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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022**

- COURSE NAME : INSTRUMENT FOR PROCESS CONTROL
- COURSE CODE : BEV 40503
- PROGRAMME CODE : BEV
- EXAMINATION DATE : JULY 2022
- DURATION : 3 HOURS
- INSTRUCTION : 1. ANSWER ALL QUESTIONS.
2. THIS FINAL EXAMINATION IS AN ONLINE ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.
3. STUDENTS ARE PROHIBITED TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

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TERBUKA

Q1

- a) As an engineer working in ABABA Sdn. Bhd., you are required to design a new boiler room for a food drying purpose. Provide a complete Piping and Instrumentation diagram (P&ID) based on **Figure Q1(a)**. It should at least contain a water source, a heat exchanger, and a heating tank. A computer-based controller is also required to ensure stable operation for the whole system.

(10 marks)

- b) PT100 is a platinum resistance temperature detector (RTD). It is commonly used to measure temperature in laboratory and industrial process, well known for accuracy, repeatability, and stability. Describe the differences between 2-wire, 3-wire, and 4-wire RTD.

(6 marks)

- c) A pressure sensor has a resistance that changes with pressure according to

$$R = \left(\frac{150\Omega}{\text{psi}} \right) p + 2500\Omega$$

This resistance is then converted to a voltage with a transfer function

$$v = \frac{10 \times R}{R + 10} \text{ volts}$$

The sensor time constant is 350 ms. At $t = 10\text{s}$, the pressure changes suddenly from 40 psi to 150 psi. Determine the voltage output and the indicated pressure at 0.5 s.

(6 marks)

- d) Explain briefly the Seebeck effect in thermocouples.

(3 marks)

Q2

- a) Suggest **four (4)** main steps in selecting a control valve in process system.

(4 marks)

- b) A control valve is operated under the following conditions:

- Vapor pressure of the following liquid is 0.6 psi
- Critical pressure ratio is 0.9
- Inlet valve pressure is 80 psi
- Outlet valve pressure is 30 psi
- Valve recovery coefficient is 0.8

- i. Determine whether the valve will **cavitate** under these conditions.

(5 marks)

- ii. Suppose the valve must allow 286gal/min with specific gravity of 1.1. Suggest a suitable valve size based on **Table Q2(b)**.

(4 marks)

- c) An equal percentage control valve has maximum flow rate of $\frac{70m^3}{hr}$ and rangeability of 20. Determine the flow at $\frac{1}{4}$ and $\frac{3}{4}$ opening. (7 marks)
- d) List the known types of control valve and describe its characteristics. (5 marks)
- a) Highlight **four (4)** main signal transmission challenges in process control engineering. (4 marks)

Q3

- b) An 8-bit microcontroller is used for a temperature measurement setup which the sensor is placed 2 meters away. The datasheet for the selected sensor stated that the sensor will produce 2mV/c at its maximum temperature which is 120 degrees Celsius. The reference voltage for the ADC is 5V.
 - i. Propose a design circuit to interface the sensor and the ADC input. (15 marks)
 - ii. If high frequency noises above 5kHz were detected as the common cause for unstable ADC input measurement, propose a solution for this issue. (6 marks)

- a) State the equipment's and elements of programmable logic control (PLC) system. (5 marks)

Q4

- b) Based on **Figure Q4(b)**, design a set of coding instructions for the OMRON PA204S. (6 marks)
- c) A liquid level control of a process system is shown in **Figure Q4(c)**. When the **start push-button** is pressed, the event sequence is the “*Valve 1*” will open to fill the tank until it reaches “*Level A*”, then the “*Valve 1*” is closed. Next, “*Valve 2*” will open to fill the tank until it reaches “*Level B*” and “*Valve 2*” is closed. The heater and motor will be turn-on for 10 minutes and later turn-off. The output valve will be opened for 10 minutes to empty the tank. This process will repeat after **reset push-button** is pressed. Design a PLC ladder diagram for this process control system (14 marks)

– END OF QUESTIONS –



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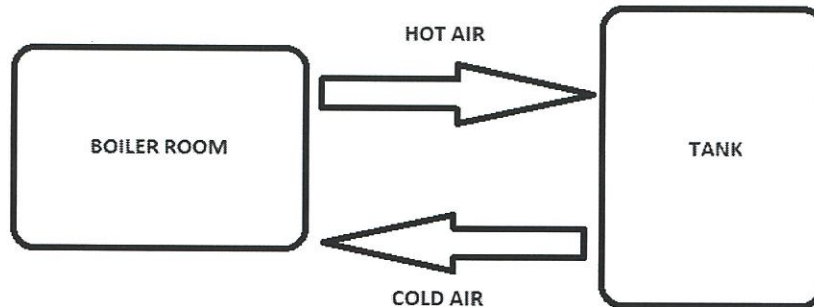


Figure Q1(a)

Table Q2(b)

Control-valve flow coefficients

Valve Size (inches)	C_v
$\frac{1}{4}$	0.3
$\frac{1}{2}$	3
1	14
$1\frac{1}{2}$	35
2	55
3	108
4	174
6	400
8	725

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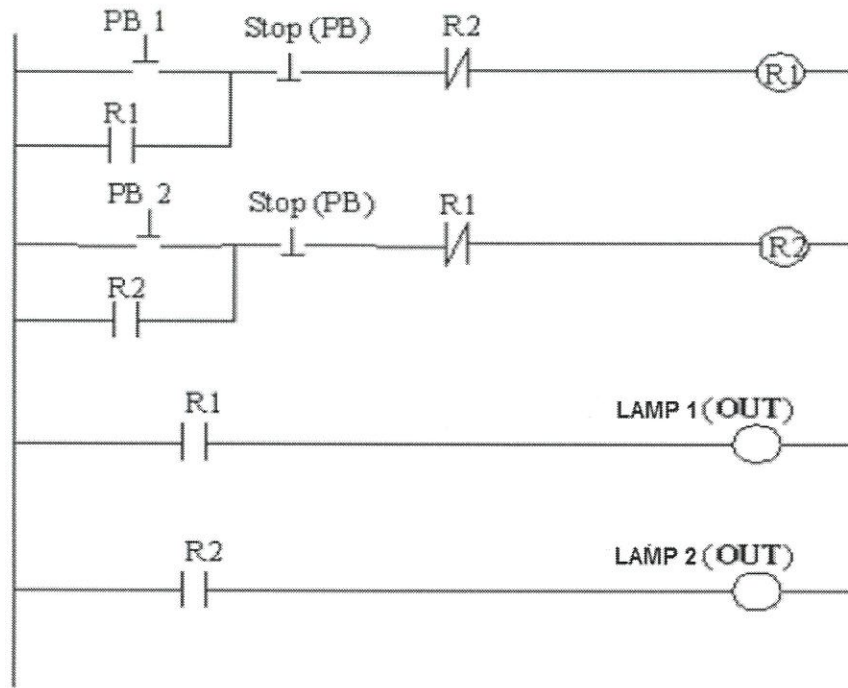


Figure Q4(b)

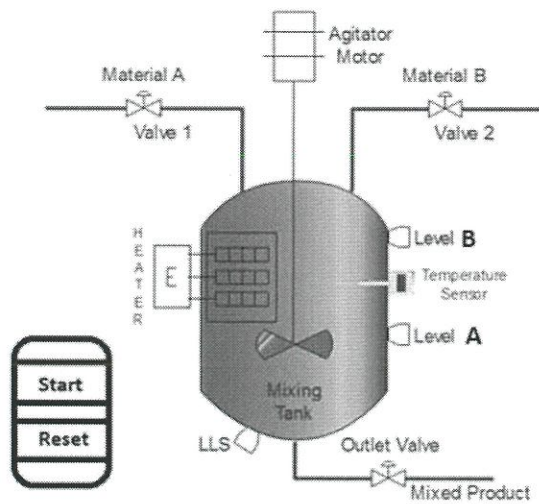


Figure Q4(c)