UNIVERSITY OF COLOMBO, SRI LANKA

FACULTY OF SCIENCE

LEVEL IV EXAMINATION IN SCIENCE - 2024 SEMESTER I

PH4019 – INDUSTRIAL AUTOMATION

(Three Hours)

This paper consists of four (04) questions in five (05) pages.

Answer All Questions

1.

A. A Double Pole Single Throw (DPST) switch can be used to control two separate circuits simultaneously. In an industrial automation system, such switches are often used to isolate different parts of the system.

I. Draw a connection diagram showing how a DPST switch can be used to:

- Control two separate devices (e.g., a motor and a light) with a single switch.
- When the switch is turned ON, both devices should be powered; when the switch is OFF, both devices should be disconnected from the power source.
- Use clear labels for the power supply, devices, and switch connections.

B. In this task, you will design a relay control circuit and then physically wire the circuit using the components provided on the panel. You should demonstrate the working circuit to an instructor for evaluation.

I. Design a lighting control system that turns on the light when a Start push button is pressed and maintains the ON state even after the button is released (latching relay). When the Stop button is pressed, the system should get off.

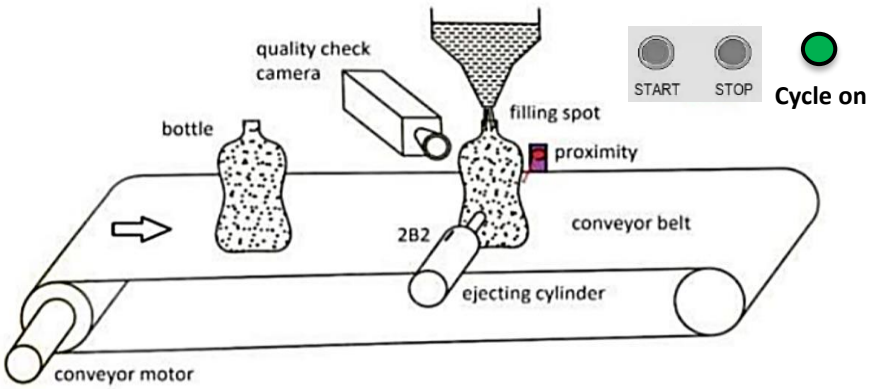
a. Draw the relay logic diagram for the above circuit.

b. Draw the hardware connection diagram for the real components using standard symbols. Clearly label contact types, the power supply, and other elements needed for proper wiring.

II. Modify the latching circuit to include a Timer:

a. After pressing the Start button, one indicator should turn on immediately.
b. After a 5-second delay, a second indicator should turn on, while the first indicator remains on.
c. The Stop button should turn off both indicators and reset the system.
d. Draw the updated relay logic diagram with the timer integrated into the circuit.
e. Draw the hardware connection diagram using standard symbols, showing how to wire the relays, timers, and switches on the panel.
f. Wire the circuit on the panel and demonstrate it to an instructor to claim marks.

2. You are required to design a PLC program for an automatic bottle filling station.



The process is as follows:

- The process begins when the **Start button** is pressed, activating the conveyor motor and turning on the **Cycle ON indicator**.
- When a bottle reaches the filling spot, it is detected by a **proximity sensor**, which stops the conveyor.
- A **camera system** inspects the bottle by receiving a trigger signal (This signal should be provided through the PLC). The camera returns a **true/false** signal based on the bottle's quality:
    - If the bottle is **bad**, an **ejecting cylinder** activates to remove the bottle.

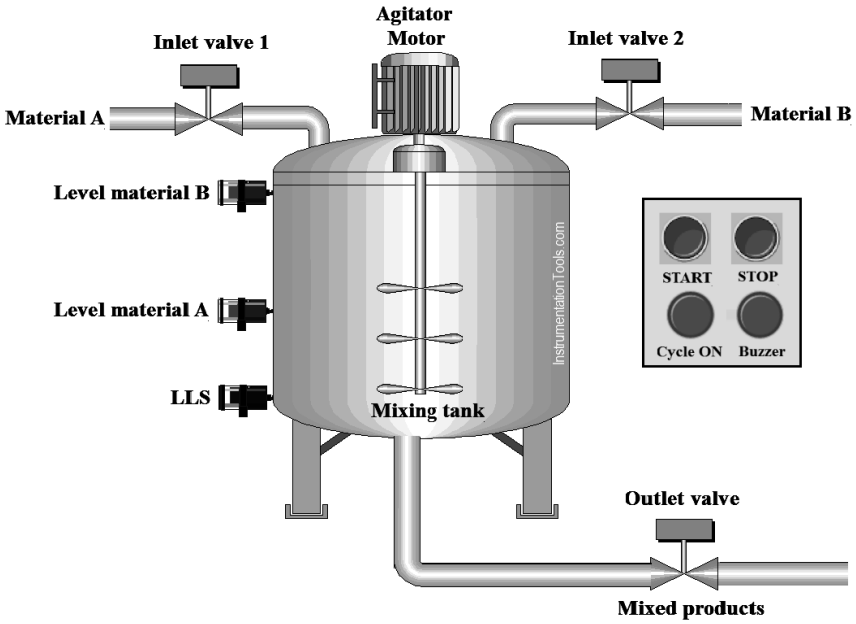
- If the bottle is **good**, the **filling valve** opens for **5 seconds** to fill the bottle with water.

- After either ejecting the bad bottle or filling the good bottle, the conveyor resumes until the next bottle is detected.
- The system should stop at any time when the **Stop button** is pressed.

Tasks:

- Design the PLC program to control the conveyor, proximity sensor, camera system, ejecting cylinder, and filling valve.
- Ensure the correct sequence for bottle detection, quality check, bottle filling or ejection, and conveyor restart.

3. Design a PLC Program for Automatic Mixing Control in a Tank



You are required to design a PLC program for the automatic control of a mixing system in a tank. The system operates as follows:

a) The process is initiated by pressing the Start button. When the system starts, the Cycle ON indicator should turn on and remain on throughout the entire process.

b) Material A and Material B are added to the tank through two separate inlet valves (Inlet valve 1 and Inlet valve 2).

c) Three sensors are used to detect material levels:

- Lower level sensor - LLS (detects if the tank is empty).
- Material A level sensor (detects when Material A is filled).

- Material B level sensor (detects when Material B is filled).

d) The process sequence:

- When the bottom level sensor is not detected and Material A level is not detected, Valve 1 opens to fill the tank with Material A until the Material A level sensor is detected.
- Once Material A is detected and Material B is not detected, Valve 2 opens to fill the tank with Material B until the Material B level sensor is detected.
- Once both Material A and Material B are detected (i.e., the tank is full), the agitator motor starts, mixing the contents for 20 seconds.
- After the mixing is complete, a buzzer activates to indicate the process is complete. The buzzer stays on for 5 seconds before automatically turning off.
- Then the outlet valve opens to drain the tank until the bottom level sensor is not detected.
- After the process is completed, the system returns to its initial stopped condition automatically, ready for the next cycle.

Note:

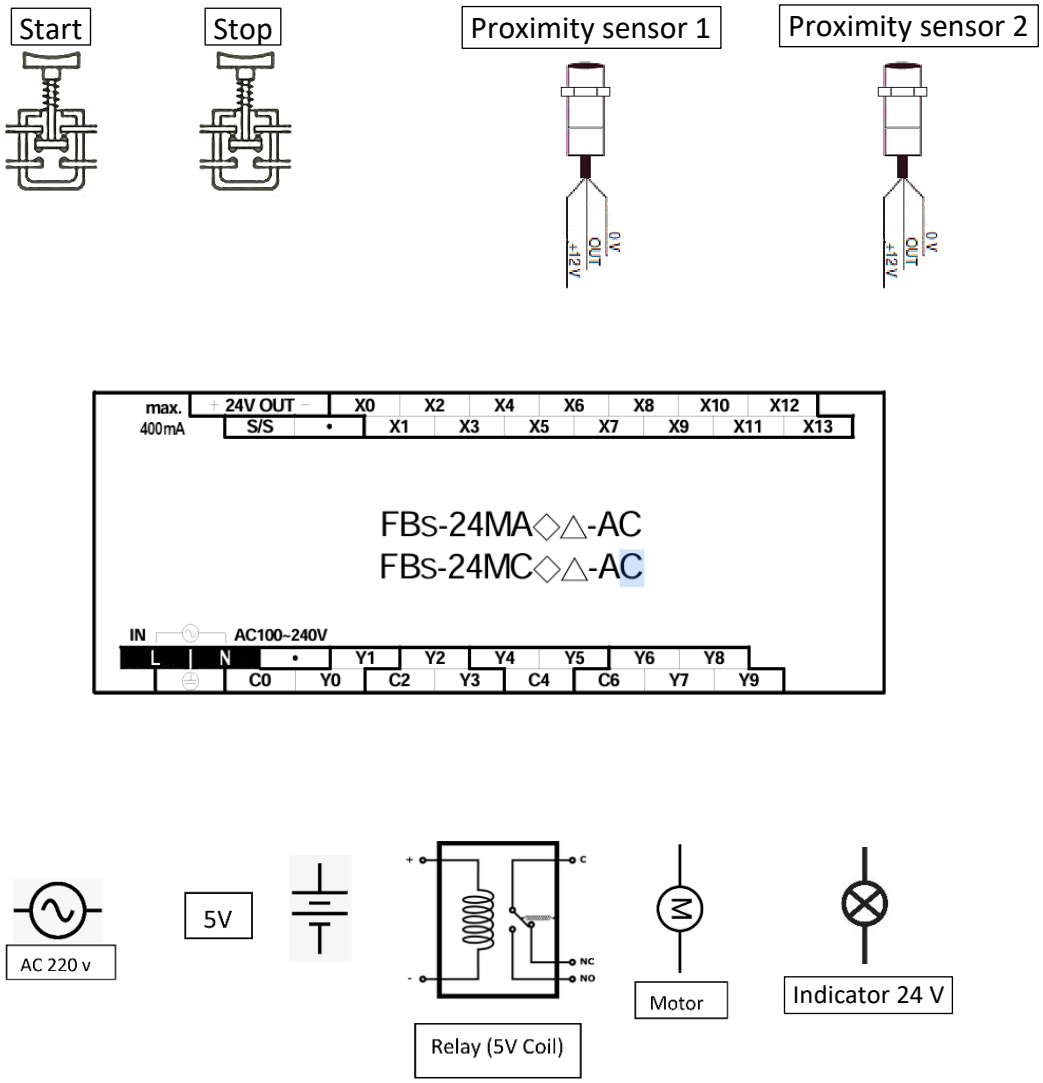
- The system should be manually stopped by pressing the Stop button at any time.
- The inlet and outlet valves are single-acting, with two states: either fully open or fully closed.
- Ensure the correct sequence of operations for filling, mixing, draining, and alerting.

4.

A. Design a PLC Program for following process:

- The system is initiated by pressing the Start button. When the system starts, the ON indicator should turn on and remain on throughout the entire process.
- The process starts when a part touches the first limit switch, but the motor should start running after a 5-second delay.
- The process will stop automatically when the finished part touches a second limit switch.
- An emergency stop switch should be included, which will immediately halt the process when pressed, regardless of the current operation.

B. Draw the hardware connection diagram, showing how the sensors, motor, relay, indicators, and buttons are connected to the Fatek FBs-24MAT2-AC PLC (with Transistor SINK (NPN) output) PLC.



C. Wire and implement the system on the provided hardware. Test and demonstrate the working setup to the instructor for evaluation. Since some real components are not available, use the following substitutions:

- Use two push buttons in place of the two proximity sensors.
- Use an additional push button as the start switch.
- Use a limit switch for the normally closed (NC) stop button.

The other components include a 12V DC motor, a 24V relay, and indicator lights.

THE END