1. A box sorting application is shown in the figure 1. It consists of the main conveyor from where boxes are loaded and two unloading converters. Unloading conveyors carry the boxes in two different directions. Four reflex sensors have been used along with the reflectors as shown in the figure 1. When a reflex sensor detects the box on the main conveyor, the main conveyor will start after 1 second. Once a box approaches sensor 2, the main conveyor will stop. Transfer conveyor will transfer 5 boxes to conveyor 1 first, and then it will transfer the remaining boxes to the conveyor 2. The counter will reset when the stop button is pressed.

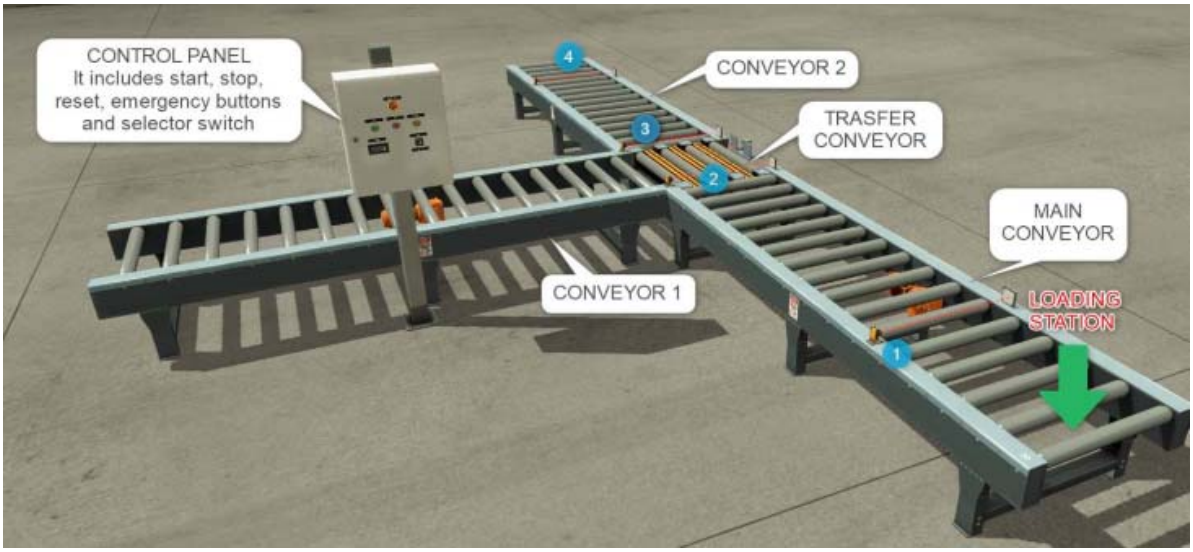

Figure 1: Box sorting application

2. The traffic light has red, amber, and green lamps. A red lamp gets on for 5s, then an amber lamp gets on for 2s and finally, the green lamp will get on for 5 sec. This cycle will continue for 1 minute.
3. Assume that the four motors are represented by four pilot lights on the trainer unit. A pushbutton START switch is used to start a sequence of motor operations that can be terminated at any time by pressing a push-button STOP switch. The sequence starts MOTOR1, then MOTOR2, then MOTOR3, and then MOTOR4. The same sequence will repeat until the process is stopped. Each selected motor will run for a simulated abbreviated period of 5 seconds while the other motors are idle. Develop a PLC program to execute the control sequence.

4. Two motors are used in a pumping-station facility. Both motors run on the activation of a START push-button switch. The activation of a STOP push-button switch stops Motor 1 immediately and then Motor 2 after 5 min. Develop a PLC program to execute this operation.
5. Figure 2 shows material conveying system is used to carry material such as grains, powder, and small granules from ground level to a certain height. An electric motor is used to move the chain. When a start_PB is pressed, the chain starts rotating and the vibratory feeder starts after 2 sec. A vibratory feeder continuously feeds the material into the bucket. Then the material is unloaded into the storage tank. If the material reaches a level sensor, it will stop the vibratory feeder first and then the conveyor will stop after 2 sec.

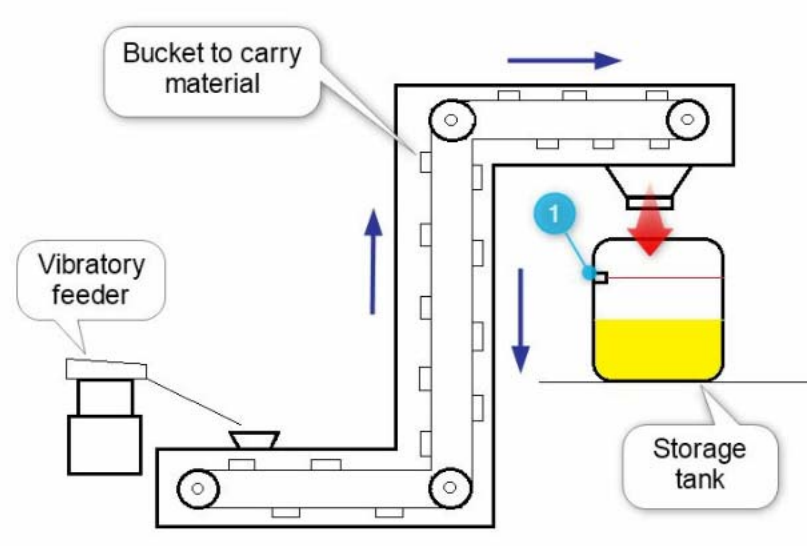

Figure 2: Material conveying system

6. The control process counts the number of rejected parts on a conveyor line by monitoring the number of time a solenoid valve goes from OFF to ON. If the number of rejected parts reaches 100, the conveyor line motor is turned OFF. A RESET push button, when pressed, clears the counter accumulated value. The START and the STOP push buttons serve the normal functions of starting and stopping the PLC-control process/motor M1. The solenoid valve SV1 is activated at an inspection station once for every rejected part. Inspection and rejection of assembled/produced items are typical in manufacturing assembly. Excessive rejection is an alarming condition that warrants shutdown of production until necessary corrections are carried out by the operator.

7. Figure 3 show material conveying system is used to lift the boxes and transfer them to a certain height. When a start_PB is pressed, the conveyor will start rotating. if a box is present at the conveyor 1 chain conveyor will stop. Then the box will enter into the conveyor, a box present sensor will sense the presence of the box at the loading station and the chain conveyor will start again after 1 sec. As the box reaches the unloading sensor, the chain conveyor will stop. A pusher will actuate after 2 sec and it will push the box on the conveyor 2. After pushing the box, the pusher will retract and the reed switch will sense the pusher (homing sensor). Once the reed switch senses the pusher, the conveyor will start again after 1 sec. This cycle will continue until a stop_PB is pressed.

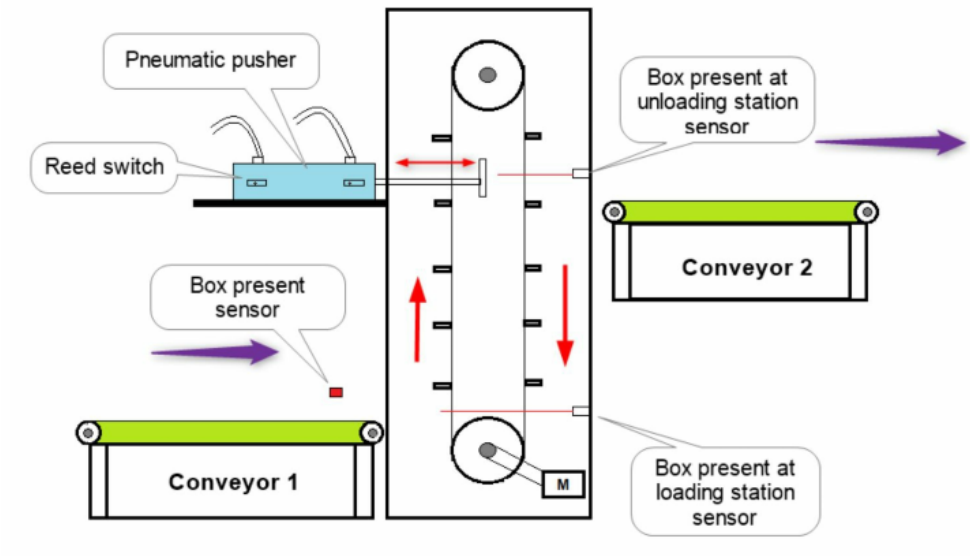

Figure 3: Box lifter

8. A part is moving on a conveyor line crossing a photoelectric cell. The photoelectric cell function is primarily to count parts. The conveyor line stops after 100 parts are counted. Design and implement a documented ladder-logic program to satisfy the following sequence of operations: The START push button starts the conveyor motor after a 5-second delay. The motor must start only if the AUTO/MANUAL switch is placed in the AUTO position. The photoelectric cell should count only when the motor is running, When the count reaches 3, stop the conveyor after a 2-second delay, The ON pilot light indicates the end of the sequence, The STOP switch, when activated, takes the system to initial conditions, The operator can restart the same sequence by activating the START switch. **NOTE:** Use SS1 for the photoelectric

cell input signal, SS2 for the motor running input indication signal, PL1 for the motor starting output signal, and PL2 for the pilot light output signal.

9. A flexible manufacturing conveyor system produces two products. Each product is counted by a photoelectric cell (PE1) mounted on the conveyor line. Batch production is enabled by activating a START push button. Each batch processing is initiated through a dedicated normally open push-button switch. Only one batch can be active at any time. A new batch can be started after completion of the ongoing batch or by forcing a termination through the STOP push button. Product 1 is produced in the amount of 2000 total parts and product 2 in the amount of 5000 total parts. A pilot light PL1 is ON after a batch is completed. The process begins by pressing the push button for the selected batch and can be terminated at any time by pressing the STOP push button. A RESET push button is used to reset the counter accumulated value at any time
10. A cascaded-tanks reactor is a typical chemical process requiring accurate timing to allow for the desired reactions among mixed materials in a recipe production. In this reactor, three tanks are cascaded through a series of solenoid valves: SV1, SV2, and SV3. Materials for the selected recipe are poured into tank 1. START push-button activation will open tank 1 SV1. Reactions take place in tank 2 for 7 hours before the material goes to tank 3 for an additional 8 hours of reaction. The final delivery of finished material through tank 3 consumes the final 5 hours.
11. An inspection station is designed to detect 10 missing stamps in a 2-hour time window. Once the detection is TRUE, the motor (M1) should stop running, and the pilot light will turn ON to indicate that a fault has occurred. To restart the motor, the operator should fix the fault and push the RESET normally closed push-button switch.
12. A reaction tank shown in figure 4 is used to heat the chemical solution liquid to a certain temperature, then maintain it to that temperature to achieve the required results, and then drain it. The process initiates when the start command is given from the SCADA screen. The PLC will switch on the inlet valve and allow the chemical liquid to enter into the tank. A load cell under the tank will measure the amount of liquid. Once it measures the 10kg weight of resin, PLC will switch off the inlet valve. After 10 sec, an agitator will start stirring the chemical liquid for 60 sec, then after 30-sec heaters will start heating the liquid until 120 deg C to 125 deg C temperature is achieved. Once the temperature inside the tank is achieved, PLC will switch on the supply of nitrogen gas and it will maintain 2 bar pressure inside the tank for 5

minutes. After the completion of 5 minutes, PLC will open the drain valve to drain out the chemical solution liquid. The agitator will stop after draining out (load cell will send a signal)

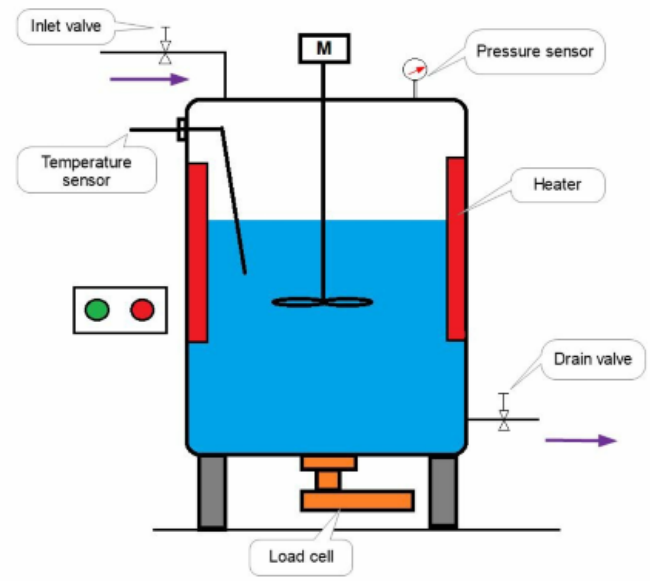

Figure 4: Reaction tank

13. A cylindrical tank shown in figure 5has an area of 10 m^2. This application maintains a liquid volume of 10 to 50m inside the tank at all times, assuming that the tank is equipped with two solenoid valves: fill (SV1) and drain (SV2), as shown in Figure 4. The tank level sensor is simulated by a count up (CTU) and a count down (CTD) counter. If the tank level is greater than or equal to 50 m, drain the tank by activating SV2. If the tank level is less than or equal to 10 m, fill the tank by activating SV1. Report the volume values in a tag labeled Tank_Volume.

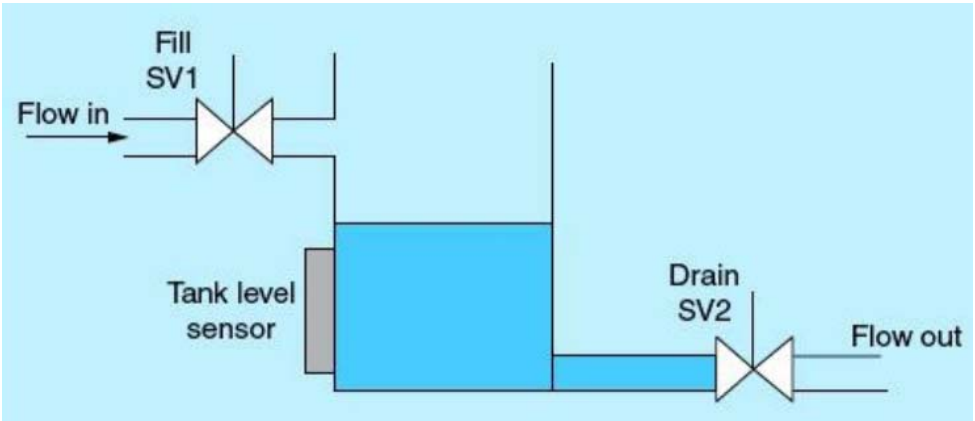

Figure 5: Tank fill/drain process