

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 2012

Electronics

ELEC4

Unit 4 Programmable Control Systems

Tuesday 29 May 2012 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

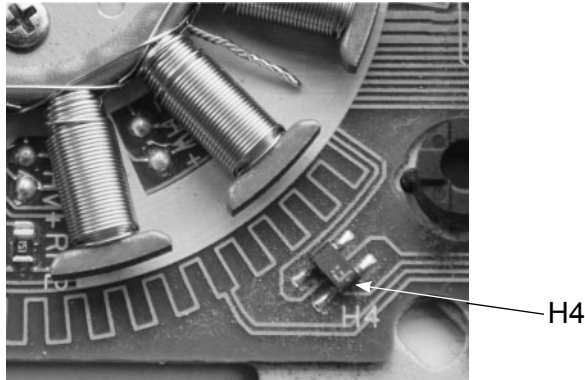
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.



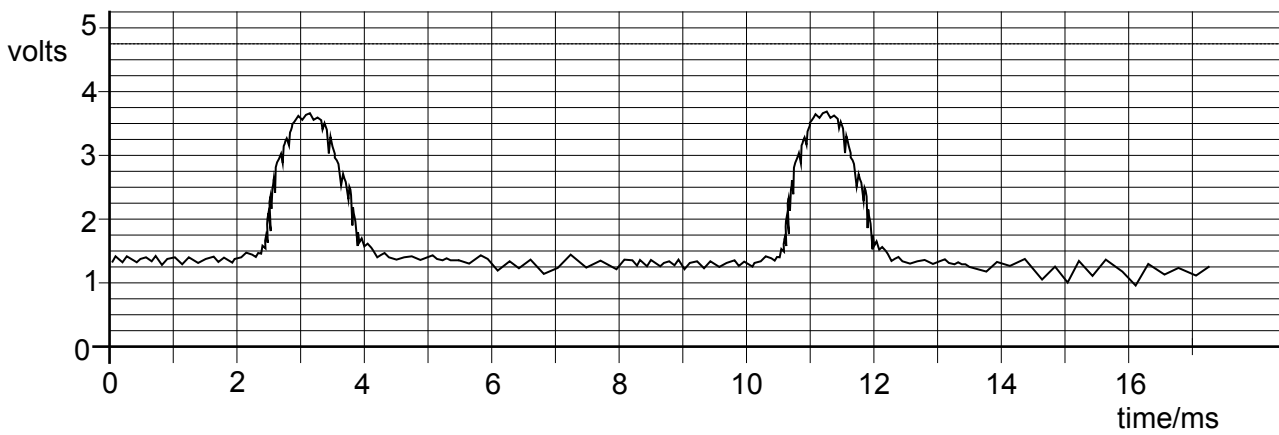
J U N 1 2 E L E C 4 0 1

Answer **all** questions in the spaces provided

1 The photograph shows a section of the inside of the motor from a disk drive.



On each rotation a small magnet passes a magnetic field sensor, H4, which detects the change in magnetic field and produces an output voltage as shown below.



1 (a) Estimate, using a calculation, the speed of the hard disk motor in revolutions per minute (rpm).

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(2 marks)

1 (b) Explain why the output from the magnetic field sensor is unsuitable to apply directly to the logic circuit of the motor controller.

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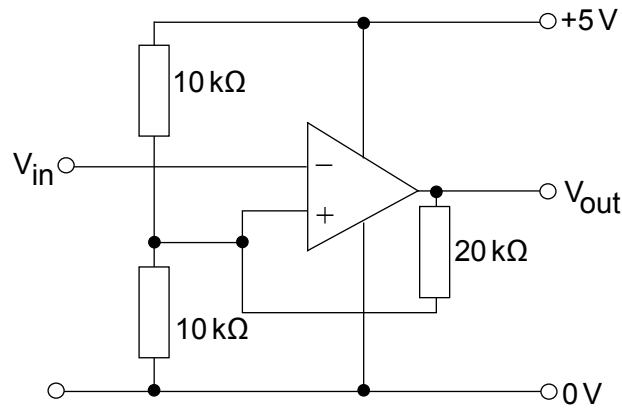
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(2 marks)



1 (c) To make the signal from the magnetic field sensor suitable, it is connected to the Schmitt trigger circuit shown below.



1 (c) (i) Calculate the upper switching level.

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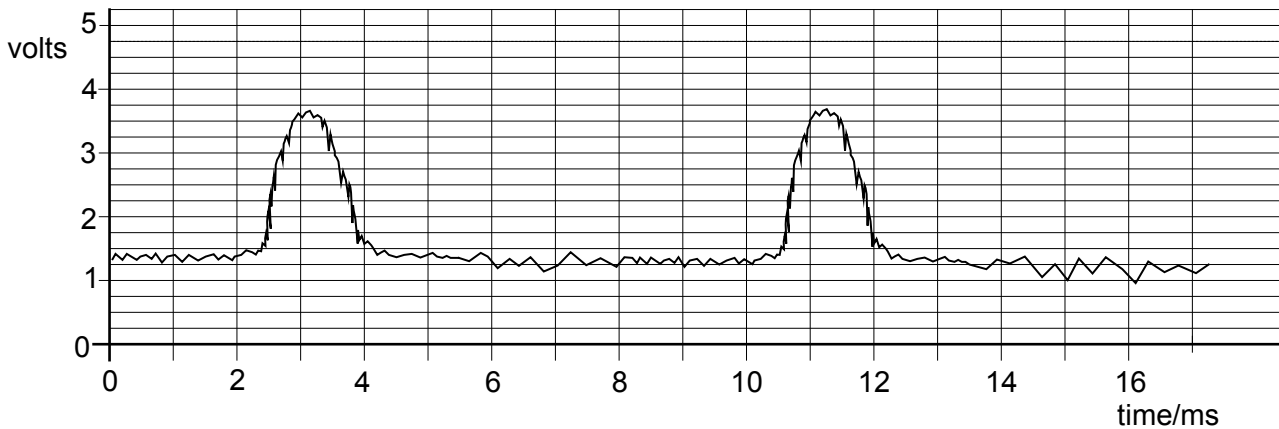
(3 marks)

1 (c) (ii) Calculate the lower switching level.

.....

(2 marks)

1 (d) The output of the magnetic field sensor is repeated below. Mark onto the graph the output from the Schmitt trigger circuit.

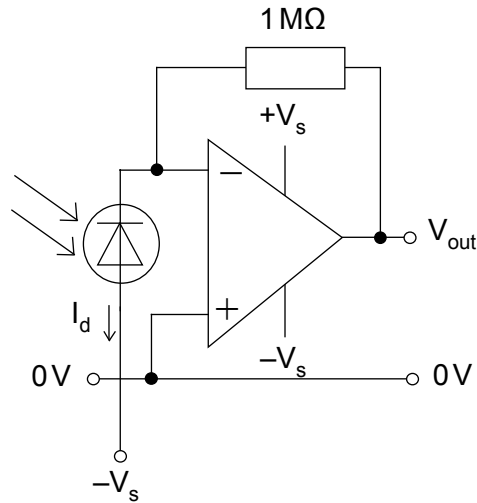


(3 marks)

Turn over ▶



- 2 An ideal photodiode is connected in the circuit shown below.



- 2 (a) Label a virtual earth point in the circuit with the letter X. (1 mark)
- 2 (b) The current, I_d , passing through the photodiode is directly proportional to the light intensity. Show that in total darkness $V_{out} = 0V$.

.....

.....

(2 marks)

- 2 (c) If $I_d = 10^{-7} \times L$, where L is the light intensity, derive an expression for V_{out} in terms of the light intensity.

.....

.....

.....

(3 marks)



2 (d) In the automatic focussing system for a camera, the output of two adjacent photodiodes (pixels) is compared by a microcontroller, and the motor which adjusts the focussing of the lens is adjusted to produce the maximum difference between the output of the photodiodes.

Draw a suitable control flow chart for the microcontroller in the space below.

(5 marks)

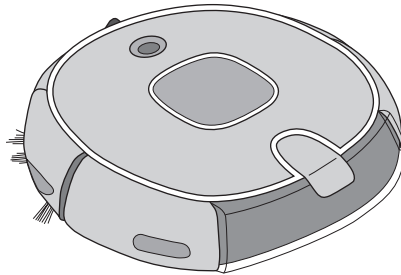
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3 A manufacturer is designing a domestic robotic vacuum cleaner.
The main design requirements to consider are

- the on-board power source
- the position sensors
- the drive motors.



3 (a) Suggest **two** suitable power sources that could supply sufficient energy for such a system. Give **one** advantage of **each** power source.

.....

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(4 marks)



3 (b) The manufacturer wants to use a video camera on the robot to provide it with position information. The video output is linked to a Neural Network which, it is hoped, will provide the robot with a 'knowledge' of its environment.

Explain what is meant by a Neural Network by considering

3 (b) (i) its processors

3 (b) (ii) its memory

3 (b) (iii) its programming

3 (b) (iv) the advantage of a Neural Network over a conventional microcontroller for this application.
.....
.....
.....

(4 marks)

3 (c) To move the robot, the manufacturer decides to use conventional motors driven by an H-bridge circuit, using n-channel and p-channel MOSFETs. Draw the circuit of an H-bridge and show where the motor is connected in the space below.

(4 marks)

12

Turn over ▶



4 A microcontroller is used to store data into a RAM storage device, which has address lines A_0 to A_{15} .

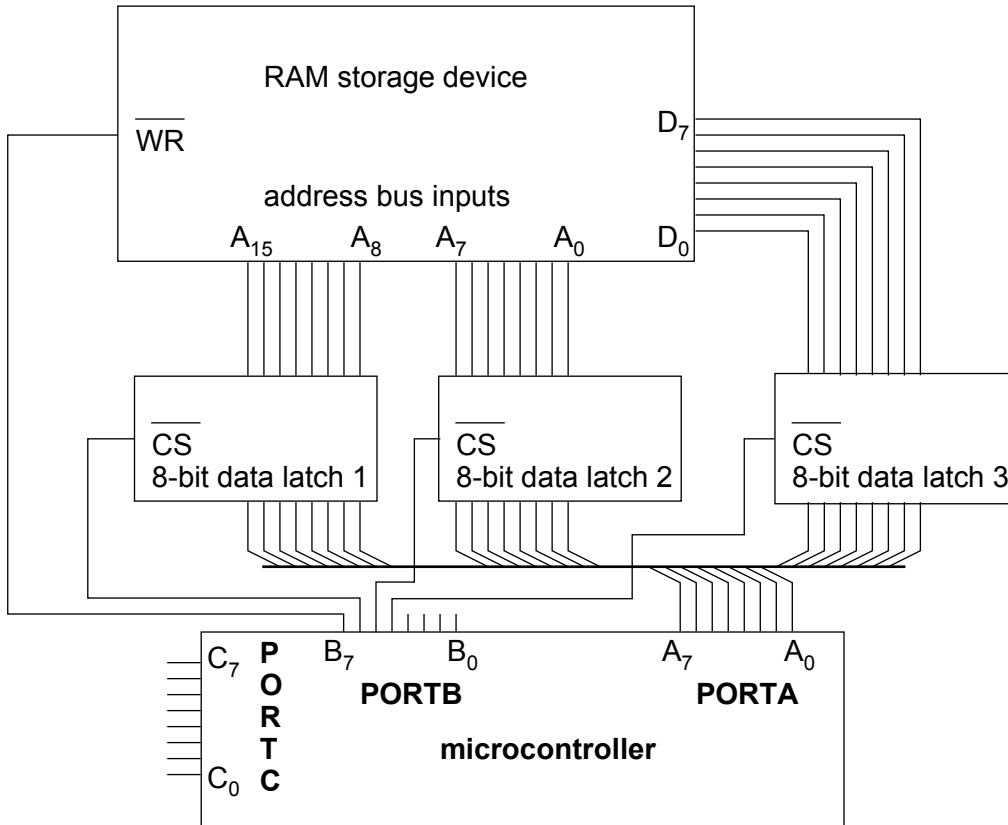
4 (a) Calculate the number of bytes of storage available.

.....

.....

(2 marks)

The circuit diagram for this memory storage unit is shown below.



4 (b) Ports A and B of the microcontroller are to be configured as outputs and port C as an input. Write the assembler code needed to configure the ports.

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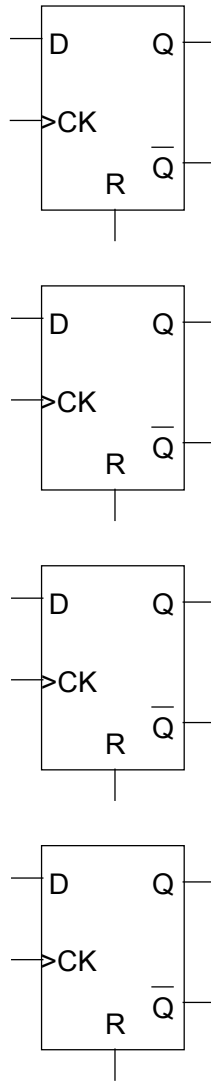
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(5 marks)



4 (c) Before being stored in the RAM, the data is temporarily stored in data latch 3 and the memory addresses in data latch 1 and data latch 2.

4 (c) (i) Complete the circuit diagram below to show how four D-type flip-flops can be connected to form a 4-bit data latch. Label the data inputs, outputs and latch select connections.



(3 marks)

4 (c) (ii) State the sequence of operations needed to store data in such a latch.

.....

.....

(2 marks)



5 An ADC is connected to the input of a system so that the value of the input voltage to the ADC can be stored in a RAM storage device, such as shown on page 8.

5 (a) Why is it not possible to store values of the input voltage directly in a RAM storage device?

.....
.....
(2 marks)

5 (b) There are two main types of ADC, digital ramp and flash. Compare these under the following headings

5 (b) (i) Speed of operation

5 (b) (ii) Complexity

5 (b) (iii) Cost

(3 marks)

5 (c) The ADC needs two control signals, Start Conversion, \overline{SC} , which is an input and End of Conversion, EoC, which is an output of the ADC. These are connected to PORTB, which is configured to accept an input using the following code.

```
MOVW    0x08
MOVWR   TRISB
```

State which bit of PORTB the EoC line is connected to and justify your answer.

.....
.....
(2 marks)

5 (d) The Start Conversion control line is connected to B₁ of PORTB and is *active low*.

5 (d) (i) Explain what is meant by the term *active low*.

.....
.....
(1 mark)



5 (d) (ii) Assuming bit B₁ is initially 1, explain why the following assembly code will be suitable for generating the appropriate Start Conversion pulse.

```

MOVW      PORTB
ANDW      0xFD
MOVW      PORTB
ORW       0x02
MOVW      PORTB

```

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(2 marks)

5 (e) The EoC line is *polled* by the microcontroller to find out when a conversion is complete.

Explain the meaning of the term *polled*.

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(1 mark)

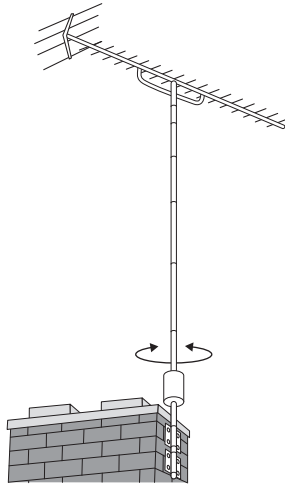
11

Turn over for the next question

Turn over ▶



6 A beam aerial, like the one shown below, needs to be pointed in the direction of the transmitter in order to maintain good quality reception of the radio signals.



6 (a) The aerial can be rotated either using a stepper motor or a conventional motor.

6 (a) (i) Give **one** advantage of using a stepper motor in this application.

.....

 (1 mark)

6 (a) (ii) Give **one** advantage of using a conventional motor in this application.

.....

 (1 mark)

6 (b) A conventional motor is used to rotate the aerial. To control the position of the motor, a 4-bit binary coded optical disc is attached to the aerial mast.

6 (b) (i) State and explain whether this will form an open loop or closed loop system.

.....

 (2 marks)



6 (b) (ii) Show that the resolution of the aerial system is 22.5° .

.....
.....
(2 marks)

6 (c) In operation, it is found that the microcontroller has difficulty reading the position of the optical disc, particularly as it moves from an output of 1111 to 0000.

6 (c) (i) Explain why this might occur.

.....
.....
.....
.....
(3 marks)

6 (c) (ii) Why is this problem overcome by using a Gray code encoded disc?

.....
.....
(2 marks)

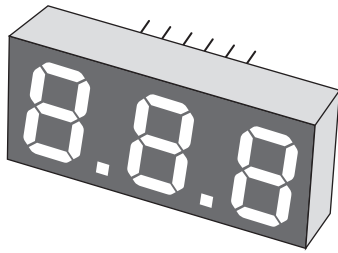
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Turn over for the next question

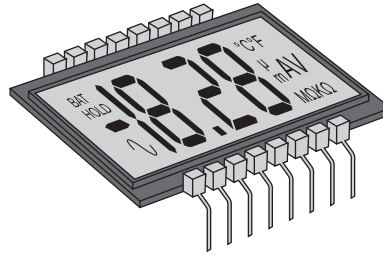
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7 A manufacturer wants to incorporate a display into a piece of battery powered equipment. There is the choice of using either LED or LCD displays.



typical LED display



typical LCD display

7 (a) Compare the two types of display under the following headings

7 (a) (i) power consumption
.....
.....
(2 marks)

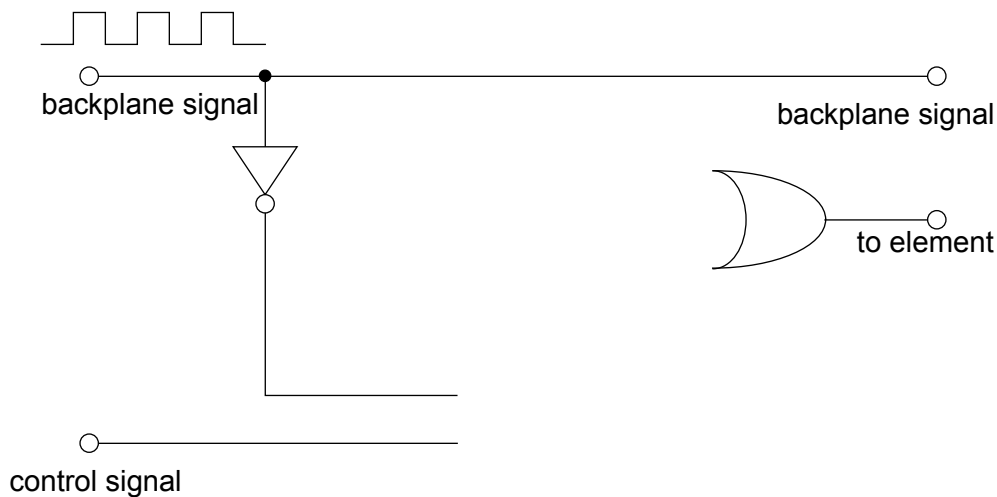
7 (a) (ii) visibility
.....
.....
(2 marks)

7 (a) (iii) ability to display custom characters
.....
.....
(2 marks)



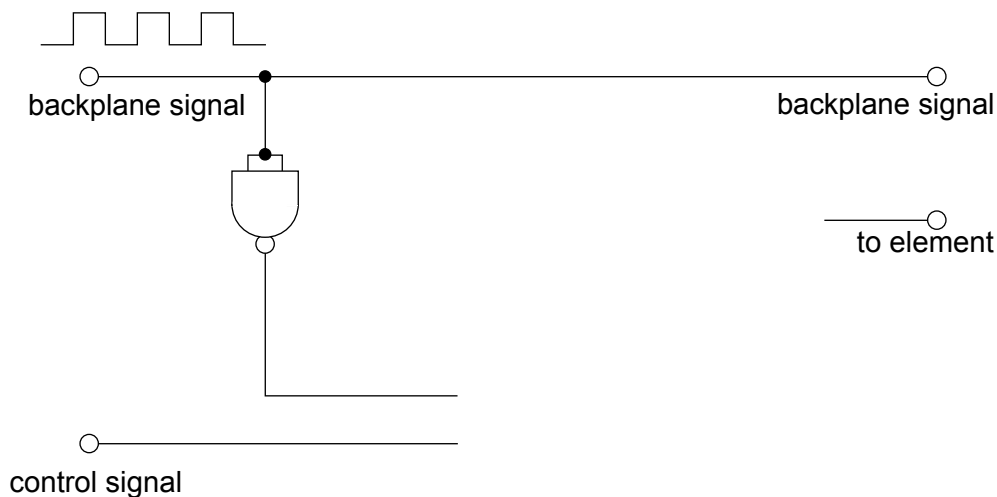
- 7 (b)** Whether an LCD element is visible or not depends on the alternating voltage applied between the element and the backplane. If the two voltages are in phase then the element is not visible. If they are out of phase then the element is visible.

Complete the diagram below by adding a **NOT gate** and **two AND gates** to achieve this for one element of an LCD display. When the control signal is high the element is visible.



(3 marks)

- 7 (c)** Complete the diagram below using only NAND gates to achieve the same function as in part (b).



(2 marks)

END OF QUESTIONS



There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED**

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