Alexandria University
Faculty of Engineering
Computer and Systems Engineering Dept.
Fourth Year

CS441: Modern Control
Fall 2016
Date: 24th Dec, 2016
Time: 60 Minutes

PLC Lab Exam

Answer the following questions

Question # 1:
Design Ladder Diagram for a Tank Level Control application:
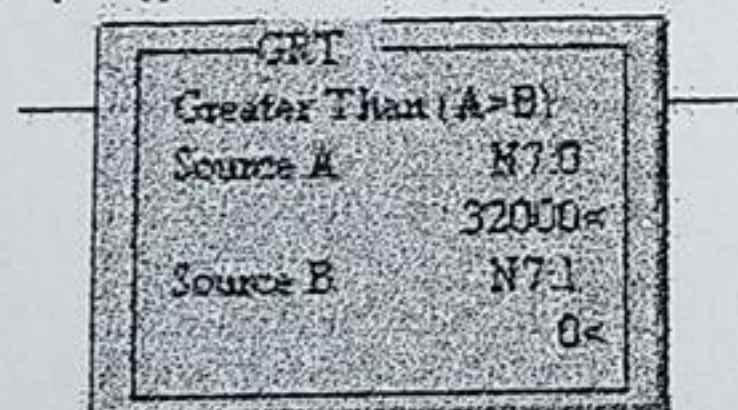
Assume a Pump is used to control the level in a Tank (the Pump is installed on the outlet of the tank). When the Pump is started, the Level in the Tank will decrease and the tank will be emptied. It is required to design a Ladder Diagram for the following operation:

a) The Pump is manually started by the operator using a Push-button. It can also be stopped manually using another Push-button after 3 seconds from pressing the Stop Push-button. Add to your Design a protective function for the motor of the Pump, where the motor is protected from High temperature by stopping the Pump when the motor bearing temperature (detected by sensor S1) is above 150 Degrees Celsius. Assume sensor S1 is Integer variable between 0 and +200 and is stored in address 0000 in the PLC memory address map.

b) Modify the Design in Part (a) by designing the Pump start/stop functionality to be fully automated (No Push-buttons exist to start or stop the Pump). Assume the Pump is operated using Automatic On/Off Control scheme where the Pump is started when the Level in the Tank (detected by sensor S2) is more than 70%, and the Pump is stopped when the Level in the Tank is less than or equal 30%. Assume sensor S2 is Integer variable between 0 to +100 and is stored in address 0001 in the PLC memory address map.

NOTES:
- Provide separate Ladder Diagram for Part (b).
- For both Part (a) and (b) use in your ladder Diagram the "GRT" comparator explained below:

It is given that PLC Ladder programming tools include the GREATER THAN "GRT" comparator shown below:

```
┌─────────────────────────┐
│  GRT                    │
│  Greater Than (A>B)     │
│  Source A        N7:0   │
│                 32000<  │
│  Source B        N7:1   │
│                     0<  │
└─────────────────────────┘
```

- If the value at source A is greater than the value at source B, the instruction is logically true (closed contact in the ladder rung).
- If the value at source A is less than or equal to the value at B, the instruction is logically false (opened contact in the ladder rung).
- Source A must be an address (integer reference). Source B can either be a program integer constant or an address (integer reference).
- The PLC Ladder programming tools do not include LESS THAN comparator. Only GRT comparator is available for Programming.

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Question #2:

A machine is being designed to wrap boxes of chocolate. The boxes arrive at the machine on a conveyor belt. The list below shows the process steps:

1. The box is manually inserted on a conveyor by the operator.
2. The Push-button "START" is pressed by the operator and the Conveyor "C" starts moving.
3. The box arrives and is detected by an optical Sensor "S". After this the conveyor "C" is stopped and the box is Fixed in place using a clamp "F".
4. Wrapping mechanism "W" is turned on for 2 seconds.
5. Sticker cylinder "K" is turned on for 1 second to put label on the box.
6. The clamp "F" is turned off and the conveyor "C" is turned on.
7. The Process stops operating when the Push-button "STOP" is pressed.
8. The Process also stops if 1000 Boxes have been processed (Include the Counter reset in your design).

a) Construct an Input-Output Table.

b) Design Ladder Diagram.

Bonus:
Assume the PLC has capacity of 4 Inputs and 4 Outputs. The factory manager notices frequent problems with the used optical sensor and suggests replacing it with a better and more reliable sensor (laser instead of optical). You notice that there is space in the unit to install two sensors on the Conveyor at the same location. What could be better solution that you can propose to the factory manager? Show how this proposal will affect your design and IO Table.

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