| • | A list of formulae and | other | inform | ation |
|---|------------------------|---------|---------|-------|
| | use in your answers | ie nrov | uidad o | n na |

- You are reminded of the need for good English and clear presentation in your answers.

| c, | Surname | | | | | Other | Names | | | |
|---------------|-----------|-------|------|--|-------|-------------|-------|--|--|--|
| Centre Number | | | | | Candi | date Number | | | | |
| (| Candidate | Signa | ture | | | | | | | |

General Certificate of Secondary Education June 2007

DESIGN AND TECHNOLOGY (SYSTEMS AND CONTROL TECHNOLOGY) Written Paper **Foundation Tier**

Wednesday 13 June 2007 1.30 pm to 3.30 pm

For this paper you must have:

• a pen, a pencil, a ruler, an eraser and a pencil sharpener.

Time allowed: 2 hours

Instructions

- Use blue or black ink or ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer eight questions. Answer all the questions from Section A. Answer one question from Section B.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

Information

- The maximum mark for this paper is 125.
- The marks for questions are shown in brackets.
- , which you may wish to use in your answers, is provided on page 2.
- All dimensions are given in millimetres unless otherwise stated.



ASSESSMENT and QUALIFICATIONS ALLIANCE

| For Examiner's Use | | | | | | |
|---------------------|------|----------|------|--|--|--|
| Question | Mark | Question | Mark | | | |
| 1 | | 9 | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | | | | | | |
| Total (Column 1) | | | | | | |
| Total (Column 2)> | | | | | | |
| TOTAL | | | | | | |
| Examiner's Initials | | | | | | |

For Examiner's Use

3546/F

| You ma | ıy use | the | following | information | when | answering | the | questions. |
|--------|--------|-----|-----------|-------------|------|-----------|-----|------------|
| | | | | | | | | |

| Pneumatics | | Force = Pressure $\times A$ | Area | | |
|---|--|---|--|--|--|
| Ratio of Simp | ole Gears | Gear Ratio = <u>Number</u> Number | r of teeth on driven gear r of teeth on driver gear | | |
| Velocity Ratio | 0 | Velocity Ratio = Diar | meter of driven pulley meter of driver pulley | | |
| | | Output speed = $\frac{\ln G}{Gear}$ | nput speed /Velocity ratio | | |
| Forces | | Moments = Force \times I | Distance | | |
| | | Sum of clockwise mor | ments = sum of anti-clockwise moments | | |
| Series Resis | tance | $R_{T} = R_{1} + R_{2} + R_{3}$ | | | |
| Parallel Resistance | | $\frac{1}{R_{T}} = \frac{1}{R_{1}} + \frac{1}{R_{2}} \text{ OR } \text{ R}$ | $T = \frac{R_1 \times R_2}{R_1 + R_2}$ | | |
| Potential Difference | | $V = I \times R$ | | | |
| Transistors | | Current Gain = Colle Bas | Current Gain = Collector Current Base Current | | |
| Amplifier Gai | in | Av = Change in output | Av = Change in output voltage Change in input voltage | | |
| Area of circle | $e = \pi r^2$ | π = 3.142 | | | |
| Resistor Cold | our Code | | E12 Resistor preferred values | | |
| Colour Black Brown Red Orange Yellow Green Blue Violet Grey White | Number 0 1 2 3 4 5 6 7 8 9 | Number of Zeros 0 00 000 0,000 00,000 000,000 0,000,00 | 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades thereafter. | | |

Turn over for the first question

SECTION A

4

Answer **all** questions in this section.

- **1** This question is about component recognition and sensing.
 - (a) Complete the following table by naming the components and drawing their symbols.

| Component name | Symbol |
|----------------|--------|
| Resistor | |
| | |
| | |

(5 marks)

(b) Complete the table below to show what each potential divider circuit is sensing.

Give an example of a product in which this could be used.



(5 marks)

Turn over for the next question

- **2** This question is about prototyping circuits.
 - (a) Give a different advantage and disadvantage for each of the following circuit construction techniques.

6

| | Advantage | Disadvantage |
|--|-----------|--------------|
| | | |
| Breadboard (prototype board) | | |
| | | |
| Strip Board Copper Strip Board (Veroboard) | | |
| | | |
| Printed Circuit Board | | |

(6 marks)

(b) (i) Give **two** advantages of modelling circuit designs on a computer rather than building them.

| Advantage 1 | |
|-------------|-----------|
| Advantage 2 | |
| | (2 marks) |

(ii) Give **one** disadvantage of modelling circuit designs on a computer rather than building them.

| (1 ma | rk) |
|-------|-----|

3 This question is about an automated train carriage door.

The door opens and closes using wheels on tracks at the top and bottom of the doorway.



(a) (i) Give **one** reason why the train door is made from aluminium.

| | (1 mark | () |
|-------|---|----------|
| (ii) | Give one reason why the door wheels are made from steel. | |
| () | , | |
| | | () |
| | | |
| (iii) | Suggest a suitable material for the door track. | |
| | | |
| | (1 mark | () |
| | · · · · · · · · · · · · · · · · · · · | <i>,</i> |

Question 3 continues on the next page

(1 mark)

(1 mark)

(2 marks)

(b) The simplified diagram below shows a sliding train carriage door. It is in the open position.

In Space **A** on the simplified diagram, design a suitable system that will open and close the carriage door.

Draw and label all components and mountings.

Your design must show

- a suitable system to close and open the door (3 marks)
- suitable mounting of the system to the fixed beam (1 mark)
- suitable mounting of the system to the door
- a suitable power source
- labelled components and mountings.



(c) Describe how the system that you have drawn in Space **A** operates.

(2 marks)

| (d) | (i) | Give two reasons for your choice of system. | |
|-----|-------|---|-----------|
| | | Reason 1 | (1 mark) |
| | | Reason 2 | (1 mark) |
| | (ii) | Name a specific component that could be used to sense that the d hit an obstruction. | oor has |
| | | | (2 marks) |
| | (iii) | Give two other Health and Safety issues that should be considered designing the door system. | d when |
| | | Issue 1 | |
| | | Issue 2 | (2 marks) |
| (e) | ln u | use it was found that the door opened and closed too quickly. | |
| | Wha | at could be added to your system to slow down the movement of the | e door? |
| | | | |
| | | | |
| | | | |
| | | | (2 marks) |
| | | Question 3 continues on the next page | |
| | | | |
| | | | |

(f) A Double Pole Double Throw (DPDT) switch can be used to control the forward and reverse direction of a motor.

Complete the diagram below to show a reversing circuit.

Marks will be awarded for

- power supply connected to switch
- switch connected to the motor.

(2 marks) (4 marks)

Μ

0 12 V DC





- 4 This question is about a timing circuit for an automatic sliding door.
 - (a) The diagram below shows a timing circuit that, once operated, keeps the train door open for five seconds.



Question 4 continues on the next page

(b) Complete the diagram below by naming the colour of the bands for a 10 K resistor.

Band 4 (Gold) has been completed for you.

(c) The Timing Circuit from page 11 has been redrawn below.

It now shows the pins of the Integrated Circuit (IC) to aid the layout of the Printed Circuit Board (PCB).



(1 mark)

(1 mark)

(1 mark)

(2 marks)

Complete the PCB layout below for the circuit diagram shown on page 12.

- Pin numbers 1, 4, 5 and 8 of the 555 integrated circuit have been labelled for you.
- The positions of the other components have been labelled.
- Add the following tracks:

| 0 | pin 2 to junction of R1 and component A | (1 mark) |
|---|---|----------|
| 0 | pin 4 to 9 V | (1 mark) |

- pin 6 to junction of R2 and C1
- pin 7 to junction of R2 and C1
- pin 8 to 9 V
- Ensure that your tracks are neat and of a reasonable size.



Turn over for the next question

5 This question is about constructing a flowchart to control a simple railway crossing signal.

The signal has the following sequence.

- When an approaching train is sensed, a flashing amber light turns ON for 10 seconds.
- Then the flashing amber light turns OFF and a red light turns ON for 40 seconds.
- Then the red light turns OFF and the system waits for the next train.

Complete the flowchart on the opposite page to control the sequence above.

The first decision box has been completed for you.

Marks will be awarded for

- adding YES and NO to the dotted outputs of the decision boxes (2 marks)
- completing the flowchart by adding the statements below in the correct boxes
 - Flashing amber light OFF(1 mark)Flashing amber light ON(1 mark)Wait 40 seconds(1 mark)Red light OFF(1 mark)Red light ON(1 mark)Wait 10 seconds(1 mark)adding feedback loops to the diagram.(2 marks)







Turn over for the next question



Turn over ►

- **6** This question is about using logic gates to control a train door.
 - (a) (i) Complete the following by naming the logic gates shown.
 - (ii) Complete the truth tables for the three logic gates.

HIGH = 1 LOW = 0

| Logic Gate Symbol | Name of Logic Gate | Truth Table | | | | | |
|-------------------|--------------------|-------------|--------|---|---|--------|--------|
| | | | 4 | E | 3 | X | |
| | | (|) | C |) | 0 | |
| | | (| C | 1 | | 0 | |
| в ^ | | | 1 | C |) | | |
| | | | 1 | 1 | | | |
| | (1 mark) | (2 marks | | | | | narks) |
| | | | | | | | |
| N | | | ŀ | 4 | Х | , | |
| | 0 | | |) | | | |
| | | | 1 | 1 | | | |
| | | | | | | | |
| | (1 mark) | | (2 mar | | | narks) | |
| | | | 4 | E | 3 | X | |
| | | (| C | C |) | 0 | |
| | | (| C | 1 | | | |
| | | | 1 | C |) | | |
| ^B Z | | | 1 | 1 | | | |
| | (1 mark) | | | | | (3 n | narks) |



- (b) It has been decided to operate the train door using push button switches.
 - Three push button switches (driver and two passenger) operate this system.
 - The process block controls the system.
 - The door device opens the door.
 - The door should open when either of the passenger push buttons are pressed and the driver's push button is pressed.

Complete the **System Diagram** at the bottom of the page by labelling the blocks drawn below, adding connecting lines and labelling the stages.



| 7 | This | s que | estion is about design issues for railway systems. | | |
|---|------|--------------|--|--|--|
| | (a) | (i) | What advantage would an automatic door system on a train give the <i>passengers</i> ? | | |
| | | | (1 mark) | | |
| | | (ii) | Give two reasons for your answer. | | |
| | | | (2 marks) | | |
| | (b) | (i) | What advantage would an automatic door system on a train give the <i>train company</i> ? | | |
| | | | (1 mark) | | |
| | | (ii) | Give two reasons for your answer. | | |
| | | | | | |
| | | | (2 marks) | | |
| | (c) | Sug fails | gest how passengers could escape from a train if the automatic door system | | |
| | | | | | |
| | | | (3 marks) | | |
| | (d) | Stat | e two maintenance requirements of an automatic train door system. | | |
| | | Rec | uirement 1 | | |
| | | Rec | juirement 2 | | |
| | (e) | Give mos | e two reasons why electric trams are more environmentally friendly than st cars. | | |
| | | Rea | ison 1 | | |
| | | Rea | nson 2 (2 marks) | | |



END OF SECTION A QUESTIONS

Turn Over For Section B Questions

SECTION B

Answer either Question 8 (page 21) about mechanisms

or Question 9 (page 23) about pneumatics.

Do **not** answer both questions.

EITHER

- 8 This question is about mechanisms and mechanical components.
 - (a) Complete the table by naming the type of drive mechanism and stating what it does.

| | Type of Drive Mechanism | What it does |
|--|----------------------------|--|
| | | Converts Reciprocating Motion to Rotary Motion |
| | | Gives Mechanical Advantage |
| () () | | |
| 600 | | |
| AND | | |
| Contraction of the second seco | | |

(10 marks)

(2 marks)

- (b) This part of the question is about a winch for a railway crane.
 - Using notes and sketches, complete the diagram below by adding a mechanism that could be used to prevent the load dropping when the winch stops.

Marks will be awarded for

- adding a suitable mechanism (4 marks)
- adding notes and sketches.



(ii) State how your system would allow the load to be lowered.

(2 marks)

(iii) State a suitable mechanism that could be used to operate the winch with an electric motor.

(2 marks)

Do not answer Question 9 if you have answered Question 8.

OR

- **9** This question is about pneumatic components and circuits.
 - (a) Complete the table by naming the type of pneumatic component and stating what each component does.

| Symbol | Pneumatic Component | What it does |
|--------|---------------------|--|
| | | Fills up with air and can be used as a time delay |
| | | Allows air in a line to be obtained from alternative sources |
| | | |
| | | |
| | | |
| | | |
| | | (10 marks) |

Question 9 continues on the next page

Turn over ►

20



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