



**L-Università
ta' Malta**

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2025 MAIN SESSION**

SUBJECT: **Computing**
 PAPER NUMBER: I – Level 1-2-3
 DATE: 20th May 2025
 DURATION: 2 hours 5 minutes

Directions to Candidates

Write your index number were indicated at the top of the page.

Answer questions of Section A in the spaces provided. You are **not** allowed to use extra sheets other than those provided in this booklet.

The answer of Section B must be coded using Thonny IDE.

The answer of Section B must be printed according to the instructions provided at the end of the examination paper.

Good English and orderly presentation are important.

The use of flowchart templates is permitted.

The use of calculators is **not** permitted.

This paper carries 100 marks.

Question Number	1	2	FOR MARKERS' USE
For Markers' use only	Total number of marks obtained by candidate		
MARKS			

Section A

1. During the winter months, shorter days often result in insufficient natural light inside greenhouses. To address this issue, an Arduino-based automatic lighting system is implemented. This system activates the lights when natural light intensity is low and turns them off when sufficient natural light is detected.

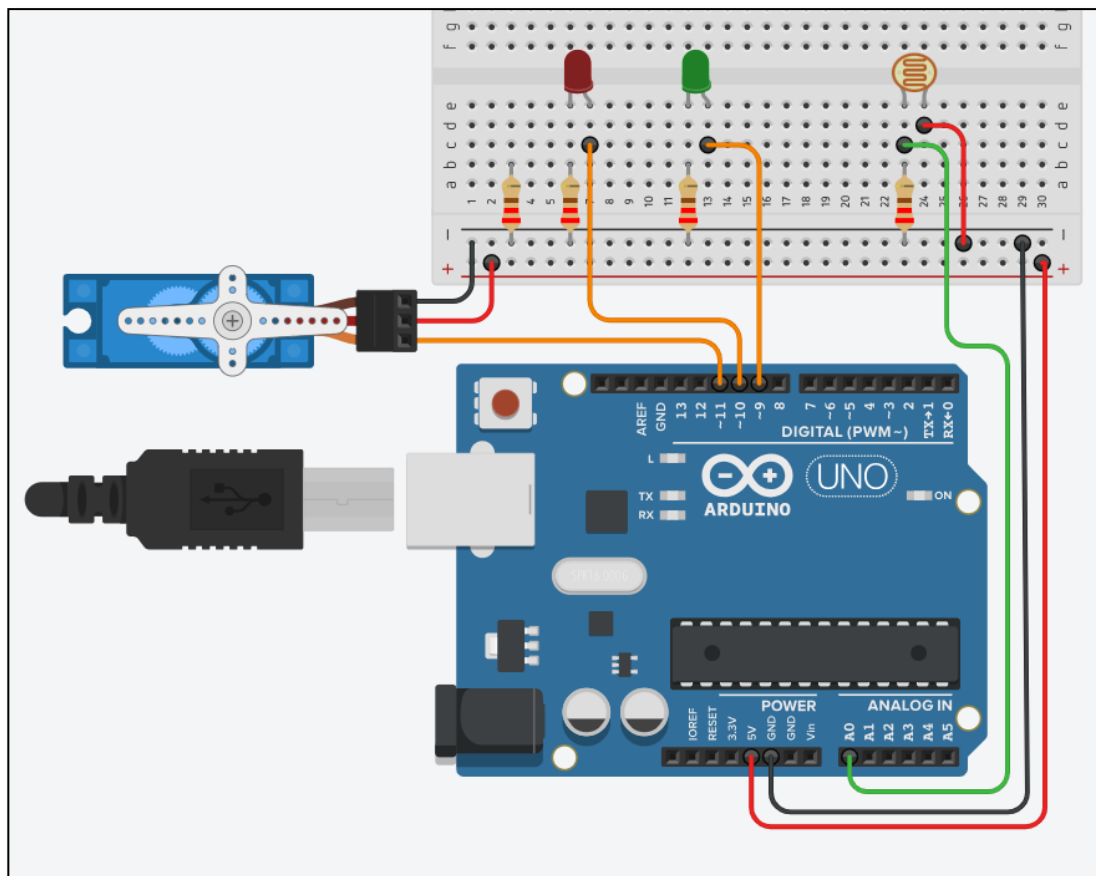
Additionally, a servo motor controls the greenhouse blinds, fully opening them when natural light is adequate and closing them when natural light intensity is low, relying only on artificial lighting.



The system operates using a photocell sensor (LDR) placed outside the greenhouse to measure natural light intensity. The Arduino board processes the sensor readings as follows:

- When the natural light intensity falls below the predefined threshold, the blinds close, and a GREEN LED is activated, indicating that the greenhouse's artificial lights have been turned on.
- When the natural light intensity exceeds the threshold, the blinds open, and a RED LED is switched on, signaling that the artificial lights have been turned off to conserve energy.

Analyse the following circuit diagram and program, and answer the questions that follow.



```

Line 1:  include <Servo.h>

Line 2:  // Define components' pins
Line 3:  int servoPin = ____;
Line 4:  int photocellPin = A0;
Line 5:  int greenLEDPin = ____;
Line 6:  int redLEDPin = 10;

Line 7:  // Define variables for system settings
Line 8:  int openAngle = 90;
Line 9:  int closeAngle = 0;
Line 10: int threshold = 400;
Line 11: ____ lowLight = false;

Line 12: // Define servo object
Line 13: Servo myServo;

Line 14: void setup() {
Line 15:     myServo.attach(servoPin);
Line 16:     pinMode(____);
Line 17:     pinMode(____);
Line 18:     pinMode(photocellPin, INPUT);
Line 19:     lowLight = true;
Line 20:     myservo.write(closeangle);
Line 21:     Serial.begin(9600);
Line 22: }

Line 23: void loop() {
Line 24:     int photocellValue = analogRead(____);
Line 25:     Serial.println(photocellValue); //trace sensor values

Line 26:     if (photocellValue < threshold) {
Line 27:         if (lowLight == false) {
Line 28:             digitalWrite(greenLEDPin, HIGH);
Line 29:             digitalWrite(redLEDPin, LOW);
Line 30:             myServo.write(closeAngle);
Line 31:             lowlight = true;
Line 32:         }
Line 33:     } else {
Line 34:         if (lowlight == true) {
Line 35:             _____;
Line 36:             _____;
Line 37:             _____;
Line 38:             _____;
Line 39:         }
Line 40:     }
Line 41:     delay(1000);
Line 42: }

```

This question continues on the next page.

a. Mention **ONE** construct used in the program snippet related to:

- i. Condition: _____ (1)
- ii. Input: _____ (1)
- iii. Library import: _____ (1)
- iv. Output: _____ (1)
- v. Variable initialisation: _____ (1)

b. Complete the code of the following lines:

- i. Line 3: _____ (1)
- ii. Line 5: _____ (1)
- iii. Line 11: _____ (1)
- iv. Line 16: _____ (1)
- v. Line 17: _____ (1)
- vi. Line 24: _____ (1)
- vii. Line 35: _____ (1)
- viii. Line 36: _____ (1)
- ix. Line 37: _____ (1)
- x. Line 38: _____ (1)

c. Can the photocell sensor be attached to pin 8? Explain.

_____. (2)

d. What is the initial angle of the servo when the program runs?

_____. (1)

e. Explain why line 18 is **not** required.

_____. (1)

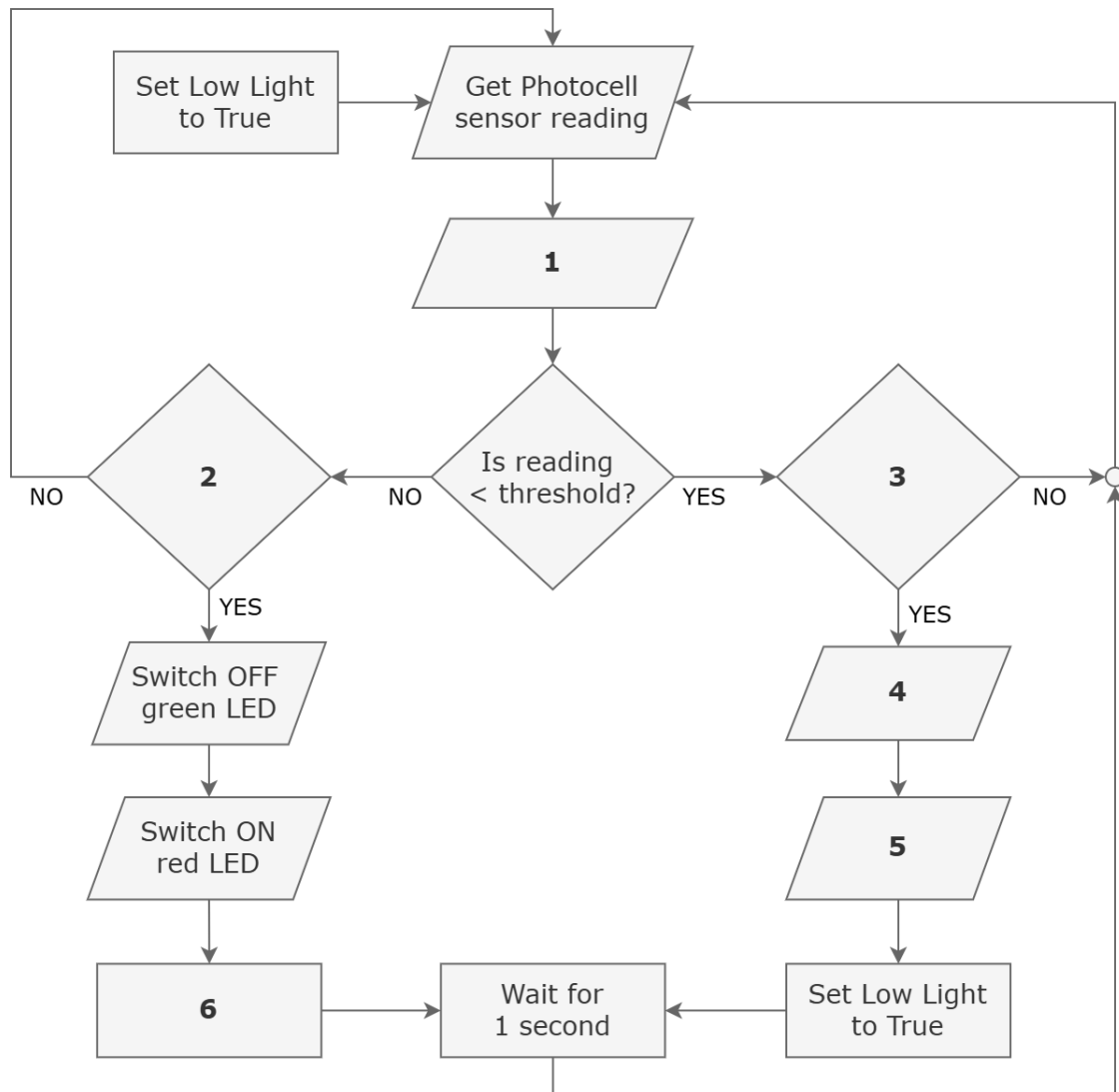
f. Suggest **ONE** use for tracing the values of the photocell sensor in line 25.

_____. (1)

- g. Good programming practices help improve code readability, maintainability, and functionality. List **THREE** good programming practices.

(3)

- h. Complete the flowchart shown below representing the algorithm of the loop function.



1: _____ (1)

2: _____ (1)

3: _____ (1)

4: _____ (1)

5: _____ (1)

6: _____ (1)

This question continues on the next page.

- i. Provide the lines of code that prevent the green LED from being switched ON and the red LED from being switched OFF repeatedly when the photocell reading is below the threshold, and the LEDs are already in the correct state. Explain your answer.

 _____ (4)

- j. Line 26 and Line 27 include a nested-if structure. Suggest how this can be rewritten as one if-structure.

 _____ (1)

- k. A buzzer is added to this system and connected to pin 13. The buzzer should make a 1000Hz sound for 5 seconds when the natural light intensity is below the threshold. The program has been modified to include this feature. Complete the missing lines in the modified code snippet below.

...	...
...	...
Line 26:	if (photocellValue < threshold) {
Line 27:	if (lowLight == false) {
Line 28:	digitalWrite(greenLEDPin, HIGH);
Line 29:	digitalWrite(redLEDPin, LOW);
Line 30:	myServo.write(closeAngle);
Line 31:	_____ ; // buzzer makes a 1000HZ sound
Line 32:	delay(5000);
Line 33:	_____ ; // buzzer stops
Line 34:	lowlight = true;
Line 35:	}
...	...
...	...

Line 31: _____ (1)

Line 33: _____ (1)

- l. Suggest how the lines 31, 32 and 33 can be coded in **ONE** line.

_____ (1)

- m. It was noted that the threshold value needs to be adjusted according to the type of greenery inside the greenhouse. A potentiometer, connected to pin A1, was added to allow the user to adjust this threshold dynamically. The following code snippet in lines 24 and 25 was added to the program.

...	...
...	...
Line 23:	void loop()
Line 24:	int potValue = analogRead(____);
Line 25:	threshold = map(potValue, 0, 1023, 200, 800);
...	...
...	...

- i. Complete the code in Line 24.

(1)

- ii. The potentiometer readings must be converted to digital signals to be processed. Based on the given code, provide the Arduino ADC sampling level (number of bits). Explain.

(2)

- iii. Provide the possible range of values that the variable `threshold` can hold.

(1)

(Total: 41 marks)

Section B: Programming Task

Mastermind is a popular board game in which one player, the codemaker, creates a secret code using 4 coloured pins. Another player, the codebreaker, tries to guess the code by placing 4 pins on the board and match the correct sequence of colours.

In this version of Mastermind, the computer will be the codemaker and the player the codebreaker. The codemaker randomises a four coloured code from six available colours that are Blue, Green, Purple, Red, Yellow, and White. The colour code can contain repetitive colours.

The codebreaker tries to guess the code within ten turns. With every guess the codemaker should display the number of correct code positions. For example, if the secret code is RYPB and the user enters the code RYBB, the codemaker displays: Code positions guessed are 3, such as in the screenshot shown below:

```
Guess the Code >> ry bb
Correct guessed positions: 3
-----
```

This question continues on the next page.

For this task:

- Create a folder on the desktop. It should be named *SEC Computing – Index Number* (e.g. *SEC Computing – 99999*). All work must be saved in this project folder.
- Use Thonny IDE to write a Python program simulating this game with the following specifications:

Game Setup:

- a. The player starts with 5000 points, stored in a variable called `points`. (2)
- b. The player has ten (10) chances to guess the secret code. The number of guesses done by the player is stored in variable `num_of_guesses` and initialised to zero (0). (2)
- c. Define a tuple data structure, called `valid_colours`, to store the available colours: red, green, blue, yellow, purple, and white. (2)
- d. Randomly generate a 4-colour secret code which can include repeated colours. Store this code in a String variable called `secret_code`. This should not be visible to the player. (3)
- e. Upon starting, the program should:
 - i. display the game title: 'MasterMind'. (1)
 - ii. display initial game statistics, including the number of guesses used and the available points. (2)

* Check sample visual below:

```
*****  
MASTERMIND  
*****
```

```
Number of guesses: 0 | Available Points: 5000  
Guess the Code >>
```

Game Logic:

- f. The program prompts the player to enter a 4-colour code. Use the following abbreviations for colours: R for red, G for green, B for blue, Y for yellow, P for purple, and W for white. A sample input would be: GBYW (1)
- g. The program should remove any spaces included before, in, or after the player's guess. So, for example the input ' AB CD ' will be changed to 'ABCD'. (2)
- h. Validate the player's input to ensure that it contains only four (4) characters from the available colours. (2)
- i. The player's input comparison should **not** be case sensitive. (1)
- j. If the input is invalid,
 - i. display an error message; (1)
 - ii. prompt the player to try again without deducting points. (1)

- k. If the input is valid, compare the player's guess with the secret code.
- i. If the guess is incorrect: (1)
 - (a) deduct 500 points; (1)
 - (b) add one guess to the variable `num_of_guesses`; (1)
 - (c) display the number of code positions that have been rightly guessed. This should be stored in a variable called `guessed_positions`; (3)
 - (d) if 10 guesses have not been used, prompt the player to guess again; (2)
 - (e) if all 10 guesses have been used, display 'game over' and reveal the secret code. (3)

* Check sample visual below:

```

Number of guesses: 8 | Available Points: 1000
Guess the Code >> abcd
!! Invalid Guess !!

Guess the Code >> rybbx
!! Invalid Guess !!

Guess the Code >> ry  bb
Correct guessed positions: 3
-----

Number of guesses: 9 | Available Points: 500
Guess the Code >> rypb

GAME OVER | Secret Code is RYBP
>>> |

```

- ii. If the guess is correct, congratulate the player, display their final points and the total number of guesses used. (4)

* Check sample visual below:

```

Number of guesses: 3 | Available Points: 3500
Guess the Code >> rybp

***** YOU WON *****
Secret Code guessed after 4 guesses
Total Points: 4500
*****
>>> |

```

This question continues on the next page.

Code Quality:

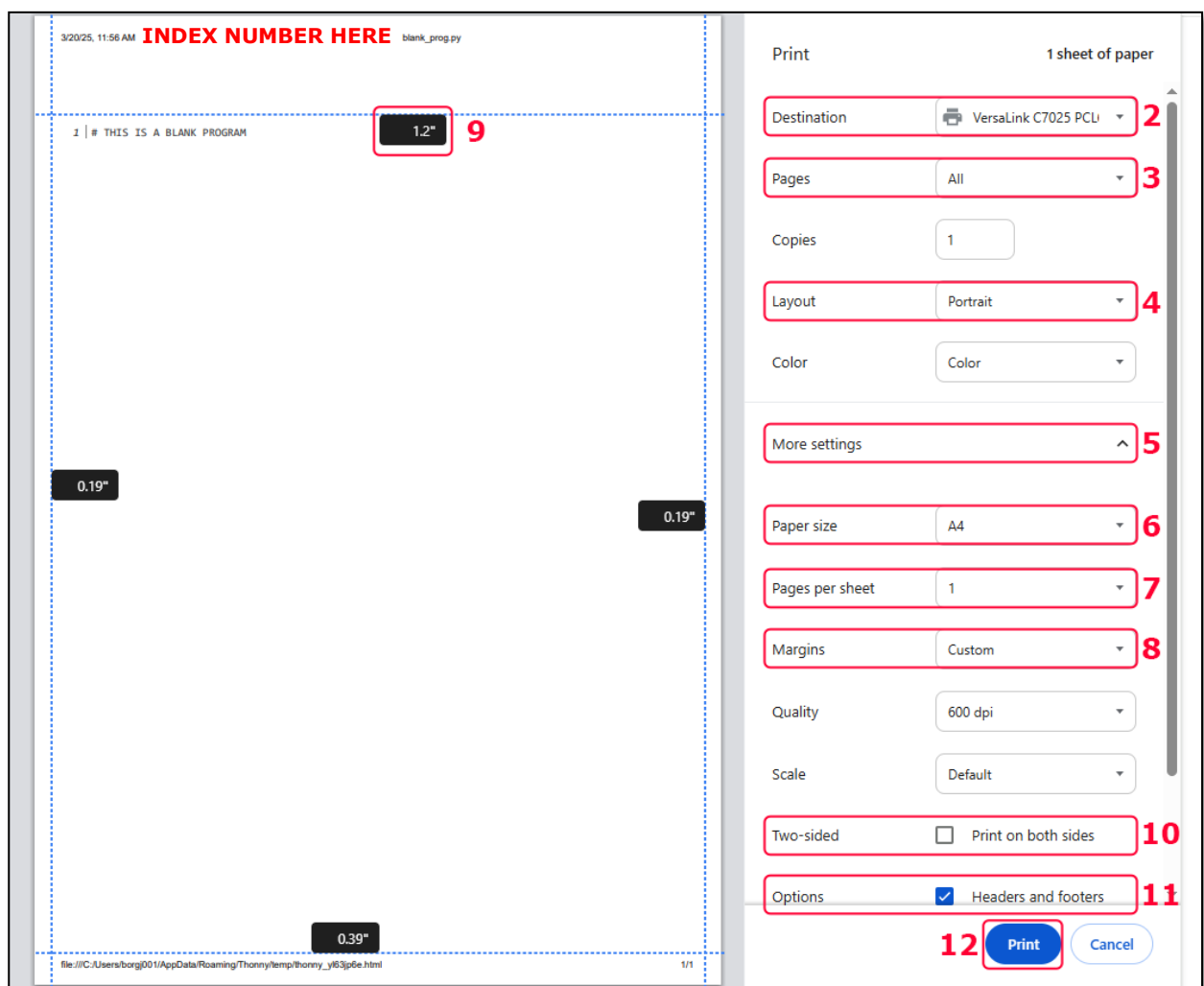
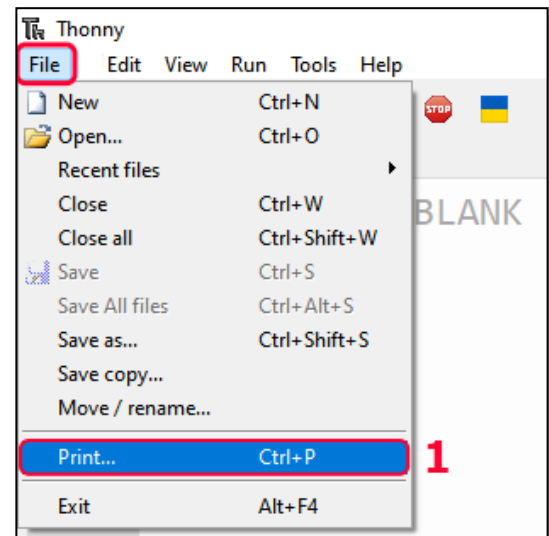
- I. The code should be modular and includes the below user-defined functions.
 - i. `show_feedback(guessed_positions, num_of_guesses, points)` (3)
This function should display feedback if the player's input does not match the secret code.
 - ii. `validate_code_input(player_input)` (4)
This function checks that the player's input is valid and returns True or False.
 - iii. `generate_secret_code()` (3)
This function returns a String with the randomly generated 4-colour code.
 - iv. `gameplay()` (2)
This function contains all the logic required for the game.
- m. The code should **not** include the use of global variables. (1)
- n. Use of meaningful variable names. (2)
- o. Use of proper inline comments. (2)
- p. Use of proper code indentation. (2)
- q. User-friendly interface:
 - i. Use blank lines (carriage returns) to separate different sections of the game for improved readability. (1)
 - ii. Enhance the presentation by displaying key messages within frames or other design elements. (1)
- r. The program runs without syntax and runtime errors. (2)
- s. Save the program as SEC2025_Mastermind.py in the folder that you have previously created on the desktop. (1)

(Total: 59 marks)

**Follow instructions to
print the source code
in the next page.**

Printing Instruction:

1. From the File main menu option choose Print...
2. Select the printer that will be used in the 'Destination' option.
3. Make sure to select All pages.
4. Make sure that the layout is set to Portrait.
5. Expand the More Settings section.
6. Make sure that the Paper size is A4.
7. Make sure that the 'Pages per sheet' option is set to 1.
8. Choose Custom Margin.
9. Change top margin to 1.2"
10. Untick the 'Print both sides' option.
11. Enable the 'Headers and Footers' option.
12. Press the Print button.
13. After printing, write down the Index Number in the header next to the Date and Time.



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EXAMINATIONS BOARD

**SECONDARY EDUCATION CERTIFICATE LEVEL
2025 MAIN SESSION**

SUBJECT: **Computing**
 PAPER NUMBER: II – Level 1-2
 DATE: 20th May 2025
 DURATION: 2 hours 5 minutes

Directions to Candidates

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Answer **ALL** questions in the spaces provided. You are **not** allowed to use extra sheets other than those provided in this booklet.

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For Markers' use only	Total number of marks obtained by candidate							
MARKS								

Section A

1. A Smart Control System is being developed to manage lighting, indoor environment, and security in an office building. Sensors, control panels, security cameras and other devices will be connected over a network.

a. Mention **TWO** advantages of networked devices over stand-alone devices.

_____. (2)

b. The control panels used to monitor and control the system will include an Embedded Operating System (OS). Provide **ONE** difference between an Embedded OS and a General-Purpose OS.

_____. (1)

c. The developers are considering including three types of User Interface (UI) for different users. These include Graphical User Interface (GUI), Command Line Interface (CLI), and Natural User Interface (NUI). Mention **ONE** difference between these types of UI.

_____. (3)

d. The developers will include a 'Backup and Restore' system utility as part of the OS. Describe **ONE** use of this utility.

_____. (1)

e. The system incorporates a database to hold records of administrators' login credentials and system access logs. Mention **TWO** advantages of using a database instead of manual record keeping.

_____. (2)

(Total: 9 marks)

2. A medical clinic uses an Internet of Things (IoT)-based system to monitor patients' health. Devices such as heart rate monitors, oxygen sensors, and digital thermometers are connected to a central server. Staff can track patients' vital signs in real-time, store data, and get alerts if any issues arise.

a. Describe the concept of the IoT.

_____. (1)

- b. An Ethernet connection was preferred over Wi-Fi for connecting the patient monitoring screens to the server. Mention **ONE** advantage and **ONE** disadvantage of an Ethernet connection.

 _____(2)

- c. Mention the network component within each IoT device that allows connection to the clinic's network system.

_____(1)

- d. Recommend a network device that should be connected to the server to provide Internet access.

_____(1)

- e. If the server is located on the ground floor, recommend a network device that would enhance Wi-Fi connectivity between medical devices located on different floors.

_____(1)

- f. Each networked device in the clinic has a Media Access Control (MAC) address and an Internet Protocol (IP) address. Mention **ONE** difference between MAC address and IP address.

 _____(1)

- g. It was decided that an IPv4 will be used instead of IPv6 for the clinic's private network. Provide **ONE** difference between IPv4 and IPv6.

 _____(1)

(Total: 8 marks)

3. A gaming company is developing a new system for a Virtual Reality (VR) gaming console. The system has two main components:

- **Game interface** that allows players to experience the VR world and interact with it using joypads and gestures. This is programmed in a High-Level Language (HLL).
- **Firmware** that controls the hardware inside the VR headset, so it responds to movements and actions in real time. This is programmed in a Low-Level Language (LLL).

- a. Tick whether the following programming languages are HLL or LLL.

Python	☐ HLL	☐ LLL
Assembly	☐ HLL	☐ LLL
SQL	☐ HLL	☐ LLL
JAVA	☐ HLL	☐ LLL

(2)

This question continues on the next page.

b. The source code of both the game console interface and the firmware needs to be translated to executable code.

i. Define source code and executable code.

Source code: _____ (1)

Executable code: _____ (1)

ii. List **THREE** different types of programming language translators.

_____ (3)

c. Tick whether the game console interface and the firmware that controls the console's hardware are system software or application software.

Game Console Interface	☐ System software	☐ Application software
Firmware	☐ System software	☐ Application software

(2)

d. The gaming console has a propriety license that gives users the right to use the game console interface with the hardware they purchased.

i. Define the concept of a software license.

_____ (1)

ii. List **ONE** other type of software license.

_____ (1)

(Total: 11 marks)

4. Digital systems rely on binary operations to process and manage data. Considering a system that uses Two's Complement 8-bit registers, answer the following questions.

a. Briefly explain why digital systems use binary to represent and process data.

_____ (1)

b. Convert the decimal value 68 to binary number. Show your working.

(2)

c. Use bit-shift operations to:

- i. Double the value of 68_{10} .

(1)

- ii. Divide 68_{10} by 4.

(2)

d. Perform the below binary arithmetic operations:

- i. Binary addition of $00000010_2 + 00000011_2$. Show your working.

(2)

- ii. Binary subtraction $68_{10} - 7_{10}$. Show your working.

(4)

(Total: 12 marks)

Section B

5. A local council manages ongoing town projects, including details about the supervisors assigned to each project and the contractors working on them. All this information is stored in a database.

a. Analyse the database sample records shown below and answer the questions that follow.

Supervisor

supervisor_id	name	contact
1245784M	Joseph Vella	68001234
8764576M	Maria Attard	68234567
6547390M	Claire Borg	68345678

This question continues on the next page.

Contractor

contractor_id	name	contact
5426181M	BuildCo Ltd.	69456789
3478970M	GreenScape Ltd.	69654321
7698543M	ABC Construction	69876543

Project

project_id	name	address	supervisor_id	contractor_id
0001	Renovazzjoni tal-Kunsill	Valletta	8764576M	5426181M
0002	Ġnien il-Ġonna Ġodda	Sliema	1245784M	7698543M
0003	Espansjoni tal-Iskola	Mosta	6547390M	3478970M

i. Identify the tables used in this database.

(3)

ii. Identify the primary keys used in each table.

(3)

iii. Identify the foreign keys used.

(2)

iv. What is the result if the below query is executed?

```
SELECT *
FROM Contractors
WHERE contractor_id = '5426181M';
```

(3)

v. Modify the query shown below so that it outputs the following result.

Query	Result
<pre>SELECT * FROM Project;</pre>	Espansjoni tal-Iskola, Mosta Ġnien il-Ġonna Ġodda, Sliema Renovazzjoni tal-Kunsill, Valletta

(3)

- b. The Python code snippet below performs a data validation check on the name entered for each contractor.

Line 1:	<code>names = []</code>
Line 2:	<code>contractor_name = ""</code>
Line 3:	<code>while contractor_name == "":</code>
Line 4:	<code> contractor_name = input("Enter Contractor Name: ").strip()</code>
Line 5:	<code> if contractor_name == "":</code>
Line 6:	<code> print("Contractor name cannot be left empty")</code>
Line 7:	<code> else:</code>
Line 8:	<code> names.append(contractor_name)</code>

- i. Define data validation.

_____ (1)

- ii. Give the type of data structure used.

_____ (1)

- iii. Mention the type of looping construct used.

_____ (1)

- iv. Describe the purpose of the `.strip()` String function in Line 4.

_____ (1)

- v. Describe what happens in Line 8.

_____ (1)

- vi. State in which case the message 'Contractor name cannot be left empty' will be displayed.

_____ (1)

- vii. Provide the instance which will terminate the loop.

_____ (1)

- c. A firewall is required to secure the database. Define the term firewall.

_____ (1)

(Total: 22 marks)

Please turn the page.

6. A laser distance meter device can measure straight-line distances, add distances in sequence, and calculate area, perimeter, and volume.

a. This device is equipped with a microcontroller with the following specifications.

CPU	ROM	RAM	Flash Memory
120 MHz ARM Cortex-M4	1 MB	64 KB	16 KB

i. Identify the primary memory components of this device.

_____ (2)

ii. What is the capacity of the secondary storage component of this device?

_____ (1)

iii. The internal flash memory is built using NAND and NOR logic gates, known as 'universal gates'. Represent these gates using their symbol.

NAND	NOR

_____ (2)

iv. The laser distance meter uses SPIFFS filing system to manage its internal storage. List **TWO** other filing systems.

_____ (2)

v. The laser meter shows distance readings on a 160x128 pixel screen that displays black-only characters. Identify the resolution and the bit-depth of this screen.

Resolution: _____ (1)

Bit-Depth: _____ (1)

vi. The CPU of the laser distance meter has a 32-bit word length. Define the term word length.

_____ (1)

vii. The device has a 16-bit address bus, providing access to 65,536 memory locations. Describe the relationship between the address bus and the address space.

_____ (1)

- b. Below is a program snippet in assembly language that calculates the area when given the length and width.

```

LOAD R1, length    ; copy the value of memory location called 'length' to register R1.
LOAD R2, width     ; copy the value of memory location called 'width' to register R2.
MUL R3, R1, R2     ; multiply the values of registers R1 and R2 and store in register R3.
STORE R3, area     ; store value of register R3 in memory location called 'area'.

```

- i. Identify **ONE** opcode and **ONE** operand.

Opcode: _____ (1)

Operand: _____ (1)

- ii. The main function of the CPU is to perform the Fetch and Execute cycle. Define the Fetch and Execute cycle.

 _____ (1)

- iii. The system bus plays a crucial role in the Fetch and Execute cycle. Briefly describe its purpose.

 _____ (1)

- iv. List the **THREE** main buses that make up the system bus.

 _____ (3)

- v. The Control Unit (CU) requires the assistance of the Arithmetic and Logic Unit (ALU) to execute the MUL instruction. It then stores the result in Accumulator R3. Briefly describe the function of the CU, ALU and Accumulator.

CU: _____ (1)

ALU: _____ (1)

Accumulator: _____ (1)

(Total: 21 marks)

Please turn the page.

7. A wildlife research team is creating a system to track the activity of animals that are active at night in a forest. The Python code below is part of the system, designed to turn on a thermal camera based on motion detection, light levels, and temperature.

a. It is proposed that the system will be powered by a microcontroller. Define microcontroller.

_____ (1)

b. The algorithm for this system will continuously check readings from three sensors and switches the thermal camera ON if:

- PIR sensor detects a motion and the temperature sensor reading is below 10°C, or
- PIR sensor detects a motion and the light sensor detects nighttime.

i. Define the term algorithm.

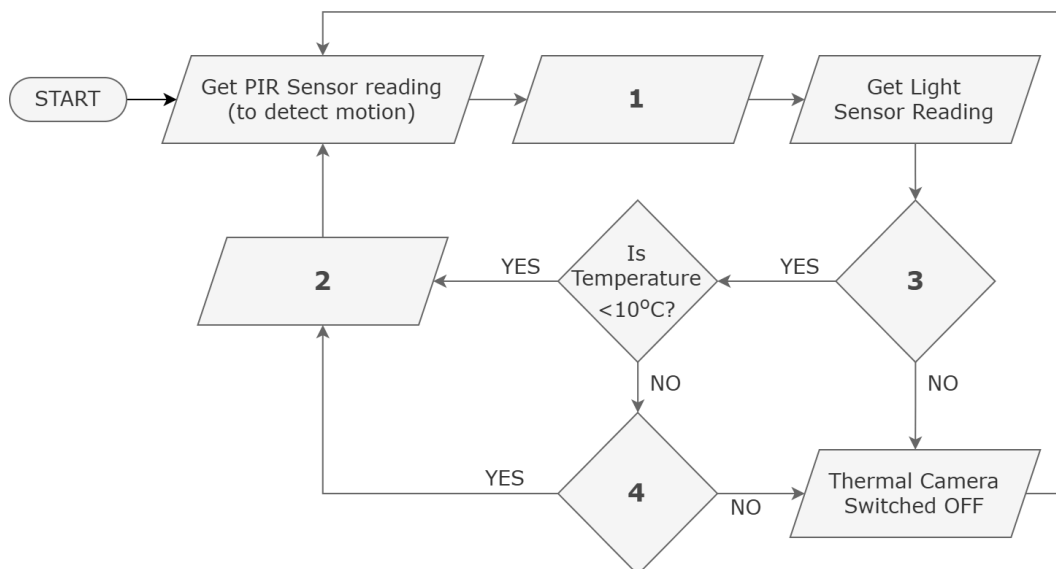
_____ (1)

ii. Identify examples of data and information within this system.

Data: _____ (1)

Information: _____ (1)

iii. Complete the flowchart shown below that represents the algorithm of this system.



1: _____ (1)

2: _____ (1)

3: _____ (1)

4: _____ (1)

- c. A serial data transfer is suitable for transmitting the data generated by the sensors to the microcontroller. Define serial data transfer.

_____ (1)

- d. The PIR sensor transmits digital data, while the light and temperature sensors transmit analogue data that must be converted to digital form by an Analog-to-Digital Converter (ADC) within the microcontroller.

- i. Define analogue data.

_____ (1)

- ii. Define digital data.

_____ (1)

- iii. Define ADC.

_____ (1)

- e. If the algorithm to activate the thermal camera had to be represented using logic gates, whereby M refers to motion, D refers to daylight, C refers to cold temperature, and T refers to thermal camera, its Boolean expression would be:

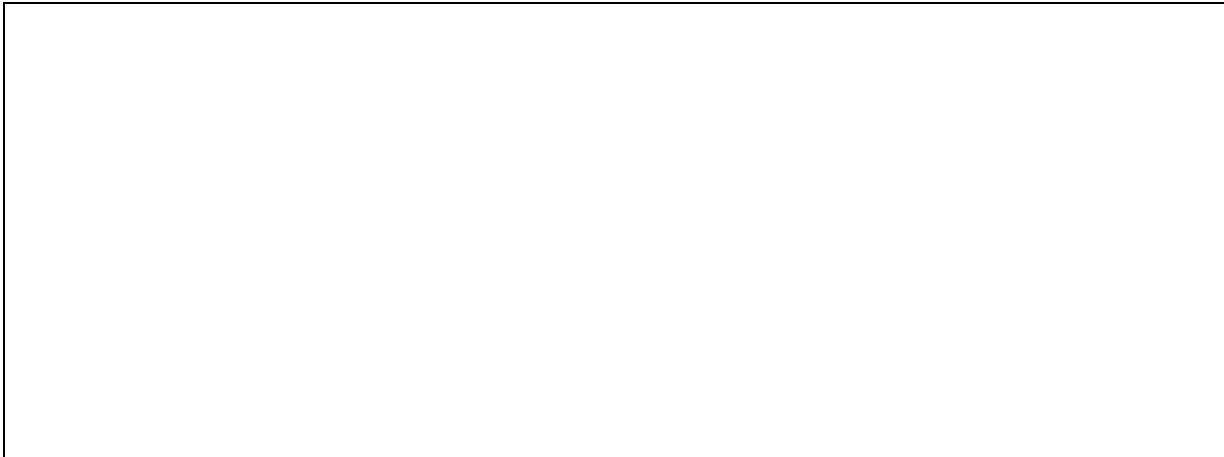
$$T = (M \text{ AND } NOT(D)) \text{ OR } (M \text{ AND } C)$$

- i. Create its truth table showing **all** input combinations and their corresponding output.

_____ (2)

This question continues on the next page.

- ii. Draw its logic circuit diagram using AND, OR and NOT gates.



(3)

(Total: 17 marks)



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a. Mention **TWO** advantages of networked devices over stand-alone devices.

_____. (2)

b. The control panels used to monitor and control the system will include an Embedded Operating System (OS). Provide **ONE** difference between an Embedded OS and a General-Purpose OS.

_____. (1)

c. The developers are considering including three types of User Interface (UI) for different users. These include Graphical User Interface (GUI), Command Line Interface (CLI), and Natural User Interface (NUI). Mention **ONE** difference between these types of UI.

_____. (3)

d. The developers will include a 'Backup and Restore' system utility as part of the OS. Describe **ONE** use of this utility.

_____. (1)

e. The system incorporates a database to hold records of administrators' login credentials and system access logs. Mention **TWO** advantages of using a database instead of manual record keeping.

_____. (2)

(Total: 9 marks)

2. A medical clinic uses an Internet of Things (IoT)-based system to monitor patients' health. Devices such as heart rate monitors, oxygen sensors, and digital thermometers are connected to a central server. Staff can track patients' vital signs in real-time, store data, and get alerts if any issues arise.

a. Briefly describe the concept of the IoT.

_____. (1)

- b. An Ethernet connection was preferred over Wi-Fi for connecting the patient monitoring screens to the server. Mention **ONE** advantage and **ONE** disadvantage of an Ethernet connection.

(2)

- c. Mention the network component within each IoT device that allows connection to the clinic's network system.

(1)

- d. Recommend a network device that should be connected to the server to provide Internet access.

(1)

- e. If the server is located on the ground floor, recommend a network device that would enhance Wi-Fi connectivity between medical devices located on different floors.

(1)

- f. Each networked device in the clinic has a Media Access Control (MAC) address and an Internet Protocol (IP) address. Mention **ONE** difference between MAC address and IP address.

(1)

- g. It was decided that an IPv4 will be used instead of IPv6 for the clinic's private network. Provide **ONE** difference between IPv4 and IPv6.

(1)

(Total: 8 marks)

3. A gaming company is developing a new system for a Virtual Reality (VR) gaming console. The system has two main components:

- **Game interface** that allows players to experience the VR world and interact with it using joypads and gestures.
- **Firmware** that controls the hardware inside the VR headset, so it responds to movements and actions in real time.

- a. Explain why a 4th Generation Language (4GL) is **not** a suitable programming language for developing the game interface.

—(1)

This question continues on the next page.

- b. Explain why Assembly language is more appropriate than Python for programming the firmware that controls the hardware.

_____(1)

- c. When developing the VR gaming console, the developers write the source code. However, before the product is sold to users, this source code must be translated into executable code.

- i. Explain why the source code must be translated to executable code.

_____(1)

- ii. Mention the type of translator that translates the source code of the VR firmware into executable code.

_____(1)

- iii. Mention the type of translator that is required to translate the source code of the game interface into executable code. Explain your choice.

_____(2)

- d. The game console interface is said to be an application software. Justify this statement.

_____(1)

- e. The gaming console allows users to download and store games on its internal storage. Additionally, it offers an optional cloud-based gaming service that enables users to play games stored in the cloud.

- i. Mention **ONE** reason why the user should use the cloud-based gaming service.

_____(1)

- ii. The cloud-based gaming service offers a small selection of games for free, but users must purchase a one-time license to access the entire collection of games available on the platform. Recommend the most appropriate software license for this service. Explain your choice.

_____(2)

(Total: 10 marks)

4. Digital systems rely on binary operations to process and manage data. Considering a system that uses Two's Complement 8-bit registers, answer the following questions.

a. Briefly explain why digital systems use binary to represent and process data.

_____ (1)

b. Convert the decimal value 68 to binary number. Show your working.

(2)

c. Use a bit-shift operation to:

i. Double the value of 68_{10} .

_____ (1)

ii. Halve the value of 68_{10} .

_____ (1)

d. Explain why 68_{10} cannot be multiplied by 4.

_____ (1)

e. Perform the below binary arithmetic operations:

i. Binary addition of $00000010_2 + 00000011_2$. Show your working.

(2)

ii. Binary subtraction $68_{10} - 7_{10}$. Show your working.

(4)

f. Briefly explain why the Half Adder is **not** a suitable logic circuit to calculate the binary addition performed in part e (i) above.

_____ (1)

(Total: 13 marks)

Section B

5. A local council manages ongoing town projects, including details about the supervisors assigned to each project and the contractors working on them.

Local council personnel use a tailor-made software application, called ProjectsTrack, to view and manage all related records. ProjectsTrack is connected to a database stored on a server.

The database design is represented in the Entity-Relationship Diagram (ERD) below.



- a. Analyse the ERD and answer the questions that follow.

- i. Briefly explain why a database is required in this scenario.

_____ (1)

- ii. Identify the foreign keys used in this database.

_____ (2)

- iii. Can a project have more than one contractor working on it? Justify your answer.

_____ (2)

- b. The Python code snippet below performs a data validation check on the id entered for supervisors and contractors to ensure that it includes seven digits and an ending letter.

```

Line 1: def check_id_format(id):
Line 2:     end_char = ('A', 'M', 'L', 'G', 'H')
Line 3:     if len(id) == 8:
Line 4:         if id[:7].isdigit():
Line 5:             if id[7] in end_char:
Line 6:                 return True
Line 7:     return False
  
```

- i. Provide the data type of the parameter id.

_____ (1)

ii. Mention the type of data structure used.

_____ (1)

iii. Distinguish between `id[:7]` found in Line 4 and `id[7]` found in Line 5.

_____ (1)

iv. Suggest a modification in Line 5 so that both uppercase and lowercase letters are accepted.

_____ (1)

v. Indicate which lines of code make up a nested if structure.

_____ (1)

vi. Suggest how the nested if structure can be rewritten to use only one if statement.

_____ (1)

c. Recommend **TWO** other data validation checks needed for the supervisor table.

_____ (2)

d. The server hosting the database has a multi-tasking OS. Mention **ONE** difference from a single-task OS.

_____ (1)

e. Analyse the below sample records, belonging to the table's contractor and project, and answer the questions that follow.

contractor_id	name	contact
5426181M	BuildCo Ltd.	68456789
3478970M	GreenScape Ltd.	68654321
7698543M	ABC Construction	68876543

project_id	name	address	supervisor_id	contractor_id
0001	Renovazzjoni tal-Kunsill	Valletta	1245784M	5426181M
0002	Ġnien il-Ġonna Ġodda	Sliema	8764576M	7698543M
0003	Espansjoni tal-Iskola	Mosta	6547390M	3478970M

This question continues on the next page.

- i. What is the result of the following query?

```
SELECT *
FROM contractors
WHERE contractor_id = '5426181M';
```

(3)

- ii. Write an SQL query that outputs the following result.

Espansjoni tal-Iskola, Mosta Ġnien il-Ġonna Ġodda, Sliema Renovazzjoni tal-Kunsill, Valletta
--

(3)

- f. Justify the need for a firewall and an HTTPS connection to secure the data stored in this database.

(2)

(Total: 22 marks)

6. A laser distance meter device can measure straight-line distances, add distances in sequence, calculate area, perimeter, and volume. Distances and results are shown on its screen.

- a. This device is equipped with a microcontroller that has the following specifications.

CPU	ROM	RAM	Flash Memory
120 MHz, 32-bit ARM Cortex-M4	1 MB	64 KB	16 KB

- i. Explain why ROM is used to store the device firmware, which includes the OS and measurement algorithms, whilst RAM is used to store raw sensor data and intermediate calculations.

(2)

- ii. The flash memory is built using NAND and NOR gates, known as 'universal gates'. Mention **ONE** advantage of using universal gates.

(1)

- iii. Indicate whether the CPU of the laser distance meter performs better compared to a CPU with a 16-bit word length. Explain.

_____ (2)

- iv. The device's OS requires a minimum of 18 KB of RAM to run. If the device had an 8-bit address bus and a byte-addressable RAM, would it be capable of running the OS? Justify your answer.

_____ (2)

- b. The laser distance meter's CPU understands the Load/Store instruction set. Briefly describe the function of an instruction set.

_____ (1)

- c. Analyse the below assembly program snippet and answer the questions that follow.

LOAD R1, length	; copy the value of memory location called 'length' to register R1.
LOAD R2, width	; copy the value of memory location called 'width' to register R2.
MUL R3, R1, R2	; multiply the values of registers R1 and R2 and store in register R3.
STORE R3, result	; store value of register R3 in memory location called 'result'.

- i. Briefly describe the overall function of this assembly program. (Do **not** provide a line-by-line description).

_____ (1)

- ii. Mention the CPU component that fetches the LOAD instruction from memory.

_____ (1)

- iii. Mention the bus that transfers the value from memory location 'length' to register R1.

_____ (1)

- iv. Mention the CPU component that executes the MUL instruction.

_____ (1)

- v. Mention the register that functions as the Accumulator. Explain.

_____ (2)

This question continues on the next page.

vi. Mention the signal that is sent to RAM via the control bus to execute the STORE instruction.

_____ (1)

vii. If the assembly program had to be written in Python, mention the **THREE** variables that will be required.

_____ (3)

(Total: 18 marks)

7. A wildlife research team is creating a system to track the activity of animals that are active at night in a forest. The Python code below is part of the system, designed to turn on a thermal camera based on motion detection, light levels, and temperature.

```
Line 1:  while (True):
Line 2:  # returns True if a motion is detected by the PIR sensor
Line 3:  motion = read_PIR_Sensor()
Line 4:  # returns True if it is daylight
Line 5:  daylight = check_light_sensor()
Line 6:  # returns True if temperature sensor reading is below 10°C
Line 7:  cold_temp = check_temp_sensor()

Line 8:  if (motion == True and daylight == False) or
          (motion == True and cold_temp == True):
Line 9:      thermal_camera(True)
Line 10: else:
Line 11:      thermal_camera(False)
```

- a. This system will be controlled by an ESP32 microcontroller. Briefly justify the use of a microcontroller instead of a System on Chip (SoC) technology to run this system.

_____ (1)

- b. Explain **ONE** reason why parallel data transfer is **not** suitable for transmitting the data generated by the sensors to the microcontroller.

_____ (1)

- c. The PIR sensor transmits digital data, whilst the light and temperature sensors transmit analogue data.

i. Distinguish between analogue and digital data.

_____ (1)

- ii. Mention **TWO** factors why a 10-bit Analogue-to-digital (ADC) is preferred over a 16-bit ADC in this system.

_____ (2)

- d. Analyse the Python code and answer the following questions.

- i. Identify the line of code that has an infinite loop.

_____ (1)

- ii. The Python interpreter causes a syntax error when running the program. Suggest a solution to fix this error.

_____ (2)

- iii. Identify **ONE** user-defined function that returns a Boolean value.

_____ (1)

- iv. Identify **ONE** user-defined function that accepts a Boolean argument.

_____ (1)

- v. Draw the flowchart of the function `check_temp_sensor()`.

_____ (3)

This question continues on the next page.

e. If the algorithm to activate the thermal camera had to be represented using logic gates, whereby M refers to motion, D refers to daylight, C refers to cold temperature, and T refers to thermal camera:

i. Create its truth table showing **all** input combinations and their corresponding output.

--

(2)

ii. Draw its logic circuit diagram using AND, OR and NOT gates.

--

(4)

iii. Write its Boolean expression.

(1)

(Total: 20 marks)