UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 3 Examination in Engineering: March 2026

Module Number: ME3210 Module Name: Principles and Application of Microcontrollers (C-23)

[Three Hours]

[Answer **all questions**; each question carries **10** marks]

(Refer to Figure 3: Arduino UNO pin diagram wherever necessary.)

Q1. a) What is a microcontroller? Explain why it is called a *"computer on a chip"*.

[2.0 Marks]

b) Briefly explain the Von Neumann and Harvard architectures, and state two advantages and one disadvantage associated with each.

[3.0 Marks]

c) Briefly explain the central processing unit (CPU) structure of a micro controller.

[2.0 Marks]

d) Differentiate between Program Memory and Data Memory, and provide two appropriate examples of each.

[3.0 Marks]

Q2. a) What is the function of a Watchdog timer?

[1.0 Marks]

b) Explain the working principle of an interrupt and list **two** types of interrupts.

[3.0 Marks]

c) Explain the difference between volatile and non-volatile memory with two examples.

[3.0 Marks]

d) Briefly describe the use of internal pull-up resistors of a microcontroller.

[3.0 Marks]

Q3. A line-following robot is designed using an Arduino microcontroller, infrared (IR) sensors, and two DC motors controlled through a motor driver module. The robot is required to follow a black line on a white surface by detecting the line position using the sensors and adjusting the motor speeds accordingly.

Answer the following questions.

Q3. Continues to the next page

a) What is Pulse Width Modulation (PWM) in digital systems? Explain how PWM is used to control the speed of a DC motor.

[3.0 Marks]

b) A line-following robot uses two infrared sensors (left sensor and right sensor) to detect the line on the ground.

Construct a **logical flowchart** that describes the control algorithm of the robot based on the following conditions:

- If both sensors detect the line, the robot should move forward.
- If only the left sensor detects the line, the robot should turn left.
- If only the right sensor detects the line, the robot should turn right.
- If neither sensor detects the line, the robot should stop or search for the line.

[3.0 Marks]

c) Write a simple pseudocode for the Arduino program that implements the control logic of the line-following robot described in - **Q3 (b)**.

Your answer should include:

- Initialization of input and output pins
- Reading sensor values
- Decision-making logic
- Motor control actions

[4.0 Marks]

Q4. The Figure 1 and Figure 2 shows the pin arrangement of the L298N Motor Driver Module and the pin arrangement of the 8 Channel IR Line Tracking Sensor Module respectively.

a) Draw a clearly labelled circuit diagram showing how the L298N Motor Driver Module can be connected to **two DC motors** and an **ArduinoUNO.** Use only the following Arduino pins for the connections:
(PWM pins: D5, D6; Digital pins: D8, D9, D10, D11; Power pins: 5V, GND).

[4.0 Marks]

b) Draw a clearly labelled circuit diagram showing how the sensor module can be connected to an Arduino UNO to detect a line, for a line-following robot.

Use only the following Arduino pins for the connections:

Digital input pins: D2, D3, D4, D5, D6, D7, D8, D9
Power pins: 5V, GND
Digital output pin: D10 (for IR control)

[4.0 Marks]

Q4. Continues to the next page

c) Define signal isolation and explain its importance in microcontroller-based systems.

[2.0 Marks]

Q5. Sensors and actuators are essential components in embedded systems that use microcontrollers for monitoring and control of physical processes.

a) Briefly explain the role of sensors and actuators in a microcontroller-based embedded system.

[2.0 Marks]

b) Define the terms sensor and transducer. Then compare the similarities and differences between them.

[2.0 Marks]

b) Explain the concept of **signal conditioning** and describe, with relevant examples, its importance in interfacing sensors with microcontrollers within embedded systems.

[3.0 Marks]

c) Briefly describe the working principle of the following sensors and the type of signal they produce:
   i) Resistance Temperature Detector (RTD – Pt100)
   ii) Ultrasonic distance sensor (HC-SR04)
   iii) Light Dependent Resistor (LDR)

[3.0 Marks]

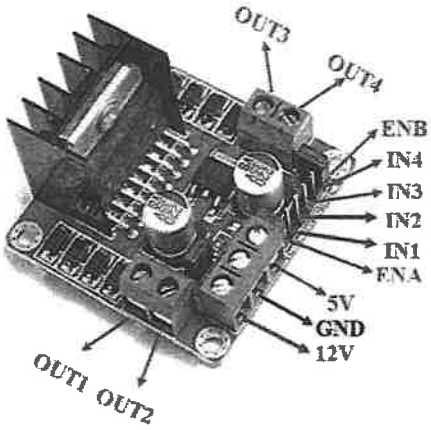

Figure 1 : Pin arrangement of the L298N

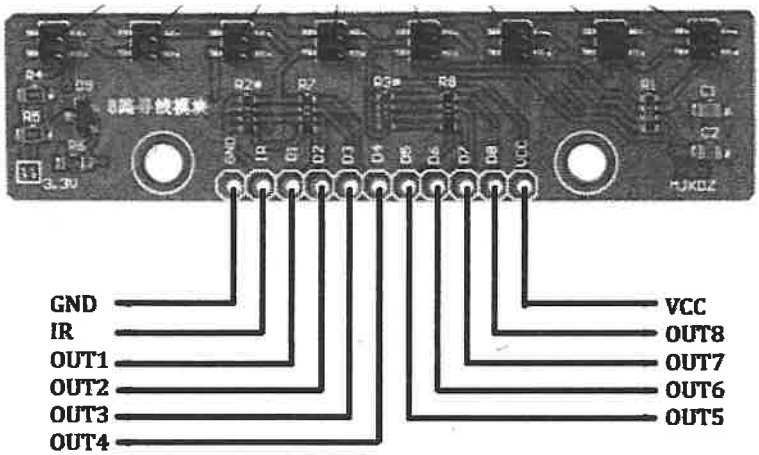

Figure 2: Pin arrangement of the 8 Channel IR Line Tracking Sensor Module

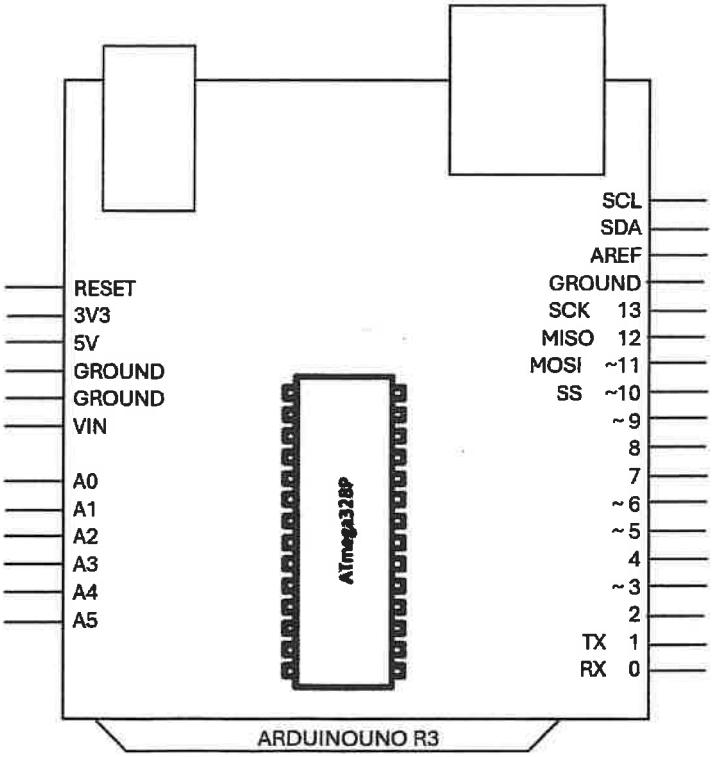

Figure 3 : Arduino UNO pin diagram