B

HUMBER

SAULT COLLEGE

BACHELOR OF ENGINEERING
MECHATRONICS ENGINEERING

HUMBER COLLEGE
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Programmable Logic Controllers

MENG 3500

Midterm Test

49

Evaluation Criteria: Understanding, Accuracy, Correct Addressing, Data Types, and Readability

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STUDENT NUMBER: N01500049

SECTION NUMBER: ØNB

Winter Semester

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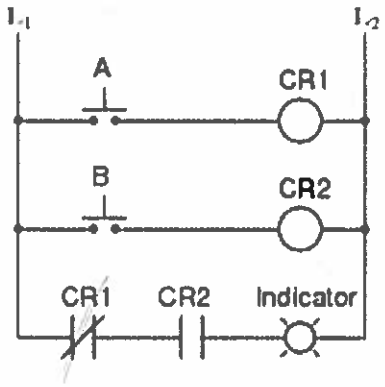
1. Analyze and complete the truth table for the following relay logic circuit, and then complete a second truth table for the same circuit with relay coil CR1 failed open (does not energize) [5 marks}

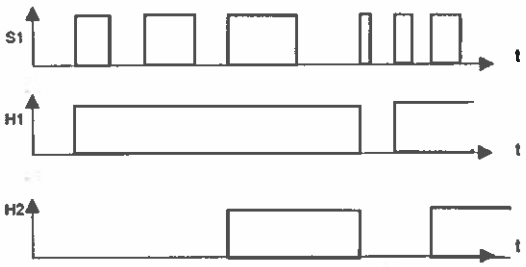


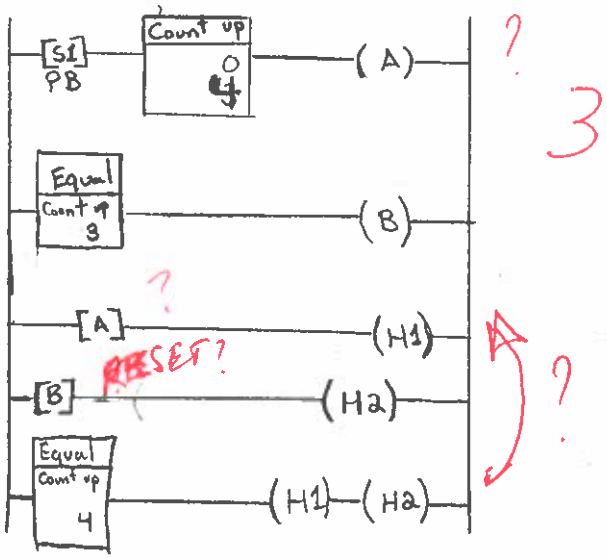
CR1 & CR2 Operating Well		
A	B	Indicator
0	0	0
0	1	1
1	0	0
1	1	0

CR1 Failed Open & CR2 Operating well		
A	B	Indicator
0	0	0
0	1	1
1	0	0
1	1	1

5

2. Create a PLC program to control the lights H1 and H2 according to the provided diagram below. When switch S1 is activated, light H1 turns on. If S1 is activated for the third time, a second light H2 turns on. Upon the next activation of S1, both lights should turn off. Utilize one-shot logic to achieve this functionality. The pattern should repeat as indicated in the timing diagram. [6 marks]





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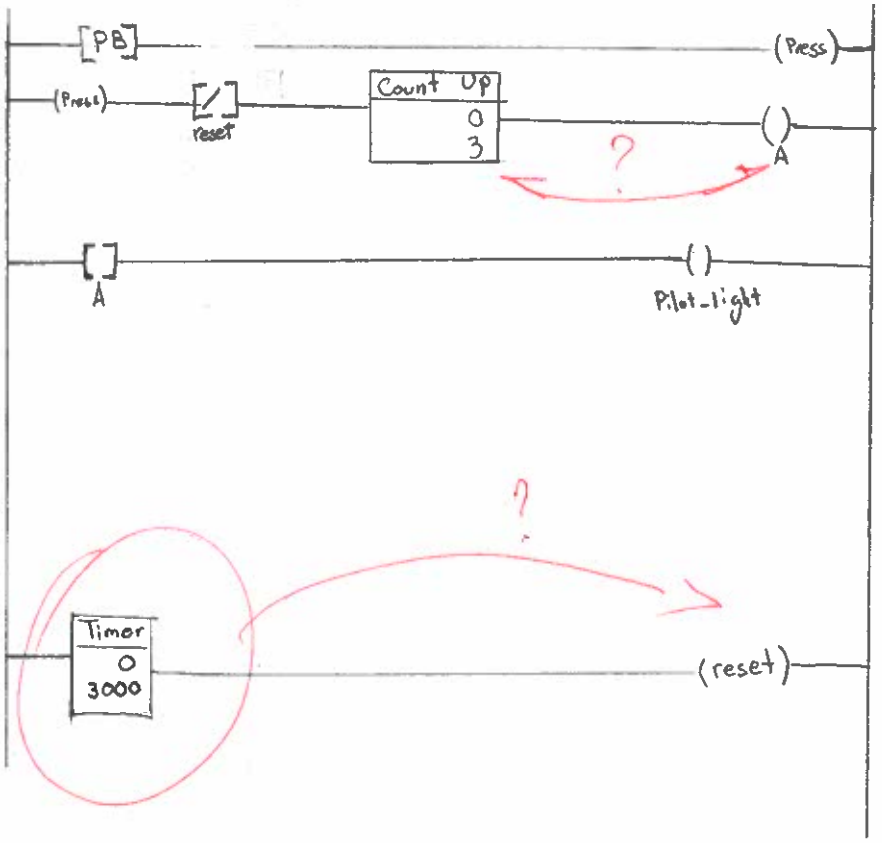
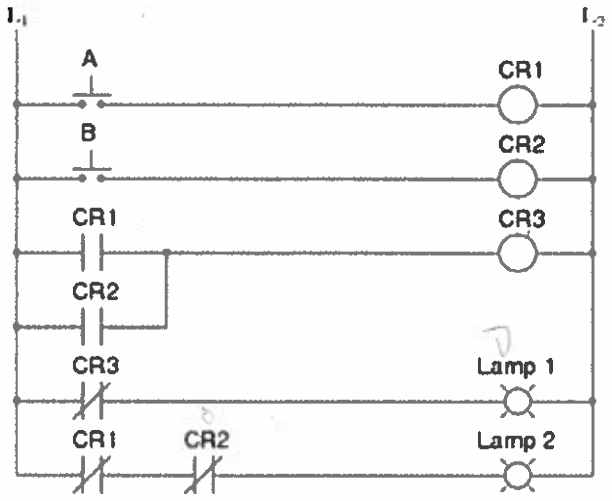
3. Develop a PLC program incorporating timers and counters to detect whether a push button has been pressed three times within a three-second timeframe/interval. Implement a pilot light to indicate when the push button has been pressed three times within this specified period. If the criteria are not met, the program should automatically reset to enable it to restart for subsequent attempts. [5 marks]



2

4. Write a truth table for indicator lamp number 2 in the following ladder diagram. [4 marks]



A	B	Lamp 2
0	0	1
0	1	0
1	0	0
1	1	0

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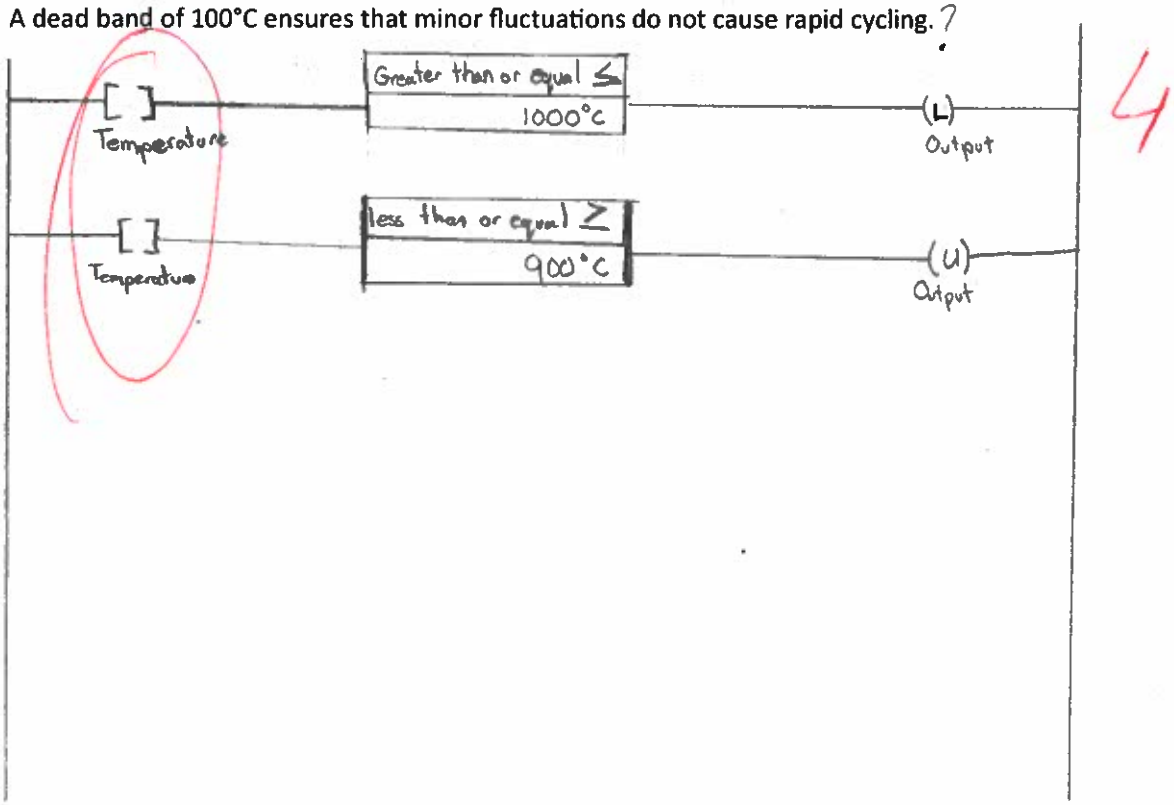
5. Design a PLC program using latch-unlatch logic (without necessarily using latch-unlatch instructions) to control the activation and deactivation of a physical output based on the temperature value of the tag "Temperature". [5 marks]

- The output should turn ON (energize) when the temperature reaches or exceeds 1000°C.
- The output should turn OFF (de-energize) when the temperature drops to or below 900°C.
- A dead band of 100°C ensures that minor fluctuations do not cause rapid cycling.



4

6. Develop a PLC program that emulates the functionality of a One-Shot Rising function without utilizing / implementing any type of One-Shot Rising Instruction. [4 marks]

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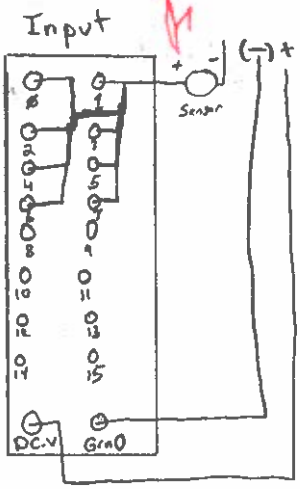
7. A discrete 24 VDC three wire sensor is to be wired in the 24 VDC Input Module of a PLC. Draw a complete wiring diagram including the power supply and the physical device wired in the input module of the PLC. [5 marks]

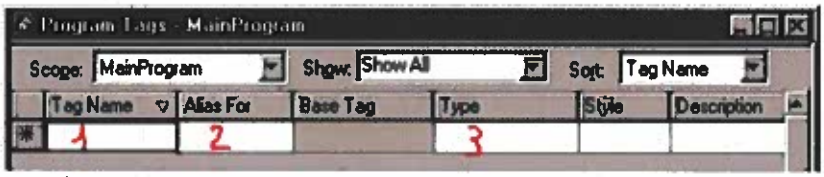
0	24 VDC
0	Out 0
0	Out 1
0	Out 2
0	Out 3
0	Out 4
0	Out 5
0	Out 6
0	Out 7

Input



3

8. Please note that there are 18 terminals in the Input/Output PLC module in the figure. Create Studio 5000 tags for each of the following memory locations below by providing a proper tag name, alias for, and data type. [5 marks]



3

a. A Push Button connected to the terminal number 0 of a 16-point input module located in slot 1 of the local chassis.

start_PB	tn_0	In_1

b. A Pilot Light connected to the terminal number 14 of a 16-point output module located in slot 2 of the local chassis.

pilot_light	tn_14	Out_2

c. A Capacitive Sensor connected to the terminal number 6 of a 16-point input module located in slot 1 of the local chassis.

Cap_Snsr	tn_6	In_1

d. A Relay connected to the terminal number 10 of a 16-point output module located in slot 4 of the local chassis.

Relay	tn_10	Out_4

e. A Photo Sensor connected to terminal 1 of a 16-point input module located in slot 2 of the local chassis.

photo_snsr	tn_1	In_2

Bool

Local : slot# : I/O : Data . Terminal #

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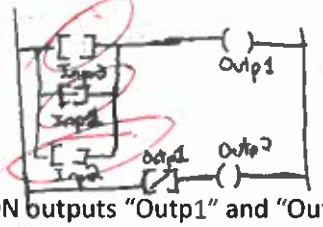
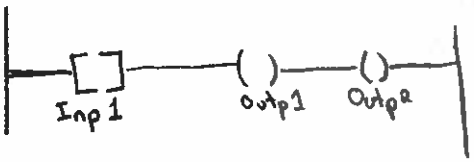
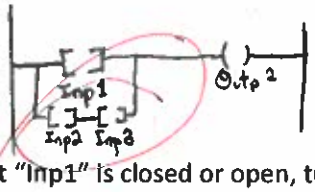
9. Create the ladder logic program needed to fulfill the following requests, considering that all inputs are normally open toggle switches: [5 marks]
   a. When either input "Inp1" or "Inp2" is closed and "Inp3" is open, turn ON output "Outp1"; otherwise, turn ON output "Outp2".



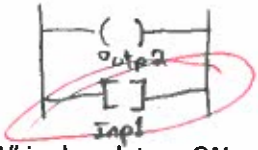
   b. When input "Inp1" is closed, turn ON and hold ON outputs "Outp1" and "Outp2" until "Inp1" opens.



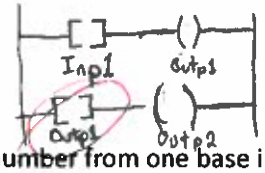
   c. When input "Inp1" is closed and either input "Inp2" or "Inp3" is open, turn ON output "Outp2"; otherwise, it should be OFF.



   d. When input "Inp1" is closed or open, turn ON output "Outp2".



   e. When input "Inp1" is closed, turn ON output "Outp1" and turn OFF output "Outp2".



10. Convert the following number from one base into the other: [5 marks]
   a. 31_{10} from base 10 into binary:

   b. 33_{10} from base 10 into hexadecimal:

   c. 16_{Hex} from base 16 into binary:

   d. 10101010_2 from base 2 into decimal:

   e. 1010101001010101 from base 2 into hexadecimal:

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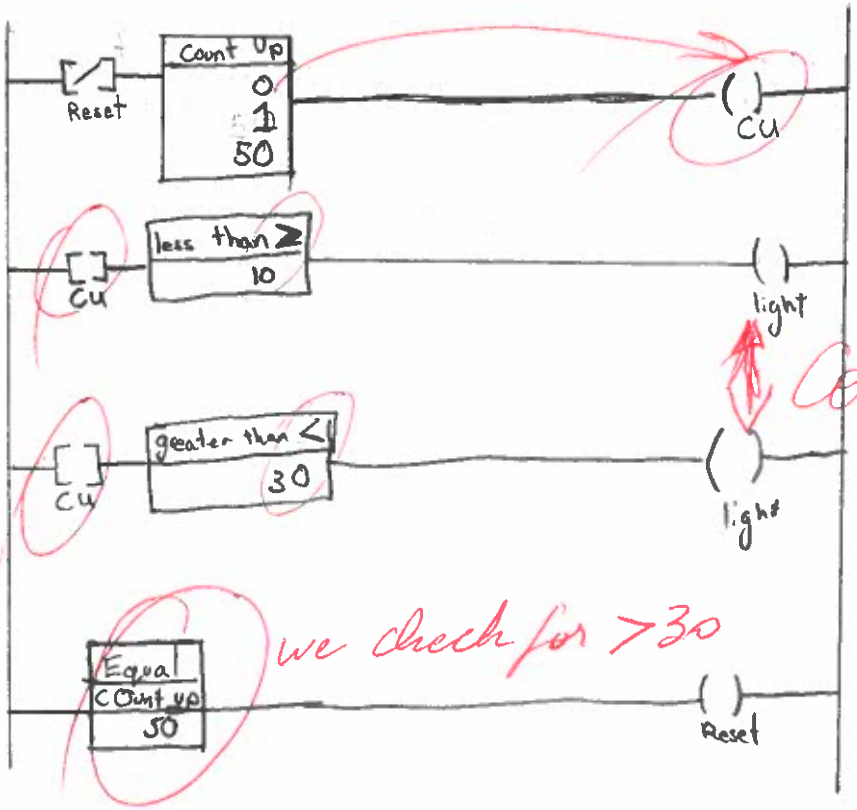
1 000

60 000 -> 1 min
60 000 -> 2
60 000 -> 3
60 000 -> 4
60 000 -> 5

180 000
120 000
300 000

11. Develop a PLC program that activates a light under the condition that the accumulated value of a PLC counter is either less than 10 or exceeds 30. Utilize a physical input to increment the counter's accumulated value and include functionality to reset the user program. [5 marks]



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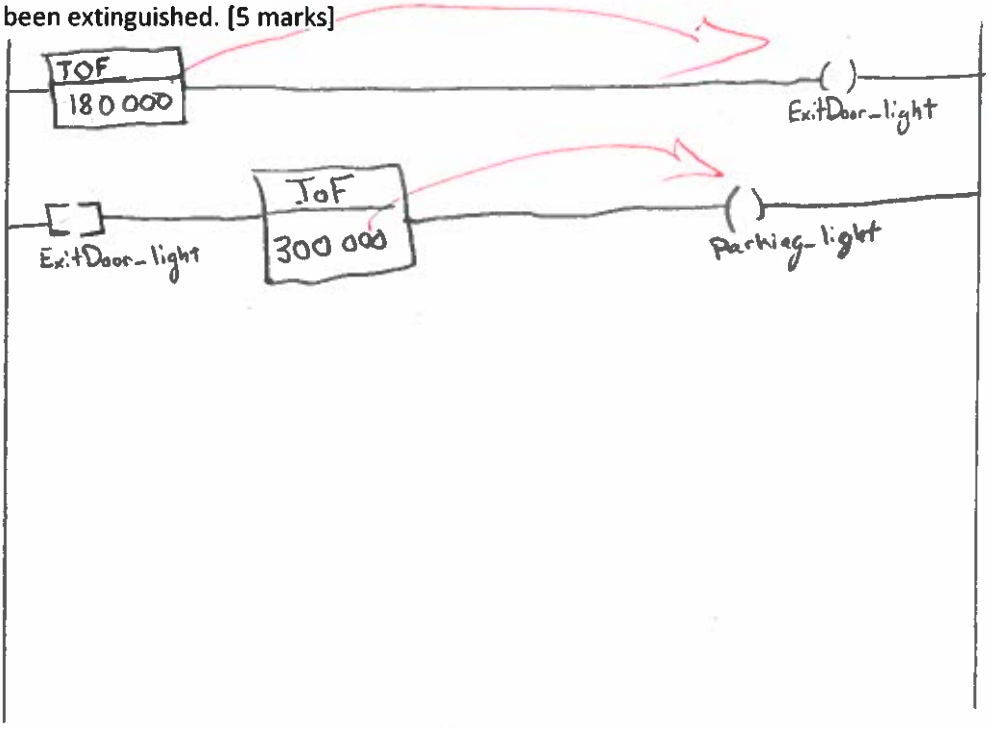
12. Design a PLC program using Timer Off Delay instructions (TOF) to address the following scenario: After turning off the lights in a building, ensure that the exit door light stays illuminated for an extra 3 minutes. Additionally, keep the parking lot lights on for an extra 5 minutes after the door light has been extinguished. [5 marks]

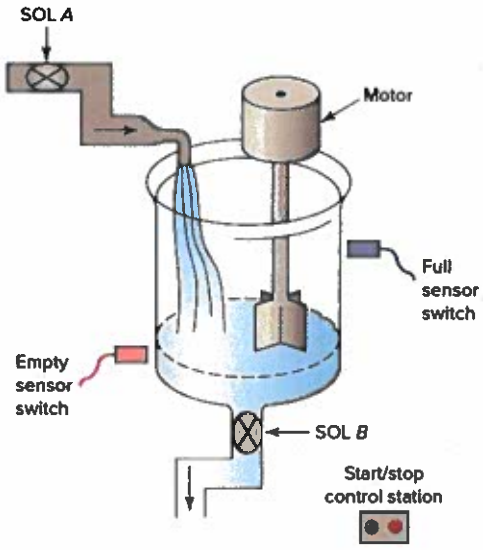


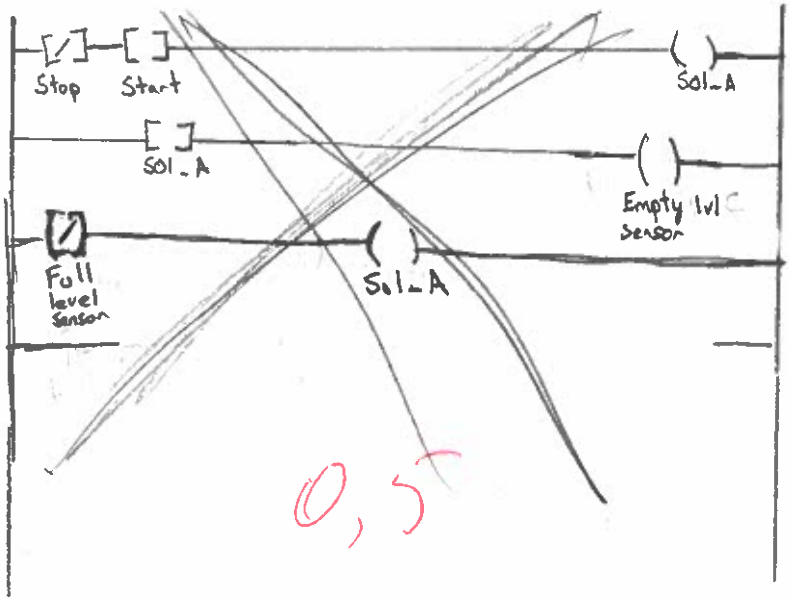
0,5

B

60
60
60

13. Write a program to implement the process illustrated below. The order of operation is to be as follows: [5 marks]
    a. Normally open start and normally closed stop pushbuttons are used to start and stop the process.
    b. When the start button is pressed, solenoid A energizes to start filling the tank.
    c. As the tank fills, the empty level sensor switch closes.
    d. When the tank is full, the full level sensor switch closes. As a result:
    e. Solenoid A is de-energized.
    f. The agitate motor starts automatically and runs for 3 min to mix the liquid.
    g. When the agitate motor stops, solenoid B is energized to empty the tank.
    h. When the tank is completely empty, the empty sensor switch opens to de-energize solenoid B.
    i. The start button is pressed to repeat the sequence.





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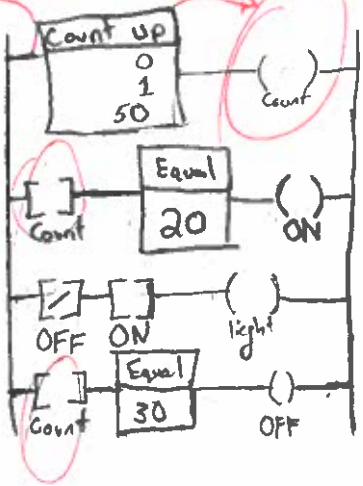
14. Design a PLC program and prepare a typical I/O connection diagram and ladder logic program for the following counter specifications: [5 marks]
    - Counts the number of times a sensor is ON.
    - Decrements the accumulated value of the counter each time a second sensor is ON.
    - Turns on a light anytime the accumulated value of the counter is less than 20.
    - Turns on a second light when the accumulated value of the counter is equal to or greater than 20.
    - Resets the counter to 0 when a selector switch is closed.

15. Create a PLC program that activates a light when the count reaches 20, and subsequently turns the light off when the count reaches 30. [5 marks]



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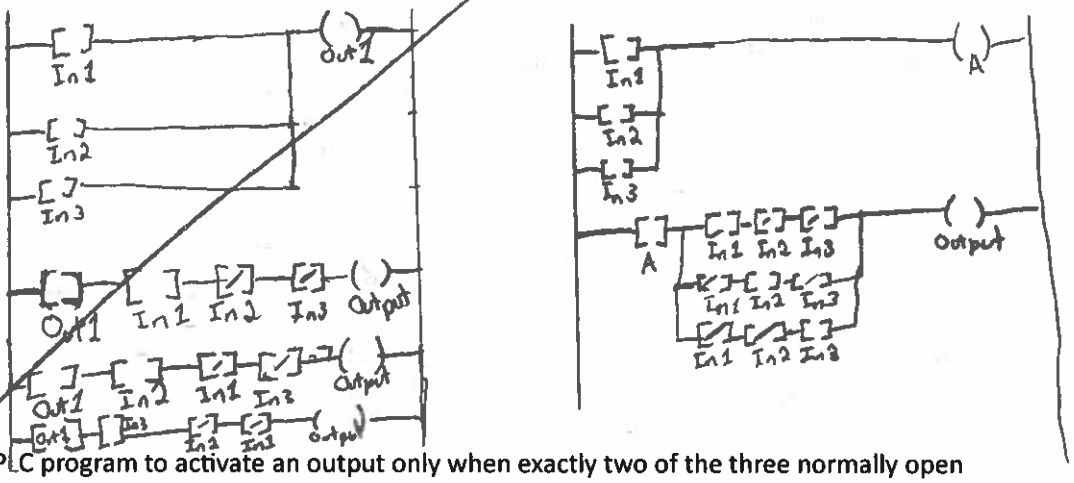
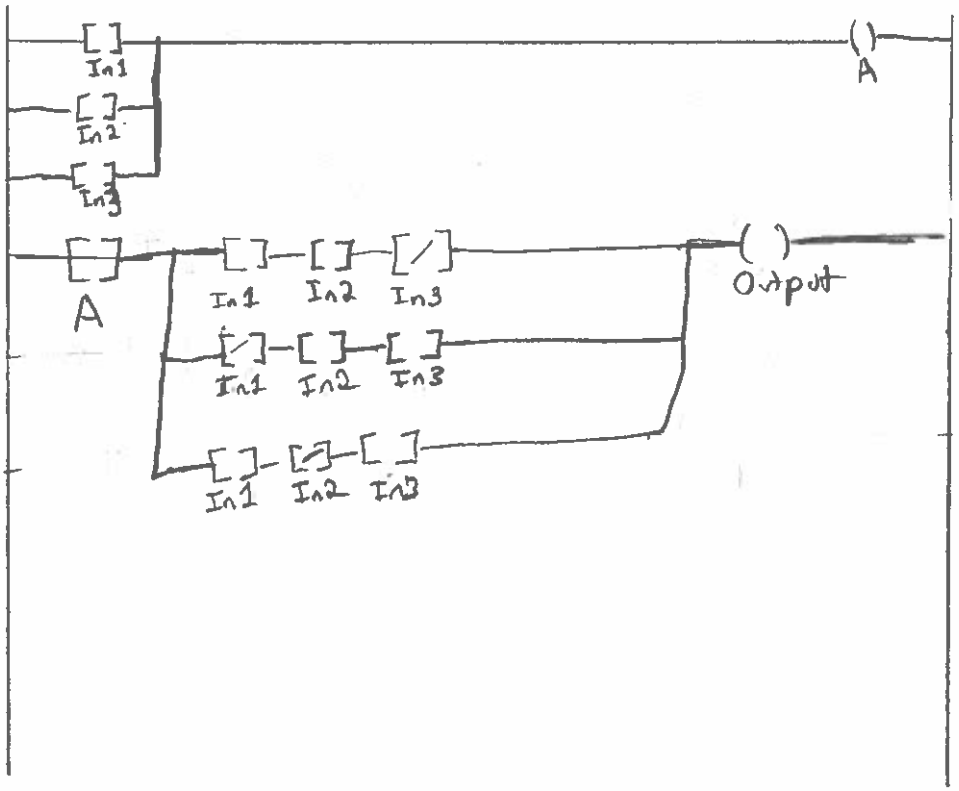
16. Design a PLC program to activate an output only when exactly one of the three normally open toggle switches is turned ON. [5 marks]
    - The output should turn ON if only one of the three inputs is active.
    - The output should remain OFF if none or more than one input is active.
    - This logic ensures that the output is energized exclusively when a single switch is ON while preventing activation if two or more switches are turned on simultaneously.

5



17. Design a PLC program to activate an output only when exactly two of the three normally open toggle switches are turned ON. [5 marks]
    - The output should turn ON if exactly two of the three inputs are active.
    - The output should remain OFF if none, only one, or all three inputs are active.
    - This logic ensures that the output is energized only when two switches are ON while preventing activation in all other cases.

5



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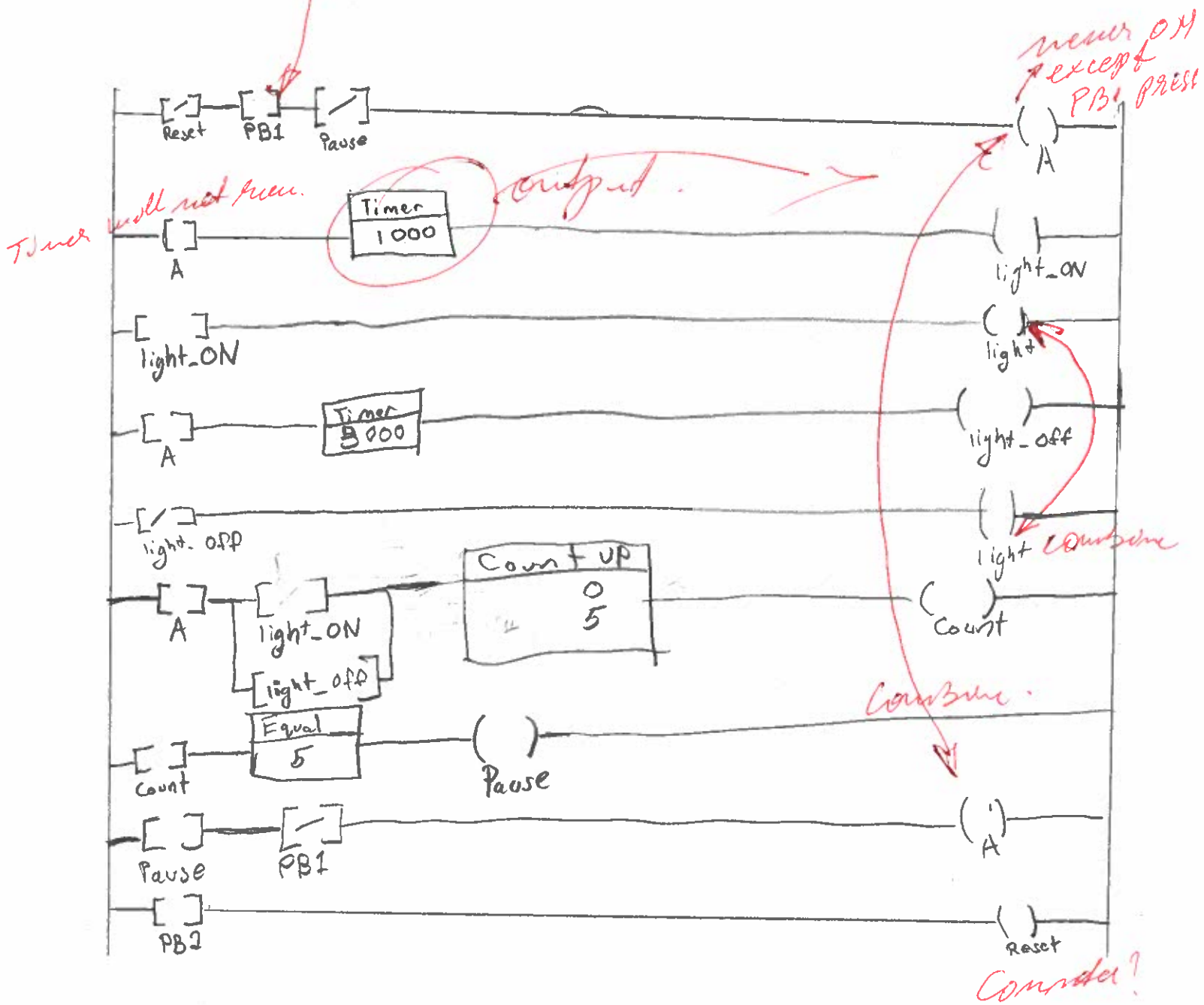
18. Design a PLC program with the following operational sequence: [5 marks]
    - Two momentary pushbuttons (PB1 and PB2) control the process:
    - Pressing PB1 starts the sequence.
    - Pressing PB2 resets the sequence at any time.
    - The light turns ON for 1 second, then turns OFF for 3 seconds, completing one full cycle.
    - The sequence repeats for a total of 5 cycles, with a counter incrementing after each cycle.
    - Once 5 cycles are completed, the sequence pauses instead of automatically resetting.
    - To restart the sequence after the pause, PB1 must be pressed again.

1, 5



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19. Design a burglar alarm system for a house using a PLC and Ladder Diagram programming language. The alarm should be activated if an unauthorized person is detected by either a Window Sensor or a Motion Detector. [6 marks]

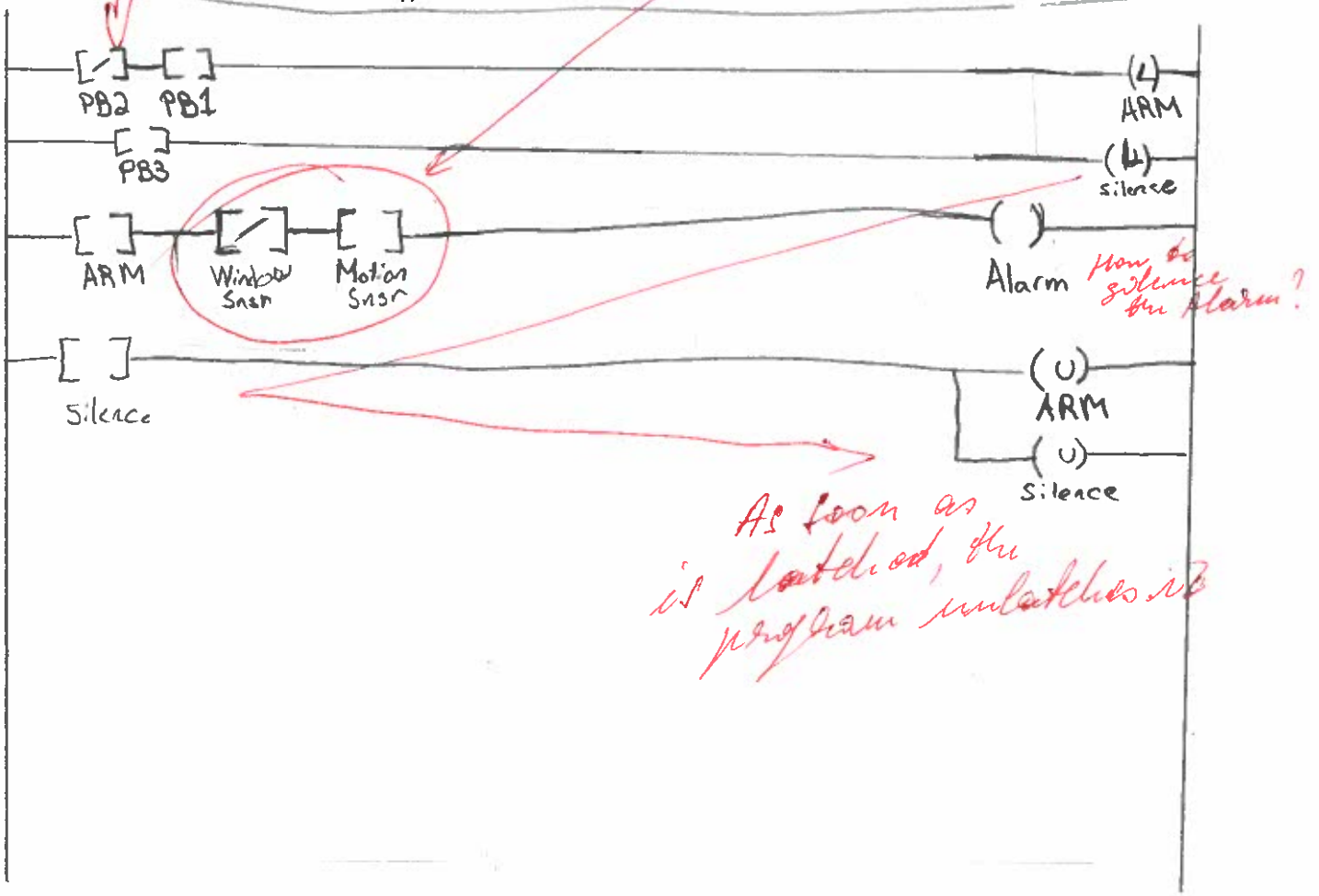
The system should include the following features:

a. Activation and Deactivation:
   i. A normally open pushbutton (PB1) is used to activate the alarm system.
   ii. A normally closed pushbutton (PB2) is used to deactivate the alarm system.

b. Acknowledging the Alarm:
   i. A third pushbutton (PB3) is used to acknowledge the alarm and silence it.

c. Sensors:
   i. The system uses two sensors: a Window Sensor and a Motion Detector.
      - The Window Sensor is a metal foil loop around the window. It outputs true as long as the window is intact. If the window is broken (causing a breakage in the foil), the output goes false.
      - The Motion Detector outputs true when motion is detected.

d. Alarm Logic:
   i. The alarm should ring when either the Window Sensor or the Motion Detector Sensor is triggered, but only if the system is activated.
   ii. When the system is not activated, the sensors should not trigger the alarm.
   iii. If the system is activated and either sensor detects a breakage (for the window) or motion (for the motion detector), the alarm will ring (even if the detection is momentary).



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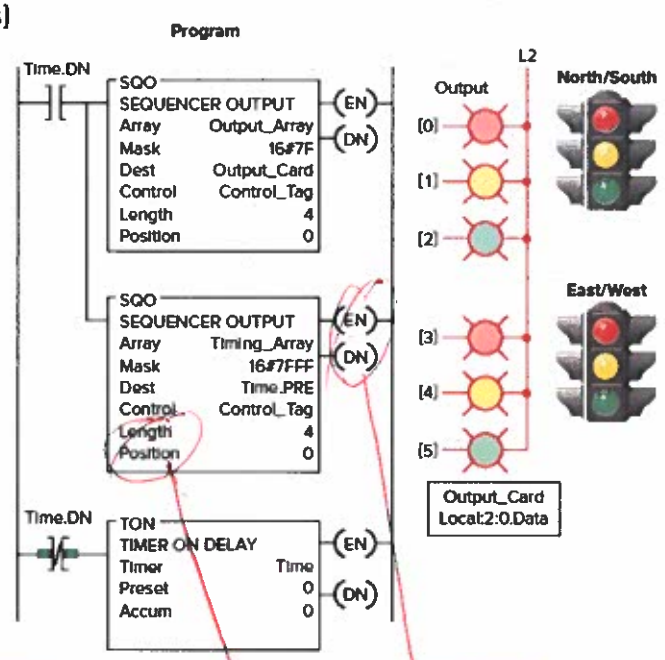
20. Answer each of the following with reference to the timer-driven sequencer program shown: [5 marks]



Timing_Array	Tag Editor / Monitor Tags	Positions
[+] Timing_Array [0]	0	0
[+] Timing_Array [1]	25000	1
[+] Timing_Array [2]	5000	2
[+] Timing_Array [3]	25000	3
[+] Timing_Array [4]	5000	4

Output_Array	Tag Editor / Monitor Tags	Positions
[+] Output_Array [0]	_0000_0000_0000	0
[+] Output_Array [1]	_0000_0010_0001	1
[+] Output_Array [2]	_0000_0001_0001	2
[+] Output_Array [3]	_0000_0000_1100	3
[+] Output_Array [4]	_0000_0000_1010	4

a. What is the significance of the Control_Tag in the SQO instruction?

If there's an issue with N Crosswalk Button? Crosswalk Button

b. What would happen if the Timing_Array values were incorrectly set to zero for all positions?

All the timers Flashing fast North/South Red light } All ways on
East/West Green light }

c. Suppose the Output_Card Local:2:0.Data fails to update the physical lights. What are some possible causes?

Wires from output card are Broken
Card configuration.

d. How would you modify the program to include a pedestrian crossing signal?

Adding the Control_Tag Ass an input to word timer

e. What changes would be necessary to adjust the traffic light timing based on real-time traffic conditions?

Seeing how much traffic is going, like if N/S is coming from highway keep lights On longer

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