Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
June 2004
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS ELE4
Unit 4 Electronic Control Systems

Thursday 1 July 2004 Morning Session

In addition to this paper you will require:
- a calculator;
- a pencil and a ruler.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen. Use pencil for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.
- A *Data Sheet* is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information
- The maximum mark for this paper is 72.
- Mark allocations are shown in brackets.
- Any correct electronics solution will gain credit.
- The paper carries 15% of the total marks for Electronics Advanced Level award.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Data Sheet

- A perforated *Data Sheet* is provided on pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- Detach this perforated sheet at the start of the examination.

TURN OVER FOR THE FIRST QUESTION

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

1 In a microprocessor control system, the various subsystems are linked by buses.

(a) (i) Explain what is meant by a 'bus'.

.....

.....

(ii) Explain why buses are used.

.....

.....

(2 marks)

(b) A microprocessor control system has a 16-bit address bus and a 16-bit data bus.

(i) What is the maximum number of discrete memory addresses available?

.....

(ii) State an essential difference between the address bus and the data bus.

.....

.....

(2 marks)

(c) Neural network computer systems are being used for more applications. Under the following headings, state the major differences between a neural network computer and a traditional microprocessor computer.

(i) processor

.....

.....

(ii) memory

.....

.....

(iii) programming

.....

.....

(iv) applications

.....

.....

(4 marks)

8

TURN OVER FOR THE NEXT QUESTION

2 In order to produce a very thin motor to operate a portable mini-disk player, the manufacturer is forced to use a stepper motor.

(a) Describe what a stepper motor does.

.....

.....

.....

(2 marks)

(b) To make the stepper motor armature rotate, power has to be supplied sequentially to the coils. This can be achieved using a PIC or an AVR device.

(i) What is a PIC/AVR?

.....

.....

(ii) How does a PIC/AVR differ from a microprocessor system?

.....

.....

(2 marks)

(c) PIC and AVR devices are used in many domestic appliances.

(i) Explain why PIC/AVR devices are favoured by domestic appliance manufacturers.

.....

.....

.....

(ii) Describe **two** social/economic effects of the extensive use of PIC/AVR devices in domestic appliances.

.....

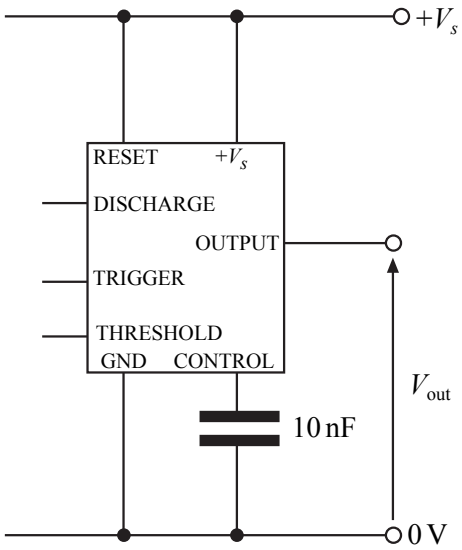
.....

.....

.....

(3 marks)

(d) The stepper motor can also be controlled by a pulse generator (astable) and a digital counting circuit.
In the space below complete the circuit diagram of the 555 astable.

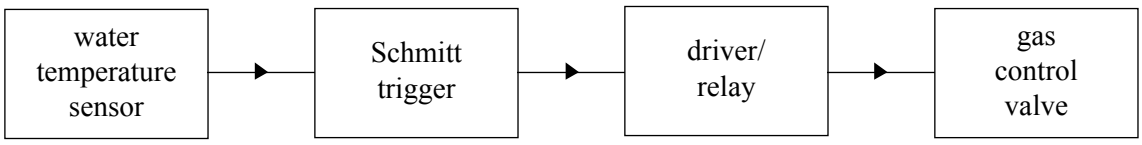


(4 marks)

11

TURN OVER FOR THE NEXT QUESTION

3 A gas central heating boiler thermostat system is shown below.



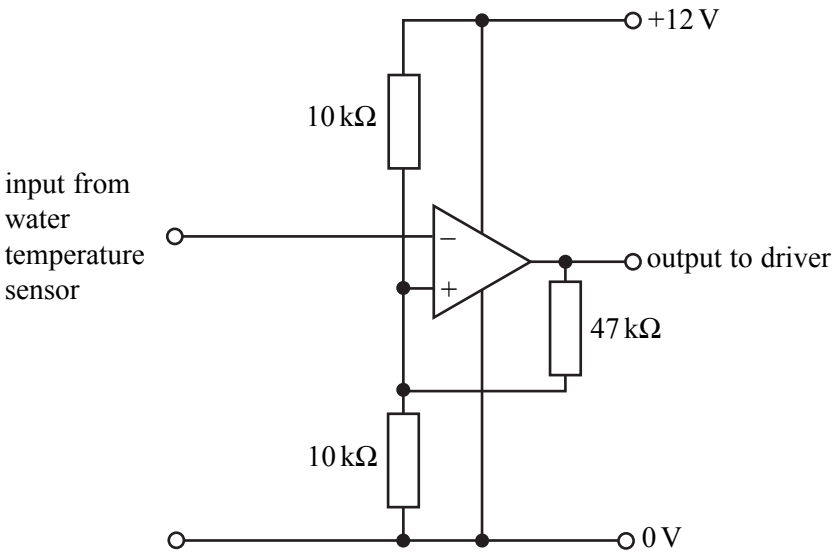
(a) State, with a reason, whether this is an open or closed loop system.

.....

.....

(2 marks)

(b) The circuit diagram for the Schmitt trigger subsystem is shown below. Assume that the op-amp is ideal.



Calculate the trigger levels of the circuit.

.....

.....

.....

(3 marks)

(c) The driver/relay subsystem contains an npn transistor and a relay.
Draw a circuit diagram below to show how you would use these and any other components you require to produce the subsystem.

(3 marks)

8

TURN OVER FOR THE NEXT QUESTION

4 (a) Why is a digital computer unable to interpret an analogue signal connected directly to its parallel port?

.....

.....

.....

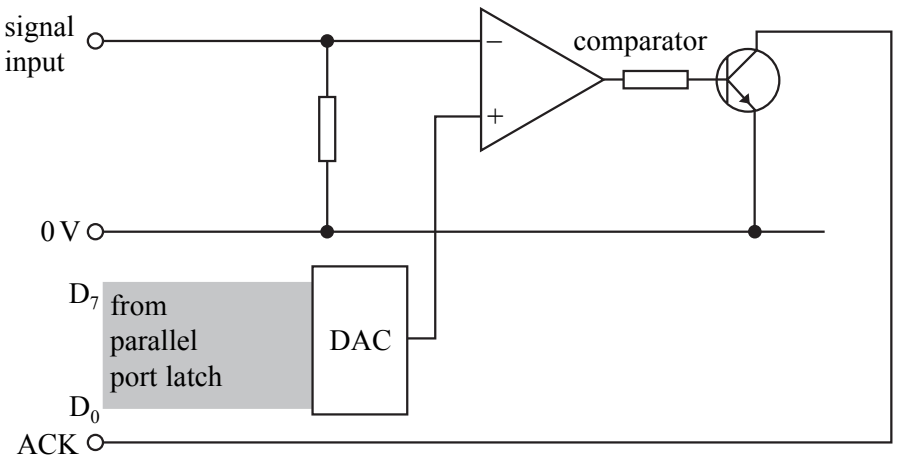
(1 mark)

(b) A system designer has the choice of using either a flash or digital ramp ADC to interface an analogue audio signal to a computer.
State **one** factor, other than cost, that you would consider when making the choice.

.....

(1 mark)

(c) The system designer decides to use a digital ramp ADC. Its simplified circuit diagram is shown below.



(i) Explain why an op-amp makes a good comparator.

.....

.....

(ii) Explain why the parallel port output signals need to be latched.

.....

.....

.....

(iii) Draw a diagram below to show how four D-type flip-flops can be connected to form a 4-bit latch.

(5 marks)

(d) Explain briefly how the digital ramp ADC functions.

.....

.....

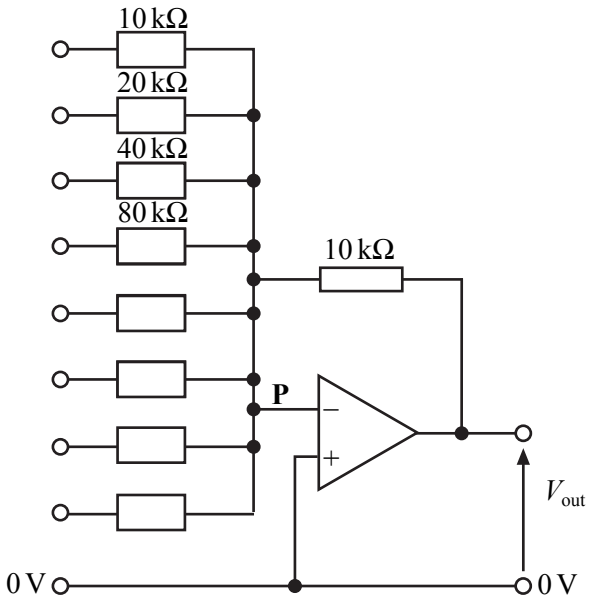
.....

.....

(2 marks)

9

5 The circuit diagram below shows an 8-bit DAC which is connected to the parallel port of a computer.



(a) Mark on the circuit diagram:

(i) where you would connect D_0 and D_7 from the parallel port.

(ii) the values of the unlabelled resistors.

(2 marks)

(b) Explain why **P** is called a Virtual Earth point.

.....

.....

.....

.....

(2 marks)

(c) The *decimal* number 80 is written to the parallel port.

(i) What is the value of this byte in binary?

.....

(ii) Calculate the output voltage from the DAC if a logic 1 input is 5 V and logic 0 input is 0 V.

.....

.....

(3 marks)

(d) The output of the DAC circuit is a negative voltage. Draw a circuit diagram of a unity gain amplifier which will convert the negative voltage to a positive voltage.
Give suitable component values.

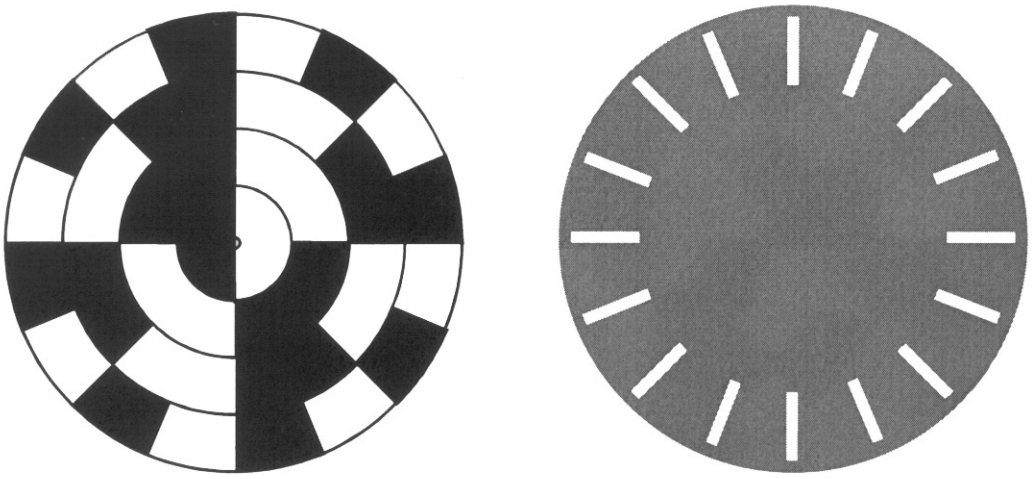
(2 marks)

9

TURN OVER FOR THE NEXT QUESTION

6 To sense the angular rotation of a shaft, a designer can use either an optical shaft encoder or a slotted disk.

Optical shaft encoder **Slotted disk**



(a) (i) What is the angular resolution of the two disks shown in the diagram above?

.....

(ii) Explain how the angular resolution of the optical shaft encoder can be increased.

.....

.....

(2 marks)

(b) Compare the data produced by the two types of disk shown above.

.....

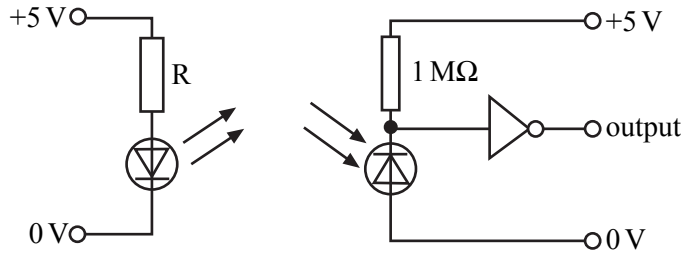
.....

.....

.....

(2 marks)

(c) The circuit diagram for a LED/photodiode pair is shown below.



(i) If the maximum current allowed through the LED is 20 mA and the forward voltage is 1.6 V, calculate the preferred value for the resistor R.

.....

.....

.....

(ii) Explain how the photodiode circuit functions.

.....

.....

.....

(5 marks)

9

TURN OVER FOR THE NEXT QUESTION

7 A computer controlling a burglar alarm has various detectors and alarms connected to its parallel port.

(a) The computer monitors the state of the various detectors by 'polling' each of them in turn.

(i) Explain what is meant by the term 'polling'.

.....

(ii) Explain how this differs from an 'interrupt' operated system.

.....

.....

(iii) Explain which is more efficient in terms of computer processor operations.

.....

.....

(3 marks)

(b) The alarm is connected, via a MOSFET driver, to bit 0 of port &H378. In the space below draw a suitable circuit diagram of a MOSFET driver.

(3 marks)

(c) The detectors are connected to the parallel port inputs as shown in the table below.

	Logic state of the detector		**Port &H379**
Detector	**Closed**	**Open**	**Bit**
Front door	0	1	D7
Windows, downstairs	0	1	D6
Windows, upstairs	0	1	D5
Garage door	0	1	D4
All other external doors	0	1	D3

The detectors are polled. When a detector is activated (becomes logic 1), the computer puts a message onto the computer monitor identifying the detector and then sounds the alarm for ten minutes or until a specific key is pressed on the key pad which will reset the system.

Draw a flowchart in the space below to represent the process above.

(5 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

(d) To read the state of each detector, the following subroutine is used.

```
scan:
N = 3
DO
Y = 2  ^ N
X = INP(&H379)
X = X AND Y
N = N + 1
IF Y > = 128 THEN N = 3
LOOP UNTIL X = Y OR INKEY$ = CHR$(33)
RETURN
```

(i) List the possible values of **Y**.

.....

(ii) Explain the purpose of each of the following lines:

X = INP(&H379)

.....

X = X AND Y

.....

LOOP UNTIL X = Y OR INKEY$ = CHR$(33)

.....

.....

(4 marks)

(e) Write a subroutine, **monwrite**:, which can be called after the above subroutine to display, on the computer monitor, which detector has been activated.

monwrite:.....

.....

.....

.....

.....

.....

.....

(3 marks)

18

END OF QUESTIONS