



TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Mechanical and Automotive Engineering

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY (MECHANICAL AND AUTOMOTIVE ENGINEERING)

TMC 4413: AUTOMATION FOR MANUFACTURING SYSTEMS

END OF SEMESTER EXAMINATION

SERIES: NOVEMBER 2024

TIME: 2 HOURS

DATE: NOVEMBER 2024

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) With the aid of a diagram explain the following types of automation systems

- i) Fixed automation
- ii) Programmable automation
- iii) Flexible automation

[12 marks]

b) Outline any three reasons for automating manufacturing systems

[6 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.

[12 marks]

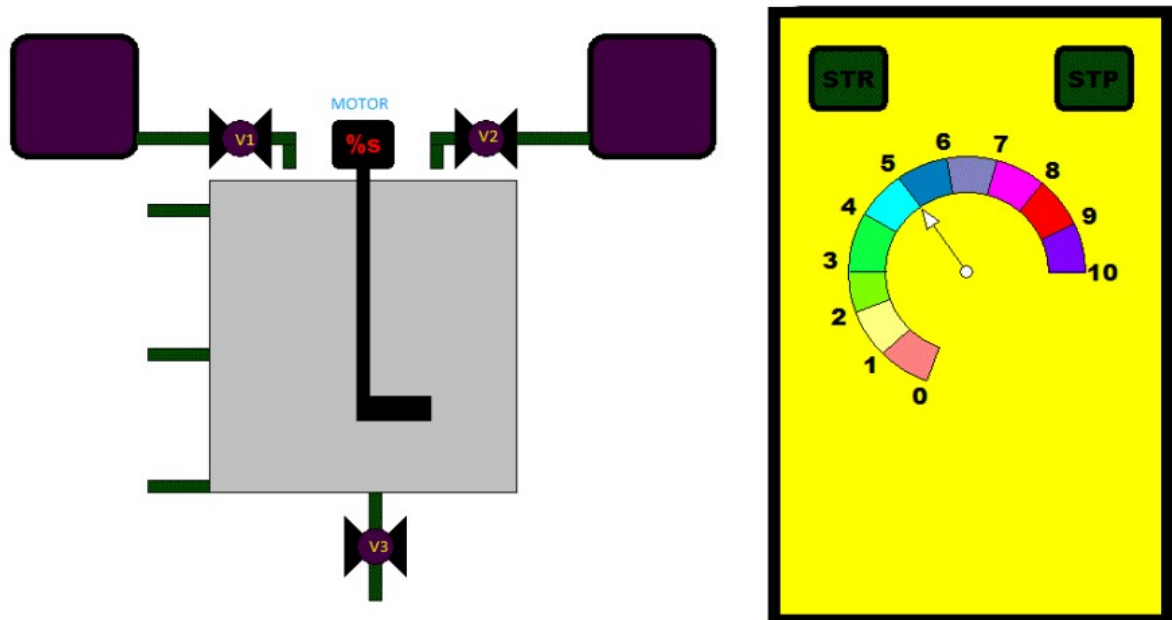


Figure Q1c

Question Two

a) 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 (0 = OK)
- S = Alarm Active switch (1 = on)

The basic operation of the alarm can be described 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)

[12 marks]

Question THREE

- a) with the aid of diagram explain the principle of operation of a two input relay controller [6 marks]
- b) Figure Q3b is a car parking area where we have entry gate Q0 and exit gate Q1. On entry we have two sensors, I0 outside and I1 inside. On exit also we have two sensors I2 and I3. When car comes in front of I0 sensor, gate Q0 is open. When car reaches to I1 sensor, nothing will happen. When car crosses sensor I1 then gate Q0 will be closed and it would be count up. Inside parking area when car reaches to sensor I2, exit gate Q1 is open. When car crosses I3 sensor then Q1 is closed and it would be count down on display to show the present number of cars inside parking area. Maximum 10 cars will be parked. When parking is full and 11th car comes in front of entry sensor I0, entry gate should not get open. Design a PLC program in ladder logic for the parking. [14 marks]

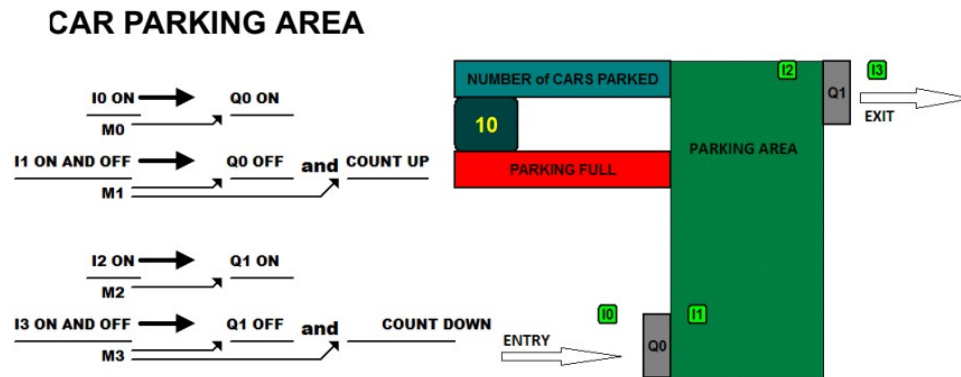


Figure Q3b

Question FOUR

- a) (i) Write the simplest Boolean equation for the Karnaugh map given below
- (ii) Convert the equation to a ladder logic

[8 marks]

	CD	$C\bar{D}$	$\bar{C}\bar{D}$	$\bar{C}D$
AB	1	0	0	1
$A\bar{B}$	0	0	0	0
$\bar{A}\bar{B}$	0	0	0	0
$\bar{A}B$	0	1	1	0

- b) Describe the main function of each of the following main components of a PLC
- (i) processor module
 - (ii) I/O modules
 - (iii) Programming device
 - (iv) power supply module

[12 marks]

Question FIVE

Figure Q5 is a mixing and filling application with alarm, acknowledgement and reset. There are two push buttons I0 and I1 for start and stop (both push buttons are NO type/ green in physical existence). There are

three level switches I2, I3, I4 and I5 for low level, middle level high level and bottle detector sensor respectively. There are 3 valves; V1/ Q0 for material 1, V2/ Q1 for material 2 and V3/ Q3 for drain. There is a motor for mixing two materials in the mixing tank and one conveyor Q4. 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 conveyor Q4 gets on. Bottle to be filled will move on it. As bottle will be detected by I5 sensor, conveyor Q4 will stop and drain V3/ Q3 will get on for 5 seconds. After 5 seconds again conveyor will be on and drain will get off. Whenever I5 detects bottle, the same cycle of conveyor and drain will repeat. As drain will get on many times, 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. There is a common low level detector sensor in both upper feeding tanks. If feeding tank low level sensor I6 goes off, whole system should stop. A red lamp Q5 and a hooter Q6 should get on as I6 is off. This is alarm condition. As alarm occurs, someone will hear hooter and will come to monitor the system. I0 push button should be pressed to acknowledge it but by pressing I0 other things should not start. As it is acknowledged, hooter will stop for 20 seconds but red lamp will keep blinking with half second of interval. If problem is not solved with in twenty seconds then hooter will start again. It can be acknowledged again. When problem is solved i. e. feeding tanks are full then hooter and red lamp both will get off and machine can be started by pressing I0 push button. Develop the ladder logic for the system

[20 marks]

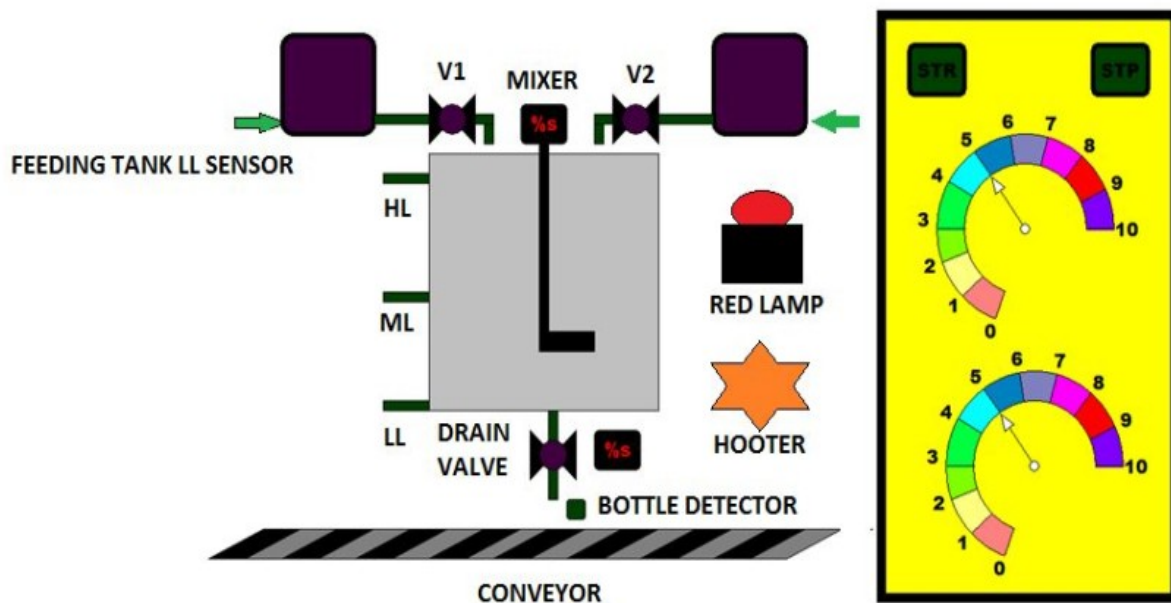


Figure Q5