



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2011/2012**

**COURSE** : INDUSTRIAL AUTOMATION SYSTEM  
**COURSE CODE** : BEH 20302  
**PROGRAMME** : BEH  
**EXAMINATION DATE** : JANUARY 2012  
**DURATION** : 2 HOURS 30 MINUTES  
**INSTRUCTION** : ANSWER **FIVE (5)** QUESTIONS ONLY

THIS PAPER CONSISTS OF FIVE (5) PAGES

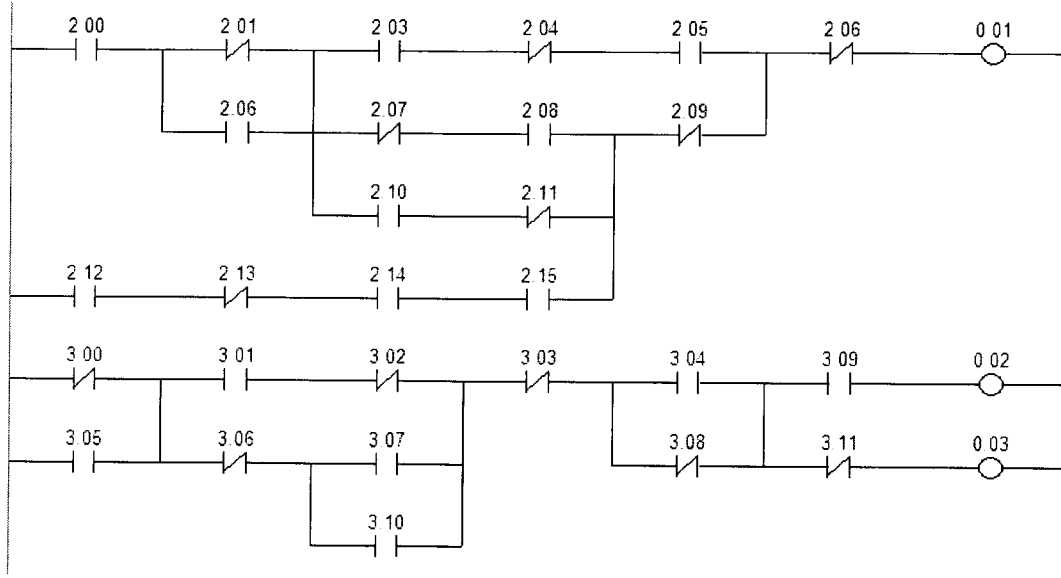
- Q1** (a) Automated manufacturing systems can be classified into three basic types. Define and discuss the production rates for each automation types below:
- (i) Fixed automation
  - (ii) Flexible automation
- (4 marks)
- (b) Recommend the type of automations for the following products. You may explain the reason and illustrate the appropriate figure to support the explanation.
- (i) Wall watch
  - (ii) Exam table
  - (iii) Mechanical pencil
- (6 marks)
- (c) The concept of automated system can be applied to various levels of factory operations. Organize five (5) levels of automation hierarchy based on the level of automation.
- (10 marks)
- Q2** (a) Differentiate active and passive sensor in industrial automation application.
- (4 marks)
- (b) A digital flow meter operates by emitting a pulse for each unit volume of the fluid flowing through it. The particular flow meter of interest here has a unit volume of 67.8 cm<sup>3</sup> per pulse. In a certain process control application, the flow meter emitted 4321 pulses during a period of 3 minutes. Determine:
- (i) Total volume of fluid that flew through the meter.
  - (ii) Flow rate of fluid flow.
  - (iii) Pulse frequency corresponding to a flow rate of 55,000 cm<sup>3</sup>/min.
- (16 marks)
- Q3** (a) Identify three (3) key features between the pneumatic and hydraulic actuators.
- (6 marks)
- (b) Relays are devices that operate as an electrical switch, opening and closing under electromagnetic condition. Relay can control large current/voltage with small electrical signal because relay coils require low current/voltage to switch but can energizes large currents or voltages. Briefly explain the electromechanical relay in terms of the following characteristics:
- (i) Working principle
  - (ii) Construction
  - (iii) Operation
- (14 marks)

- Q4** (a) Briefly explain the 'commutator' in a DC motor. (4 marks)
- (b) A DC servomotor has a torque constant at 0.124 Nm/A and a voltage constant at 0.12 V/(rad/sec). The armature resistance is 2.25 ohms. A terminal voltage of 30 V is used to operate the motor. Determine:
- The starting torque generated by the motor when the voltage is initially applied.
  - The maximum speed at torque equal to zero.
  - The operating point of the motor when it is connected to a load whose torque characteristic is proportional to speed with a constant of proportionality at 0.012 Nm/(rad/sec).
  - Power delivered by the motor at operating point in unit of Watts.
- (16 marks)
- Q5** (a) The two types of component in a ladder logic diagram are contacts and coils. Give two examples of each type. (4 marks)
- (b) Construct the ladder logic diagrams for the following Boolean logic equations:
- $Q1 = (A + B' \cdot C) \cdot D' + (E \cdot F')$
  - $Q2 = (G + H') + I + J' \cdot (K \cdot L')$
  - $Q3 = M + \{(N' \cdot O + P') \cdot Q\} \cdot (R' + S)$
  - $Q4 = \{T' + (U + V' \cdot W + X') \cdot Y\} \cdot Z'$
- (16 marks)
- Q6** (a) Differentiate the function OR and OR LD in a ladder logic diagram construction. (4 marks)
- (b) Write down the instruction list (mnemonic code) for the ladder diagram as shown in Figure Q6(b). (16 marks)

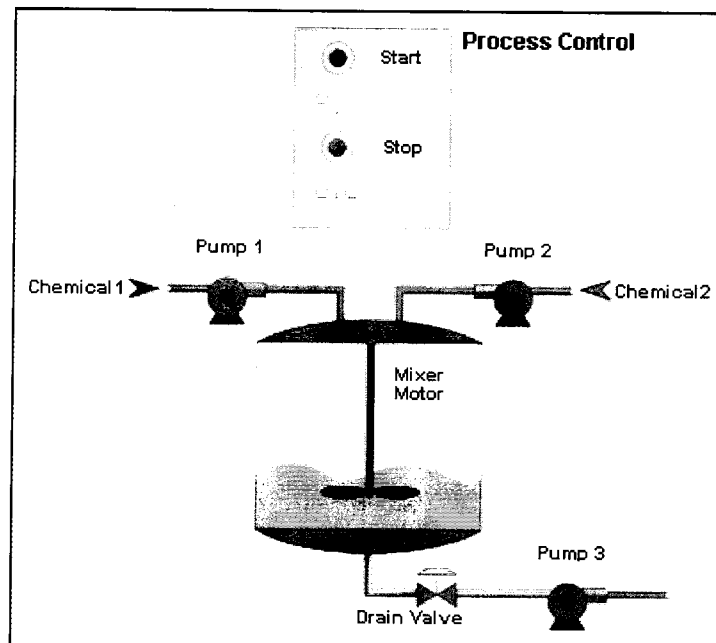
- Q7** (a) Identify and illustrate the basic components of Programmable Logic Controller (PLC).  
(5 marks)
- (b) In the Figure Q7(b), a tank will be filled with two chemicals, mixed, and then drained. When the Start button is pressed, the program will start Pump 1. Pump 1 runs for 5 seconds, filling the tank with the first chemical, then shuts off. The program then starts Pump 2 to fill the tank with second chemical until float switch is triggered. After Pump 2 shut off, the program starts the mixer motor to mix these two chemicals for 60 seconds. The program then opens the drain valve and starts Pump 3. Pump 3 shuts off after 8 seconds and the process stops. A manual Stop switch is also available in the system.
- (i) Identify the input and output.  
(ii) Describe the process flow by motion diagram.  
(iii) Construct the PLC ladder diagram for the system.  
(15 marks)
- Q8** (a) Briefly explain the operation of single acting cylinder with 3/2 way directional valve.  
(4 marks)
- (b) A pneumatic system is operated at a pressure of 1200 kPa. Calculate the diameter of cylinder required to move a load at 8 kN of force.  
(4 marks)
- (c) A hydraulic cylinder is to be used to move a workpiece in a manufacturing operation through a distance of 55 mm in 8 seconds. A force of 15 kN is required to move the workpiece. Determine the required working pressure and hydraulic liquid flow rate if a cylinder with a piston diameter as follows:  
(i) 125 mm.  
(ii) 100 mm.  
(12 marks)

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**Figure Q6(b)**



**Figure Q7(b)**