## Technology and Design

## Unit 2:

Systems and Control
Element 1: Electronic and Microelectronic Control Systems
[GTD21]

FRIDAY 7 JUNE, AFTERNOON

## TIME

1 hour.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Complete in blue or black ink only. Do not write in pencil or with a gel pen.
Answer all questions.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 80 .
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

## 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

$$
V_{2}=\frac{R_{2}}{R_{1}+R_{2}} \times V_{T}
$$



3 Series Resistors

$$
R_{\mathrm{T}}=R_{1}+R_{2}+R_{3} \text { etc }
$$

Parallel Resistors

$$
\frac{1}{R_{\mathrm{T}}}=\frac{1}{R_{1}}+\frac{1}{R_{2}} \quad \text { or } \quad R_{\mathrm{T}}=\frac{R_{1} \times R_{2}}{R_{1}+R_{2}}
$$

4 Time Constant $T=R \times C$

1 (a) (i) In the space below produce a sketch of the symbol for an NPN transistor.

(ii) Clearly label and name each of the three legs of the transistor. [3]
(iii) Outline how a transistor can be switched on when used in a circuit.
$\qquad$
(b) Fig. 1 shows a Voltage Divider circuit diagram.


Fig. 1
(i) State another name for this circuit.
(ii) Name the components shown by their electronic symbols $\mathbf{A}$ and $\mathbf{B}$ in Fig. 1.
$\qquad$

B
(iii) What type of switch is shown at C in Fig. 1?
$\qquad$
(iv) With reference to the labelled components A, B and C in Fig. 1 explain how an output at point $\mathbf{X}$ is achieved.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(c) The circuit in Fig. 1 is to be developed by including a resistor and a LED between the 9 V and $\mathbf{O V}$ rails at points D and E .
(i) Show this addition to the circuit in Fig. 1.
(ii) With reference to the labelled component $\mathbf{C}$ explain how the additional parts will function in the circuit.
$\qquad$
$\qquad$
$\qquad$
(iii) What purpose will this additional part of the circuit serve?
$\qquad$
(iv) If the LED used is rated at $2 \mathrm{~V}, 6 \mathrm{~mA}$ calculate in the space below the minimum value that should be used for the resistor.
(d) A further development in the circuit is to add an NPN transistor to operate a relay when required.
(i) Develop the circuit in Fig. 1 by adding the NPN transistor and relay coil to enable this operation. Include any additional components that may be required. Neatly label the relay coil.
(ii) In the space below state the names of any additional components used and the reason for their use in the circuit.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(iii) Outline one possible use for the relay in this circuit.
$\qquad$
$\qquad$ [1]

| Examiner Only |  |
| :---: | :---: |
| Marks | Remark |
|  |  |
|  |  |

2 Fig. 2 shows a circuit board with a microcontroller circuit.


Fig. 2
© New Wave Concepts Ltd
(a) Suggest a method of modelling an electronic circuit.
$\qquad$
(b) Suggest a benefit of using this method of modelling.
$\qquad$
$\qquad$
(c) Analogue and digital inputs are used in microcontroller circuits. They are usually defined by how they function within a circuit.

Outline the difference between a digital and analogue input signal.
$\qquad$
$\qquad$
$\qquad$
$\qquad$
(d) Complete Table 1 to identify if the component is a digital or an analogue component.

Table 1

| Component | Digital/Analogue |
| :--- | :--- |
| 7 Segment Display |  |
| Toggle Switch |  |
| LDR |  |
| Reed Switch |  |

(f) A student is to design an electronic circuit for a rotating night-light using a PIC microprocessor. The night light is to operate automatically once the toggle switch is turned on. An LDR will act as a sensor to determine when the room becomes dark. The PIC microprocessor will control a motor and some LEDs.

The PIC has 2 inputs and 5 outputs.
The inputs and outputs are shown in Tables 2 and 3.
When the room is dark the LDR input will be high.
Binary 1 indicates high (on) and binary 0 indicates low (off).

## Digital Panels

Table 2

| BIT | 1 | 0 |
| :---: | :---: | :---: |
| PIC Input | Toggle Switch | LDR |

Table 3

| BIT | 4 | 3 | 2 | 1 | 0 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| PIC OUTPUT | Motor | Blue LED | Green <br> LED | Yellow <br> LED | Red LED |

Complete a series of flowcharts to represent the operating routines as follows:
(i) Complete a flowchart and its relevant bit patterns in Fig. 4 to represent the LIGHTS macro as follows:

The red and yellow LEDs must turn on for 6 seconds. Two seconds after the red and yellow LEDs turn on the green and blue LEDs should turn on for 4 seconds. All LEDs should then switch off. After a delay of 2 seconds all LEDs should switch on and remain on for 10 seconds before they all switch off. The macro will then end.


Fig. 4
(ii) Complete the flowchart in Fig. 5 and its relevant bit patterns to represent the MOTOR LIGHTS macro as follows:

The motor will turn on for 2 seconds. The motor will then turn on for a further 10 seconds with all LEDs lit. The motor and LEDs will turn off and the macro will end.

|  | MOTOR <br> LIGHTS |  |  | BIT PATTERN |
| :--- | :---: | :---: | :---: | :---: |
|  |  |  |  |  |

Fig. 5
Examiner Only
(iii) Use Fig. 6 to complete the flowchart for the full operation of the night light.

Once the toggle switch is turned ON and the room has become dark, the following sequence should happen:

- The motor should turn ON for 25 seconds
- The LIGHTS macro should operate 20 times
- The MOTOR LIGHTS macro should operate
- The sequence should repeat as long as the room remains in darkness


Fig. 6

$\left[\begin{array}{c} \\ \\ \hline \text { THIS IS THE END OF THE QUESTION PAPER } \\ \hline\end{array}\right.$

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