

The Open University of Sri Lanka
Faculty of Engineering Technology



Study Programme	: Bachelor of Technology Honors in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: MEX6270 – Factory Automation
Academic Year	: 2015/16
Date	: 18 th November 2016
Time	: 0930hr-1230hr
Duration	: 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper has **eight** questions. All questions carry equal marks.
3. Answer **five** questions only.

Question 01

- a) Give suitable automation types for each of the following production types.
 - i. Job shop production
 - ii. Batch production
 - iii. Mass production
- b) Fixed automation and flexible automation are two of the basic approaches employed in industrial automation. Explain on the above two types of approaches and discuss the suitability of each approach in industrial automation.
- c) Briefly describe why the end effector is not included in a manufacturer's specification of a robot's work envelope.

Question 02

- a) Describe the term "bang-bang control" with using a suitable example (sketch the output signal of the controller).
- b) The two types of outputs available in industrial controllers (eg: PLC/PID controller) are electro-mechanical relays and solid state relays. Discuss the differences and applicability of both types.

- c) Derivative control always used with proportional control in control systems. It is never used separately as a controller without proportional control. Explain.
- d) State the main advantage of incorporating an integral element into a proportional control system.

Question 03

- a) Explain the differences between microprocessors and microcontrollers.
- b) Write three common programming languages that are used in PLC programming.
- c) Draw Ladder Logic diagrams to implement the following gates.
i) OR ii) AND
- d) Draw a Ladder Logic diagram to implement a motor controller using two push button switches as shown in figure Q3-d.

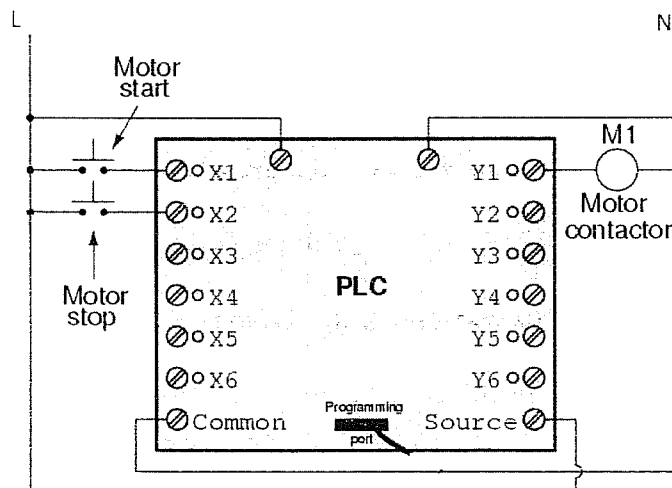


Figure Q3-d

Question 04

- a) What is meant by a Variable Frequency Drive (VFD).
- b) Identify section i and ii of the simplified diagram of a VFD shown in the figure Q4-b.

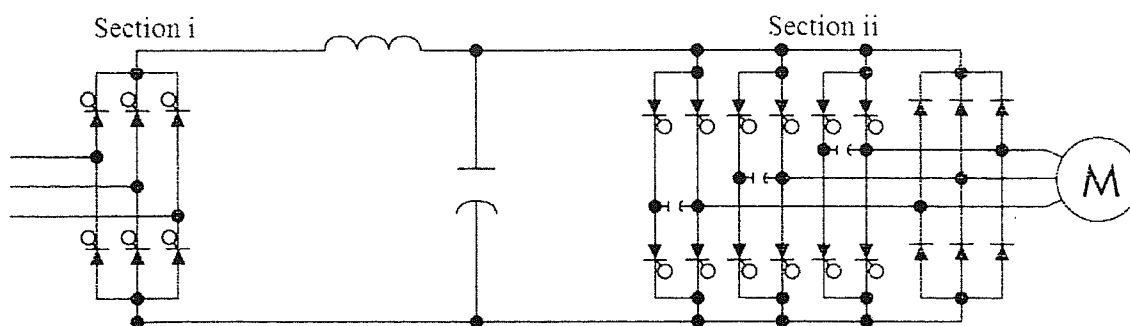


Figure Q4-b

- c) Differentiate between sensitivity and cross-sensitivity in relation to sensors.
- d) Discuss the main advantage of Gray code used in rotary encoders for an industrial application.

Question 05

- a) What are the differences between pneumatic and hydraulic systems? State any four.
- b) State three main functions of a pneumatic air service unit.
- c) Draw symbols of following pneumatic components.
 - i. 2/2 way directional control valve
 - ii. 3/2 way directional control valve
- d) A pneumatically operated vice is shown in figure Q5-d. The vice is to be operated by a double acting cylinder and should close slowly for allowing to position the work-piece.

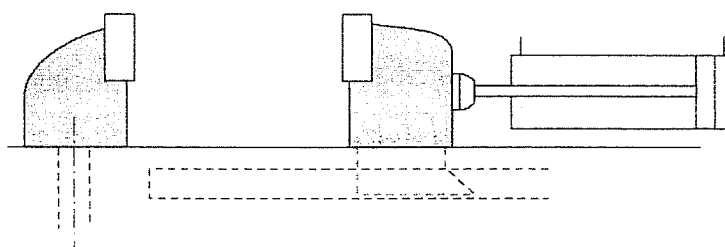


Figure Q5-d

Design a pneumatic system that will perform this task. (Draw pneumatic system using standard symbols and name each component of the system clearly).

Question 06

Figure Q6 shows a simplified schematic diagram of an automated packing station. The station packs six wine glasses individually into a preassembled wine glass box.

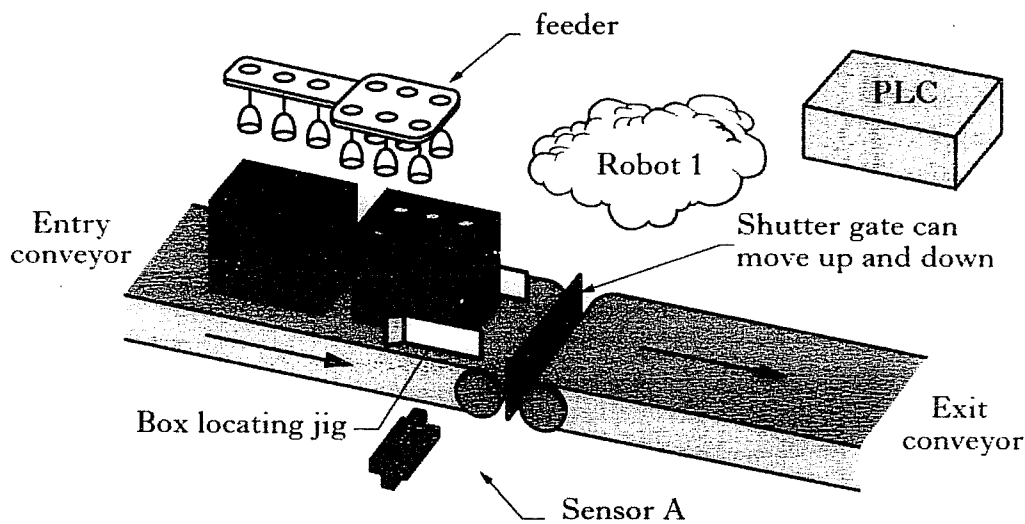


Figure Q6

The automated packing station operates as follows.

- The Exit conveyor runs continuously.
- The Entry conveyor starts and stops as required.
- An empty box arrives at the Box locating jig on the entry conveyor.
- Sensor A detects the arrival of the empty box.
- The arrival of the box at Sensor A stops the Entry conveyor and triggers the raising of the Shutter gate.
- Robot 1 loads six glasses, one at a time, from the Feeder into the box, then returns to the home position and sends a “load complete” signal to the PLC.
- The Shutter gate is lowered, the Entry conveyor starts and the loaded box moves over the shutter gate and onto the Exit conveyor.
- The fully packed box is transported away from the automated packing station.

The system is fully automated once started. A continuous supply of glasses and boxes is provided by the glass Feeder system and the Entry conveyor respectively. The complete system is controlled by a Programmable Logic Controller (PLC) which monitors the input and provides the output signals for the various parts of the automated packing station.

- a) Briefly describe a suitable device for Sensor A that would detect a box arriving at the Box locating jig.
- b) State a suitable actuator that could be used for the shutter gate on this system and give two reasons for your selection.
- c) The system is to be modified to include variable speed control of the entry conveyor. How the speed of the conveyor could be measured? (hint: select a sensor);

- d) Suggest a suitable robot geometry for Robot 1 and justify your choice.
- e) There is a problem with damaged glasses being packaged by the automated packing station. Any damaged glass is to be automatically deposited in a waste bin. Describe a suitable system that would;
- detect if a glass was damaged prior to packaging.
 - enable the system to carry out disposal.
- f) State two hazards associated with this automated packing station and briefly describe how they may be addressed at the design stage.

Question 07

- Discuss the applicability of CNC technology in factory automation.
- Explain the significance of tool offset in CNC programming.
- Describe the two methods of positioning employed in CNC programming.
- Indicate the position of A, B, C of the figure Q7 using both methods.
(Start from point A, then B, end at point C).

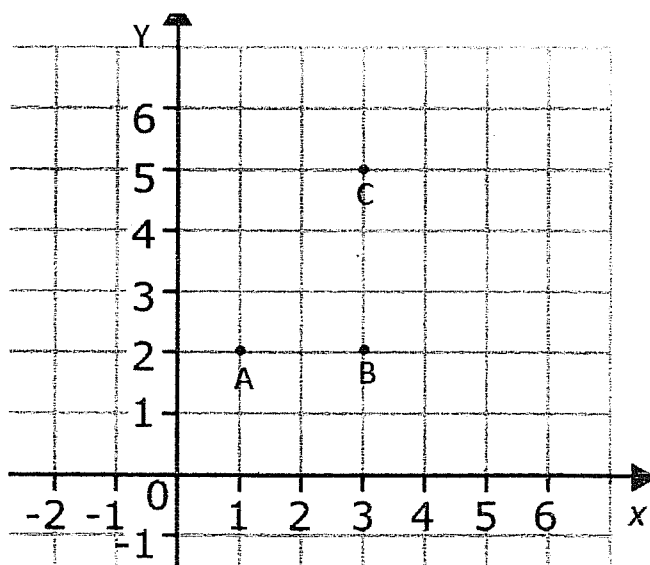


Figure Q7

Question 08

- a) Explain the term of 'primitive communication' in relation to factory automation with using a suitable example.
- b) Write any two serial communication protocols used in the industrial communication systems and briefly explain.
- c) Discuss the applicability of Profibus in the industrial automation.
- d) Explain the operation and advantages of following device buses.
 - i. AS-i bus
 - ii. CAN bus

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