OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **2530**

ELECTRONICS

Control Circuits

TUESDAY 10 JUNE 2008 Afternoon

Time: 1 hour 15 minutes

Candidates answer on the question paper
Additional materials (enclosed): Microprocessor Instruction Set

Additional materials (required):
Calculator

CUP/T44946

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You may assume, unless otherwise stated, that:
  - **(i)** the p.d. across a forward-biased silicon diode is 0.70 V,
  - **(ii)** the base-emitter p.d. for a conducting silicon transistor is 0.70 V,
  - **(iii)** the power supplies for operational amplifiers are +15 V and –15 V,
  - **(iv)** the saturation levels for operational amplifiers are +13 V and –13 V,
  - **(v)** logic 1 = 5 V and logic 0 = 0 V.
- The quality of written communication will be assessed in your answers to all the questions.
- **QUESTION 6 REQUIRES THE MICROPROCESSOR INSTRUCTION SET INCLUDED.**

FOR EXAMINER'S USE	
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2	
3	
4	
5	
6	
QWC	
TOTAL	

This document consists of **13** printed pages, **3** blank pages and an insert.

[Turn over

1 Explain the purpose of the following as they apply to microprocessor systems.
State where each is located in the system.

(a) Program Counter

.....

.....

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.....[3]

(b) Accumulator

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.....[2]

(c) Look-up table

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.....[2]

(d) Arithmetic Logic Unit

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.....[2]

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2 Fig. 2.1 shows a circuit containing two relays which are energised by relatively small currents. Each relay has one (normally open) switch.

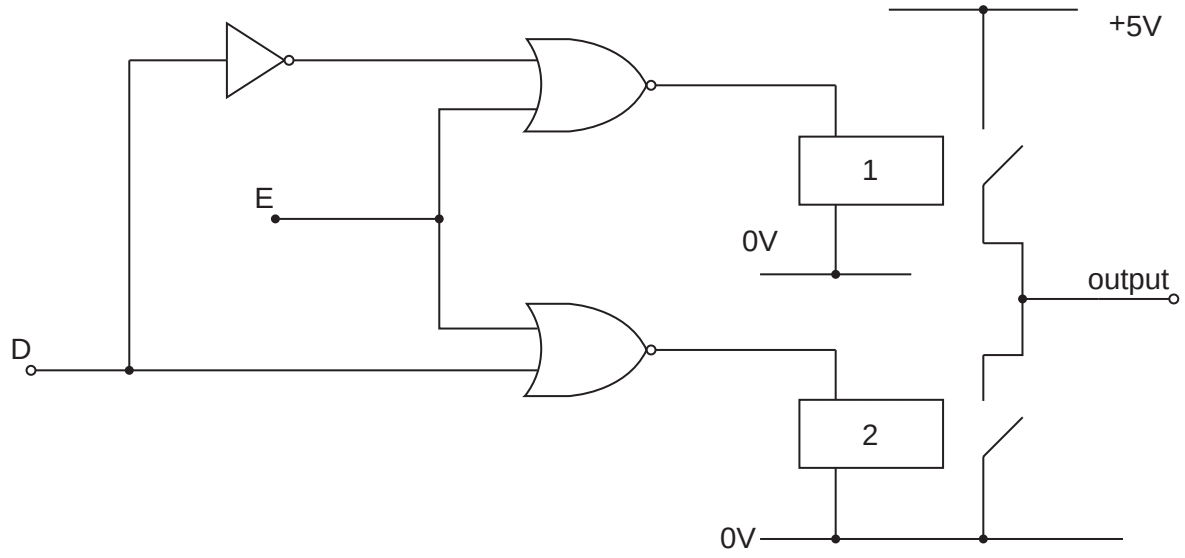

Fig. 2.1

(a) (i) State and explain the logic level at E which will prevent both relays from energising.

.....

.....

.....[2]

(ii) State and explain the output voltage under these circumstances.

.....

.....

.....[2]

(b) Explain why it is impossible for both relays to be energised at the same time.

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.....[2]

(c) State and explain the logic levels at D and E necessary to energise relay 1.

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.....[2]

(d) Computer systems use a component which performs the same function as the circuit of Fig. 2.1.

(i) Name this component .....[1]

(ii) Draw and label its symbol with appropriate inputs and output.

[2]

(iii) Explain why it is used

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.....

.....[2]

3 Fig. 3.1 shows a circuit designed by a student to switch on and off a lamp on top of a tower.
At first the small push switches S_1 and S_2 are wired into the circuit to check that the lamp will operate as required.

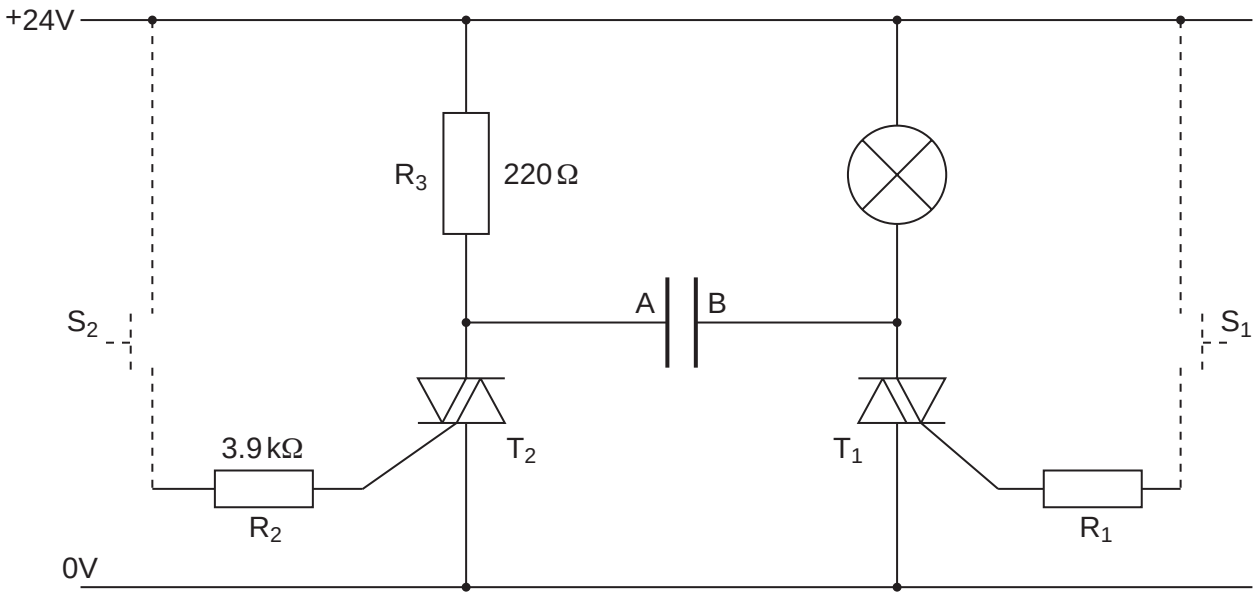

Fig. 3.1

When switch S_1 is given a brief push the lamp must operate at full power.
When switch S_2 is given a brief push the lamp must turn off.

(a) Triac T_1 requires a gate current of at least 30 mA in order to fire.
Calculate the maximum value which can be used for the resistor R_1.

maximum R_1 = ...Ω [2]

(b) When operating, the lamp requires a power of 100 W.
Calculate the current in the lamp and suggest a suitable current rating for the triac T_1.

current rating = ... A [3]

(c) The triac T_2 requires a gate current of at least 4 mA in order to fire and a main terminal current of at least 50 mA to remain conducting.
Calculate the maximum values which can be used for:

(i) the resistor R_2

maximum R_2 = ...Ω [1]

(ii) the resistor R_3

maximum R_3 = ...Ω [1]

(d) Initially, both triacs are in the off state. When switch S_1 is pressed briefly and then released, the lamp comes on and stays on.
Explain why this happens.

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.....[2]

(e) When switch S_2 is given a brief press, the lamp goes off. Explain why this happens. In your answer, you should refer to the voltages at the terminals A and B of the capacitor.

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.....[3]

(f) The student intends to replace both switches with two potential dividers, each containing a light dependent resistor (LDR). The idea is that a torch beam shone on one LDR should cause the lamp to operate while the torch beam shone on the other should cause it to go off.
In the space below, draw a suitable potential divider for the triac T_2. Show how it should be connected to allow T_2 to fire.

+24V

0V

[3]

(g) The teacher suggests to the student that there are easier ways to operate the lamp rather than using triacs. This is because triacs are not normally used in d.c. circuits.
Explain why they are generally used with a.c. circuits.

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.....[2]

4 Fig. 4.1 and Fig. 4.2 show two methods by which a circuit A can communicate information or control signals to another circuit B. In both cases, the two circuits A and B are isolated from each other.

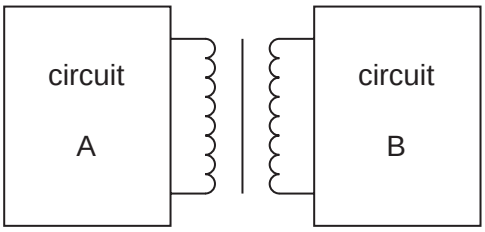

Fig. 4.1

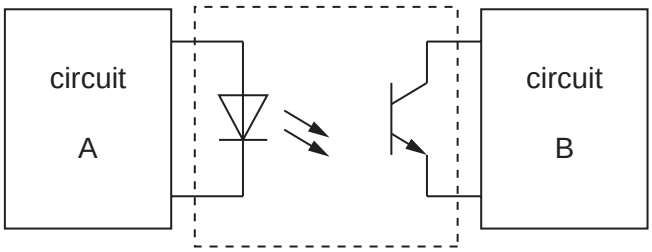

Fig. 4.2

(a) Explain what is meant by *isolation* in the context of these methods.

.....

.....[1]

(b) For **Fig. 4.1**

(i) State the name of the device which links the circuits A and B.

.....[1]

(ii) Explain how information or control signals are communicated from circuit A to circuit B.

.....

.....

.....[2]

(c) For **Fig. 4.2**

(i) State the name of the device which links the circuits A and B.

.....[1]

(ii) Explain how information or control signals are communicated from circuit A to circuit B.

.....

.....

.....[2]

(d) Explain the fundamental difference between these two isolation techniques.

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.....[2]

5 Fig. 5.1 shows a block representing a RAM chip with some of the pins missing.

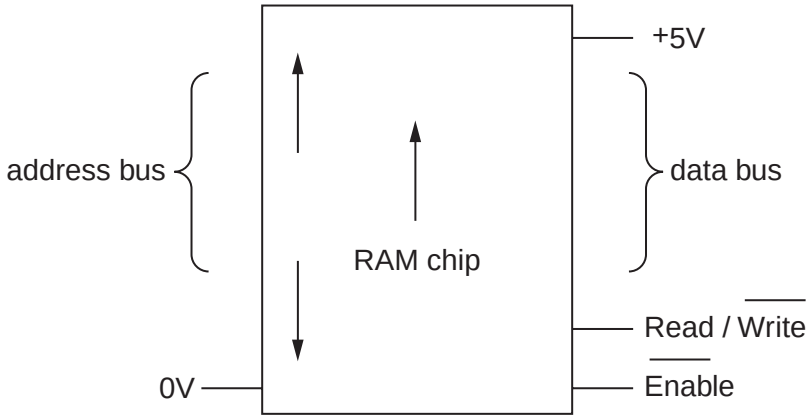

Fig. 5.1

(a) This RAM chip has available 8192 different addresses.
Calculate the number of address pins on the chip. Show your working.

number of address pins = ...[3]

(b) The total number of memory cells inside this RAM chip is 131072.
Calculate the number of data pins on the chip.

number of data pins = ...[1]

(c) Explain why the address bus is *unidirectional*.

.....

.....[1]

(d) Explain why the data bus is *bidirectional*.

.....

.....[1]

(e) The RAM chip also has a pin marked Read / $\overline{\text{Write}}$ and a pin marked $\overline{\text{Enable}}$. Explain how these pins and the busses are used in the storage and subsequent retrieval of a word.

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.....[5]

6 Fig. 6.1 shows a microprocessor system designed to control a game which compares the speed of reaction of two contestants A and B.

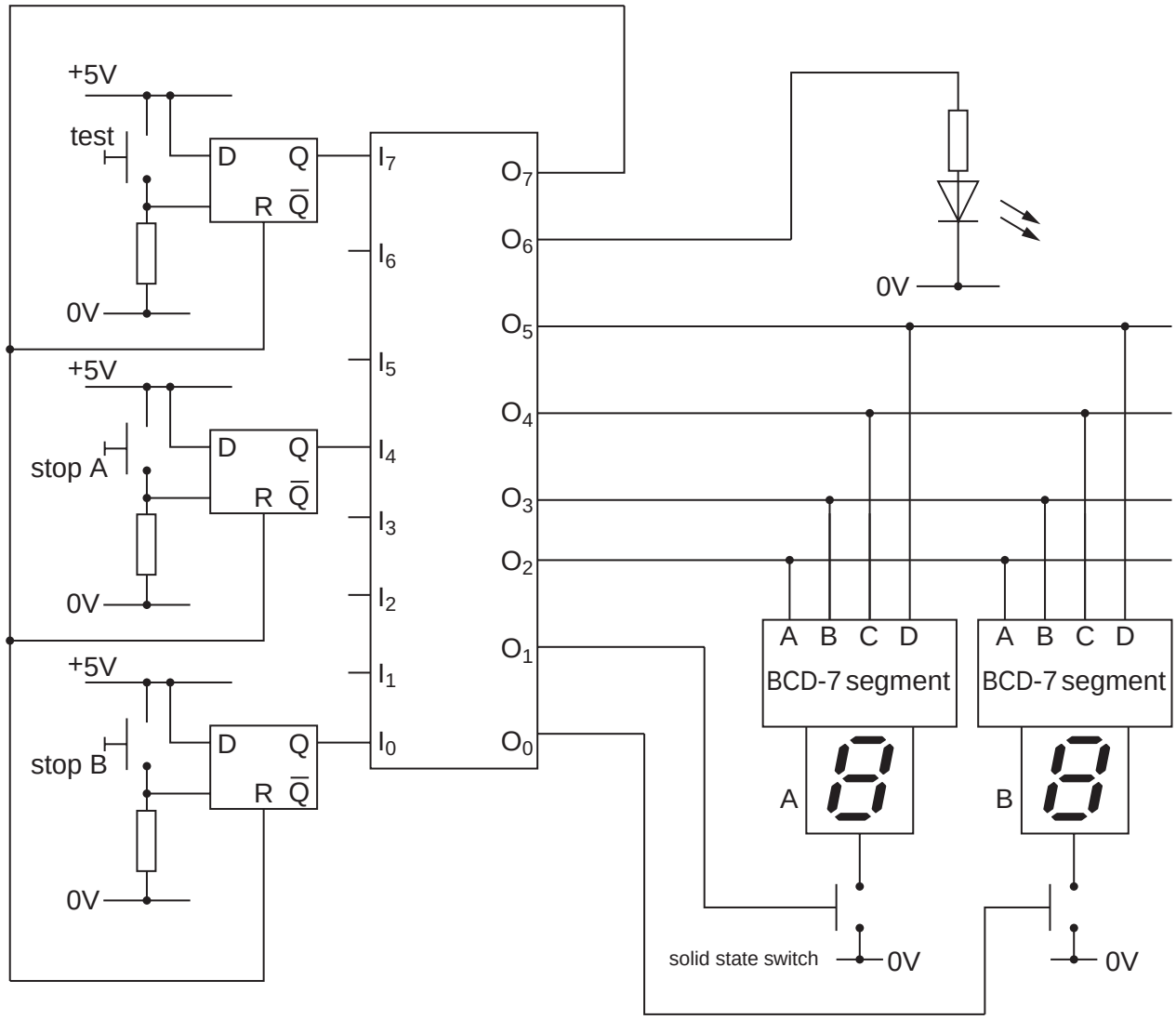

Fig. 6.1

At the beginning of the game, both 7-segment displays read zero.
The referee presses the test switch and a moment later the displays go blank and the LED comes on.
The two contestants must now react to the light as quickly as they can by pressing their stop switch.
The contestant who presses their switch first has one point added to their score.
Their score (and that of their opponent) is shown on the 7-segment displays.
The referee can now press the test switch again to allow another test of the contestants' reactions.

The 7-segment display can be switched off by a logic 0 to the solid-state switch.

You may find it useful to know that memory location AA will contain the contestant A's score and memory location BB will contain the contestant B's score.

The program to make the microprocessor operate in the required way is shown in sections **(a)** to **(e)** below. Using the instruction set provided, explain the function of each program line and summarise the effect of each section.

(a)

Address	**Contents**	**Explanation**
00	3E 00	.....
02	32 AA	.....
04	32 BB	.....
06	3E 03	.....
08	32 FF	.....

Summary .....

.....

.....

[5]

(b)

0A	3A EF	.....
0C	E6 80	.....
0E	CA 0A	.....
10	3E 00	.....
12	6F	.....
13	C9	.....
14	7D	.....
15	C2 13	.....
17	C3 30	.....

Summary .....

.....

.....

[8]

(c)

Address	Contents	Explanation
30	3E 40	.....
32	32 FF	.....
34	3A EF	.....
36	E6 11	.....
38	CA 34	.....
3A	E6 10	.....
3C	C2 50	.....
3E	C3 60	.....

Summary .....

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.....

[7]

(d)

Address	Contents	Explanation
50	3A AA	.....
52	C6 04	.....
54	32 AA	.....
56	C3 70	.....
60	3A BB	.....
62	C6 04	.....
64	32 BB	.....
66	C3 70	.....

Summary .....

.....

.....

[3]

(e) **Address** **Contents** **Explanation**

70	3E 80	.....
72	32 FF	.....
74	3A AA	.....
76	C6 02	.....
78	32 FF	.....
7A	3A BB	.....
7C	C6 01	.....
7E	32 FF	.....
80	3A EF	.....
82	E6 80	.....
84	CA 74	.....
86	C3 10	.....

Summary .....

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[5]

Quality of written communication [3]

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