higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

INTRODUCTION TO ROBOTICS
NQF LEVEL 3
(Second paper)

(10041053)

3 December 2024 (X-paper)
09:00–13:00

This question paper consists of 6 pages.

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INTRODUCTION TO ROBOTICS
NQF LEVEL 3
(Second paper)
TIME: 4 HOURS
MARKS: 80

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Download all necessary files from the server as allocated by your lecturer.
5. Scripts should be saved to the server as directed by your lecturer. Write your name and student number in the first line of any scripts used.
6. Photographic evidence must be obtained of your physical artefacts and saved to the server as directed by your lecturer.
7. Use only a black or blue pen.
8. Write neatly and legibly.

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QUESTION 1

Read the scenario below and complete the questions that follow:

A local park needs an automated dustbin to keep the area clean. The dustbin should automatically open when someone approaches to dispose of trash and should also monitor how full it is, alerting the maintenance team when it needs to be emptied.

You are tasked with creating a prototype of this automated dustbin. The requirements are as follows:

- Detect when a person approaches the dustbin using an ultrasonic sensor.
- Automatically open the dustbin lid when a person is detected.
- Keep the lid open for a set duration and then close it.
- Monitor the fill level of the dustbin using a second ultrasonic sensor.
- Activate an LED and buzzer to alert when the dustbin is full.
- Continuously repeat the process to ensure the dustbin operates autonomously.

You have the following resources:

- 1 × Arduino Uno
- 2 × Ultrasonic distance sensor (HC-SR04)
- 1 × Servo motor (SG90 or similar)
- 1 × LED Indicator
- 1 × Buzzer
- Resistors (as needed)
- Breadboard
- Jumper wires (as needed)

1.1 Name FIVE examples of how robots can improve public cleanliness in urban areas. (5)

1.2 Create a new Arduino sketch for this project and write the code to fulfil all the criteria. You will be marked according to the following rubric:

Criteria	3 Marks	2 Marks	1 Mark	0 Marks
Planning	Planning present and well thought out. Flow diagram used.	Planning evident but lacks detail or flow.	Minor planning evident.	No Planning Evident
Pin and variable definitions		Pins and variables correctly declared and instantiated.	Incorrect pin and variable declarations.	Missing pin and variable declaration
Initialisation and Setup	Correct setup and initialisation of all components.	Setup and initialisation done with errors.	Incorrect setup and initialisation.	Missing setup and initialisation
Code logic and operations	Code runs as expected with no errors.	Code runs but has minor logical errors.	Code runs but has major errors.	Code does not run
Comments		Clear and extensive comments used.	Incorrect comments.	no comments

(13)

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1.3 Setup and correctly wire the project according to the requirements. You will be marked according to the following rubric:

Criteria	6 Marks	4 Marks	2 Marks	0-1 Marks
Arduino wiring and connections		Correct pins used for components. Safe wiring and powering of Arduino.	Some wiring issues or incorrect pin connections.	Incorrect or unsafe wiring and pin connections.
Component wiring and connections		All components wired correctly and safely for operation	Some components wired incorrectly or with issues.	Incorrect or unsafe wiring of com
Operation of artefact	Prototype works correctly and meets all criteria.	Prototype works with minor issues.	Prototype has significant issues or only partially meets criteria.	Prototype does not work or fails to meet criteria.

(14)

1.4 Write a short user manual for the project. The user manual should include the following:

- Artefact name and description
- Basic operations
- Troubleshooting
- Frequently asked questions (FAQs)

Provide ONE example of each and an explaination/ description of each example. (8)

[40]

QUESTION 2

You are tasked with designing an IoT app that uses a DHT11 or DHT22 sensor to monitor temperature and light up RGB LEDs to indicate different temperature ranges. The temperature readings should be viewable from a local browser page. You will also be modifying and preparing a 3D print file for the sensor.

The requirements are as follows:

- Monitor temperature using a DHT11 sensor.
- Light up the RGB LED to indicate different temperature ranges (e.g., blue for cold, green for moderate, red for hot).
- Display the current temperature on a local web page that can be accessed from a browser.
- Update the LED colour based on the real-time temperature readings.

You have the following resources:

- 1 × DHT11 OR DHT22 temperature and humidity sensor
- 1 × RGB LED (Common Anode or Common Cathode)
- Resistors (as needed)
- 1 × ESP32 OR ESP8266 (Microcontroller with Wi-Fi capability)
- Breadboard
- Jumper Wires (as needed)

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2.1 Open the file "**DHT11_Case_Body.stl**" in any slicing software. Prepare the design by setting:

- The resolution to 0.2mm.
- The wall thickness to 1mm (top and bottom)
- Enabling a brim adhesion layer.
- There should not be any supports and the infill should remain at the default setting (20%).

Take a screenshot of the settings and save the screenshot to the server. Save the .stl file and export the model for 3D printing.

DHT11 Sensor Module Case
by telekineticyeti is licensed under the Creative Commons - Attribution license.
https://www.thingiverse.com/thing:3494647/files

(4)

2.2 The current HTML concatenation functionality can be used for your project:

TEMP *refers to the temperature reading from your code and should be replaced with your reading on line 2 below.*

```
1.  String html = "<html><body><h1>Temperature Monitoring</h1>";
2.  html += "<p id='temp'>Temperature: " + *TEMP* + " °C</p>";
3.  html += "<script>";
4.  html += "function reloadPage() {";
5.  html += "    window.location.reload();";
6.  html += "}";
7.  html += "setInterval(reloadPage, 5000);";
8.  html += "</script></body></html>";
9.  request->send(200, "text/html", html);
```

- Create another element that displays the temperature in °F. Remember: °F=(°C×9/5)+32.
- The page should reload every 10 seconds.

This code will be marked in your project code that you write in 2.3. (4)

2.3 Write the Arduino sketch for this project. You will be marked according to the following criteria:

Criteria	5 Marks	3 Marks	2 Marks	0 Mark
Planning		Planning present and well thought out. Flow diagram used.	Planning evident but lacks detail or flow.	Little to no planning evident.
Initialisation and Setup	Correct setup and initialisation of all components.	Minor errors in the initialisation of one of the components.	Setup and initialisation done with errors.	Incorrect or missing setup and initialisation.
Code logic and operations	Code runs as expected with no errors.	Code runs but has minor logical errors.	Code runs but with significant logical errors.	Code does not run or has major errors.
Comments			Clear and extensive comments used.	Little to no comments or incorrect comments.
Web library setup and utilisation	Correctly setup web server that responds to a local request.	Correctly setup web server with minor issues on request handling.	Some errors in web server setup with issues in request handling	Web server not setup or major faults in setup.

(20)

2.4 Setup and correctly wire the project according to the requirements. You will be marked according to the following rubric:

Criteria	4 Marks	2 Mark	0 Marks
Arduino wiring and connections	Correct pins used for components. Safe wiring and powering of Arduino.	Some wiring issues or incorrect pin connections.	Incorrect or unsafe wiring and pin connections.
Component wiring and connections	All components wired correctly and safely for operation	Some components wired incorrectly or with issues.	Incorrect or unsafe wiring of com
Operation of artefact	Prototype works correctly and meets all criteria.	Prototype has significant issues or only partially meets criteria.	Prototype does not work or fails to meet criteria.

(12)
[40]

TOTAL: 80

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