



## UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: August 2018

Module Number: ME 7313

Module Name: Industrial Automation and Control

[Three Hours]

[Answer all questions, each question carries ten marks]

You may make additional assumptions where necessary, but clearly state them in your answers. Symbols stated herein denote standard parameters.

- Q1. a) Explain the difference between “*fixed position layout*” and “*process layout*” related to the plant layout concepts. [1.0 Mark]
- b) Briefly describe “*USA principle*” in industrial automation. [1.0 Mark]
- c) What is meant by “Automation mitigation strategy”? What are the three phases of a typical automation mitigation strategy? [4.0 Marks]
- d) The degree of automation can be described as a function of production quantity and product variety. What are the three main types of automation and how would you relate those types of automation to production quantity and product variety? [4.0 Marks]
- Q2. a) Compressed air used in pneumatic systems needs good preparation. State three possible consequences of non-prepared air usage on the system and environment. [1.0 Mark]
- b) Differentiate adsorption drying and absorption drying in related to primary air treatment. [2.0 Marks]
- c) Consider a simple operation where a double-acting cylinder is used to transfer parts from a magazine in a fully pneumatic system. The cylinder is to be advanced either by operating a push button or by a foot pedal. Once the cylinder is fully advanced, it is to be retracted to its initial position. A 3/2 way roller valve is to be used to detect the full extension of the cylinder. You may use one master switch to turn ON/OFF the whole circuit. Draw a pneumatic circuit for the above system. [3.0 Marks]
- d) Figure Q2 (d) shows a press machine used in a plastic manufacturing plant. An electro-pneumatic system is used to operate it. Once switched ON, the machine should satisfy the following requirements.
- The operator can control the movement of the top half of the press machine using two electrical push buttons; PB1 and PB2.
  - When PB1 is pressed, the top half of the press machine should move down.
  - When the electrical limit switch (LS2) is activated, the press will remain at its

position for 5 s (Using an on-delay relay) and retract.

- When the electrical limit switch (LS1) is activated the press will move down again automatically.
- Up-Down movement of the press will take place until PB2 is pressed using LS1 and LS2 signals.
- When PB2 is pressed, the process will stop immediately and the press will move to the initial position.

Draw both electrical circuit and pneumatic circuit diagrams for the above system.

[4.0 Marks]

Q3. a) Describe the main scan cycles of a typical PLC.

[1.0 Mark]

b) A motor starter system is powered ON/OFF using a master selector switch. The motor starter is to be controlled by two switches. After switching on the master selector switch, the GO switch (Normally open) will start the motor and the E-stop switch (Normally closed) will stop it.

- If the E-Stop switch was used to stop the motor, the GO switch must be pressed twice to start the motor.
- If the system is switched off using the master selector switch, the motor can be turned ON just by pressing GO switch once.
- When the motor is active, a light should be turned ON.

Draw the PLC ladder program for the motor starter system. Use PLC inputs/outputs as mentioned in the Table Q3.

[3.0 Marks]

c) A blinking bulb should get turned on using push button A and turned off using push button B. When the button A is pressed, the blinking cycle should continuously run satisfying following timing. In onecycle, the bulb should be turned ON for 5 s and turned OFF for 2 s. When the button B is pressed, the cycle should get turned OFF. Construct a timing diagram for the above system satisfying all given conditions.

[3.0 Marks]

d) The main motor of a CNC spindle is to be controlled using a single push button. Pressing the button two times within 5 seconds should switch ON the main motor. The main motor bearing is lubricated using a lubricating pump while at operation. When switched ON, pressing the same button once should switch OFF the main motor. After switching OFF the main motor, it takes about 30 seconds for it to slow down. Hence, lubrication for main motor bearings is required for 30 s after the supply of the motor is switched OFF.

Construct a PLC ladder program (Siemens STEP 7 for 300 series) for the above system satisfying all the given conditions.

[3.0 Marks]

Q4. Industrial automation facilitates to increase the product quality, reliability, and production rate while reducing production and design cost by adopting new, innovative and integrated technologies and services. Hierarchy of an Industrial automation system consists of four main levels of automation: Fixed level, Control level, Supervising and

production control level, and Information level.

- a) List 3 characteristics of each level and compare with respect to the various devices used for the automation.

[3.0 Marks]

- b) As the automation engineer of a beverage manufacturing plant, you are assigned to automate manual soft-drink bottling process that has a demand for 600ml glass bottles and 10,000 bottles filling per lot. Bottles can be loaded manually and afterward following steps are planned to be automated with the maximum level of possibility.

- Checking of bottles for cracks and impurities and rejection of those bottles automatically.
- Transporting of bottles to filling station.
- Confirmation of volume (i.e. the bottle volume between 600 and 605 ml), make an alarm when the volume of the bottle is not within the range and reject such bottles automatically.
- Install the bottle cap.
- Printing code number, date of manufacture, date of expiry, and price.
- Bottle counting.
- Unloading to crates with 24 bottles capacity.

- i. What level of hierarchy do you propose to automate the above process, explain with reasons?
- ii. Prepare a list of sensors and actuators required to automate each step of the above process

[7.0 Marks]

Q5. Figure Q5 depicts the green tea withering process using dry air and continuous belt system. You are requested to automate the process.

- a) What are the physical parameters which have to be sensed and controlled?

[2.0 Marks]

- b) List the required sensors, controllers and actuators to be fixed in order to automate the process.

[4.0 Marks]

- c) Draw a schematic diagram showing the locations of installing the components that you listed in (b)

[4.0 Marks]

Q6. Automated material handling is an integrated system that involves handling/transporting, storing, and controlling of materials/goods. Forklifts, Conveyers, Automated Guided Vehicles (AGVs) and Overhead/Floor Monorail are some of the technologies, which can be used for the transportation of materials.

- a) Explain four factors to be considered when designing an automated material handling solution using above technologies and compare them.

[3.0 Marks]

- b) In modern industry, Automated Mobile Robots (AMRs) are mostly applicable than AGVs. Contrast (explain differences) AGVs vs AMRs.

[2.0 Marks]

- c) Optical sensors are widely used in materials handling and packaging industries.
- What are the three basic configurations of photoelectric sensing? Briefly explain each of them.
  - What are the constraints in proximity (diffuse) scanning and propose a method to overcome them.

[5.0 Marks]

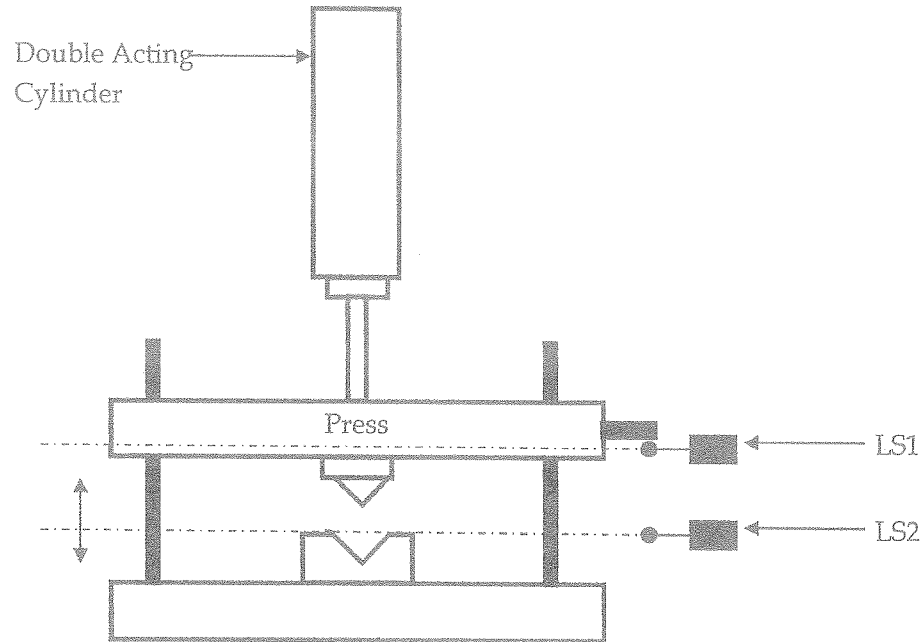


Figure Q2(d): Press Machine

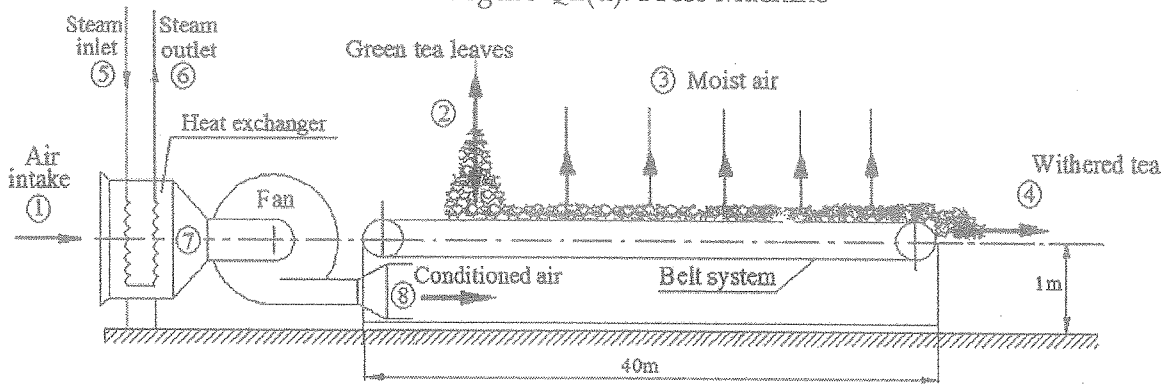


Figure Q5: Schematic layout of the green tea withering process using dry air and continuous belt system.

Table Q3

Inputs	Terminal	Outputs	Terminal
Master selector switch	I0.0	Motor starter	Q0.0
GO switch - push button (NO)	I0.1	Light	Q0.1
E-Stop switch - push button (NC)	I0.2		