ASSESSMENT and QUALIFICATIONS ALLIANCE

DESIGN & TECHNOLOGY:
SYSTEMS AND CONTROL TECHNOLOGY   SCT1
Unit 1   Materials and Components

Thursday 8 January 2004 Morning session

In addition to this paper you will require:
- a lined answer book (AB08) which is provided separately;
- normal writing and drawing instruments.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil and coloured pencils should be used only for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is SCT1.
- Answer Question 1 and any **two** of Questions 2 to 4.

Information
- The maximum mark for this paper is 100.
- Mark allocations are shown in brackets.
- 40 marks are allocated to Question 1, 28 to each of Questions 2 to 4, and 4 marks overall for Quality of Written Communication.
- This paper carries 30 per cent of the total marks for Advanced Subsidiary awards and 15 per cent for Advanced awards.
- You are reminded of the need for good English and clear presentation. The quality of your written communication will be assessed across all questions.

Advice
- Your answers should be illustrated with sketches and/or diagrams wherever you feel it is appropriate.

SCT1

Answer Question 1.

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1 A student is building a vehicle that has the ability to follow a white line. It will use LDRs to sense light reflecting off the white line and will be driven by small DC motors.

(a) Draw a potential divider circuit using one of the LDRs that will give a signal that goes positive when it senses light reflecting off the white line. *(4 marks)*

(b) When light is detected by one of the LDRs a motor will rotate in a forward direction. When no light is detected the motor will rotate in a reverse direction. Draw a circuit that will satisfy the above requirement. *(12 marks)*

(c) The student can build a permanent version of their circuit using a variety of methods.

Describe **two** methods of circuit board manufacture. *(2×3 marks)*

(d) The DC motors rotate at 300 rpm.

Design a gear system that will drive the wheels of the vehicle at 100 rpm.

You may use *any* combination of 20, 30 and 40 tooth gears. Use an annotated sketch in your answer and show all necessary calculations. *(6 marks)*

(e) The diameter of the wheels of the vehicle are 50 mm, and rotate at 100 rpm. Calculate the linear speed in *m/s* of the vehicle.
(Circumference = $\pi \times d$.)
($\pi = 3.14$). *(6 marks)*

(f) Stepper motors are frequently used in motion control applications in preference to DC motors.

Compare and contrast the use of these **two** types of motor. *(6 marks)*

Answer any **two** of Questions 2 to 4.

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2   A lift is raised and lowered using a worm and worm wheel system.

(a)   Using annotated sketches describe the operation of a worm and worm wheel making reference to its suitability to this application. *(8 marks)*

(b)   The motor driving the worm rotates at 200 rpm and the worm wheel has 40 teeth.

Calculate the output speed of the worm wheel. *(4 marks)*

(Remember to show all of your calculations.)

(c)   A worm and worm wheel translates rotary motion between two shafts at 90° to each other.

Using annotated sketches describe **two** other methods of transmitting rotary motion between two shafts at 90°. *(2×5 marks)*

(d)   Outline **three** safety issues concerning the operation of lifts in public buildings. *(3×2 marks)*

3   A student has developed a machine that will test the wear properties of various fabrics. The machine is designed to repeatedly rub a wire brush across the fabric using a crank and slider mechanism.

(a)   Using annotated sketches describe the operation of a crank and slider mechanism. *(6 marks)*

(b)   A similar motion of the wire brush could be achieved by using a solenoid. Compare and contrast the use of a solenoid and a crank and slider mechanism for this application. *(6 marks)*

(c)   Using an annotated sketch show a suitable method of sensing each revolution of the crank in part 3(a). *(4 marks)*

(d)   The fabric testing machine should stop automatically after 50 revolutions of the crank.

Using annotated sketches describe **one** method of achieving this requirement. *(12 marks)*

TURN OVER FOR QUESTION 4

4   A hot drinks vending machine has a water tank containing a water level sensor that gives a HIGH output if there is water in the tank. The machine has two buttons, one for coffee and one for tea both giving a HIGH output when pressed.

The machine's control system should send a HIGH output to a valve if there is water in the tank and one of the two buttons are pressed, but *not* if both buttons are pressed at the same time.

(a)   Draw a truth table for the above system. *(8 marks)*

(b)   Design a logic diagram for this control system. *(8 marks)*

(c)   During the development of this control system the designer could test the operation of the circuit by either prototyping using real components or by simulating the operation of the system using a computer software package. Compare and contrast these **two** methods of testing logic systems.
(2×4 marks)

(d)   Micro-electronics is one method of producing logic systems.

Describe an alternative method of producing logic systems. *(4 marks)*

END OF QUESTIONS