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 ELEC4

Unit 4 Programmable Control Systems

Tuesday 8 June 2010 9.00 am to 10.30 am

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

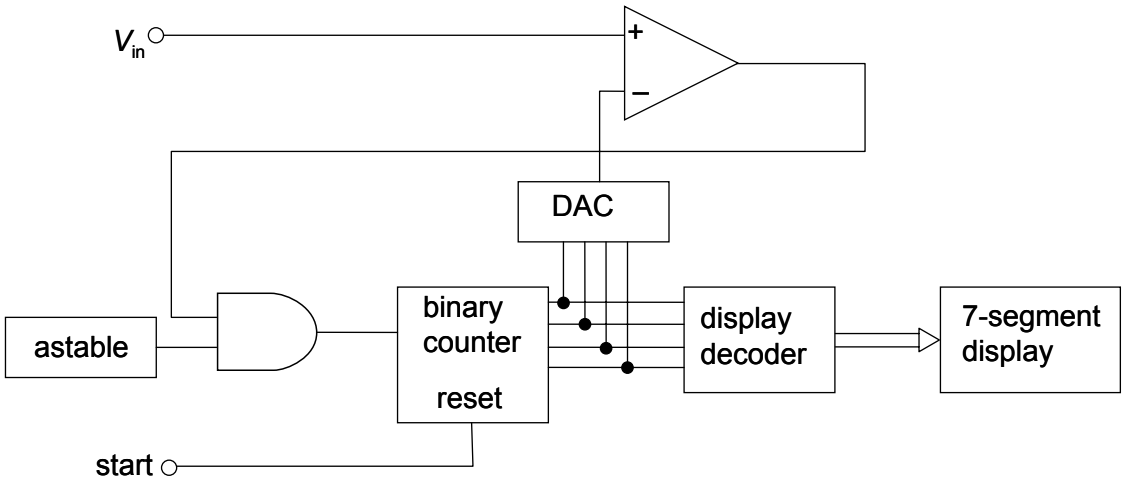
Time allowed
- 1 hour 30 minutes

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.

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

1 The block diagram of a digital voltmeter containing a digital ramp ADC connected to a 7-segment display via a decoder is shown below.
The voltage being measured is V_{in}.



1 (a) What is meant by the terms:

1 (a) (i) ADC

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(1 mark)

1 (a) (ii) DAC?

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(1 mark)

1 (b) Describe the function of the display decoder in this circuit.

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(2 marks)

1 (c) The conversion begins when the start signal causes the binary counter to reset to zero. State how the voltage at the output of the DAC varies with time after this reset occurs.

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(1 mark)

1 (d) Explain the sequence of operations of this digital ramp ADC, referring to the subsystems in the block diagram on **page 2**.

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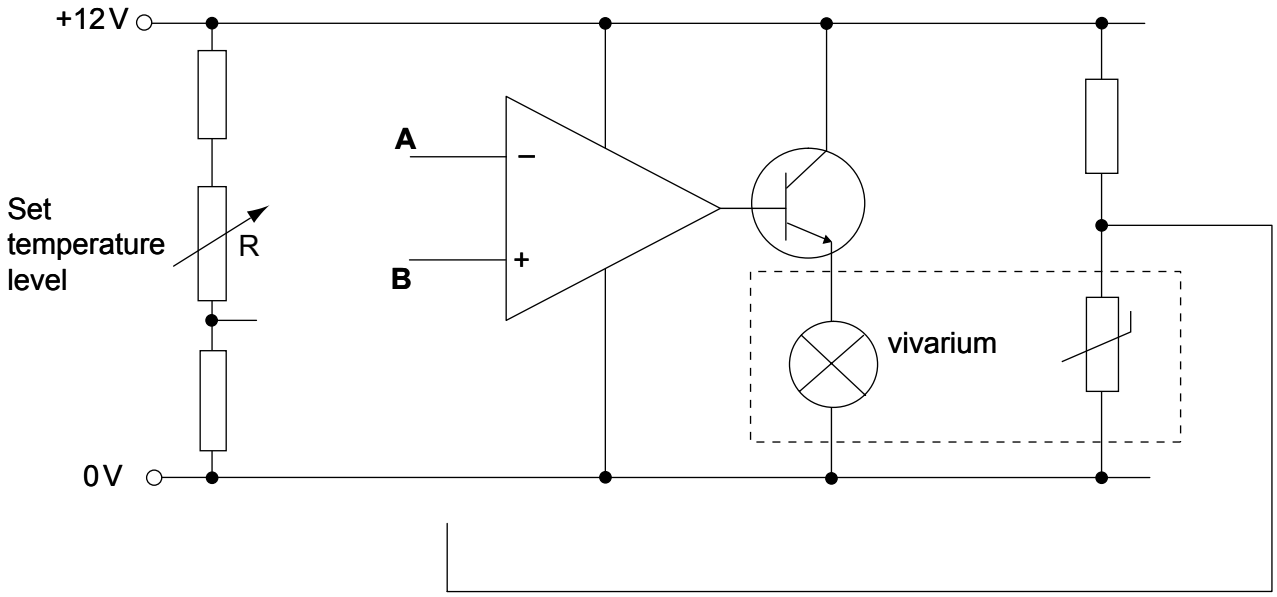
(4 marks)

9

Turn over for the next question

2 A student has a pet corn snake that is housed in a vivarium.
It is important that the snake's environment is kept at a constant temperature of about 31°C. The student decides to design a temperature control system using a lamp, beneath the gravel, as the heat source, and a thermistor as the temperature sensor. She designs the system shown below.



2 (a) Complete the circuit diagram by connecting the input and feedback signals to the correct points (**A** and **B**) on the circuit.

(2 marks)

2 (b) State whether this system is a closed loop control system or an open loop control system, and give a reason.

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(2 marks)

2 (c) When the system has stabilized at a particular temperature, the resistance of R is then suddenly increased.
Explain, with reference to the circuit diagram on **page 4**, how the system behaves as it reaches a new stable temperature.

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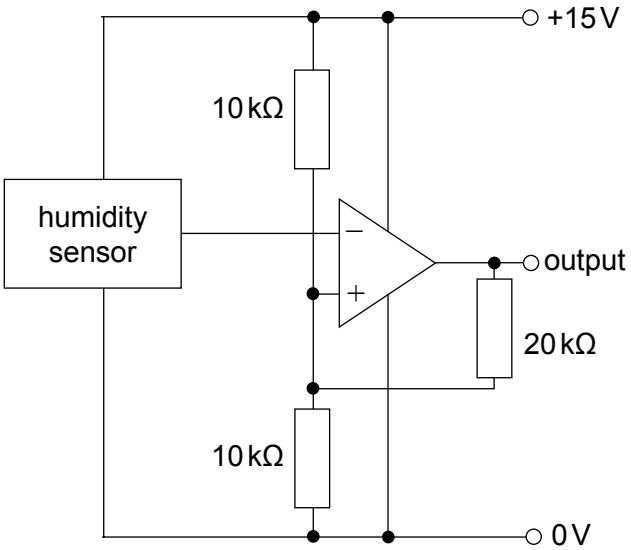
(5 marks)

9

Turn over for the next question

3 An extractor fan for a bathroom has a built in humidity sensor. Once activated, the fan will continue to operate until the humidity of the air drops below a preset value. The Schmitt trigger part of the circuit diagram is shown below.



3 (a) Show that the lower switching level is approximately 6 V.

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(3 marks)

3 (b) Calculate the upper switching voltage.

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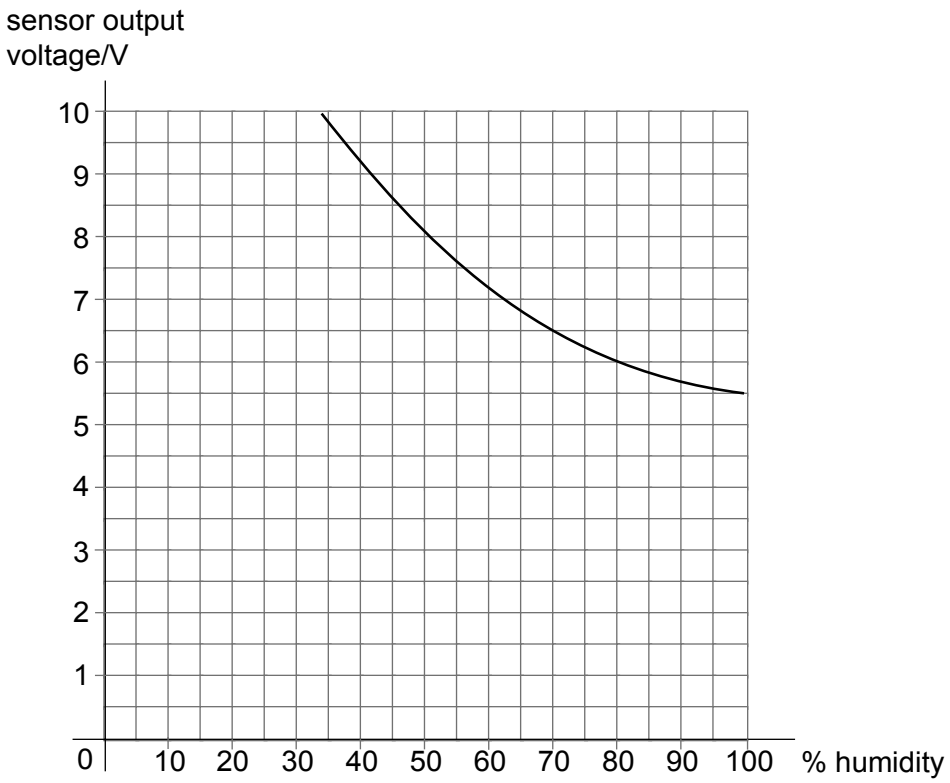
(3 marks)

3 (c) The graph of output voltage against % humidity for the humidity sensor is shown below.



3 (c) (i) At what % humidity will the output of the op-amp become 15 V?

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(1 mark)

3 (c) (ii) Explain how you arrived at your answer.

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(2 marks)

9

4 An electronic weighing machine is to have a *multiplexed* four digit 7-segment display.

4 (a) (i) Explain the meaning of the word multiplexed in this context.

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(1 mark)

4 (a) (ii) Describe **one** advantage and **one** disadvantage of using multiplexed displays.

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(2 marks)

4 (b) Multiplexed displays can be either LED or LCD.
Describe **one** advantage and **one** disadvantage of LED displays compared with LCD displays.

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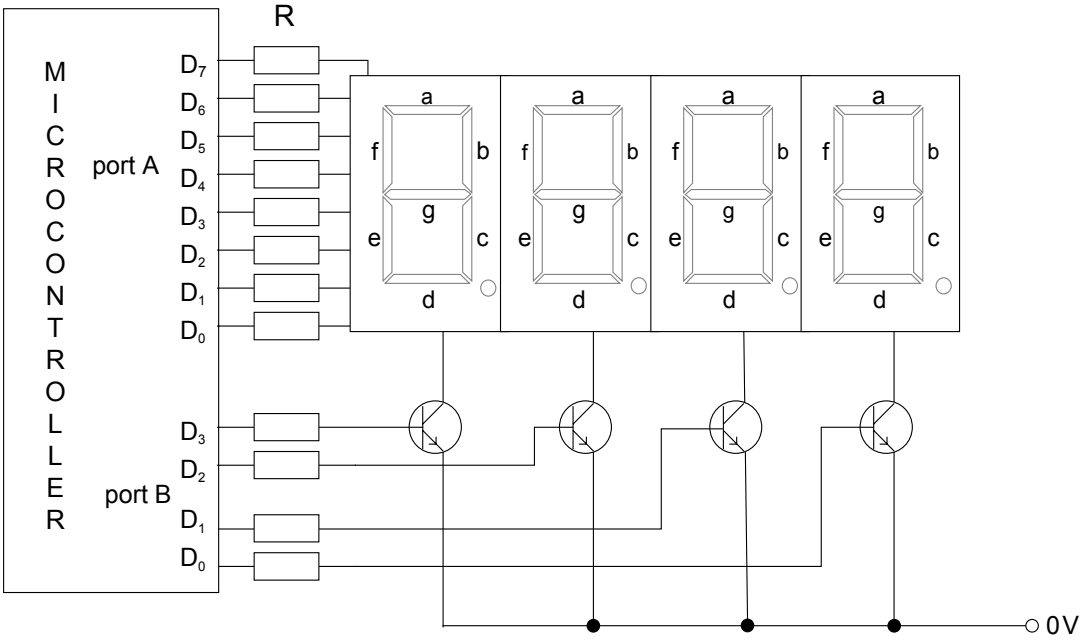
(2 marks)

4 (c) The circuit diagram for such an LED display is shown below.



4 (c) Why is a common cathode display needed in this circuit?

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(1 mark)

4 (d) (i) The maximum output voltage from port A of the microcontroller is 5 V.
Each segment in the 7-segment displays has a forward voltage of 1.9 V and the saturated collector-emitter voltage of the transistors is 0.1 V.
The maximum power dissipation of each segment is 76 mW.
Calculate a suitable value for R.

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(5 marks)

4 (d) (ii) Estimate the peak current that each transistor must be able to switch.

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(2 marks)

4 (e) If the display is to be scanned from left to right, state the sequence of numbers which must be sent to port B.

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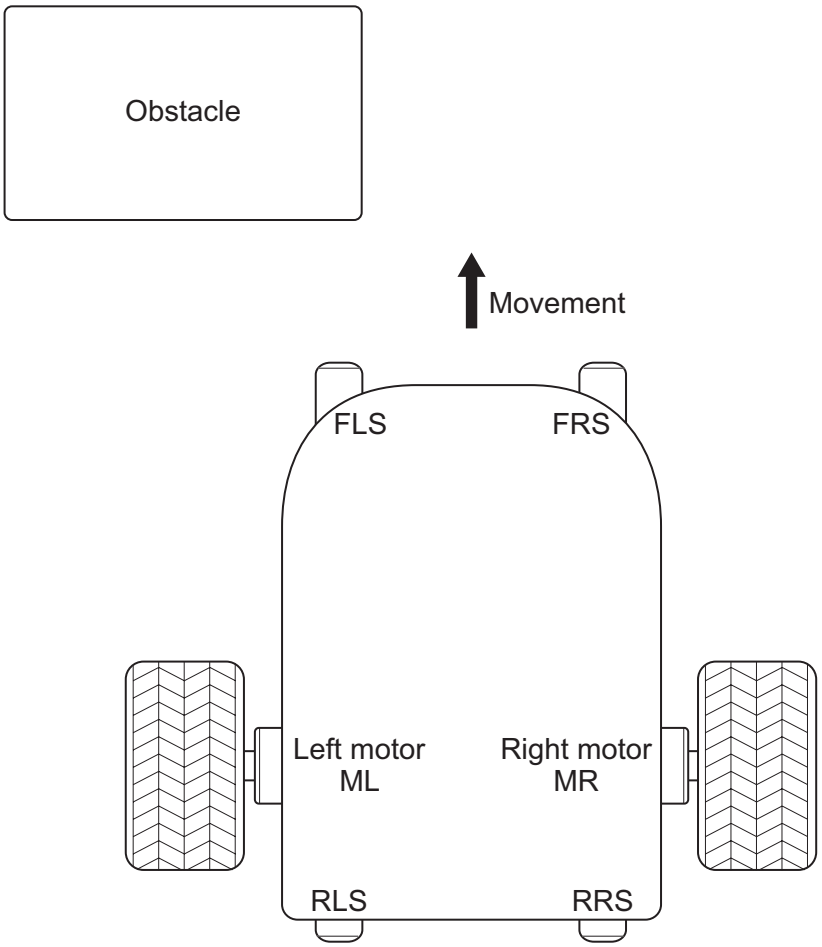
(2 marks)

15

5 A robot, moving forward, receives a signal from its front left sensor (FLS) that there is an obstacle ahead.



5 (a) Identify **two** possible devices that could be used to detect an obstacle and briefly describe the operation of **one** of these.

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(3 marks)

5 (b) The robot needs to move around the object and then continue in its original direction.
Describe a sequence of control commands that must be sent to the motors in order for the robot to accomplish this.

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(4 marks)

5 (c) The robot uses rechargeable batteries for its power source.
State **two** different technologies used in rechargeable batteries and discuss their relative merits.

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(4 marks)

11

Turn over for the next question

6 (a) Name the arrangement of MOSFETs in the circuit below.

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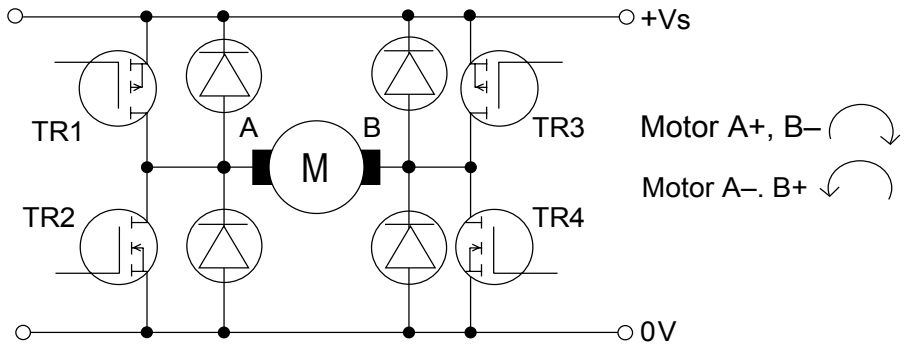
(1 mark)



6 (b) Explain, giving **two** reasons, why MOSFETs are a good choice of device for this application.

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(4 marks)

6 (c) Explain the function of the diodes.

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(1 mark)

6 (d) Complete the table below to show the logic state of the gates of the MOSFETs for the given directions of the motor.

Motor direction	TR1	TR2	TR3	TR4
				
				
Stop				

(4 marks)

10

7 (a) Describe **one** way in which the architecture of a microcontroller differs from that of a microprocessor.

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(2 marks)

7 (b) The data direction register of a microcontroller sets a bit on port A to input if it is logic 1 and output if it is logic 0, as shown in the table below.

	D_7		D_6		D_5		D_4		D_3		D_2		D_1		D_0	
TRISA	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
PORTA	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in

7 (b) (i) Which bits are inputs if 0xFA is written to TRISA?

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(3 marks)

7 (b) (ii) What value, in hexadecimal, must be written to TRISA so that D_7 and D_6 are inputs and all of the others are outputs?

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(1 mark)

7 (b) (iii) What are the **two** assembler instructions needed to write 0xFA to TRISA?

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(2 marks)

Question 7 continues on the next page

Turn over ▶

7 (c) The following is a *subroutine* from a microcontroller system.

```
start:
MOVRW PORTA
ANDW 0x80
JPZ start
MOVW 2
MOVWR PORTA
RET
```

7 (c) (i) Explain what is meant by a subroutine.

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(2 marks)

7 (c) (ii) Explain the meaning of each of the instructions.

start:

.....

MOVRW PORTA

.....

ANDW 0x80

.....

JPZ start

.....

MOVW 2

.....

MOVWR PORTA

.....

RET

.....

(7 marks)

17

END OF QUESTIONS

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