



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024**

COURSE NAME : INDUSTRIAL AUTOMATION SYSTEM

COURSE CODE : BEJ34103

PROGRAMME CODE : BEJ

EXAMINATION DATE : JULY 2024

DURATION : 2 HOURS 30 MINUTES

- INSTRUCTION
1. ANSWER ALL QUESTIONS
 2. THIS FINAL EXAMINATION IS CONDUCTED VIA
 Open book
 Closed book
 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

- Q1** (a) State **TWO (2)** reasons how do industrial robots improve efficiency in the manufacturing industry (3 marks)
- (b) **Figure Q1.1** shows an industrial robot with **THREE (3)** joints end effector attached to it

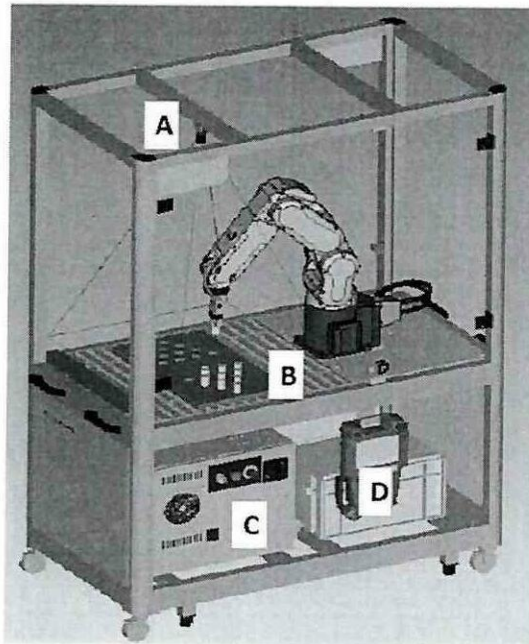


Figure Q1.1

- (i) Examine the degree-of-freedom possessed by robot and the operational process. (2 marks)
- (ii) Categorize the robot body-and-arm configuration and the joint notation scheme. (3 marks)
- (iii) Analyze component A – D in the **Figure Q1.1**, name it and state their functions. (8 marks)
- (iv) Discover the robot operating space with an appropriate diagram representation indicating the coverage angle. (4 marks)

- Q2** (a) Industrial production involves numerous cycles of repetitive and sequential operations. From time to time, the automation sequences could be modified or altered to meet the production need in short notice. Identify **TWO (2)** benefits and **TWO (2)** limitations of using a programmable logic controller (PLC) in industrial automation for production. (4 marks)
- (b) **Figure Q2.1** shows a separate conveyor to divert one (1) part out of every twenty (45) parts to the quality control line automatically for inspection purposes.

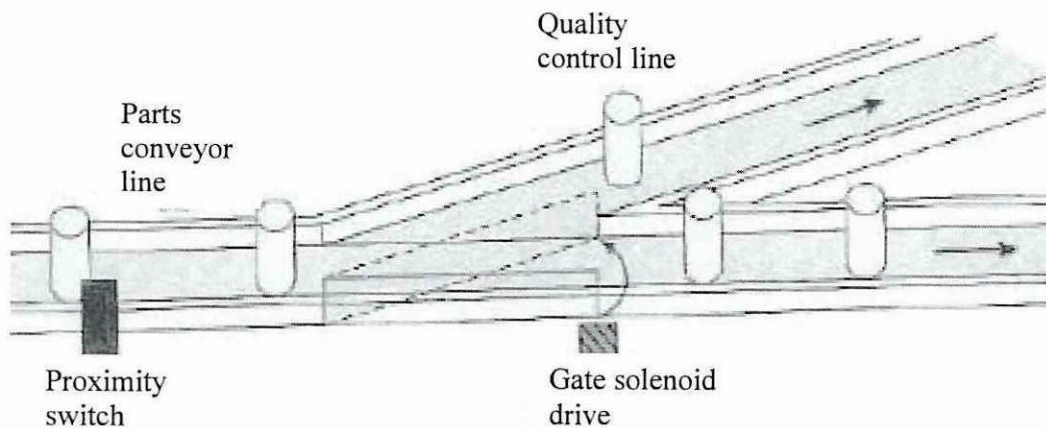


Figure Q2.1

The operation is as follows:

1. A Start/Stop push-button is used to turn the conveyor motor on and off.
 2. A proximity sensor counts the parts as they pass by on the conveyor.
 3. When a count of 45 is reached, the counter's output activates the gate solenoid, diverting the part into the inspection line.
 4. The gate solenoid is energized for 4 seconds, which allows enough time for the part to continue to the quality line.
 5. The gate return to its normal position when the 4 seconds time period ends.
 6. The counter reset to 0 and continue to accumulate counts.
 7. A reset pushbutton is provided to reset the counter manually
- (i) Develop the Sequential Flow Chart (SFC) for the process description. (7 marks)
- (ii) Propose your preferred process description method and justify your answer. (3 marks)

- (c) Draw the diagram of Computer Aided Design (CAD)/ Computer Aided Manufacturing (CAM) and Computer Integrated Manufacturing (CIM) and explain the concept of CIM.

(6 marks)

Q3 Figure Q3.1 shows a drilling machine for holes opening on object A, manually placed by an operator. The machine has a movable cover to protect the operator from lubricating liquids and insertion of the hand during the operation, where:

C_1 = cylinder that lowers or raises the chuck

C_2 = cylinder that lowers or raises the protective cover

S_0 = sensor detecting the lower position of the piston C_1 when the drilling has finished

S_1 = sensor detecting the presence of an object in the drilling position

S_2 = sensor detecting the lower position of the protective cover

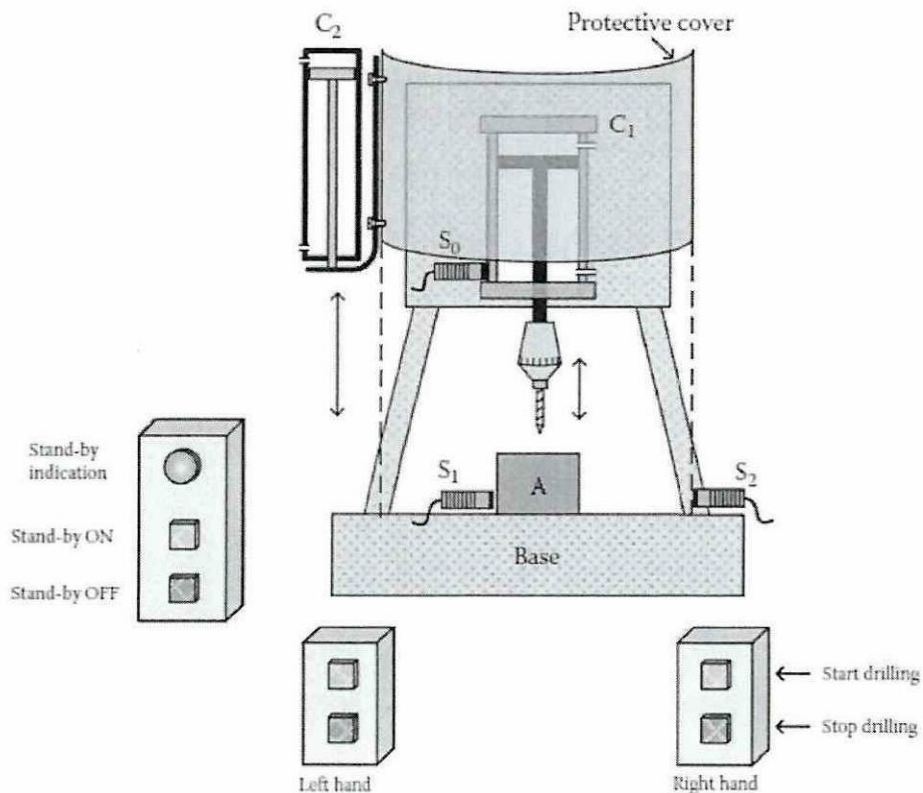


Figure Q3.1

The standby control panel is the two-button control box with which the machine is set to a standby status. The light indicator expresses the “stand-by ON” status.

The operation control panel is the two-button control box in a double function to start or stop the drilling procedure.

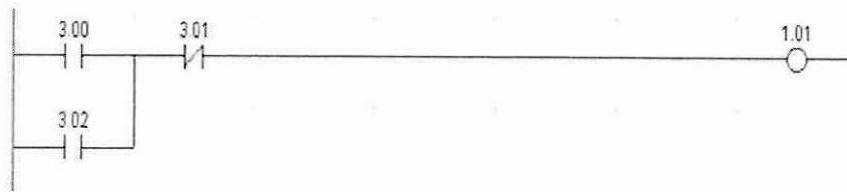
The machine operation is as follows:

1. The initial position of the two pistons is “up”.
2. Machine start to operate when the “Stand-by ON” button is pressed and indicator lights up.
3. When sensor S1 detects an object placed on the base, only the drilling can be started.
4. When the two buttons “start drilling” are pressed at the same time (requires both hands of the operator for safety reasons), the protective cover (activation of the relay C₂) starts to lower. If the two buttons are released, the cover returns to its original position.
5. When the protective cover is brought to its final position, it is detected by sensors S2 and then the piston C₁ (activation of the relay C₁) starts to lower, while simultaneously the drilling head starts its rotation. At this stage, the two “start drilling” buttons need not to be pressed because the protective cover has already been lowered.
6. Piston C₁ and the drilling head press down the object until drilling is complete when sensor S₀ activated.
7. Once S₀ is activated, the drilling head and the protective cover return simultaneously to the initial position. Then the machine is ready to accept a new object.
8. If at any time, either the two “stop drilling” buttons are pressed simultaneously or the “Stand-by OFF” button is pressed alone, the process stops and the two pistons return to the “up” position

- (a) Analyse the input and output of the machine and set the address accordingly (10 marks)
- (b) Construct the ladder diagram for the operation and indicate the address clearly (10 marks)

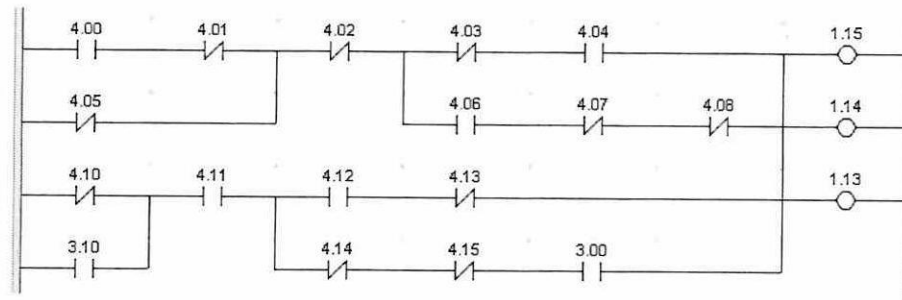
Q4 (a) In a manufacturing plant, a critical production line is controlled by a Programmable Logic Controller (PLC). The production manager notices an unexpected behavior in the production process, and immediate adjustments are required to avoid disruptions. However, due to the urgency and the on-site nature of the issue, accessing a computer in the control room may not be the most practical solution. As an engineer with expertise in PLC programming, please provide the instruction list, represented in mnemonic code, for a given ladder diagram below.

(i)



(4 marks)

(ii)



(6 marks)

(b) The use of Boolean concepts is fundamental in Programmable Logic Controller programming due to its ability to represent and control binary states, which aligns well with the discrete nature of many industrial processes. Construct the ladder diagrams for the following Boolean logic equations.

(i) $X = (01' + 03 \cdot 02) \cdot 06' + (05' \cdot 04)$

(5 marks)

(ii) $Y = (07 \cdot 08') + \{13 + 09' \cdot (10 \cdot 11)\} \cdot 12$

(5 marks)

Q5 (a) Give **TWO (2)** industries that used automation system and state the reasons.

(3 marks)

(b) In the industrial automation and control technologies,

(i) Explain three types of automation manufacturing systems classification in detail

(9 marks)

(ii) As a newly hired automation engineer in the robotics industry, you are responsible to improve the automation system in the factory. Explain how you can deliver the task.

(8 marks)

-END OF QUESTIONS -