



TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Electrical and Electronic Engineering

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)

EEE 4432: INDUSTRIAL AUTOMATION

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: APRIL 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory.

In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) Explain the following terms as applied to PLC programming

- (i) Symbolic Addressing
- (ii) Absolute addressing
- (iii) Immediate addressing
- (iv) Direct addressing

[8 marks]

b) Distinguish between the following as applied to Programmable logic controllers (PLC) program processing

- (i) Linear program processing
- (ii) Structured program processing

[4 marks]

c) **Figure Q1c** is chemical mixing process when I0 is pressed, Q0/ V1 will get on resulting material 1 inlet to mixing tank. As material 1 comes in mixing tank, low level sensor I2 will get on and further middle level sensor I3 will be on. As I3 is on, Q0/V1 should get off and Q1/V2 should get on. As V2 is on, material 2 will come in mixing tank resulting increase in level and reaches to I4 sensor. As I4 is on, Q1/V2 will get off and motor Q2 will get on for 10 seconds. After 10 seconds, motor gets off and drain

V3 gets on. As drain is on, mixing tank will start getting empty. Slowly level will go down resulting I4 off, I3 and I2 sensors off one by one. As I2 is off repeat the process. I1 is manual stop. Write a PLC program (ladder diagram) for the process.

[13 marks]

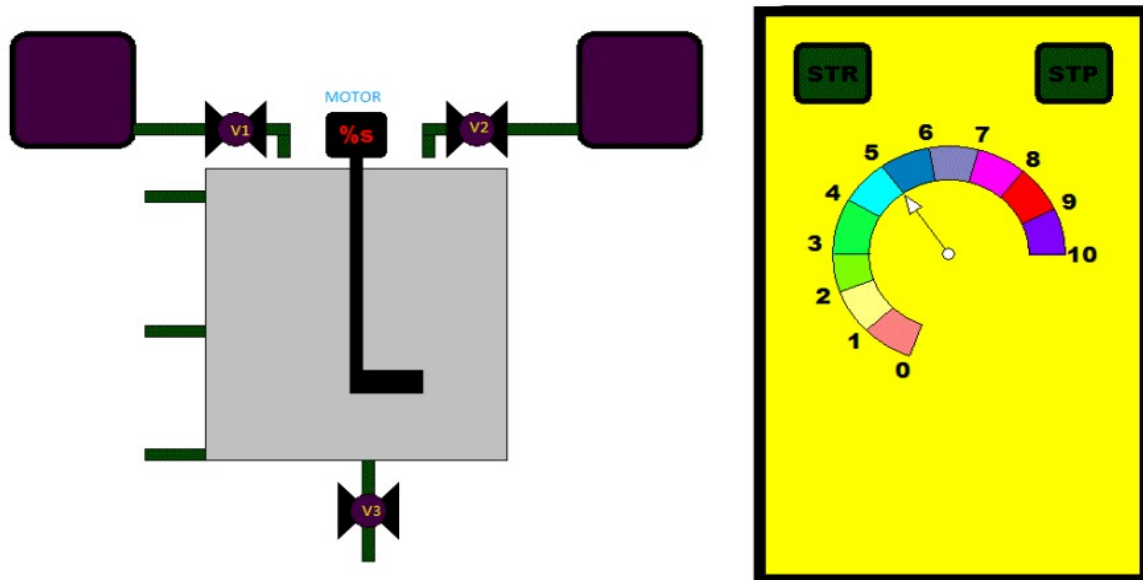


Figure Q1c

- d) Outline the five programming languages used in programmable logic controllers

[5 marks]

Question Two

- a) With the aid of diagrams explain the principle of operation of a DC inputs (sink/source) module

[8 marks]

- b) The design a burglar alarm for a house is such that when activated an alarm and lights will be activated to encourage the unwanted guest to leave. This alarm is activated if an unauthorized intruder is detected by window sensor and motion detector. The basic operation of the alarm system and the inputs and outputs of the controller are as follows:

The inputs and outputs are chosen to be

A = alarm and lights switch (1 = ON)

W = window/ door sensor (1 = OK)

M = motion sensor

S = alarm active switch (1 = ON)

The basic operation of the alarm can be described as with rules

- (1) If alarm is on, check sensors
- (2) If window/ door sensor is broken (turns off), sound alarm and turn on lights.

Required for this alarm system:

- (i) The truth table
- (ii) The Boolean equation
- (iii) Logic circuit diagram
- (iv) PLC program in
 - (I) Ladder logic
 - (II) Functional Block Diagram (FBD)
 - (III) Statement List (STL)

[11 marks]

Question Three

- a) Explain why a stop button must be normally closed and a start button must be normally open.
- b) Consider a case where an input to a Programmable Logic Controller (PLC) is a normally closed stop button. The contact used in the ladder logic is normally open as shown in **Figure Q3b**. explain why they are not both the same.

[6 marks]

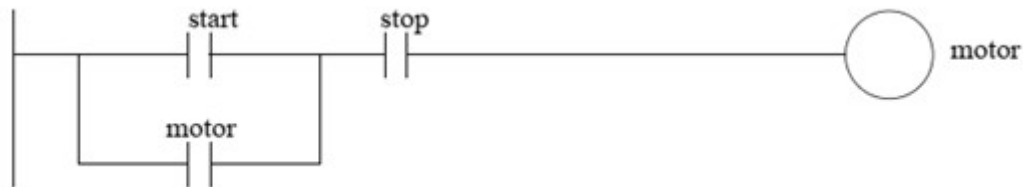


Figure Q3b

- c) Given a system that is described with the following equation

$$X = A + (B \cdot (\bar{A} + C) + C) + A \cdot B \cdot (\bar{D} + \bar{E})$$

- (i) Simplify the equation using Boolean Algebra
- (ii) Implement the original and then the simplified equation with a digital circuit.
- (iii) Implement the original and then the simplified equation in ladder logic.

Question FOUR

- a) Outline any Four advantages of PLC Over relay logic automation
- b) With the aid of a diagram explain the parts of a programmable logic controller

[12 marks]

Question FIVE

- a) Distinguish between the following
- (i) SCADA
 - (ii) DCS

[4 marks]

b) Outline the four basic parts of SCADA system

[4 marks]

c) Conventional programming approach proves inadequate for modern PLC, explain the following limitations in the context of the modern PLC system

- (i) Lack of software structure
- (ii) Problems in reusability
- (iii) Poor data structure definition

[12 marks]