THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

**ADVANCED GCE**

# ELECTRONICS

Control Circuits

**2530**

Candidates answer on the Question Paper

**OCR Supplied Materials:**
- Microprocessor Instruction Set (inserted)

**Other Materials Required:**
- A calculator may be used

**Tuesday 8 June 2010**
**Morning**

**Duration:** 1 hour 15 minutes

*OCE/10291*

| Candidate Forename | | Candidate Surname | |
|---|---|---|---|

| Centre Number | | | | | | Candidate Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|

**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use 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. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

**INFORMATION FOR CANDIDATES**

- The number of marks 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 7 REQUIRES THE MICROPROCESSOR INSTRUCTION SET INCLUDED.**
- This document consists of **16** pages. Any blank pages are indicated.

**A calculator may be used for this paper**

**1** Explain the following as they apply to microprocessor systems.

**(a)** General Purpose Register.

.....

.....

.....

..... **[2]**

**(b)** Fetch – execute cycle.

.....

.....

..... **[2]**

**(c)** Subroutine.

.....

.....

..... **[2]**

**(d)** Handshaking.

.....

.....

..... **[2]**

**2** A tristate can be used as part of a microprocessor memory system.

**(a)** Draw the symbol for a tristate.

Label the input, output and enable.

**[2]**

**(b)** Complete the truth table below for a tristate.

| Enable | Input | Output |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**[2]**

**(c)** Explain why tristates are used in microprocessor systems.

.....

.....

.....

..... **[2]**

**3** **(a)** Fig. 3.1 shows a circuit symbol for a triac.

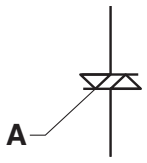


**Fig. 3.1**

**(i)** State the name of terminal **A**.

**A** ..... **[1]**

**(ii)** Describe how a triac can control alternating current in a load.

.....

.....

.....

..... **[3]**

**(iii)** Explain why it is easier to control the operation of a triac with alternating current rather than direct current.

.....

.....

..... **[2]**

**(b)** Fig. 3.2 shows a triac being used as part of a protection circuit for a motor.

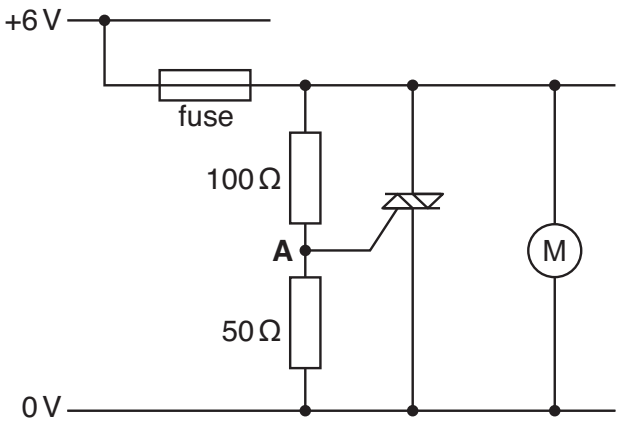


**Fig. 3.2**

**(i)** The power supply is operating normally.

Calculate the voltage at point **A** in Fig. 3.2 if the triac is not conducting.

voltage = ..... V **[3]**

**(ii)** The power supply develops a fault and its output voltage rises.

The triac begins to conduct when point **A** reaches 2.5 V.

Calculate the voltage of the power supply when this occurs.

voltage = ..... V **[2]**

**(iii)** Explain how the triac and fuse protect the motor as the power supply voltage rises.

.....

.....

.....

..... **[3]**

**4** Fig. 4.1 shows a circuit for heating an animal house.

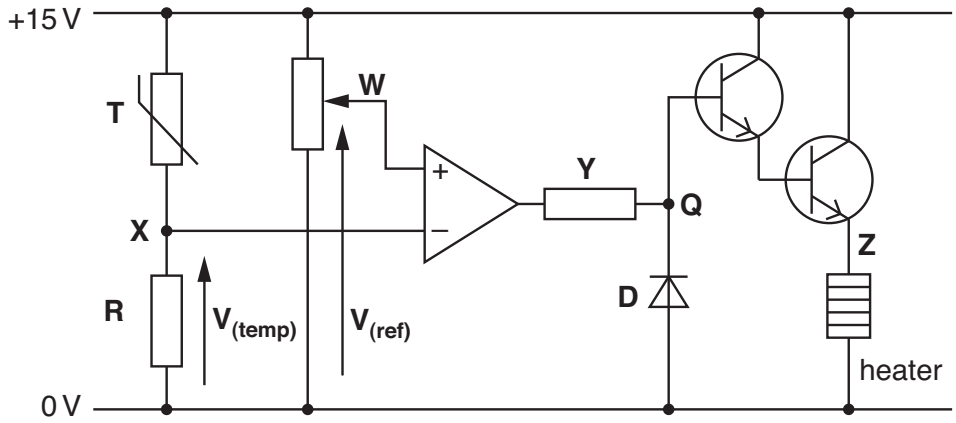


**Fig. 4.1**

**(a) (i)** State the name of component **T**.

**T** ..... **[1]**

**(ii)** Explain why the voltage at point **X** rises as the temperature increases.

.....

.....

..... **[3]**

**(iii)** The component **T** in Fig. 4.1 is placed near the heater.

Describe and explain the changes within the circuit following a sudden increase in the voltage $\mathbf{V_{(ref)}}$.

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.....

..... **[5]**

**(iv)** State and explain the voltage at point **Q** when the op amp saturates negatively.

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.....

..... **[2]**

**(b)** An improved version of the temperature control circuit is shown in block diagram form in Fig. 4.2.

The output of the Difference Amplifier is (X-W) when its inputs are **W** and **X** as shown.

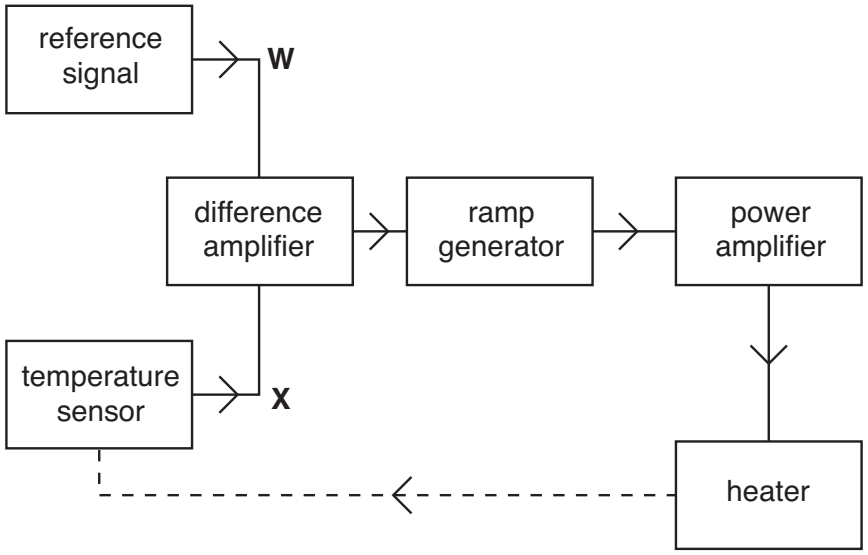


**Fig. 4.2**

**(i)** Draw a circuit diagram of a ramp generator.

Component values are not required.

**[3]**

**(ii)** Explain why the presence of a ramp generator in the temperature control circuit will lead to an improvement in the way that the circuit functions compared with that in Fig. 4.1.

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..... **[4]**

**5** **(a)** State the function of the following in the operation of a microprocessor.

**(i)** Clock.

.....

..... **[1]**

**(ii)** Address Bus.

.....

..... **[1]**

**(iii)** Data Bus.

.....

..... **[1]**

**(b)** Binary and hexadecimal are commonly used to represent data and instructions.

Convert the following:

**(i)** 1010 1111 from binary to hexadecimal.

..... **[1]**

**(ii)** D 4 from hexadecimal to binary.

..... **[1]**

**(c)** A register can be used to store a single word.

D-type flip-flops can be arranged to create a register.

Complete the circuit diagram of Fig. 5.1 for a 4-bit register.

Label the inputs and outputs.

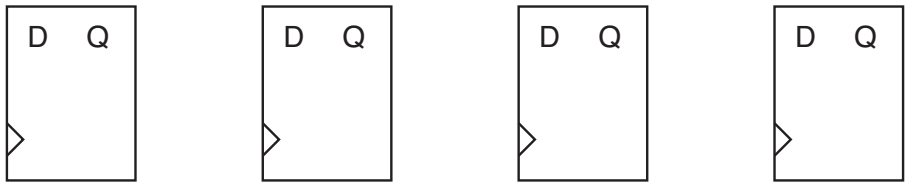


**Fig. 5.1** **[3]**

**6** **(a)** A small read only memory was created from components shown in Fig. 6.1.

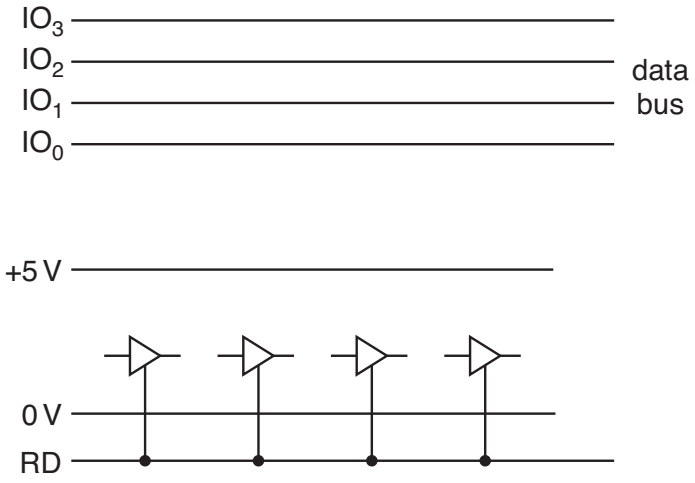


**Fig. 6.1**

**(i)** Complete Fig. 6.1 to show how the memory would **permanently** store the binary value 0110. **[2]**

**(ii)** State how this binary value would be placed on the data bus.

.....

..... **[1]**

**(b)** A random access memory was created from components shown in Fig. 6.2.

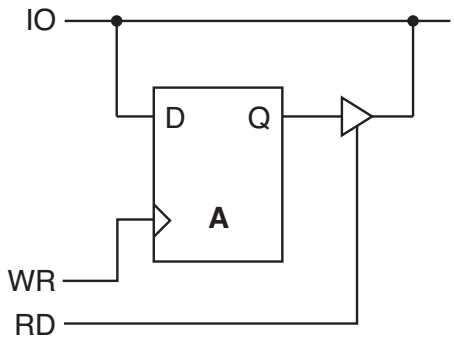


**Fig. 6.2**

**(i)** State the name of component **A**.

**A** ..... **[1]**

**(ii)** The line marked IO shown in Fig. 6.2 is said to be *bi-directional*.

State what is meant by *bi-directional*.

.....

..... **[1]**

**(c)** A 4-bit RAM is shown in Fig. 6.3.

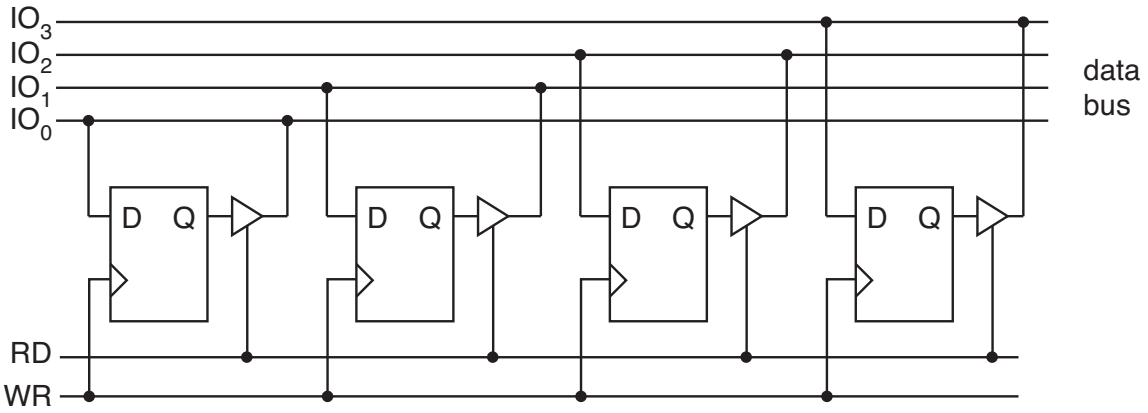


**Fig. 6.3**

Explain

**(i)** how a 4-bit word would be saved from the data bus.

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.....

..... **[2]**

**(ii)** how a 4-bit word stored in the RAM would be placed on the data bus.

.....

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..... **[2]**

**7** Fig. 7.1 shows a microprocessor system designed to operate as a word game.

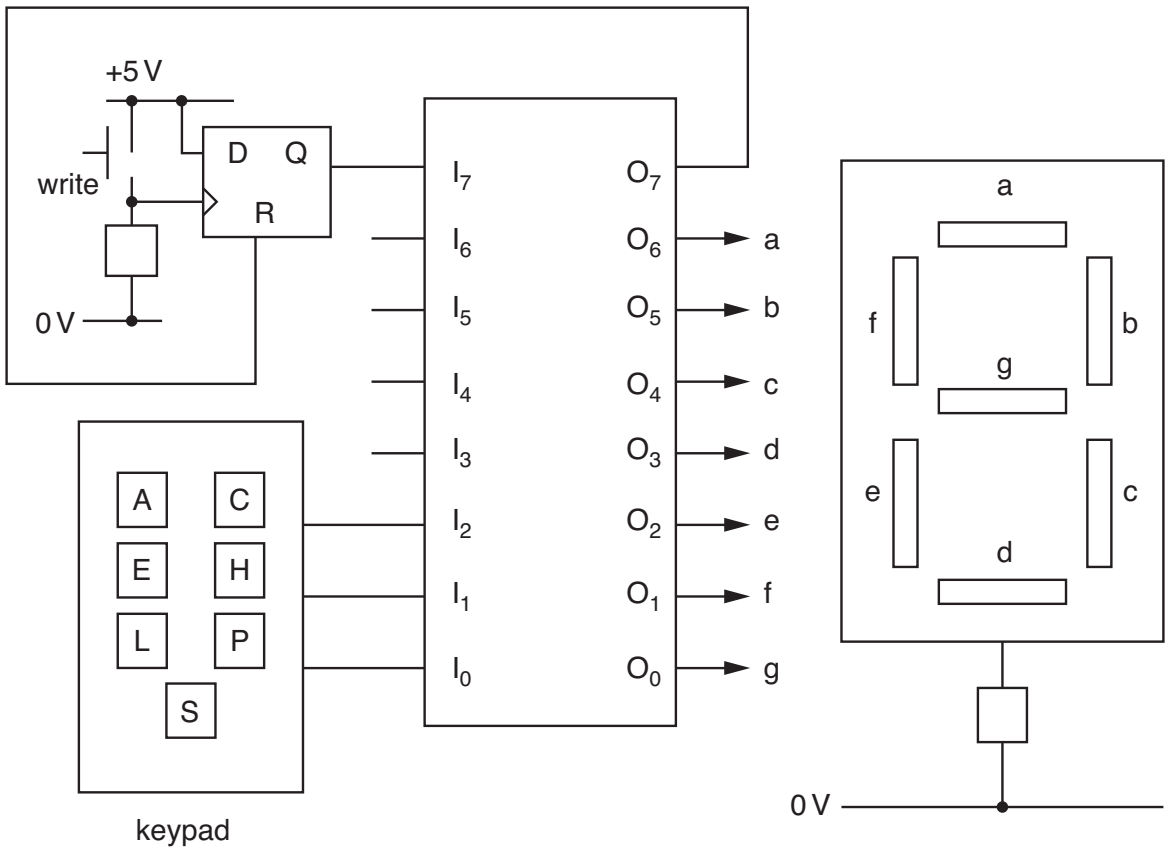


**Fig. 7.1**

The player of the game has a keypad with seven keys. Each key represents a capital letter which can be displayed on the 7-segment display. The object of the game is to compose as many words as possible using only the seven letters on the keypad.

To play the game, the player selects the first letter of the new word and pushes the appropriate key for a few moments before releasing it. They then press the next letter of their word and again release the key. This continues for all the letters in their word. They then press the "write" button, after which the microprocessor will display the word on the 7-segment display in the letter order the player originally set. At the end of the sequential letter display, the microprocessor will return to its starting state for the player to compose another word.

**(a)** The 7-segment codes of the seven letters are stored in a look-up table at addresses A1 to A7. These addresses contain codes which will both reset the D-type and illuminate a particular letter on the display. Complete the table below to show the contents of this look-up table.

| Address | Reset + Letter | Contents |
|---|---|---|
| A1 | 1 + A | F7 |
| A2 | 1 + C | CE |
| A3 | 1 + E | CF |
| A4 | 1 + H | |
| A5 | 1 + L | |
| A6 | 1 + P | |
| A7 | 1 + S | |

**[4]**

**(b)** When no key is being pushed, the keypad output is 000. When any one of the keys is pressed, the keypad outputs a 3-bit word which is not 000.

The programme segment starting at address 00 has to perform the following function:

Blank the 7 segment display
Store 00 into address DD
Test to see if any key on the keypad has been pressed
If this has occurred go to address 14

In the space below write the appropriate coding for this programme segment using the instruction set provided.

**Address** **Contents**

00 ……

…… ……

…… ……

…… ……

…… ……

…… ……

**[7]**

**(c)** The program uses the following addresses.

Address DD is used to store the **number** of letters in the player's word.
Address EE is used as a temporary store for the 7-segment code of the letter.

Each time a key is pressed on the key pad, the following code is executed.

Using the instruction set provided explain the function of each programme line and summarise the effect of this section.

| Address | Contents | Explanation |
|---|---|---|
| 14 | C6 A0 | ..... |
| 16 | 6F | ..... |
| 17 | 7E | ..... |
| 18 | 32 EE | ..... |
| 1A | 3A DD | ..... |
| 1C | C6 B0 | ..... |
| 1E | 6F | ..... |
| 1F | 3A EE | ..... |
| 21 | 77 | ..... |
| 22 | 3A DD | ..... |
| 24 | C6 01 | ..... |
| 26 | 32 DD | ..... |
| 28 | 3A EF | ..... |
| 2A | E6 07 | ..... |
| 2C | C2 28 | ..... |
| 2E | C3 06 | ..... |

Summary .....

.....

.....

**[10]**

**(d)** The final part of the programme includes a segment starting at address 46 to provide a time delay.

In the space below write the appropriate addresses and coding for this segment using the instruction set provided.

| Address | Contents |
|---|---|
| 46 | |

**[3]**

Quality of Written Communication **[3]**

**END OF QUESTION PAPER**

**PLEASE DO NOT WRITE ON THIS PAGE**