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 2010

Electronics ELEC5

Unit 5 Communications Systems

Tuesday 15 June 2010 1.30 pm to 3.00 pm

For this paper you must have:
- a pencil and ruler
- a calculator
- a Data sheet.

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.

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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

1 Part of a communication system has the following subsystems:

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

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

(3 marks)

1 (b) Describe the operation of each of the subsystems in part (a), stating for each one its action on its input signal(s) and the form taken by its output signal.

1 (b) (i) carrier generator .....

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(2 marks)

1 (b) (ii) input transducer .....

.....

.....

(2 marks)

1 (b) (iii) modulator .....

.....

.....

(3 marks)

1 (b) (iv) transmitter .....

.....

.....

(2 marks)

12

2 (a) (i) Draw a labelled diagram to show a ray of light travelling along a step-index optical fibre laid on a curving path. Show the structure of the fibre clearly.

(3 marks)

2 (a) (ii) Describe and explain how the ray of light travels along the fibre.

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(3 marks)

2 (b) Explain how dispersion affects the performance of a step-index optical fibre.

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(2 marks)

2 (c) Optical signals can also suffer from the effects of attenuation and radiation.

2 (c) (i) Explain:

a possible cause and the effect of attenuation

.....

.....

(2 marks)

2 (c) (ii) a possible cause and the effect of radiation.

.....

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(2 marks)

2 (d) State **two** technical advantages of an optical fibre system over a wired system.

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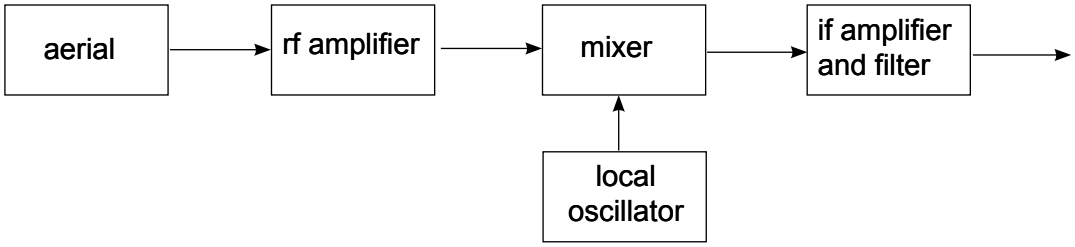
(2 marks)

14

Turn over for the next question

3 The first five subsystems of a superhet radio receiver are shown below.



3 (a) Describe the operation of each of these subsystems.

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(6 marks)

3 (b) The rf signal frequency is 693 kHz and the local oscillator frequency is 1148 kHz.

3 (b) (i) Calculate which **two** new frequencies are produced by the mixer.

.....

(2 marks)

3 (b) (ii) Which **one** of the frequencies produced by the mixer will pass through the if amplifier and filter?

.....

(1 mark)

3 (b) (iii) Calculate the frequency of the second channel or image response.

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(1 mark)

10

4 (a) A digital communication system produces a PWM signal.

4 (a) (i) What does PWM stand for?

.....

(1 mark)

4 (a) (ii) Describe how an analogue information signal is encoded to produce a PWM signal.

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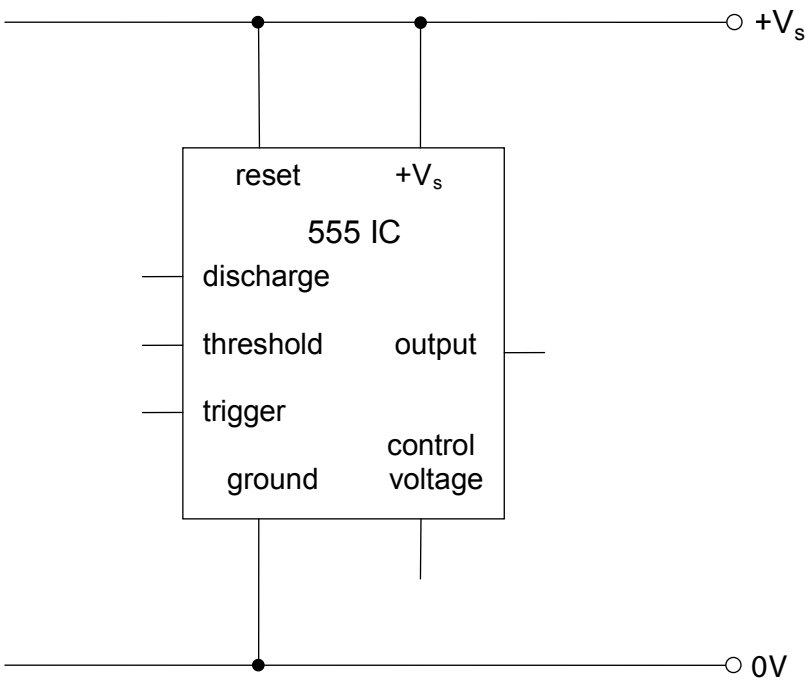
.....

(1 mark)

4 (b) PWM pulses can be produced by a 555 IC monostable circuit, which is triggered by an astable pulse generator. Complete the circuit diagram below to show how a 555 IC is connected as a monostable, adding appropriate connections and components. Show where this monostable would be connected to the astable pulse generator and the analogue information signal. Show where the PWM signal is produced.



(6 marks)

4 (c) When no analogue signal is present, the desired output pulse width from the monostable is 20 µs. Calculate the value of the timing resistor required if the timing capacitor has a value of 1.8 nF.

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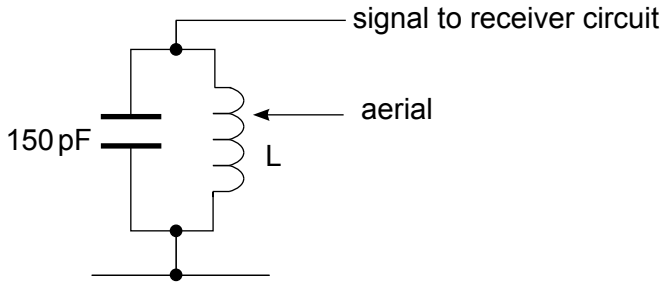
(2 marks)

10

Turn over ▶

5 Radio frequency identification (RFID) is a system now widely used as an alternative to barcodes. A typical application is in the anti-theft tags used on shop goods.

5 (a) The aerial in the transceiver transmits a signal which activates the tag. The tag then transmits data to the transceiver. The frequency of the signals is typically 13.56 MHz. The transceiver's aerial is made of a coil of wire, which also acts as the inductor for the tuned circuit.



5 (a) (i) Show that a suitable value for the inductor, L, is approximately 920 nH.

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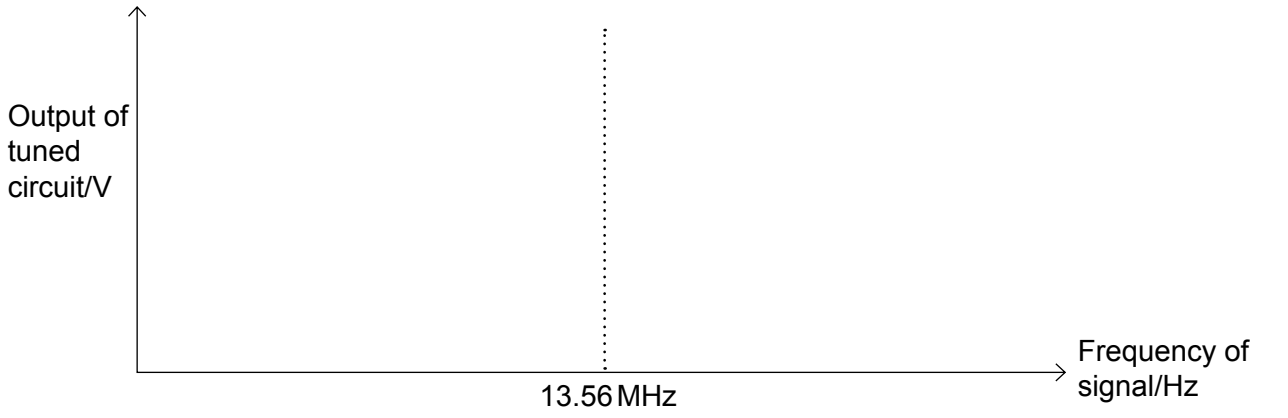
(2 marks)

5 (a) (ii) On the graph below sketch what you would expect the frequency response curve for the tuned circuit to look like.



(2 marks)

5 (a) (iii) It is important for reliable operation that the RFID system has high *selectivity*. This can be achieved if the tuned circuit has a high *quality factor (Q)*. With reference to your graph, explain what these terms mean.

selectivity .....

.....

quality factor .....

.....

(2 marks)

5 (b) Communication between the tag and the transceiver is *half-duplex.* Explain what this term means.

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(2 marks)

5 (c) The data transfer rate between the tag and the transceiver is 106 KBaud. The data is transmitted serially in bytes, each with a start and stop bit. If the tag contains 1 Kbyte of memory, calculate how long it would take the transceiver to read all the data from the tag.

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(2 marks)

10

Turn over for the next question

6 For DAB radio, the regulatory authorities have allocated the UK seven multiplex frequency blocks in the range 217.5 – 230.0 MHz. The frequencies are given below.

block	frequency/MHz
11B	218.640
11C	220.352
11D	222.064
12A	223.936
12B	225.648
12C	227.360
12D	229.072

6 (a) In which band of the radio spectrum are these frequencies?

.....

(1 mark)

6 (b) Show that a multiplex bandwidth of 1.536 MHz can be accommodated, without danger of interference, by this allocation of frequencies.

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(2 marks)

6 (c) Calculate the length of a half-wave dipole for receiving these DAB signals.

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(2 marks)

The multiplex for BBC national radio carries up to eleven stations, each of which is transmitted at a particular bit rate, for example as shown below.

station	bit rate/kbps
Radio 1	128
Radio 2	128
Radio 3	192 or 160
Radio 4	128 or 80
Radio 5 Live	80 or 64
Radio 5 Sports Extra	64
6 Music	128
1Xtra	128
World Service	64
Asian Network	64
BBC 7	80

6 (d) The stations have different programme content and some are only transmitted in mono. Explain why different bit rates are used for different stations.

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(3 marks)

6 (e) The audio signal for Radio 3 is sampled at a frequency of 48 kHz, with 16-bit resolution, in stereo. Calculate the bit rate of the data produced by this sampling.

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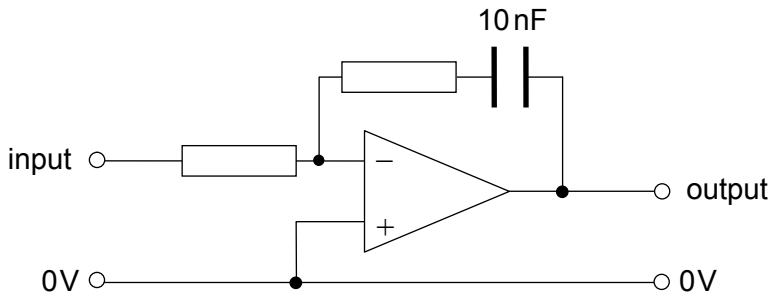
(2 marks)

10

7 A student is designing a bass boost circuit based on an op-amp, for an audio amplifier system. The initial circuit is shown below.



7 (a) (i) Calculate the value of feedback resistor required if the breakpoint frequency of the circuit is to be 500 Hz.

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(3 marks)

7 (a) (ii) Choose a suitable resistor value from the E24 series for the feedback resistor and state what effect your choice will have on the exact breakpoint frequency.

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(2 marks)

7 (b) (i) In operation, the student finds the bass boost system causes the loudspeaker to produce excessive bass at frequencies at or below 50 Hz. What type of circuit could be used to reduce the response to signals at 50 Hz and below?

.....

(1 mark)

7 (b) (ii) The student decides to use a capacitor value of 1 µF in series with a resistor to reduce the response to these very low frequencies. Calculate the reactance of this capacitor at a frequency of 50 Hz.

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(2 marks)

7 (b) (iii) State a suitable value for the resistor required in series with the capacitor in part (b)(ii) to achieve the required effect.

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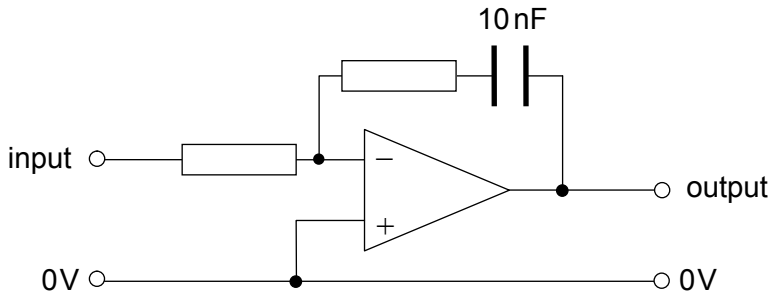
(1 mark)

7 (b) (iv) The student then realises that if the resistor chosen in part (b)(iii) is used as the input resistor in the original bass boost design in part (a), then the extra capacitor can also be placed in the original circuit. Add a capacitor symbol to the diagram below in the correct location.



(1 mark)

7 (b) (v) Using the value of resistor in part (b)(iii), calculate the voltage gain of the original circuit at a frequency well above the higher breakpoint frequency.

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(2 marks)

7 (c) In use, the student finds that the circuit operates correctly for only a few seconds before the output becomes increasingly distorted, finally giving no output at all. Measurement of the output voltage of the op-amp shows that it gradually drifts until it approaches the power supply voltage.
Describe the cause of this problem and suggest a solution.

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(2 marks)

14

END OF QUESTIONS

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