The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical & Computer Engineering

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code	**: EEX4436**
Title	**: Microprocessors and Interfacing**
Academic Year	: 2023/24
Date	: 14th March 2025
Time	: 0930-1230hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Four (4)** questions in **SECTION A** [70 Marks] and **two (2)** questions [30 Marks] in **SECTION B** on **Five (5)** pages.
3. Answer **ALL Questions.**
4. The answer to each question should commence from a new page.
5. This is a Closed Book Test (CBT).
6. Answers should be in clear handwriting.
7. Do not use Red colour pens.

Special Instructions

- When you write any Assembly Language Program (ALP), you need to provide appropriate comments where necessary. **Full marks will only be given to correct programs with comments**.
- Refer **datasheet of the 8051 microcontrollers (given separately)** when you answer the questions in this paper. **Do not attach it to the answer script.**
- State your assumptions (if any) clearly.

Section A

Answer all questions [70 Marks]

Automatic Car Washing System (ACWS)

The Automatic Car Washing System (ACWS) is an 8051 microcontroller-based automated solution designed to clean vehicle exteriors through sequential operations. The system integrates mechanical, electrical, and electronic components to execute a fully automated washing process. It supports vehicles weighing up to **2000 kg** and follows a structured five-stage workflow including entering/parking the vehicle.

The ACWS operates as a drive-through system divided into distinct stages. A vehicle first enters the parking bay, where sensor **S1** detects its presence and initiates the process. The conveyor belt, controlled by a PWM-driven motor (**M**) at **25% duty cycle**, moves the vehicle forward after a **5-second delay**.

You are required to analyse and design the **ACWS** (Figure 1) according to the given requirements.

Washing Process

1. Pre-Wash Phase
   A movable spray mechanism travels bidirectionally (front-to-back and back-to-front) to coat the vehicle evenly. Solenoid valves, **Vs** (soap spray) and **Vw1** (water rinse) activate sequentially, with **Vw1** operating for **15 seconds** first to loosen dirt and then **Vs** for **15 seconds** soap spray on the car.

2. Mechanical Brushing
   Three motors scrub the vehicle, **M1**, **M2** (left and right vertical brushes) and **M3** (top brush). Brushes operate at **120 RPM**, controlled by motor drivers. Activation occurs only when sensor **S2** confirms the vehicle's presence in this stage.

3. High-Pressure Rinsing
   Fixed spray nozzles (**Vw2**) deliver a high-pressure rinse for **10 seconds** to remove residual soap and debris.

4. Drying Cycle
   Movable air blowers operate at **75% PWM duty cycle**, adjustable based on vehicle size. The blowers run for **15 seconds** or until sensor **S4** detects the vehicle's exit, ensuring complete water removal.

For safety and monitoring, there are their status indicators, which provide real-time feedback where green lamps show normal operation, yellow shows the state transition, and red shows the emergency/fault (e.g., conveyor halt, motor stall)

In case of an Emergency, there is a stop button to immediately stop all operations in the system. After the stop button is pressed, manual override via a keypad allows conveyor reversal/forward motion to take the vehicle out from the bay.

The 8051 microcontroller coordinates all stages using sensor inputs (S1–S4) to activate components only when the vehicle is correctly positioned. Safety interlocks prevent unintended brushes or spray activation. The pressure of spray nozzles (e.g., water pressure $\leq$ 60 PSI) is maintained.

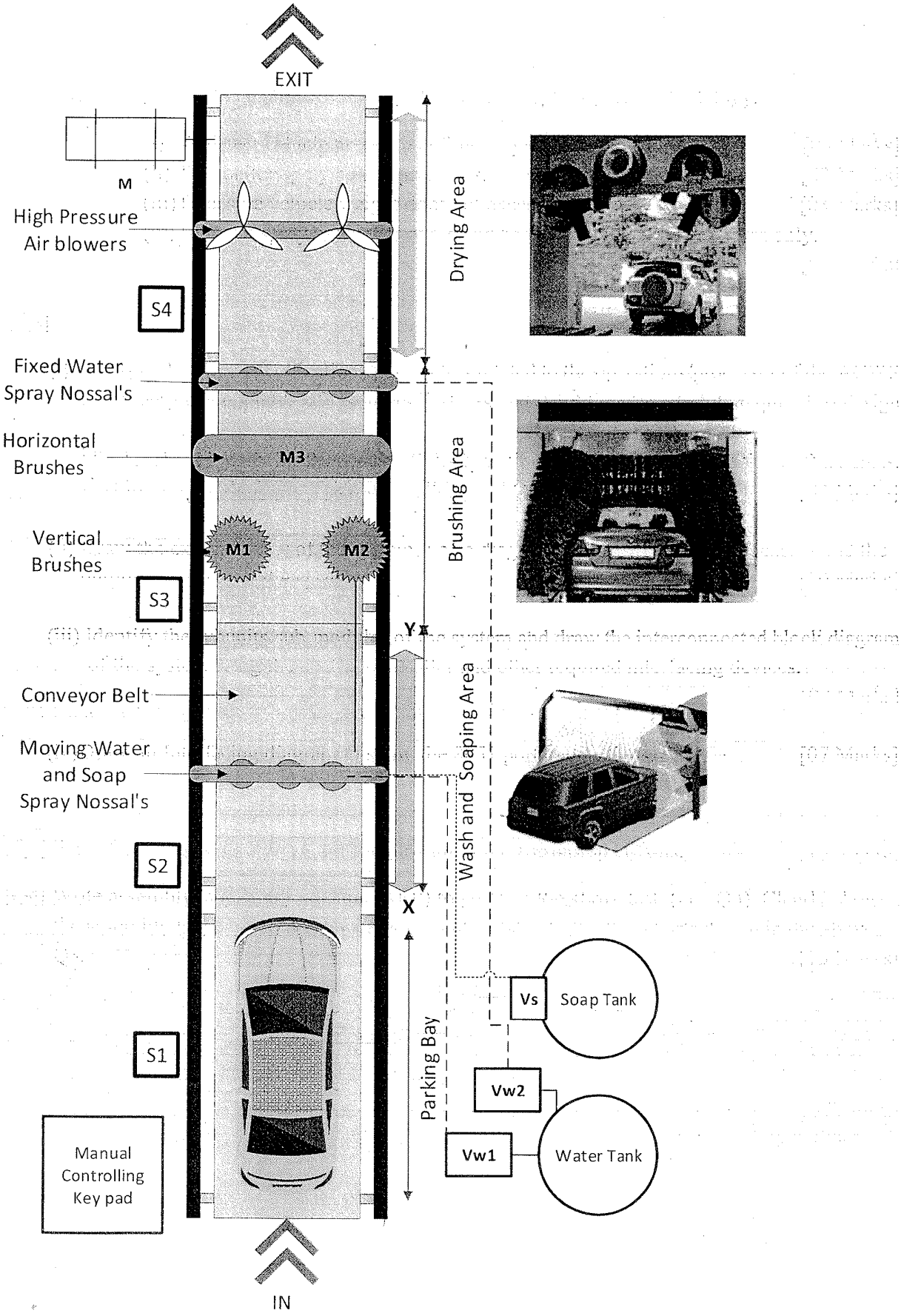

Figure 1: Typical Process view of the ACWS

State all the assumptions clearly (if any) when answering questions.

[Q1] For the proposed mechanism, identify suitable sensors and actuators to detect the following and draw simple block/interfacing diagrams for each to explain your methodology.

(i) To detect vehicle presence at four stages (S1-S4). [03 Marks]
(ii) To monitor spray nozzle pressures. [03 Marks]
(iii)To ensure vehicle weight does not exceed 2000Kg. [03 Marks]
(iv)To move spray nozzles forward and backward within the X-Y area only. [03 Marks]

[Q2]

(i) Analyse the given specifications/parameters related to the operations/processes of the ACWS and then prepare a table of resources/features and conditions/constraints required to design the ACWS.
(Table should contain Processes, Sub-Operations, Parameters, Conditions, Resources, Feature Required of 8051 microcontrollers, and Comments). [04 Marks]

(ii) Draw the external view of the system, i.e., a diagram that shows the inputs/sensors and the outputs/actuators of the system. [10 Marks]

(iii) Identify the subunits/sub-modules of the system and draw the interconnected block diagram of the system using the central controller and other required interfacing devices. [07 Marks]

(iv)Draw an Interfacing diagram to show the 8051 port connections. [07 Marks]

[Q3] Draw flowchart(s) to represent the algorithm of the ACWS operations. [15 Marks]

[Q4] Write assembly language programs (ALP) to perform the above task (i.e., Q3). Clearly show the assembly language routines with comments related to the flowcharts drawn in the above Q3. [15 Marks]

Section B

Answer all questions [30 Marks]

[Q5]

(a) A temperature sensor outputs an analogue voltage between 0V and 5V, representing a temperature range of 0°C to 100°C. You need to display the temperature on an LCD.

Draw a block diagram showing how to interface the temperature sensor to the 8051 microcontrollers, including any necessary ADC. Specify the ADC resolution needed for a temperature resolution of 1°C.

[7Marks]

(b) Write an interrupt service routine (ISR) that increments a software counter representing seconds (**SS**). When the **ss** counter reaches 60, it should reset to 0 and increment the minutes counter (**SM**). Similarly, handle minutes and hours. Store the hours, minutes, and seconds in internal RAM locations 30H, 31H, and 32H, respectively.

[8 marks]

[Q6]

(a) You are designing a system to log data from a sensor to a computer via serial communication. Write an assembly language program to continuously transmit the value stored in register R7 to the computer at a baud rate of 9600 bps. Assume a crystal frequency of 11.0592 MHz. Use 8 data bits, 1 stop bit, and no parity. Include comments.

[07 Marks]

(b) A conveyor system is controlled using a stepper motor with a step angle of 1.8° (in full-step mode) and an 8051 microcontroller. The system should work as follows;

- When Sensor 1 (connected to P1.0) detects an object, the motor should rotate clockwise by 50 steps.
- If Sensor 2 (connected to P1.1) detects an obstruction, the motor should stop immediately.
- When the system is idle (not detecting any objects or obstructions), a "System Ready" LED (connected to P2.0) should be turned on.

Draw a flowchart to show how this process can be implemented.

[08 Marks]

END