



General Certificate of Secondary Education

Centre Number

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Candidate Number

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Technology and Design

Unit 2

Option A:
Electronic and Microelectronic
Control Systems



[GTY21]

GTY21

Assessment

TIME

1 hour 30 minutes.

Assessment Level of Control:

Tick the relevant box (✓)

Controlled Conditions	
Other	

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Questions which require drawing or sketching should be completed using an H.B. pencil.

All other questions must be completed using black ink only.

Do not write in pencil or with a gel pen.

Answer **both** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Quality of written communication will be assessed in Question **1(e)**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

The Formula sheet is on page 2.

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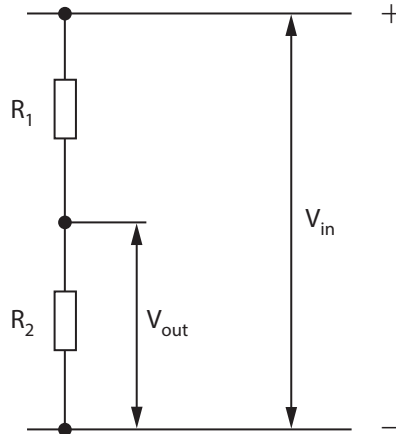
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Formulae for GCSE Technology and Design

You should use, where appropriate, the formulae given below when answering questions which include calculations.

1 Potential Difference = current \times resistance ($V = I \times R$)

2 For potential divider $V_{\text{out}} = \frac{R_2}{(R_1 + R_2)} \times V_{\text{in}}$



3 Series Resistors $R_t = R_1 + R_2 + \dots + R_n$

4 Parallel Resistors $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}$ or $R_t = \frac{R_1 \times R_2}{R_1 + R_2}$

5 Time Constant $T = R \times C$

6 Period $T = \frac{1}{f}$

7 Frequency (Hz) $f = \frac{1.44}{(R_1 + 2R_2)C}$ for the output of an astable circuit using a 555 timer

8 Time $T = 1.1 \times C \times R$ for the output of a monostable circuit using a 555 timer



Answer **all** questions

- 1 (a) (i) Sketch and name the symbols for a polarised and a non-polarised capacitor in the space below.

[2]

- (ii) Name a unit of measurement for capacitance.

[1]



(iii) Outline the main purpose of a polarised capacitor if fitted at **C** in the circuit in Fig. 1.

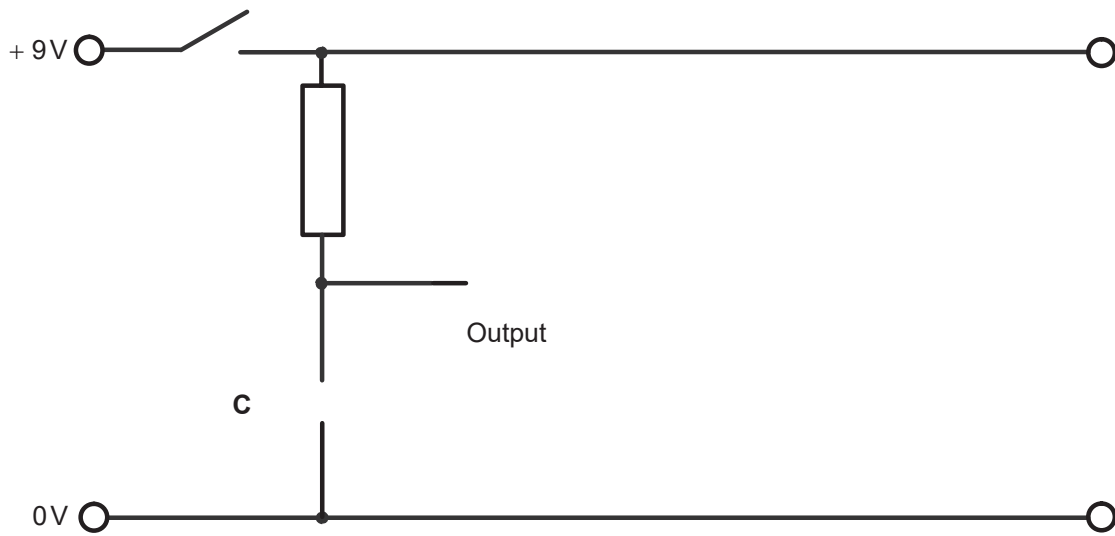


Fig. 1

_____ [1]

(iv) Compare how to connect a polarised capacitor in a circuit with connecting a non-polarised capacitor.

_____ [2]

(v) Outline **two** advantages that polarised capacitors have over non-polarised capacitors.

1. _____
2. _____ [2]



(b) (i) Complete the electronic circuit shown in Fig. 2 to enable an NPN transistor and a thermistor to operate a buzzer. [8]

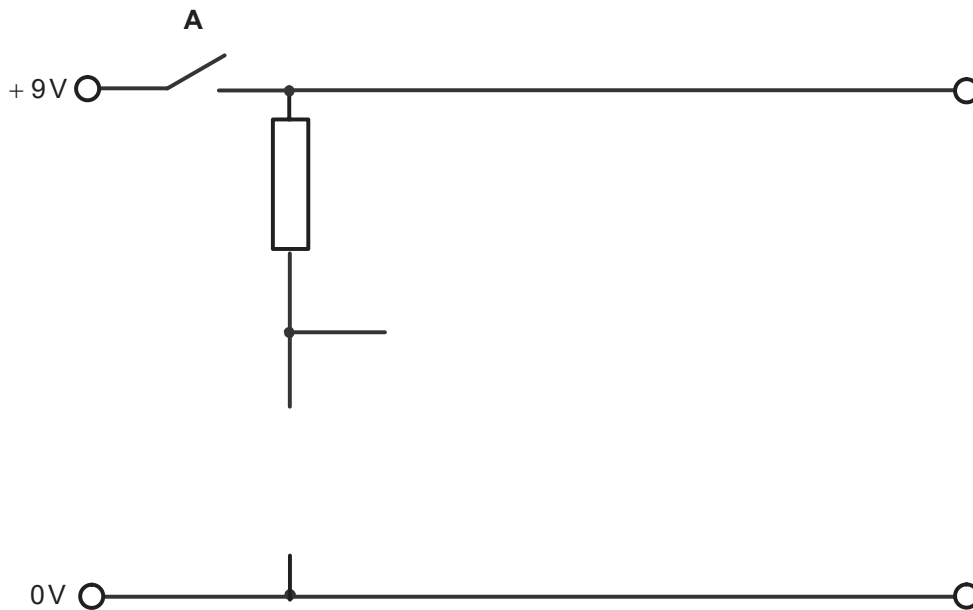


Fig. 2

(ii) Describe how the buzzer is made to operate in the circuit, making reference to the function of all the components needed to complete the circuit.

[6]

[Turn over



(c) (i) Complete **Fig. 3** by inserting a polarised capacitor as part of the timing circuit. [1]

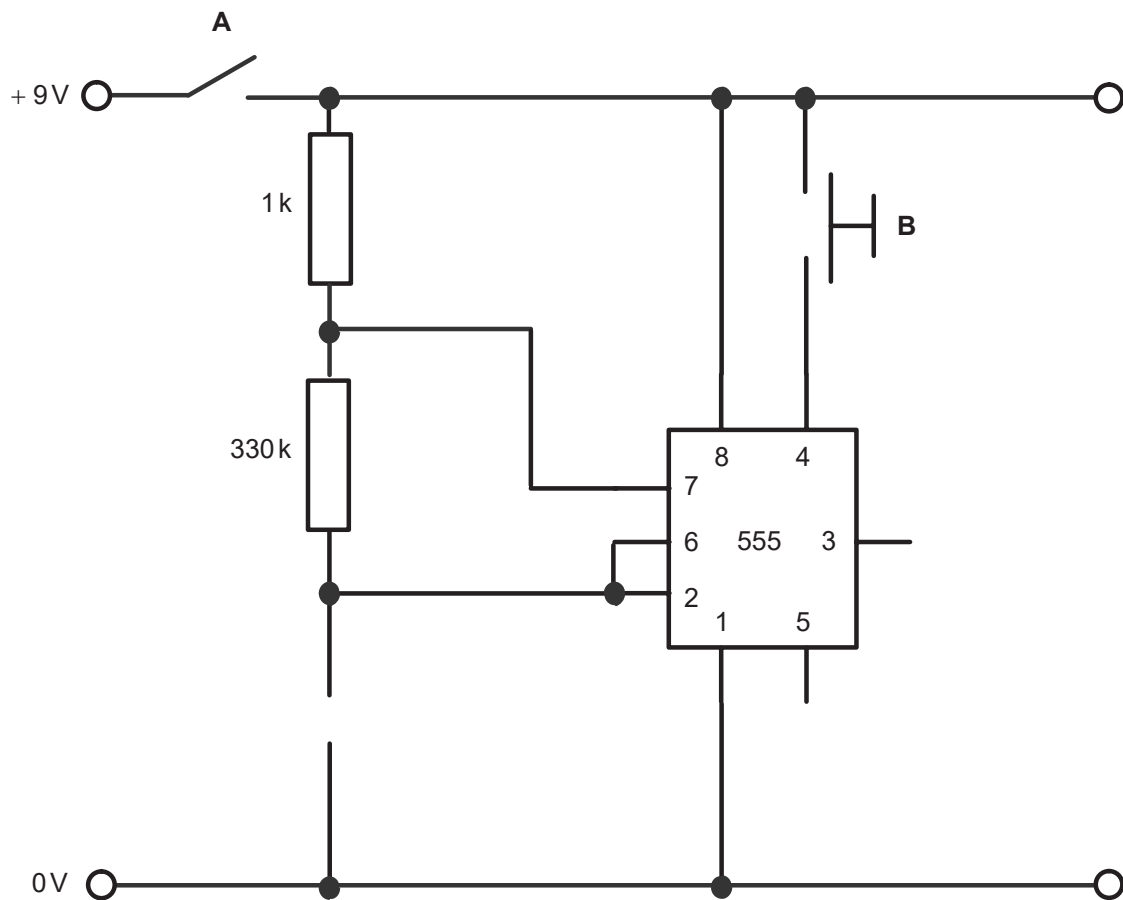


Fig. 3

(ii) Name the circuit shown in **Fig. 3**.

_____ [2]

(iii) Name the type of switch shown at **B** and explain its purpose in this circuit.

 _____ [2]



(iv) Which pin is used to provide the output from this circuit?

_____ [1]

(v) Explain the purpose of pin 6 in this circuit.

_____ [2]

(d) (i) If the polarised capacitor inserted in **Fig. 3** has a value of $10\mu\text{F}$ calculate the frequency of the expected output in **Fig. 3**.

Answer _____ [5]

(ii) Calculate the time period for this circuit.

Answer _____ [3]

(iii) Sketch the waveform for the expected output of the circuit in **Fig. 3**, clearly labelling the time period.

[2]

[Turn over





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2 Fig. 4 shows a car assembly line.



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Fig. 4

(a) Modern manufacturing systems make use of robotics as shown in Fig. 4.

Give **two** different features of each of the following systems for robots such as those shown in Fig. 4.

Note: Repeat answers are not acceptable.

Microcontroller systems:

[2]

Mechanical systems:

[2]



Pneumatic systems:

[2]

(b) Switches are used in a variety of electrical/electronic applications.

Table 1 gives the name of **four** types of switch. From the list shown, insert the most appropriate letter which describes the use of each switch.

- A:** To turn on a household light.
B: To activate an intruder alarm from a door mat.
C: When a door is closed a magnet turns the switch on.
D: In the cover lid of the belt and pulley system in a pillar drill.
Note: Each letter may be used only once.

Table 1

Types of switch	Use
Reed switch	
Microswitch	
Rocker switch	
Membrane switch	

[4]

[Turn over



(c) (i) In the space below draw the electronic symbol for a microcontroller (PIC).

[1]

(ii) The PIC makes use of the binary system. What **two** numbers are used in a binary system?

[1]

(iii) Explain what each number represents when used for digital logic.

[2]

(iv) Convert the decimal number 25 to a binary number.

Answer _____ [1]



(v) Convert the binary number 1001010 to a decimal number.

Answer _____ [1]

(d) **Decrement** and **Expression** symbols are used in many flowcharts.

(i) Explain what **Decrement** means and why it is as used in a flowchart.

[2]

(ii) Explain what an **Expression** means and why it is as used in a flowchart.

[2]

[Turn over



(e) **Fig. 5** shows a side view and plan view of a model robotic arm and its control panel. The robotic arm is controlled by a microcontroller (PIC). The robotic arm lifts a product from conveyor belt 1, rotates through 90° and places the product on conveyor belt 2. The product is then sent along conveyor belt 2 for dispatching. The dotted outlines in **Fig. 5** show the different positions of the robotic arm.

The model robotic arm uses three motors: base Motor **A**, shoulder Motor **B** and grab Motor **C**. Anticlockwise rotation of Motor **B** lowers the arm. Clockwise rotation of Motor **C** closes the grab. A microswitch and two LEDs are also used. The control panel has an operate and a stop switch.

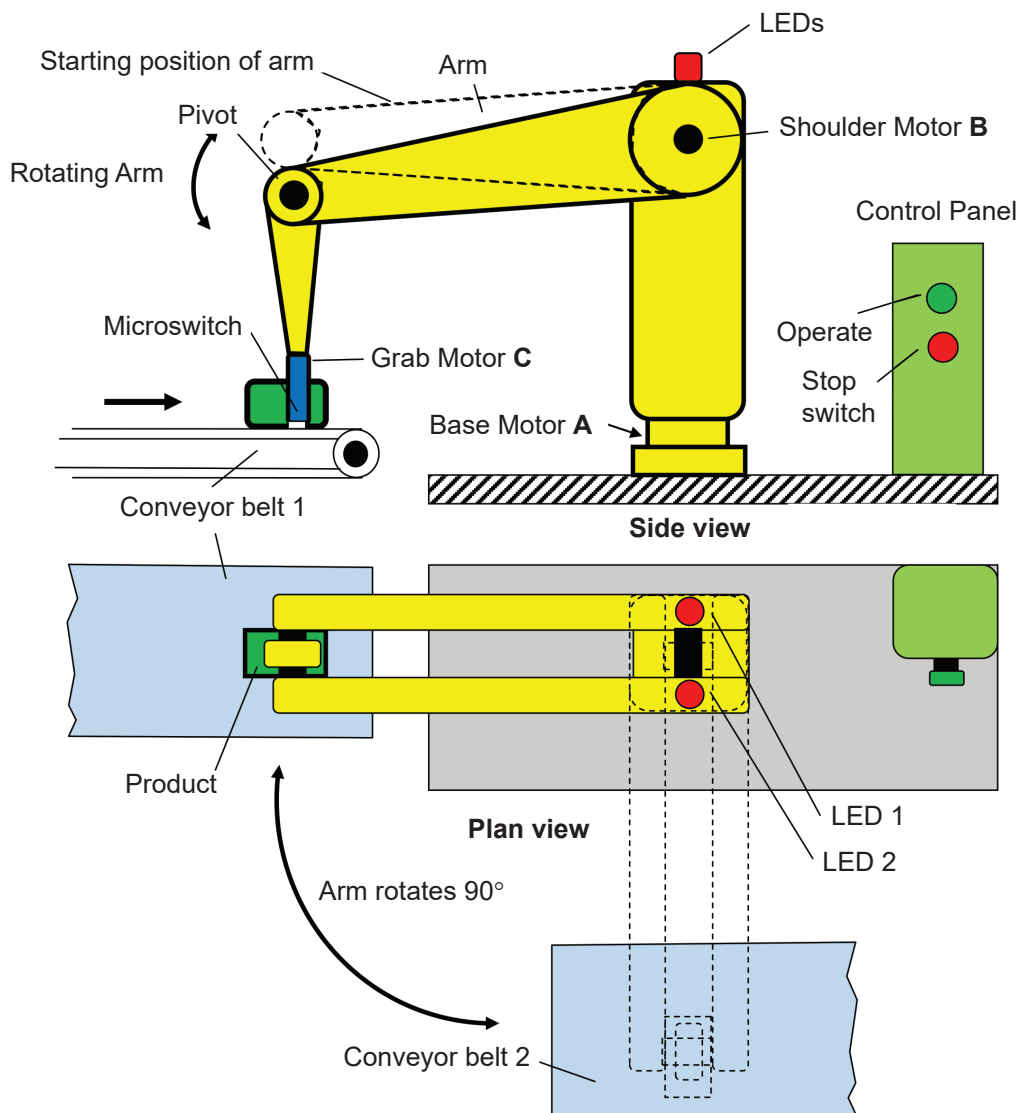


Fig. 5



A series of flowcharts, which includes three macros is required to operate the robotic arm.

(i) Complete the macro flowchart **FLASH** in **Fig. 6** as follows:

LEDs 1 and 2 switch on and off alternately. Each LED remains on for one second before switching off. There is a two second delay between the operation of each LED. The process should operate four times. [8]

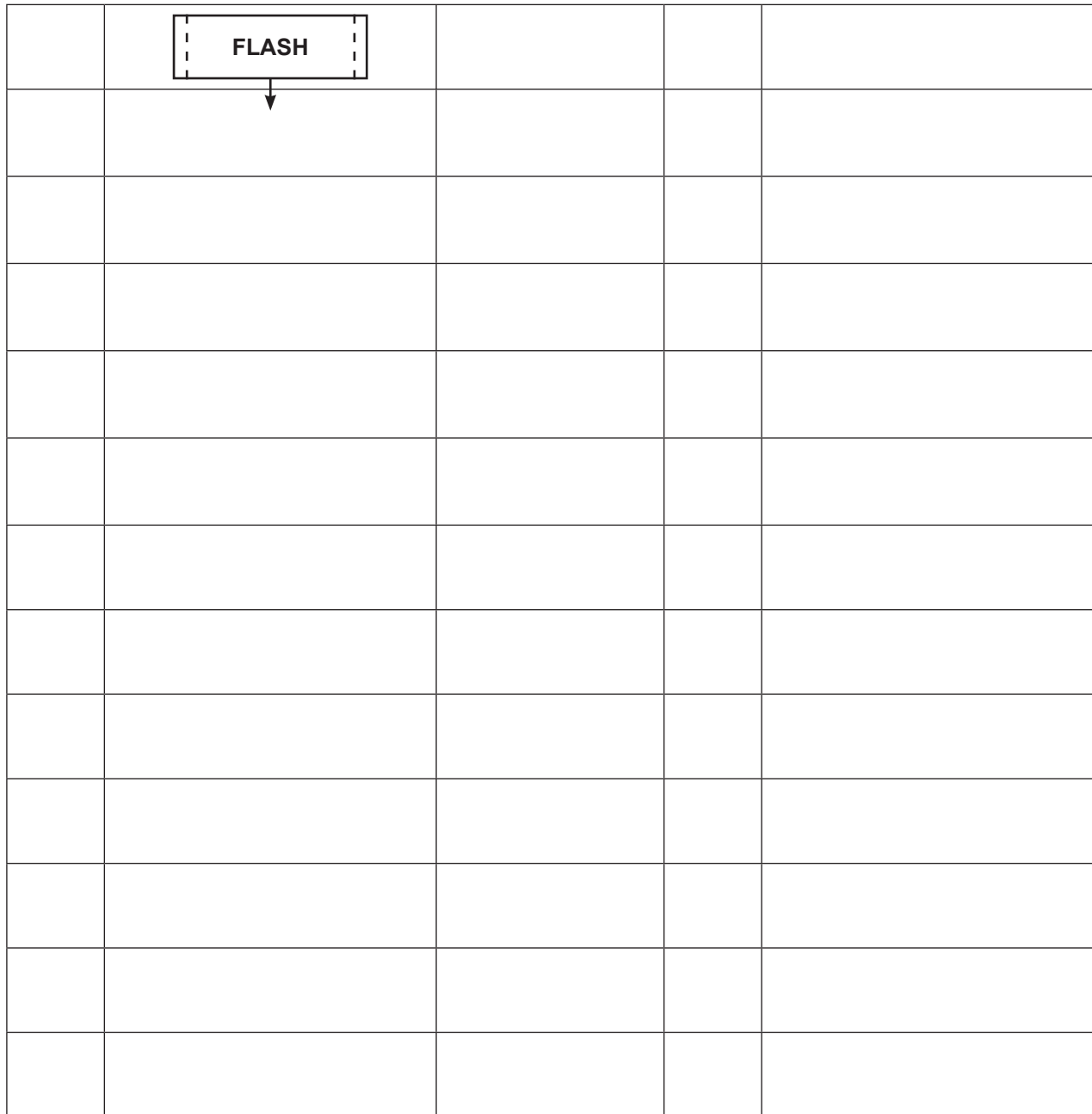


Fig. 6

[Turn over



(iv) Complete the overall flowchart in **Fig. 9** to show the full operation of the robotic arm:

When the operate switch is pressed, the **FLASH** macro starts, followed by the **GRAB** macro. Base Motor **A** rotates the robotic arm through 90° to the position above conveyor belt 2 as shown in **Fig. 5**. This takes 10 seconds to complete. After the **RELEASE** macro, base Motor **A** returns the robotic arm to its original position. This process is continuous. [10]



Fig. 9





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Question Number	Marks
1	
2	

Total Marks	
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Examiner Number

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