Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	INDUSTRIAL AUTOMATION
COURSE CODE	:	DAE 31203
PROGRAMME CODE	:	DAE
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWERS **ALL** QUESTIONS.
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **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 **EIGHT (8)** PAGES

Q1 (a) Describe the benefits of these electromechanical devices in controlling systems.

(i) Relay
(ii) Solenoid
(iii) Timer

(6 marks)

(b) List all common types of non-contact limit switches.

(4 marks)

(c) Optical proximity switch turns ON and OFF depending on the light's presence. There are **three (3)** basic configurations for these switches.

(i) Name all the configurations.

(3 marks)

(ii) Illustrate all of them with a proper label.

(7 marks)

(d) Motor is a main actuator in the industrial automation system. By referring to **Figure Q1(d)**, answer the following questions.

(i) Identify the type of this electric motor.

(1 marks)

(ii) Describe the working principle of this motor.

(4 marks)

Q2 (a) State the differences between Ladder Diagram and Function block diagram (FBD).

(2 marks)

(b) Describe the operation of the following Function Block Diagram (FBD) as shown in **Figure Q2(b)(i)** and **Figure Q2(b)(ii)**.

(i)

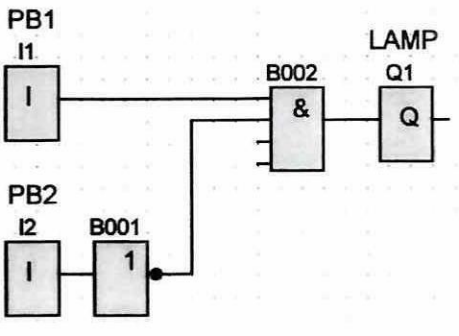


Figure Q2(b)(i)

(3 marks)

(ii)

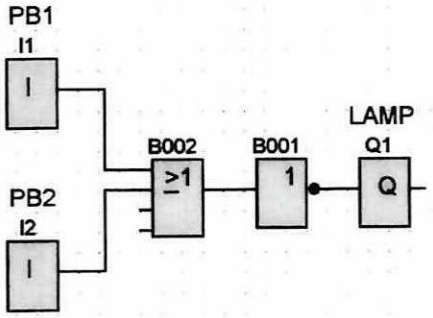


Figure Q2(b)(ii)

(3 marks)

(c) Consider the application shown in **Figure Q2(c)**. An electric motor is being used to drive a conveyor that moves and dumps a product into a bin. When 100 products are dumped into the bin, the conveyor automatically shuts off. The system reset and restarts when start button is pressed again. An optimal proximity switch, O_1 is used to count the product.

(i) Identify the input and output of the system.

(3 marks)

(ii) Develop the corresponding ladder diagram to control the process.

(7 marks)

(d) Develop the corresponding FBD to control the process stated below.

A conveyor belt starts running when the green pushbutton OR the white pushbutton is ON, OR when both are ON. An inductive sensor is placed at the end of the conveyor belt to detect the product. When the inductive sensor detects the product, the motor stops, and a solenoid extends to push off the product from the conveyor belt.

(7 marks)

Q3 (a) The PLC can be programmed by several methods. Based on the following Mnemonic Code, sketch each instruction to the corresponding ladder diagram as shown in **Table Q3(b)(i)** and **Table Q3(b)(ii)**:

(i) **Table Q3(b)(i)**

Address	Instruction	Operands
00000	LD	00000
00001	AND NOT	00001
00002	LD NOT	00002
00003	AND	00003
00004	OR LD	-
00005	LD	00004
00006	AND NOT	00005
00007	OR LD	-
00008	OUT	10001

(7 marks)

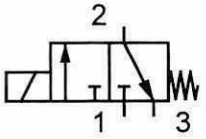
(ii) **Table Q3(b)(ii)**

Address	Instruction	Operands
00000	LD	0.00
00001	TIM	000
00002		#010
00003	LD	TIM 000
00004	OUT	100.00

(4 marks)

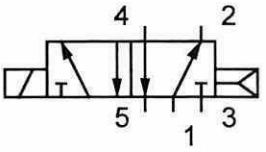
(b) The directional control valve plays a crucial role in developing the sequential movement in pneumatic and hydraulic system. Based on the following symbols of directional control valve, give the complete name for each valve.

(i)



(2 marks)

(ii)



(2 marks)

(c) A KUKA Gantry Robot as shown in **Figure Q3(c)(i)** has 3-axes in completing the left-right movement, forward and reverse at Z-axis, and goes up and down the arm. Meanwhile **Figure Q3(c)(ii)** shows the ladder diagram to make the robot move left and right. Motor Q:100.03 will move the robot to the right meanwhile Motor Q:100.02 will move the robot in the opposite direction. Based on the ladder diagram, answer the following questions.

(i) Name the input devices for the KUKA Gantry Robot.

(4 marks)

(ii) Discuss the roles of Normally Closed Contact of W0.01 at rung 1.

(2 marks)

(iii) Predict the operation of circuit if the Normally Open Contact of W0.00 at rung 1 and the Normally Open Contact of W0.01 at rung 2 are not connected there.

(4 marks)

Q4 (a) Fixed automation, programmable automation and flexible automation are the three standard types in manufacturing automation. State **one (1)** advantage and **one (1)** disadvantage for each of the manufacturing automation types.

(6 marks)

(b) **Figure Q4(b)** shows four (4) types of robot configurations.

(i) Name the robot configuration for robot (a), (b), (c) and (d).

(4 marks)

(ii) Draw the corresponding work envelope for robot (a), (b), (c) and (d).

(8 marks)

(c) **Figure Q4(c)** illustrates a transformation of the end-effector of a robot manipulator to reach point P. Given that, the coordinate of the end-effector at frame {A} relative to frame {W} is $\begin{bmatrix} 0 \\ 5 \\ 5 \end{bmatrix}$.

(i) Express the total degrees of freedom (DOF) of the robot.

(1 mark)

(ii) State the type of transformation of frame {A} to frame {B}.

(1 mark)

(iii) Find the final coordinates, P of the end-effector relative to frame {W}.

(5 marks)

-END OF QUESTIONS-

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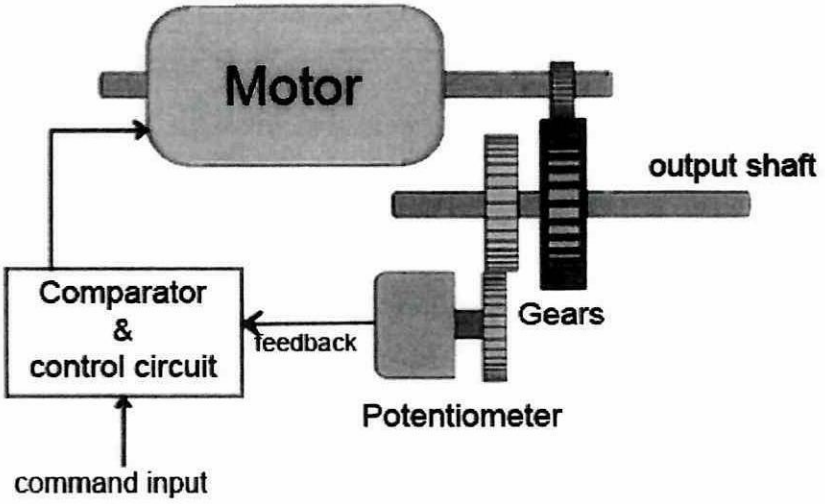

Figure Q1(d)

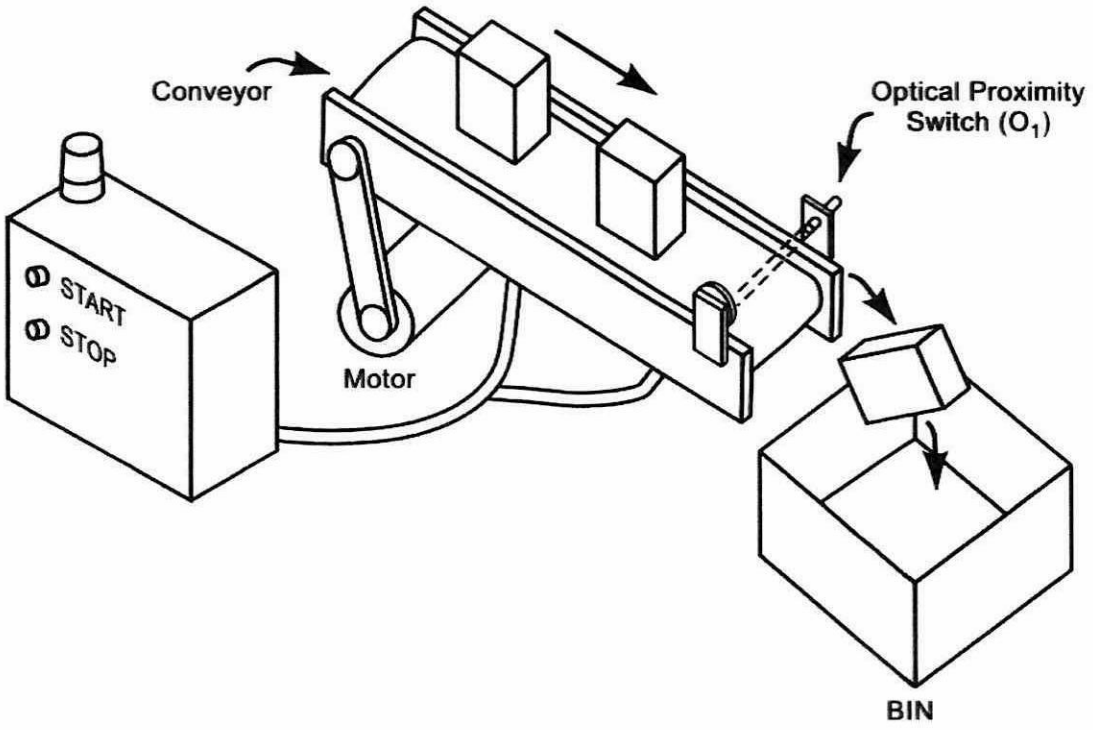

Figure Q2(c)

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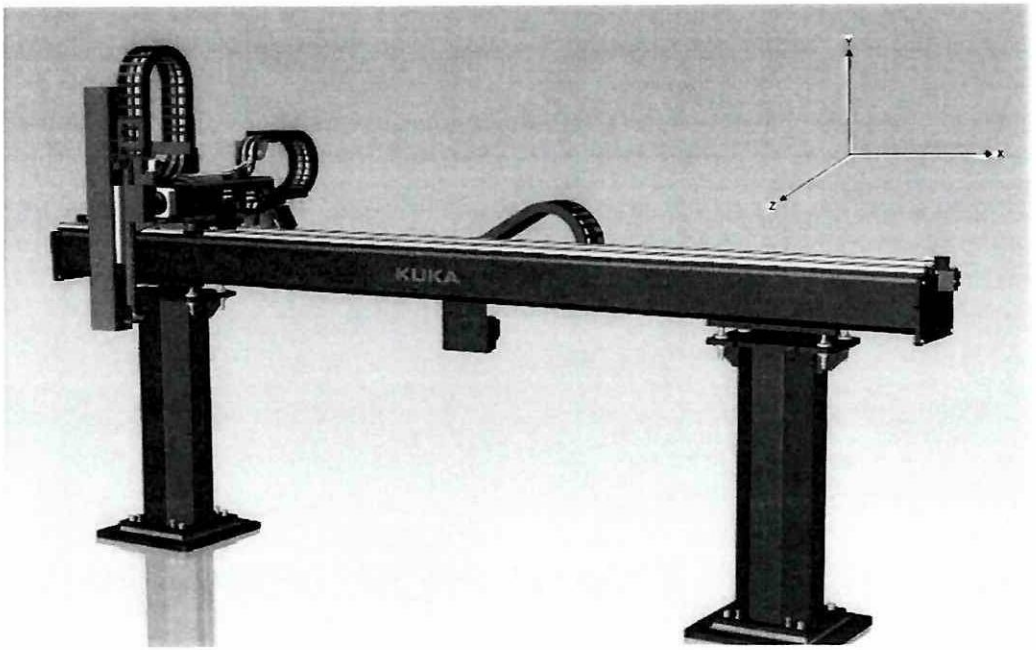

Figure Q3(c)(i)

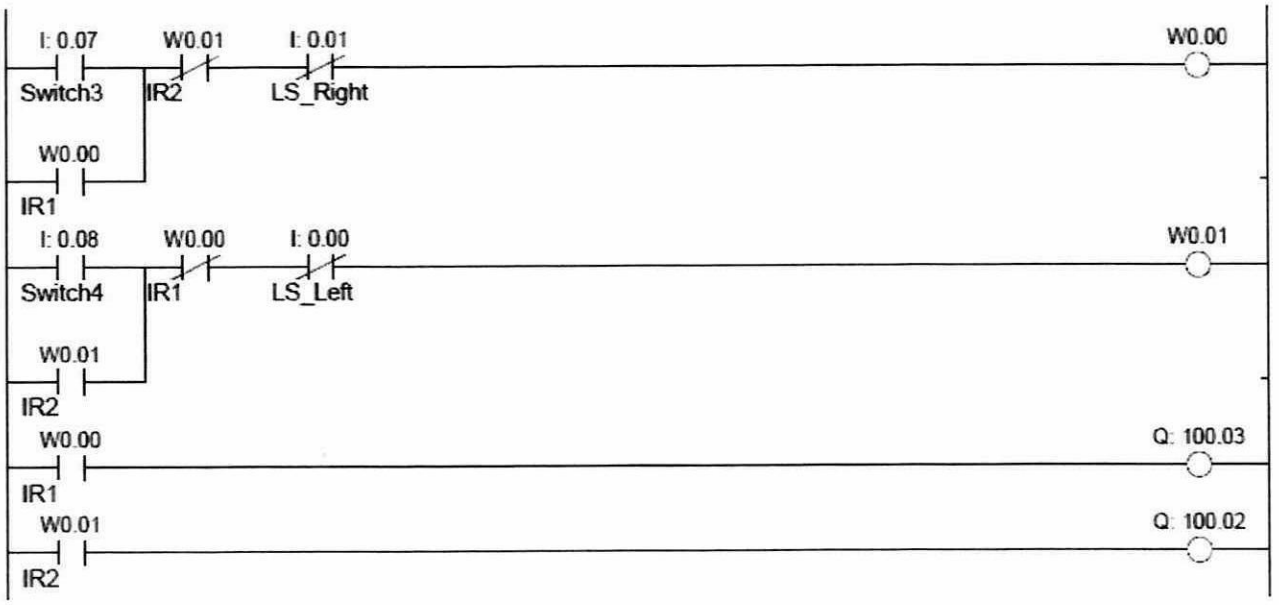

Figure Q3(c)(ii)

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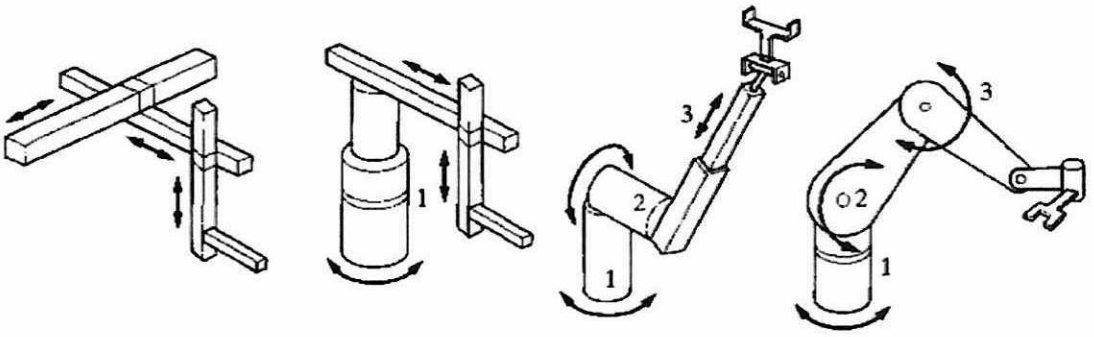

(a) (b) (c) (d)

Figure Q4(b)

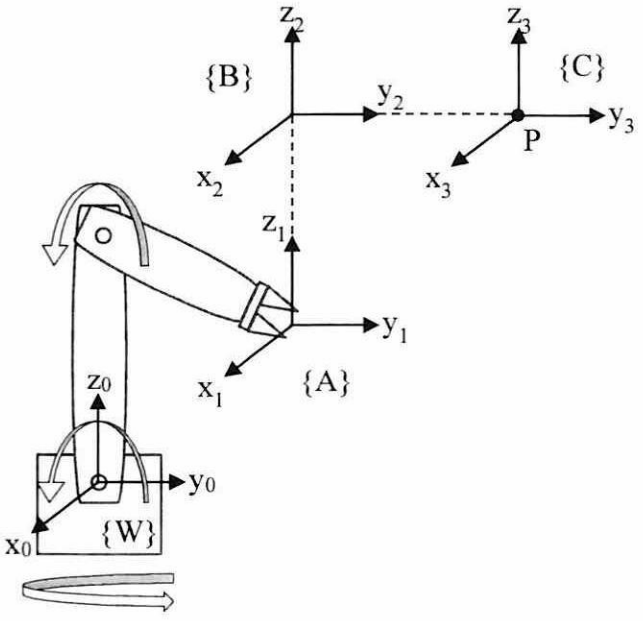

Figure Q4(c)