Automated Control System Design and Programming - [60 Points]

The purpose of this exam question is to demonstrate a basic understanding of how to design and program a PLC-based Control System in a factory automation environment. This includes the usage of sensors, actuators, PLC I/O modules, communication network devices, operator interface (HMI) functionality, and a Ladder Diagram program based on the operational requirements and good programming practices.

The Packaging Conveyor shown below feeds a Robot which glues and closes flaps on a box. The conveyor is fed by an INFEED with two different production lines each requiring a different glue pattern. The Packaging Conveyor consists of two separate sections (SECT 1 and SECT 2) which provide a gap between boxes. After a Robot completes gluing and closing the box it is conveyed to an OUTFEED system.

An Operator Interface (HMI) is required for system start/stop, set-point/data input and system monitoring. The system is started and stopped by a HMI maintained push button.

An Ethernet/IP based Bar Code Scanner identifies the box glue pattern as it enters Conveyor SECT 1. This information must be saved and tracked with the box for the Robot Glue Pattern command. The Bar Code scanner should be triggered on when a box is detected at the INFEED and the Bar Code read saved when box is detected at SECT 1.

Each section will use an induction motor and require variable speed control. The gap is accomplished by running conveyor SECT 2 at 20% higher speed. The percentage should be adjustable to change the box gap, via the HMI. Three boxes can be accumulated on conveyor SECT 2. Sensors should detect boxes on the INFEED, SECT 1 and SECT 2, and detect the OUTFEED is empty.

Solenoid air control valves raise and lower a pop-up stop at the glue station. It should be raised for boxes arriving at the Glue Station for squaring and locating the box.

When the box arrives at SECT 2 the Robot Glue Pattern and Robot Start Glue signal commands are sent to the Robot via Ethernet/IP. The Robot will respond with a Robot Glue Complete signal when finished, which should turn off the Start Glue Command. The Stop should be lowered and the box conveyed to the OUTFEED.

A thermocouple is used to monitor the glue temperature and the glue heating system is analog controlled (PID control is required). The temperature must be maintained based on a set point from entered the HMI. The Glue temperature should be displayed on the HMI. Assume maximum temperature is 175 degrees F.

Include detection of a Box Jam Fault on conveyor SECT 2 that will shut the system down and require a HMI Reset (assume all boxes will be removed from the conveyor prior to reset).

Keep track of the total number of boxes that have been glued and display this value on the HMI.
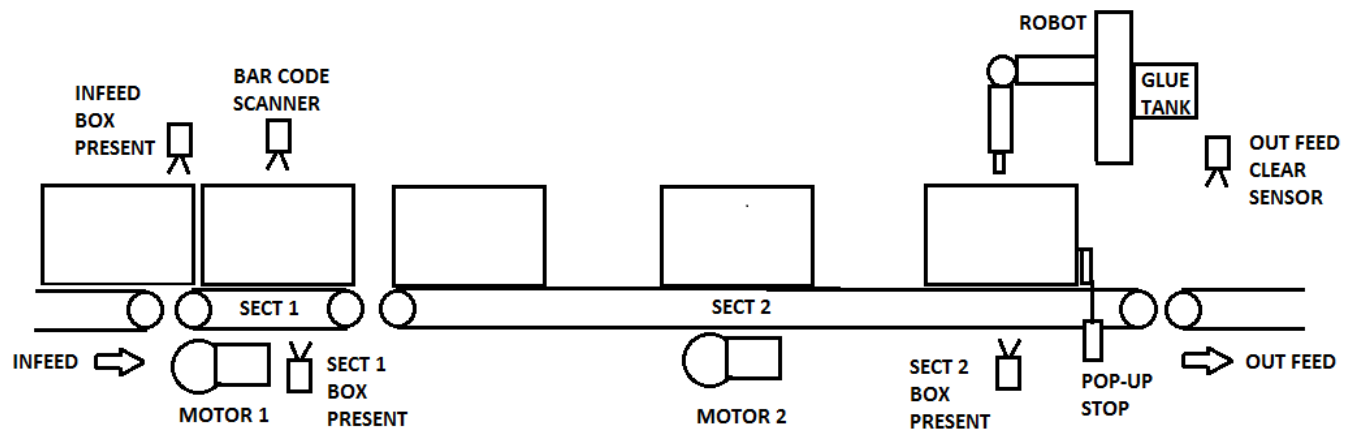
Provide a PLC control system design for the Packaging Conveyor shown above. Include all control device and HMI requirements. Devices such as the Robot, Bar Code Scanner, Drives and HMI should communicate with the PLC via Ethernet/IP. Program routines are only required for the Packaging Conveyor (SECT 1 and SECT 2). You're not responsible for the infeed, Robot and out feed control.

Include the following in a **Word document** with filename format; "Your Last Name MFET 340/670 Final Exam". Use RSLogix5000 to develop your Ladder Diagram code and the **Snipping Tool** to include the Ladder rungs in your submittal. **Submit to the myCourses Final Exam Dropbox by 5/17/2016 and bring a printed copy to the final exam.**

1. List all devices that are wired to PLC's I/O modules. Describe device and I/O module type for each. Describe the normal not actuated or not blocked state for input devices. You do not need to list I/O addresses.
2. List all Ethernet network based devices include associated PLC tag names.
3. List HMI screen functionality such as push button, data entry and display objects. Include PLC tag names which should start with "HMI_" to indicate they are associated with the HMI.
4. Write a Ladder Diagram routine based on the operational description. Use descriptive tag names. Use tag names from items 2 and 3 for network devices and HMI functionality.

The Ladder Diagram routine should consist of **10 rungs** organized as follows. The only Latch instruction that can be used is the SECT 2 Jam Fault. Use descriptive tag names only. It's not necessary to show I/O addressing. Include the description below with each rung. State any assumptions you have made.

1) SECT 1 conveyor motor run.
2) SECT 2 conveyor motor run.
3) SECT 1 and SECT 2 calculate and set motor speeds.
4) Popup stop raise and lower.
5) Bar Code Scanner trigger bit and read glue pattern number.
6) Set Robot glue command bit and write Robot glue pattern number.
7) Glue temperature control.
8) SECT 2 Jam Fault detection.
9) Total boxes glued.
10) System reset to initial state (i.e. after a fault condition).