Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2014

Electronics ELEC5

Unit 5 Communications Systems

Wednesday 11 June 2014 9.00 am to 10.30 am

For this paper you must have:
- a pencil and ruler
- a calculator
- a Data Sheet (enclosed).

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

Answer **all** questions in the spaces provided.

1 (a) Draw a system diagram below for a radio transmitter consisting of **four** subsystems. Label each subsystem and indicate the type of signal at the output of each subsystem.

[8 marks]

1 (b) It is possible to send signals along a twisted pair, coaxial cable or optical fibre. Compare the use of these media.

You should include references to bandwidth and security.

[6 marks]

.....

.....

.....

.....

.....

.....

.....

.....

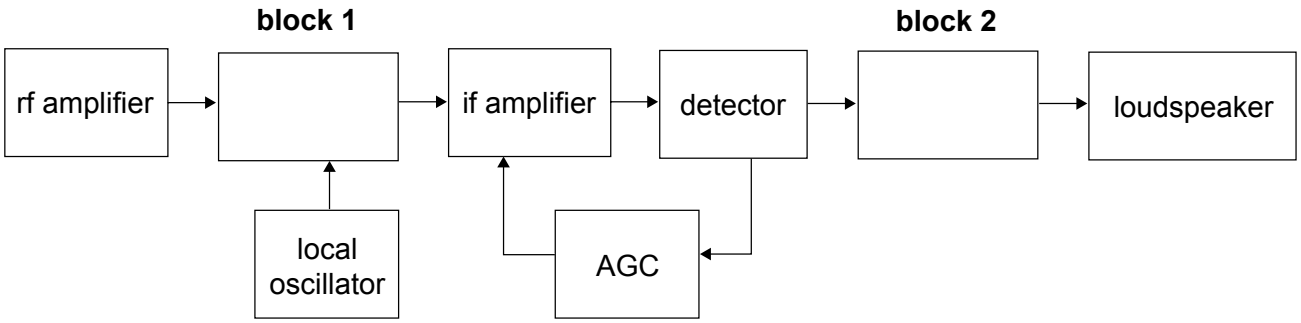
.....

14

Turn over for the next question

2 **Figure 1** shows the system diagram of a superheterodyne radio receiver.

Figure 1



2 (a) Complete **Figure 1** by adding the names of **block 1** and **block 2**.

[2 marks]

2 (b) (i) Describe the function of **block 1**.

[3 marks]

.....

.....

.....

.....

2 (b) (ii) State the function of **block 2**.

[1 mark]

.....

.....

2 (c) The radio receiver local oscillator is on a frequency of 1455 kHz. The if amplifier is tuned to 455 kHz and the local oscillator frequency is higher than the signal frequency.

2 (c) (i) Calculate the received radio frequency.

[1 mark]

.....

.....

2 (c) (ii) Calculate the image or second channel frequency.

[1 mark]

.....

.....

2 (c) (iii) Explain what the image or second channel response is, and why it occurs.

[2 marks]

.....

.....

.....

.....

10

Turn over for the next question

3 PMR446 (Private Mobile Radio, 446 MHz) is a part of the UHF radio frequency range that is available for business and personal use in most of the EU. PMR446 is used in consumer-grade walkie-talkies where analogue FM is used.

3 (a) (i) State the meaning of the term **UHF**.

[1 mark]

.....

3 (a) (ii) State the meaning of the term **FM**.

[1 mark]

.....

3 (a) (iii) Explain how analogue information is carried on FM.

[2 marks]

.....

.....

3 (b) **Table 1** shows the channels available for use.

Table 1

PMR Channel	Frequency (MHz)
1	446.00625
2	446.01875
3	446.03125
4	446.04375
5	446.05625
6	446.06875
7	446.08125
8	446.09375

3 (b) (i) Calculate the wavelength of the radio signal generated on channel 8.

[2 marks]

.....

.....

.....

3 (b) (ii) The optimum antenna length for a hand-held radio is equal to one half of a half-wave dipole.
Calculate this length for channel 8.

[1 mark]

.....

3 (c) (i) Calculate the spacing of PMR446 channels.

[1 mark]

.....

3 (c) (ii) Show by calculation that a maximum information frequency of 3 kHz and a deviation of ±2.5 kHz can be supported in this system.

[2 marks]

.....

.....

3 (c) (iii) Explain the effect of using ±5 kHz deviation.

[2 marks]

.....

.....

.....

3 (d) All these channels are used for half-duplex communication.
Explain the meaning of the term **half-duplex** and how each channel can be used for two-way communication.

[2 marks]

.....

.....

.....

.....

14

Turn over for the next question

4 The microphone signal in a mobile phone is analogue.

4 (a) The signal is converted using an ADC at a sampling rate of 8 kHz.

4 (a) (i) Explain why the input frequency should **not** be greater than 4 kHz.

[2 marks]

.....

.....

4 (a) (ii) How could the signal frequency be limited to 4 kHz?

[1 mark]

.....

.....

4 (a) (iii) Each sample results in eight bits.

At the sampling rate given in part **(a)**, show that the data rate of the resulting signal is 64 kbps.

[1 mark]

.....

.....

.....

4 (b) The ADC produces an 8-bit parallel output.
What subsystem is required to make the output suitable to be transmitted on the uplink channel?

[1 mark]

.....

4 (c) The short message service (SMS) on a mobile phone can send a maximum of 160 characters per message. Each ASCII character consists of seven bits.

4 (c) (i) Calculate the number of bytes in an SMS message of maximum length.

[2 marks]

.....

.....

4 (c) (ii) How long does it take to send just the data in a maximum length SMS message at a data rate of 64 kbps?

[2 marks]

.....

.....

4 (c) (iii) The SMS message must also contain other information.
State **one** example of this other information.

[1 mark]

.....

10

Turn over for the next question

5 A friend gives you an audio amplifier to test. He says the sound output is noisy and distorted.

5 (a) Noise and distortion both cause unwanted changes in the audio signal.
Referring to the changes that occur in the signal, explain the difference between noise and distortion.

[4 marks]

.....

.....

.....

.....

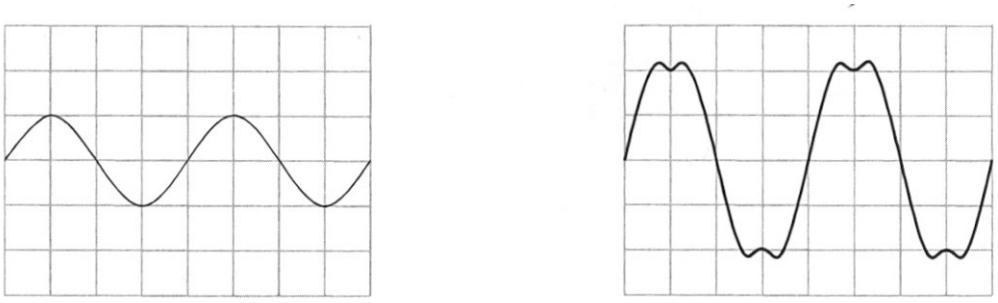
.....

5 (b) Noise and distortion in an amplifier can be investigated by applying a sinusoidal signal to the input and displaying the input and output waveforms on an oscilloscope, as **Figure 2** shows.

For the oscilloscope trace connected to the input, timebase = 1 ms/div,
y-sensitivity = 5 mV/div

Figure 2

input **output**



State the peak voltage and period, and calculate the frequency for this input signal.

[3 marks]

peak voltage .....

period .....

frequency .....

5 (c) With the input signal set to 0 V, there is no measurable output signal.
Explain therefore whether the amplifier suffers from noise and/or distortion.

[2 marks]

.....

.....

.....

5 (d) Signal-to-noise ratio is a quantity which may appear on the data sheet for an amplifier.

$$\text{signal-to-noise ratio} = 20 \log_{10} \left\{ \frac{V_{\text{signal}}}{V_{\text{noise}}} \right\} \text{dB}$$

The data sheet for a simple amplifier designed for an intercom system states a signal-to-noise ratio of 60 dB. The rms output voltage is 4 V.
Calculate the rms voltage of the noise expected from this amplifier.

[3 marks]

.....

.....

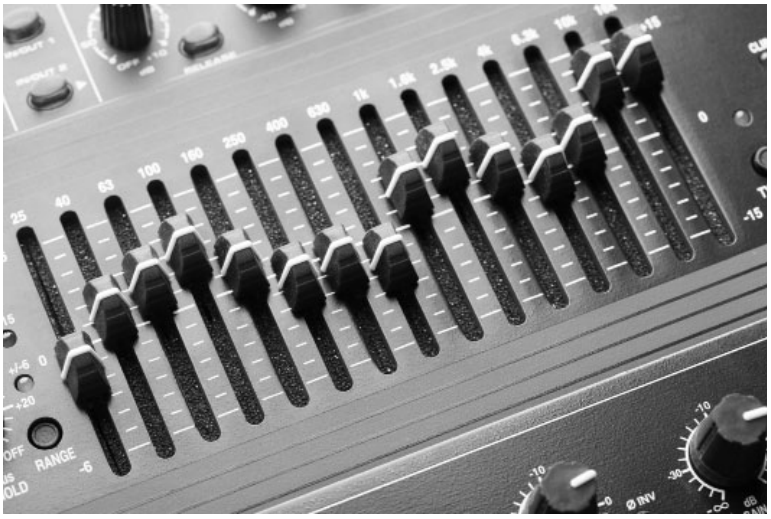
.....

12

Turn over for the next question

6 A graphic equalizer is a piece of equipment commonly used in recording studios to adjust the levels of different frequencies in an audio signal.
Figure 3 shows a typical graphic equalizer.

Figure 3



Each slider controls the amplitude of a particular, small band of frequencies, and the sliders together cover the entire audio range.

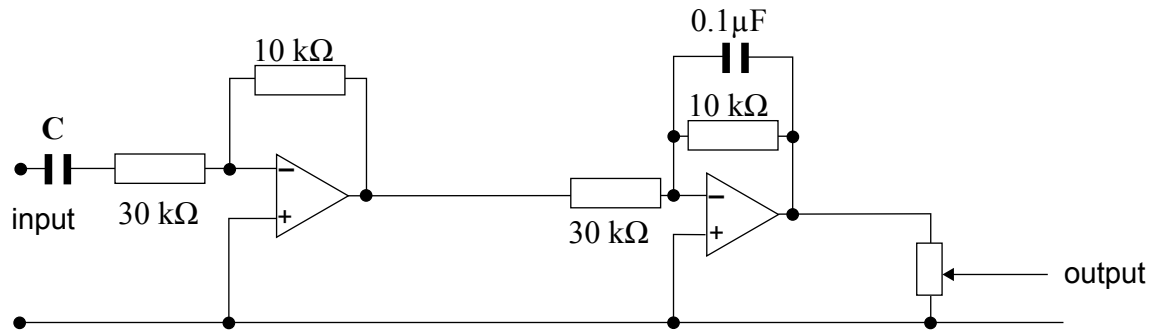
6 (a) State the typical range of audio frequencies.

[2 marks]

.....

6 (b) A student decides to build a simple graphic equalizer, and for each frequency band she uses two active filters, as shown in **Figure 4**.

Figure 4



....

6 (b) (i) Write the name of **each** type of filter in the spaces provided on **Figure 4**.

[2 marks]

6 (b) (ii) What is meant by the **breakpoint frequency** of a filter?

[1 mark]

.....

6 (b) (iii) One of the standard frequency bands used in graphic equalizers is centred on 160 Hz. Show that the breakpoint frequency for the filter on the right of **Figure 4** is at approximately this frequency.

[3 marks]

.....

.....

.....

6 (b) (iv) Calculate the approximate value that C would have to give a breakpoint frequency of 160 Hz for the filter circuit on the left of **Figure 4**.

[2 marks]

.....

.....

.....

10

Turn over for the next question

7 (a) Draw a labelled diagram of a length of a step-index optical fibre laid on a curved path, including reference to the refractive index of parts of the fibre.

Include on your diagram the path of a ray of light travelling through the fibre.

[4 marks]

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

[1 mark]

.....

7 (c) State how optical signals can travel along a fibre that is curved.

[1 mark]

.....

7 (d) Describe the cause and effect of **scattering** and **dispersion** on an optical signal travelling along a fibre.

[4 marks]

scattering .....

.....

.....

dispersion.....

.....

.....

10

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Acknowledgement of copyright-holders and publishers

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements in future papers if notified.

Question 6 ©Thinkstock