Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Subsidiary Examination
June 2010

Electronics ELEC1

Unit 1 Introductory Electronics

Thursday 20 May 2010 9.00 am to 10.00 am

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

Time allowed
- 1 hour

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 67.

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

1 The Boolean equation for a logic circuit with inputs A and B and output Q is:

$$Q = (A \cdot B) + (\overline{A} \cdot \overline{B})$$

1 (a) Complete the truth table to show the logic values of the terms below for all the combinations of the inputs A and B.

A	B	$\overline{A}$	$\overline{B}$	A . B	$\overline{A} \cdot \overline{B}$	Q
0	0					
0	1					
1	0					
1	1					

(5 marks)

1 (b) Complete the diagram below to show how a logic circuit can be constructed that has the same function as the Boolean equation above using **two** AND gates, **two** NOT gates, and **one** OR gate.

(5 marks)

1 (c) State the logic function of the complete circuit above.

....

(1 mark)

11

2 A student designs an electronic system to control a ventilation fan for a greenhouse. The fan should be switched on only when both the temperature and humidity exceed certain levels that can each be set independently.

2 (a) Choosing appropriate input, process and output subsystems from the list below, draw a labelled block diagram to show a possible design for the system.

Choose from:

AND gate	**comparator**	**driver**	**humidity sensor**
fan motor	**temperature sensor**	**voltage divider**	

(7 marks)

2 (b) In which subsystem would:

2 (b) (i) a MOSFET be used ....

(1 mark)

2 (b) (ii) an op-amp be used ....

(1 mark)

2 (b) (iii) a thermistor be used? ....

(1 mark)

2 (c) The controller circuit operates from a 12 V power supply and draws a current of 25 mA under all conditions.
The fan motor requires a current of 450 mA when switched on and operates from the same 12 V power supply.

Calculate:

2 (c) (i) the total current drawn by the whole system when the fan motor is switched on

....

(1 mark)

2 (c) (ii) the input power to the whole system when the fan motor is switched on.

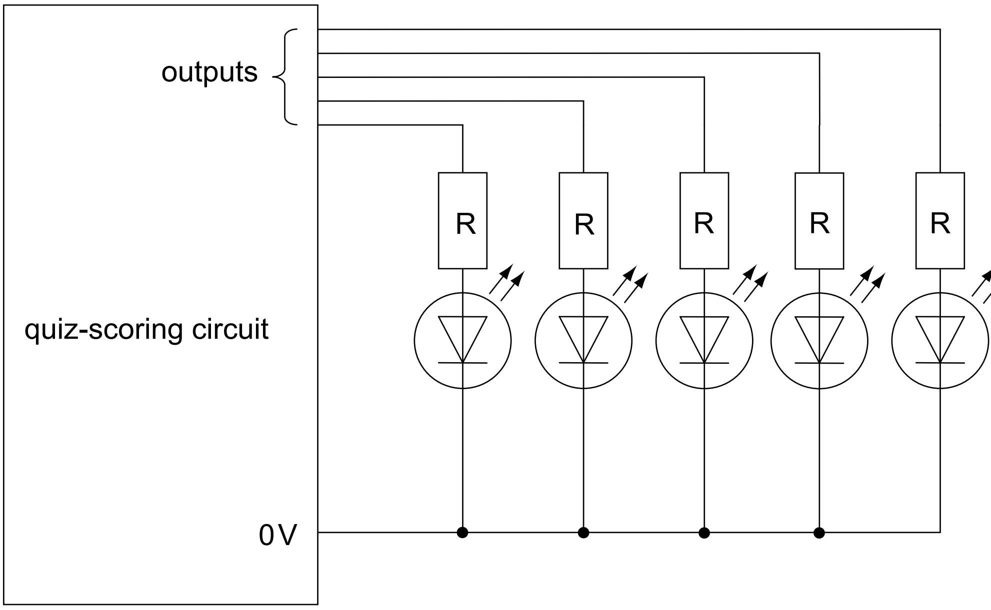
....

(2 marks)

13

Turn over ▸

3 A student builds a quiz-scoring circuit that has five LEDs as its output. The student connects each of the five outputs of the circuit to the LEDs via five identical resistors as shown below.



3 (a) Each LED has a forward voltage drop of 1.7 V at the maximum forward current of 20 mA and the circuit produces a 9 V output signal when the corresponding LED is switched on.

3 (a) (i) Calculate the voltage across a resistor R when its LED is switched on.

....

(1 mark)

3 (a) (ii) Calculate the value of the resistor R needed.

....

....

(2 marks)

3 (a) (iii) Select the most suitable preferred value from the E24 series for R if the maximum current for the LED is not to be exceeded.

....

(1 mark)

3 (a) (iv) Calculate the actual current through the LED when the preferred value of resistor in part (a)(iii) is used; assume the LED forward voltage drop remains at 1.7 V.

....

....

(2 marks)

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3 (a) (v) With no LEDs switched on, the quiz-scoring circuit alone draws 30 mA from the 9 V power supply. Calculate the current consumption of this circuit with all the LEDs switched on.

....

(1 mark)

3 (a) (vi) Comment on the suitability of a small, low capacity 9 V battery to power this system.

....

....

(1 mark)

3 (b) The student decides to economise on resistors by connecting all the LED anodes directly to the outputs of the circuit, and using a single resistor of the preferred value chosen in part (a)(iii) to connect all LED cathodes to 0 V.

3 (b) (i) Estimate the current through each active LED when three of them are switched on at the same time.

....

(1 mark)

3 (b) (ii) Describe the appearance of the LEDs as different numbers of them are switched on. Comment on the desirability of using a single resistor.

....

....

(2 marks)

11

Turn over for the next question

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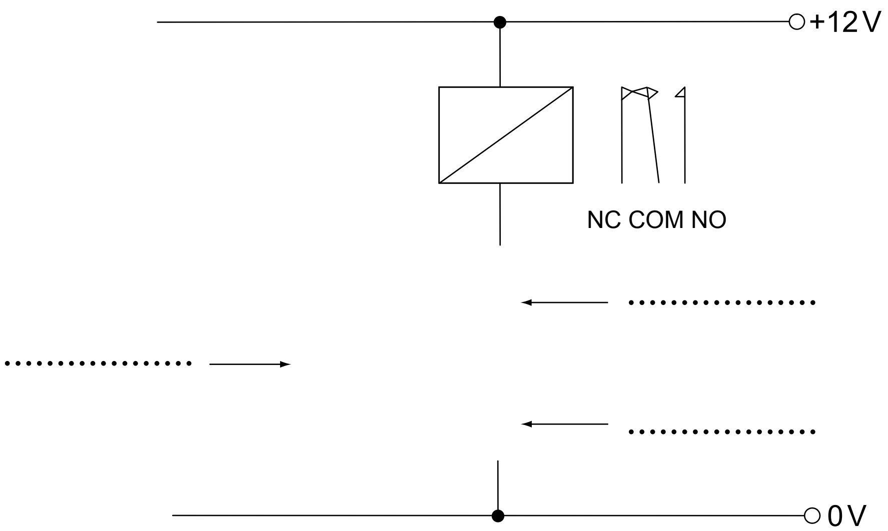
4 An electromagnetic relay is controlled by a MOSFET from a 12 V power supply.

4 (a) Complete the circuit diagram below to show how the relay is connected to the MOSFET. Draw the symbol for, and label the leads of the MOSFET.



(4 marks)

4 (b) Draw on the circuit diagram above the component required to protect the MOSFET when the relay coil is switched off. *(2 marks)*

4 (c) Write out in full the meaning of the relay contact labels.

NC..

COM..

NO..

(3 marks)

9

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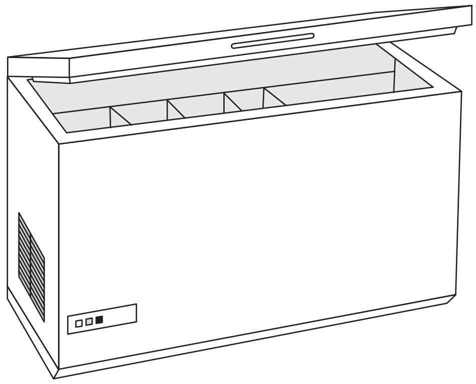
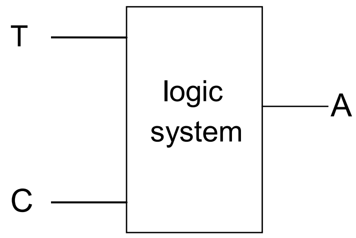
5 A butcher wants to fit an alarm to a deep freeze, which will warn him if there is a danger of damage to stock in the freezer.



The freezer has sensors with the following outputs:

T is logic 1 if the temperature is too high to store frozen food; and logic 0 if the temperature is at or below the required temperature
C is logic 1 if the lid is closed and logic 0 if the lid is open.



A student is asked to produce a logic system to give an output A to operate the alarm (the alarm sounds if A is high). He decides that the alarm should sound if:

the lid is closed and the temperature is too high, or
the temperature is low and the lid is left open.

5 (a) He designs a system to implement this function. Write a Boolean expression for the output A, in terms of T and C.

....

(3 marks)

5 (b) Draw a logic diagram for the system, using any type of logic gates.

(5 marks)

5 (c) Using NAND gates only, draw a diagram of a logic system which has the same function as a 2-input OR gate.

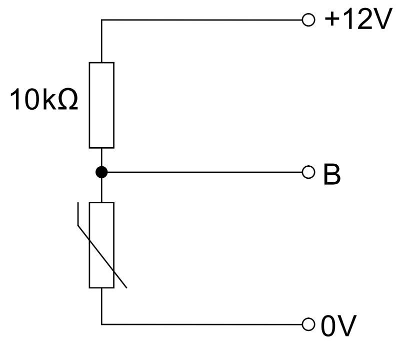
(2 marks)

5 (d) Draw a logic diagram for the system in part (b), using NAND gates only. Draw a ring round any redundant gates or re-draw the final system.

(5 marks)

15

6 A temperature sensor input subsystem is shown below.



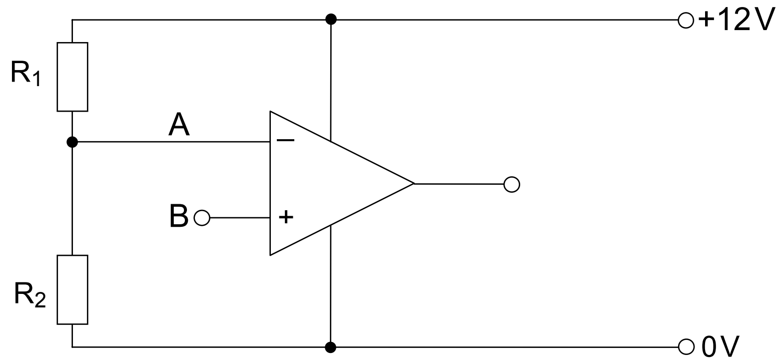
6 (a) The thermistor shown above has a resistance of 45 kΩ at 0 °C, 20 kΩ at 25 °C, and 1 kΩ at 100 °C.
Calculate the output voltage at B at a temperature of 25 °C.

....

....

(3 marks)

6 (b) The temperature sensor input subsystem is connected to the comparator circuit as shown below.



Calculate and choose values of resistors, in the 1 kΩ to 10 kΩ range, for the circuit that will make the comparator switch at 25 °C. Label these on the diagram.

....

....

(3 marks)

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6 (c) What voltage would you expect from the output of this circuit when:

6 (c) (i) the temperature is 20 °C ....

(1 mark)

6 (c) (ii) the temperature rises to 30 °C? ....

(1 mark)

8

END OF QUESTIONS

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