 108 − 88 = 20 MHz✓
20 MHz ÷ 200 kHz = 100 channels✓

(ii) λ = v ÷ f = 300 ÷90 = 3.3m✓ λ÷2 = 1.65m✓

(c) less noise, or wide bandwidth, or stereo (any one) ✓

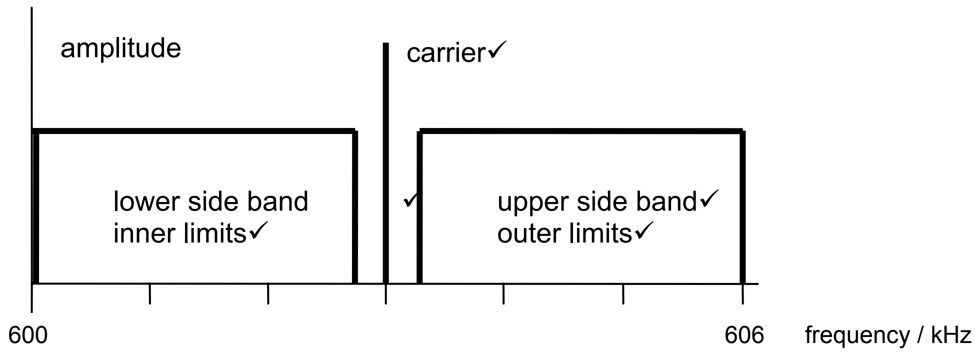
**Total – 10**

**Amplitude Modulation (ELE5, Q3, 2007)**

**3** (a) medium waveband✓

*(1 mark)*

(b)




*(5 marks)*

(c) 6000Hz✓

*(1 mark)*

*(Total 7 marks)*

**AM & FM (ELE5, Q2, 2006)**

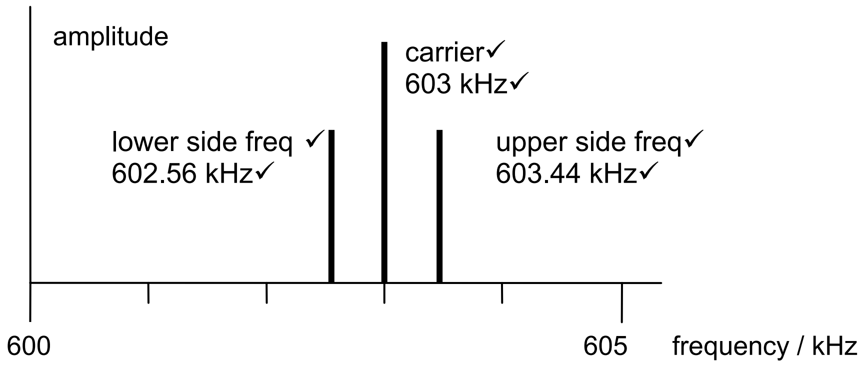
**2** (a) amplitude of carrier fluctuation✓
rate of change of carrier amplitude fluctuation✓

*(2 marks)*

(b) amount of frequency deviation✓
rate of change of frequency deviation✓

*(2 marks)*

(c)




*(6 marks)*
*(question total 10 marks)*

**Superhet (ELE5, Q6, 2009)**

**6** (a) The mixer combines the amplified rf signal with the local oscillator signal✓ producing the required if signal✓

(b) (i) $1 \div (2\pi\sqrt{2.5 \times 10^{-14}})$ ✓ 1.007 MHz✓

(ii) 1.461 − 1.007✓ = 454 kHz✓

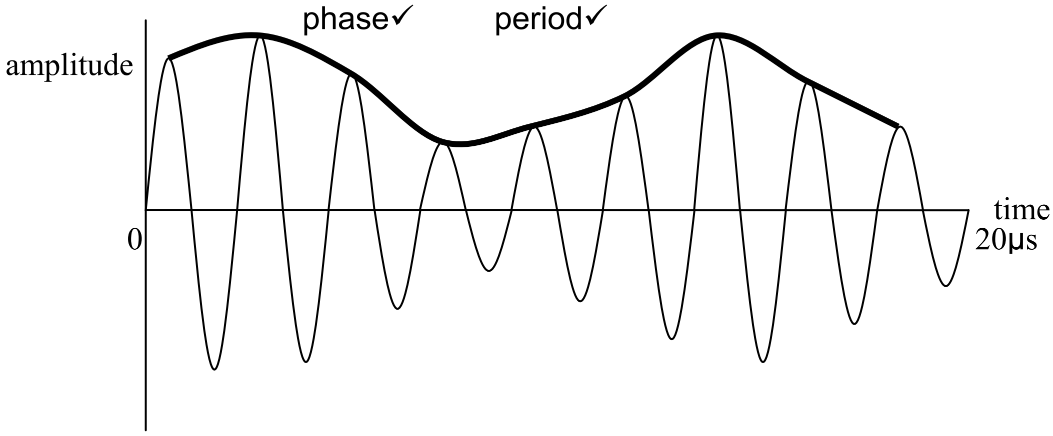
(iii) 1.461 + 0.455✓ = 1.916 MHz✓ *(8 marks)*

## Radio Receiver (ELE5, Q1, 2007)

**6** (a) 20 / 9 = 2.2μs✓
1 / 2.2 × $10^{-6}$✓ 450 kHz✓

*(3 marks)*

(b)




*(2 marks)*

(c) (i) use of f = 1 / 2π √LC✓ 1592 kHz✓

(ii) 1592 + 455 or 1592 – 455✓

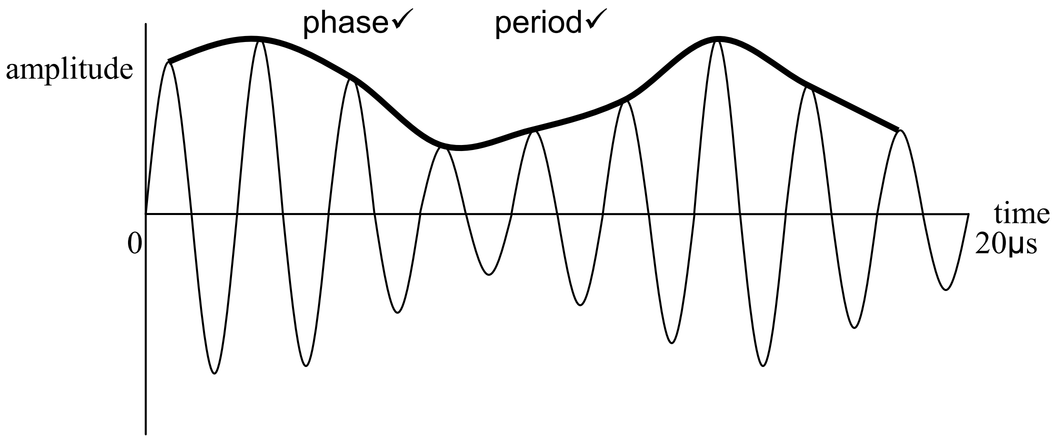
*(3 marks)*

*(Total 8 marks)*

## Superhet (ELE5, Q6, 2007)

**6** (a) 20 / 9 = 2.2μs✓
1 / 2.2 × $10^{-6}$✓ 450 kHz✓ *(3 marks)*

(b)




*(2 marks)*

(c) (i) use of $f = 1 / 2\pi \sqrt{LC}$✓ 1592 kHz✓

(ii) 1592 + 455 or 1592 – 455✓

*(3 marks)*

*(Total 8 marks)*

**Tuned Circuit (ELE5, Q4, 2006)**

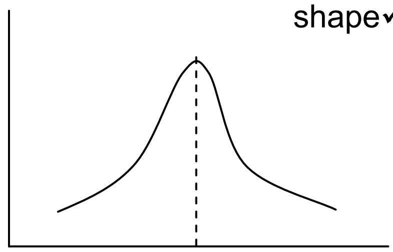
**4** (a) (i) selecting required frequency or tuning✓

(ii) improve selectivity or reject unwanted signals better✓

(iii) use of $f = 1/ 2\pi\sqrt{LC}$ $1/ 6.28\sqrt{50 \times 10^{-6} \times 300 \times 10^{-12}}$✓
1.3MHz✓

(iv) amplitude (impedance)

shape✓



frequency labelled axis ✓

*(6 marks)*

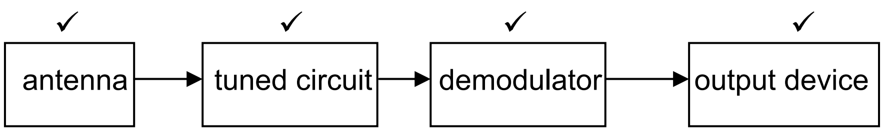
(b) (i) sensitivity✓

(ii) rf amplifier✓

*(2 marks)*
*(question total 8 marks)*

**Radio Receiver, Half-Wave Dipole, Tuned Circuit (ELE5, Q1, 2005)**

**1** (a)




(4 marks)

(b) (i) $\lambda = v/f = 3 \times 10^8 / 0.6 \times 10^6$✓ = 500 m✓

(ii) 500 / 2 = 250 m✓

(iii) $L = 1 / 4 \pi^2 f^2 C$ =✓

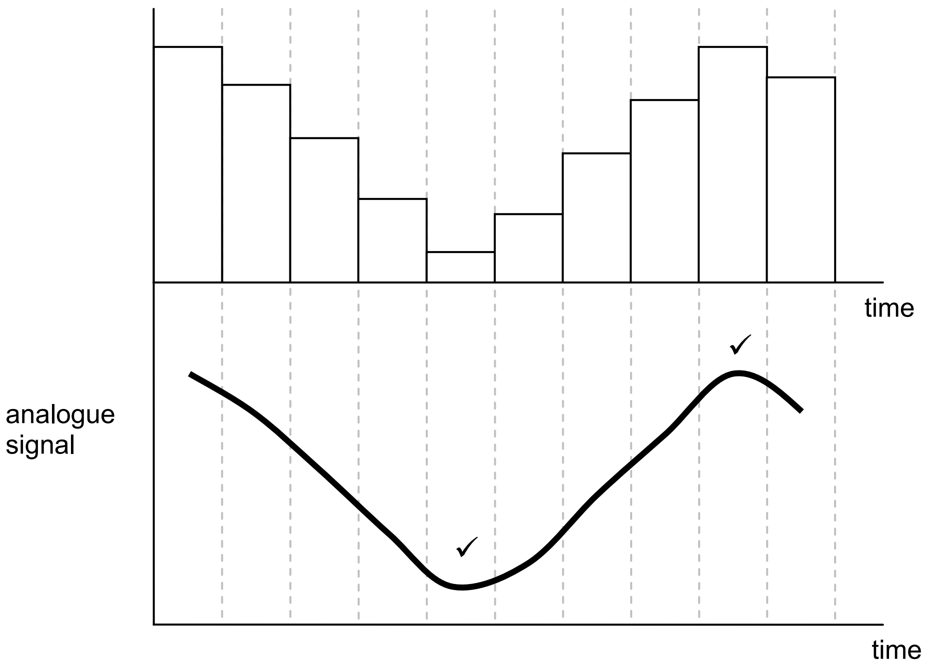
$1 / 40 \times 0.36 \times 10^{12} \times 500 \times 10^{-12}$ =✓

140 μH✓ (6 marks)

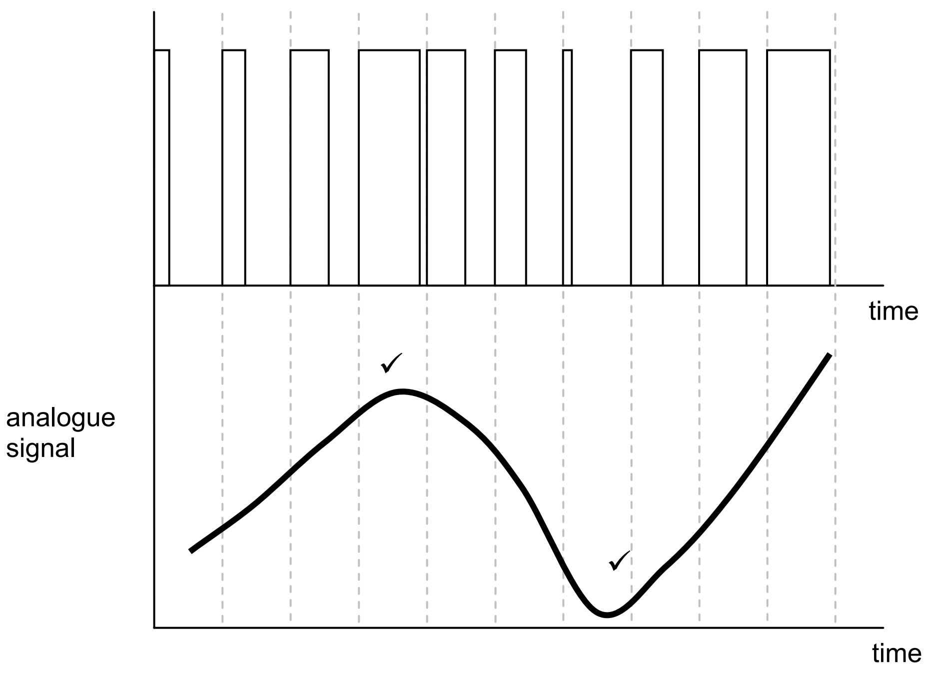
**Total 10 marks**

## Pulse Modulation (ELE5, Q2, 2009)

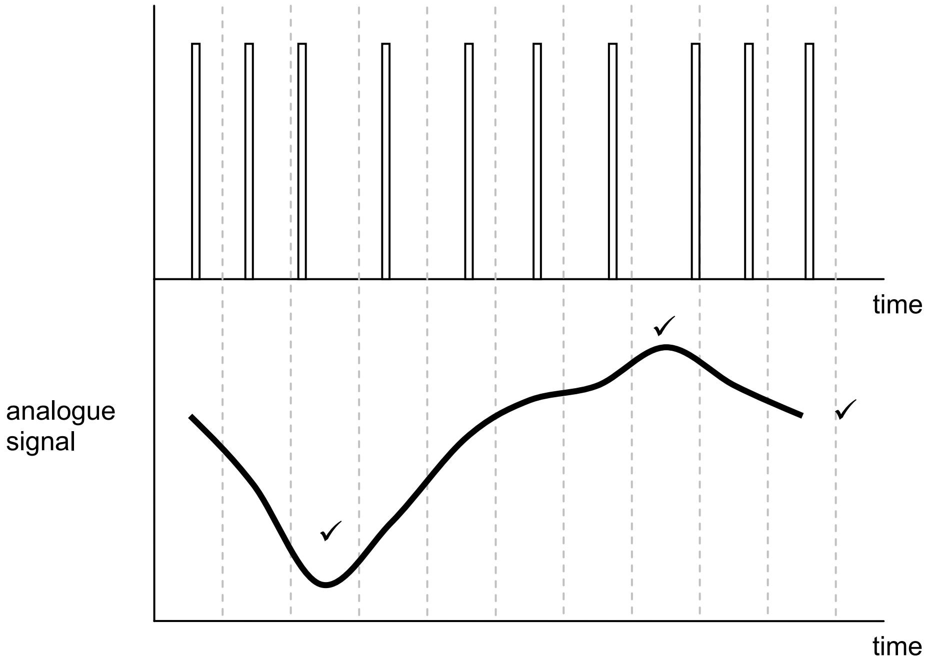
**2** (a)



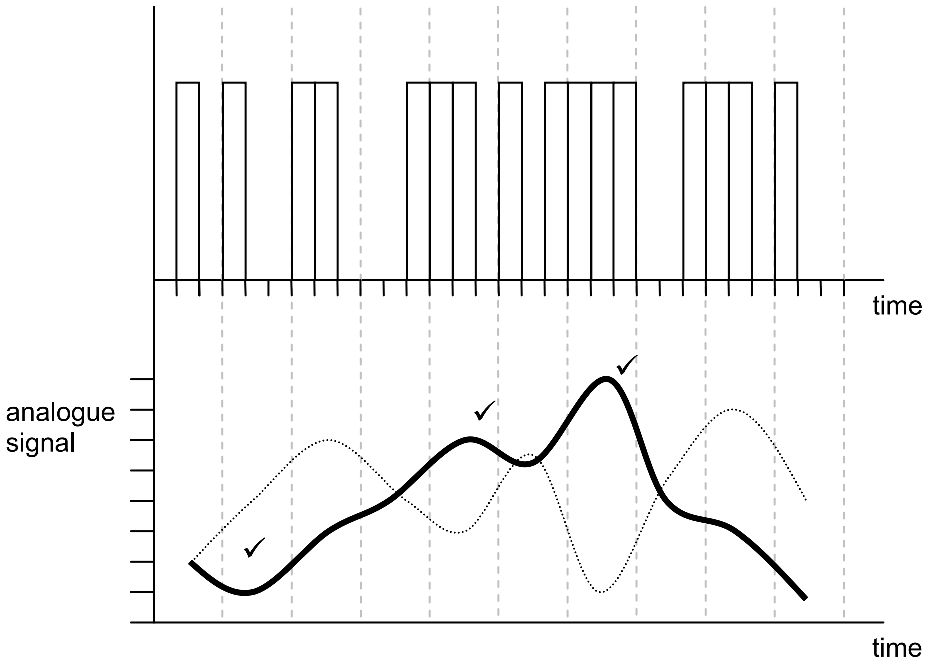

(b)



(c)




(d)




allow LSB or MSB first

*(10 marks)*

**Filter, Multiplexer, Sample Rate, Baud Rate (ELE5, Q4, 2009)**

**4** (a) (i) Low pass/ treble cut✓

(ii) To prevents signals of frequencies higher than 4kHz✓
aliasing ✓

(iii) 4 × 2 = 8kHz✓

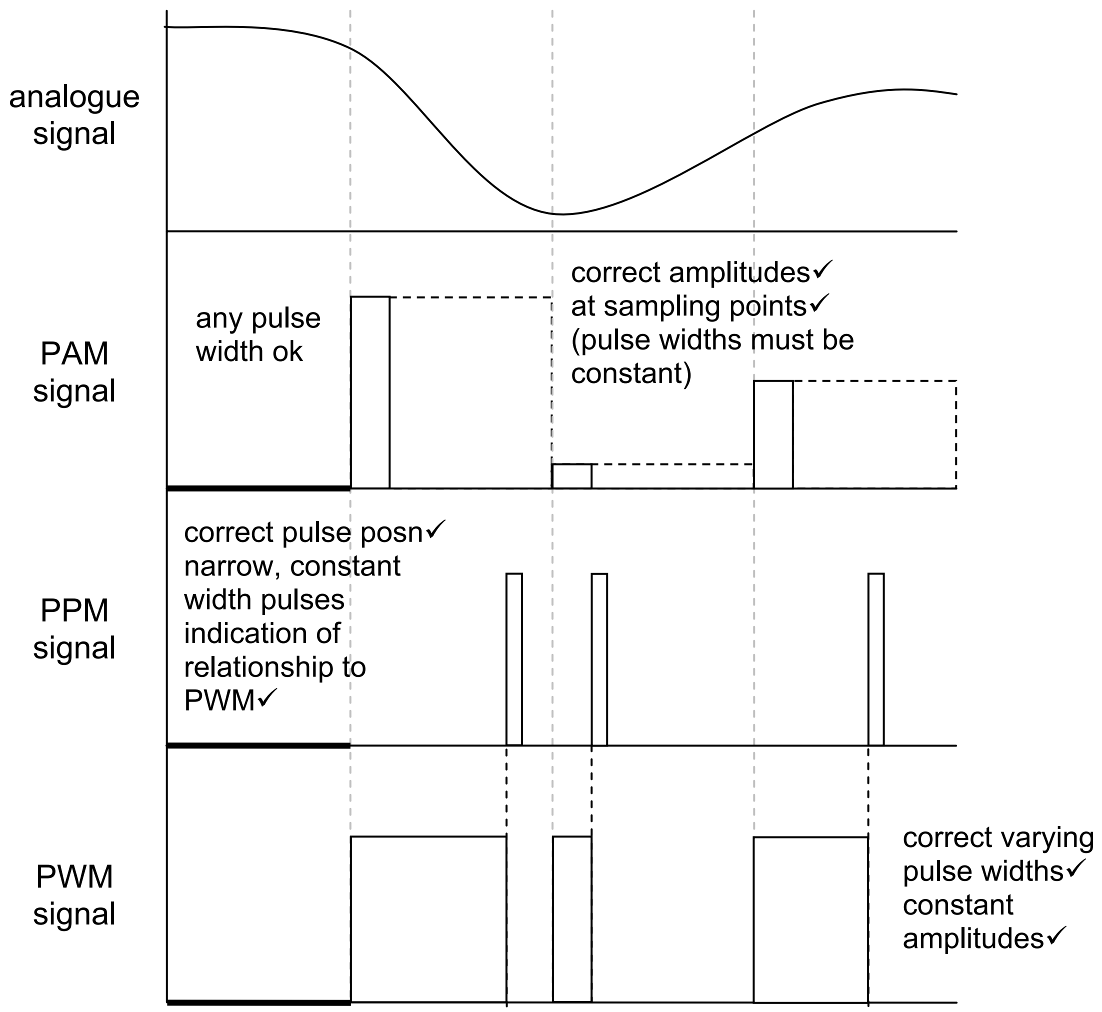
(b) (i) Parallel to serial converter✓

(ii) 8 bits × 8 kHz = 64 kb/s✓

(ii) 12 × 8 = 96kb/s✓ *(7 marks)*

**Pulse Modulation, Filter, Baud Rate (ELE5, Q2, 2008)**

**2** (a)




(b) sample and hold✓

(c) (i) low pass✓

(ii) 10 ÷ 2 = 5kHz✓

(iii) parallel to serial converter ✓

(iv) 10000 × 8 bits = 80kbs$^{-1}$✓

(v) to tell when data is to be sent, when it is complete, and check if errors have been received✓

(vi) 8 + 1 + 1 +2 = 12, 12 × 10000 = 120kbs$^{-1}$✓

**Total – 13**

**Multiplexer (ELE5, Q4, 2008)**

**4** (a)

| A | B | S | Q | |
|---|---|---|---|---|
| 0 | 0 | 0 | **0** | ✓ |
| 0 | 1 | 0 | **1** | |
| 1 | 0 | 0 | **0** | ✓ |
| 1 | 1 | 0 | **1** | |
| 0 | 0 | 1 | **0** | ✓ |
| 0 | 1 | 1 | **0** | |
| 1 | 0 | 1 | **1** | ✓ |
| 1 | 1 | 1 | **1** | |

(b) Q = S.A✓ +✓ $\bar{S}$.B✓

(c) Allows two different information sources to be connected to one communication link✓
When S = 1, signal A is connected to the link✓
When S = 0, signal B is connected to the link✓

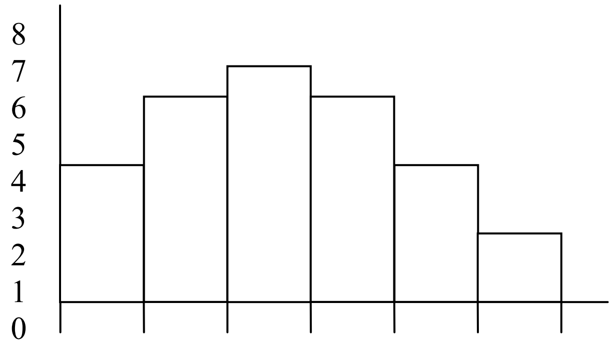
(d) (i) Time division multiplex✓

(ii) Frequency division multiplex✓

**Total – 12**

## Pulse Modulation (ELE5, Q4, 2007)

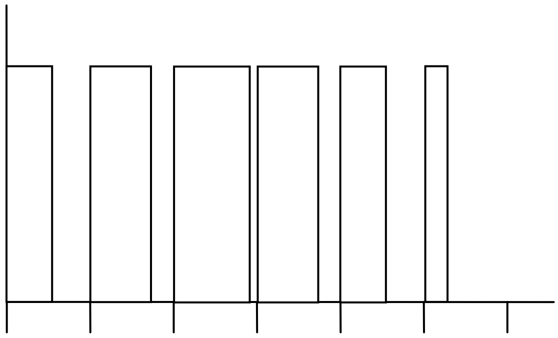
**4** (a) PAM signal




✓✓

*(2 marks)*

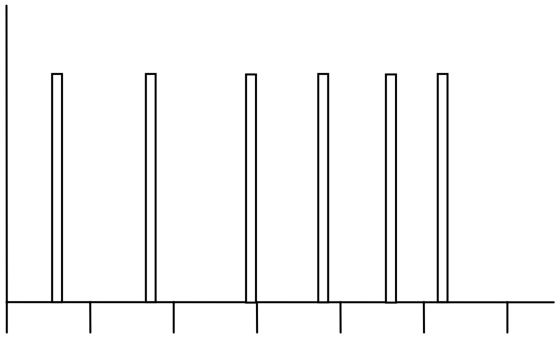
(b) PWM signal



✓✓

*(2 marks)*

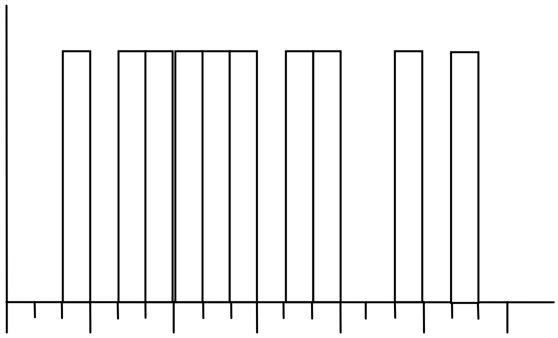
(c) PPM signal



✓✓✓

*(3 marks)*

(d) 3-bit PCM signal



✓✓✓

*(3 marks)*

*(Total 10 marks)*

**Analogue/Digital Transmission (ELE5, Q5, 2006)**

**5** (a) examples only

(i) Analogue is more prone to noise✓
Digital signals are encoded✓
Analogue uses superhets, digital uses logic gates✓

(ii) Digital is better, noise can be removed✓
Digital is more secure✓
Digital uses simpler circuits✓

*(6 marks)*

(b) TDM✓FDM✓ (any order)

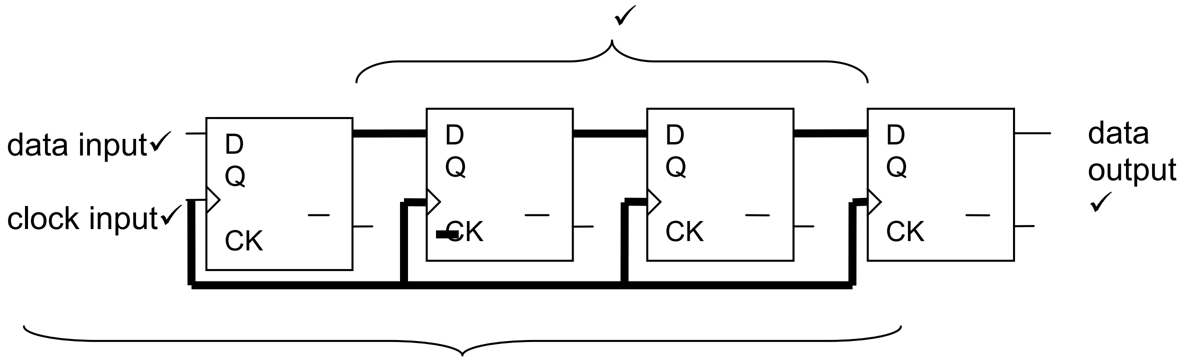
*(2 marks)*
*(question total 8 marks)*

**Shift Register, Serial/Parallel Transmission (ELE5, Q7, 2006)**

**7** (a) Data on D input is sent to Q✓ when clock signal goes high✓

*(2 marks)*

(b)




*(4 marks)*

(c) serial✓ only one connection/channel required✓

*(2 marks)*

*(question total 8 marks)*

**Mobile Phones (ELE5, Q7, 2005)**

**7** (a) radio waves✓ (1 mark)

(b) (i) time division✓

(ii) 16 x 8 =✓ 128 users✓

(iii) 200 / 8 =✓ 25 kHz✓ (5 marks)

(c) responding to signal voltage levels✓

in such a way as to lessen the effect of noise✓

schmitt trigger sub –system✓

has two threshold levels✓ (4 marks)

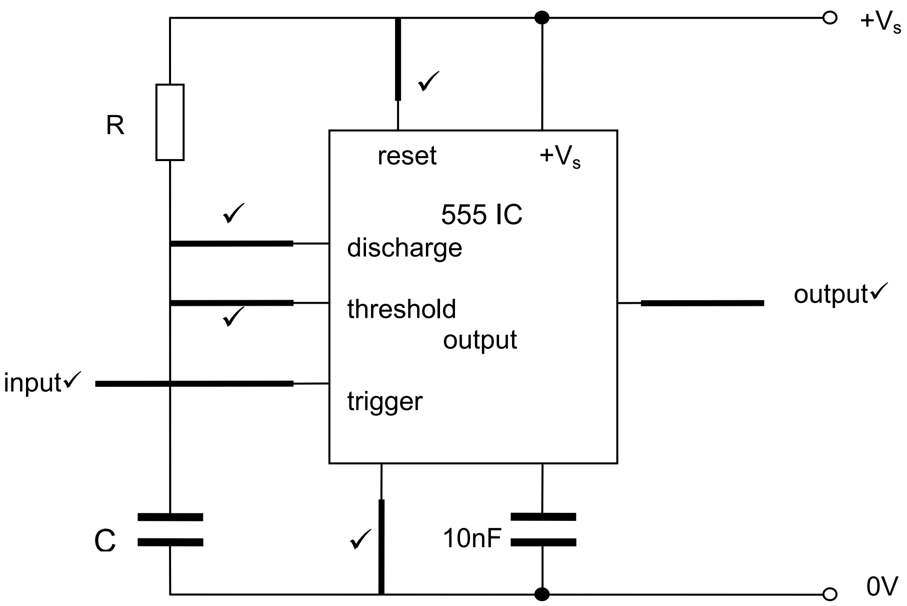
**Total 10 marks**

## Optical Fibre, 555 Monostable, Logic System (ELE5, Q7, 2009)

**7** (a) (i) Attenuation of signal✓(allow causes of attenuation)
Dispersion of signal✓

(ii) E.g. security✓

(b) (i)




(ii) C = T ÷ 1.1 R✓ $10^{-5} \div 1.1 \times 3.3 \times 10^{-3}$✓ 2.7nF✓

(c) (i)

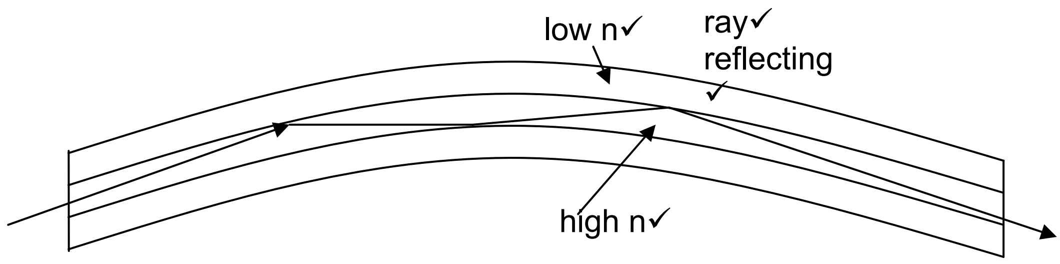
| A | B | S | C | D | Q |
|---|---|---|---|---|---|
| 0 | 0 | 0 | **1** | **1** | **0** |
| 0 | 1 | 0 | **1** | **0** | **1** |
| 1 | 0 | 0 | **1** | **1** | **0** |
| 1 | 1 | 0 | **1** | **0** | **1** |
| 0 | 0 | 1 | **1** | **1** | **0** |
| 0 | 1 | 1 | **1** | **1** | **0** |
| 1 | 0 | 1 | **0** | **1** | **1** |
| 1 | 1 | 1 | **0** | **1** | **1** |

✓ ✓ ✓

(ii) 2 i/p multiplexer✓
When S = 0, B is transmitted✓
When S = 1, A is transmitted✓ *(18 marks)*

## Optical Fibre, 555 Astable, Mobile Phones (ELE5, Q7, 2007)

**7** (a)

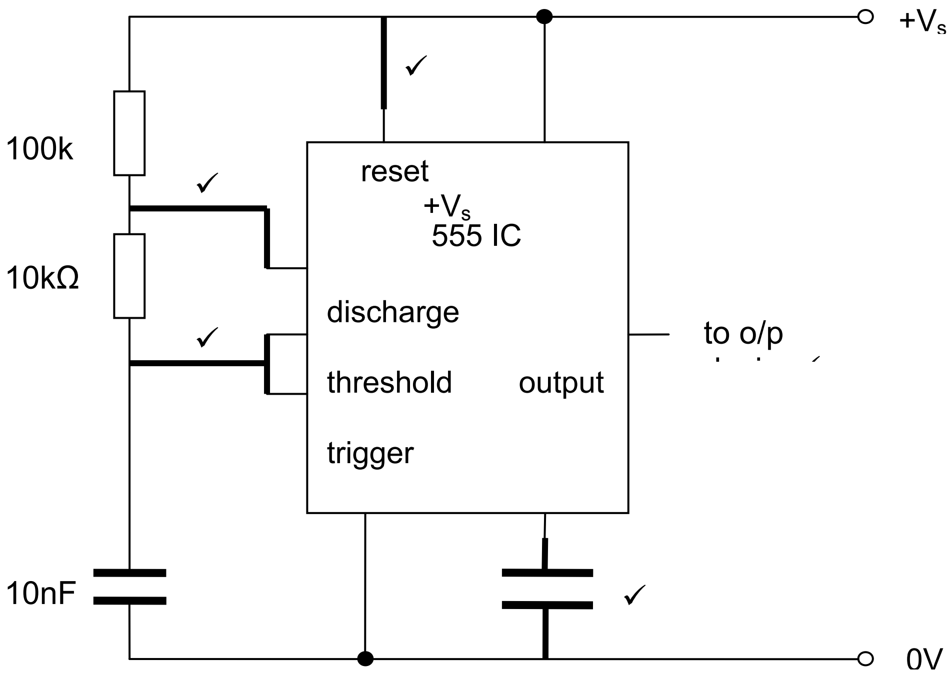



*(4 marks)*

(b) laser diode/LED✓

*(1 mark)*

(c) (i)




(ii) use of $f = 1.44 / R_A + 2R_B$✓ 1200Hz✓

(iii) $0.7 \times 10^{-4}$s✓

*(8 marks)*

(d) (i) radio waves✓

(ii) explanation using:
cells✓
frequency re-use✓
channels✓
time division multiplex✓

*(5 marks)*

*(Total 18 marks)*

**Optical Fibre, Filter, Sampling (ELE5, Q6, 2006)**

**6** (a) (i) optic fibre✓

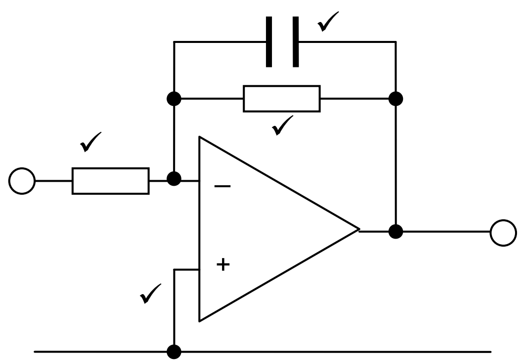
(ii) total internal reflection✓

(iii) attenuation✓ dispersion✓ (any order)

(iv) Vr = 12 – 2 = 10V✓ R = Vr/I = 10/0.01 = 1000Ω✓

*(6 marks)*

(b) (i)




(ii) either calculate the reactance of C at 4 kHz and show it to be nearly equal to $R_f$, or use of formula for breakpoint frequency.
Use of correct formula✓ numerical substitution✓
answer✓

(iii) -✓ 3.9✓

(iv) 8 kHz✓
sampling rate must be at least twice highest signal frequency✓
one sample positive, one negative for highest frequency✓
or diagram, or anti-aliasing

*(12 marks)*
*(question total 18 marks)*