



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023**

COURSE NAME : INSTRUMENTATION FOR PROCESS CONTROL
COURSE CODE : BEV 40503
PROGRAMME CODE : BEV
EXAMINATION DATE : FEBRUARY 2023
DURATION : 3 HOURS

- INSTRUCTION
1. ANSWER ALL QUESTIONS
 2. THIS FINAL EXAMINATION IS A **OFFLINE** ASSESSMENT AND CONDUCTED VIA **CLOSED 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

- Q1 (a)** Describe the importance of process control in term of:
- (i) Consistent product quality. (2 marks)
 - (ii) Lower manufacturing costs. (2 marks)
- (b)** **Figure Q1(b)** shows a three wires RTD bridge circuit. The RTD has $\alpha_0 = 0.004/^\circ\text{C}$, at 28°C the RTD resistance is $68\ \Omega$ and the dissipation constant is $20\text{mW}/^\circ\text{C}$ at temperature 28°C . If resistance $R_1=R_2= 500\ \Omega$, the supply is $10\ \text{V}$ and resistance R_3 is a variable used to null the bridge.
- (i) Determine the RTD resistance at 100°C without including the effects of dissipation. (2 marks)
 - (ii) Determine the RTD resistance at 100°C with including the effects of dissipation. (7 marks)
- (c)** A liquid flow is to be controlled from $10\ \text{gal}/\text{min}$. The flow is measured using an orifice plate system. A bellows measures the pressure with a LVDT output is $1.2\ \text{V}/\text{psi}$. If the LVDT output voltage range is $0.12\ \text{V}$ to $2.4\ \text{V}$:
- (i) Determine a constant for the pipe and liquid type, K in $\text{gal}/\text{min}/\text{psi}^{1/2}$ (4 marks)
 - (ii) Analyze the maximum liquid flow rate. (2 marks)
- (d)** A solid-state pressure sensor that outputs $20\ \text{mV}/\text{kPa}$ for a pressure variation of 0.0 to $50\ \text{kPa}$ will be used to measure the level of a liquid with a density of $1300\ \text{kg}/\text{m}^3$ and acceleration due to gravity is $9.8\ \text{m}/\text{s}^2$.
- (i) Determine output voltage for level variations from 0 to $5\ \text{m}$ (4 marks)
 - (ii) Determine the sensitivity for level measurement in mV/cm (2 marks)

- Q2** (a) (i) List **THREE (3)** main parts of control valve. (3 marks)
- (ii) State **THREE (3)** types of control valve characteristics based on stem position and flow rate. (3 marks)
- (iii) Sketch the stem position versus flow rate in **Q2(a)(ii)**. (5 marks)
- (b) A control valve has a maximum flow of $50 \text{ cm}^3/\text{s}$ and a minimum of $2 \text{ cm}^3/\text{s}$ with the full travel is 0.04 m . In this process control the opening stem position is 1.6 cm .
- (i) Determine the liquid flow rate if a linier valve control is applied. (2 marks)
- (ii) Determine the liquid flow rate if an equal percentage valve control is applied. (4 marks)
- (c) A process control has nominal flow rate of $65 \text{ m}^3/\text{h}$. The valve actuator of an equal percentage control valve used in this process control has a rangeability of 30 and a maximum stem travel of 5 cm .
- (i) Analyze the minimum and maximum flow rate of the control valve if at nominal flow rate the valve to be half-open. (4 marks)
- (ii) If the flow rate is $100 \text{ m}^3/\text{hr}$, determine the stem opening position of the control valve in cm . (4 marks)
- Q3** (a) List **FIVE (5)** signal transmission issue. (5 marks)
- (b) Temperature is to be measured in the range of 10°C to 100°C with an accuracy of $\pm 0.5^\circ \text{C}$. The sensor is a resistance that varies linearly from 280Ω to 1060Ω for this temperature range. Power dissipated in the sensor must be kept below 2 mW . An analog signal conditioning that provides a voltage varying linearly from 1 to 5 V for this temperature range.
- (i) Analyze the maximum current. (2 marks)
- (ii) Determine signal conditioning equation. (5 marks)

(c) A measurement of pressure using a sensor that outputs 20 mV/kPa must measure to 100 kPa. A 4-bit ADC with a 10-V reference is used.

(i) Calculate and draw a circuit to interface the sensor and the ADC. (7 marks)

(ii) Analyze the pressure resolution of this signal conditioning. (6 marks)

Q4 (a) **Figure Q4(a)** shows a ladder logic diagram and its lookup table, analyze the output signal of the given lookup table (4 marks)

(b) A process control has a valve and a pump has operation sequence:
- When the switch-A is closed, the pump is stopped and the valve closed
- When the switch-B is closed, the pump is run and the valve open
- When the switch-C is closed, the pump is stopped and the valve closed

In order to design a PLC ladder diagram program of this process control

(i) List kind of input switch variable. (3 marks)

(ii) List kind of internal relay variable. (2 marks)

(iii) Sketch a PLC ladder diagram programming (10 marks)

(c) (i) List **FOUR (4)** types of communication protocols used in SCADA system. (3 marks)

(ii) Describe an advantage of a SCADA system. (2 marks)

-END OF QUESTIONS -

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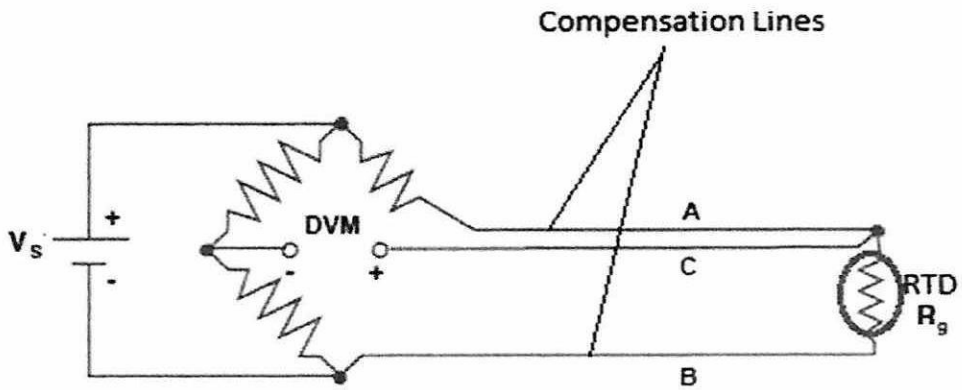


Figure Q1(b)

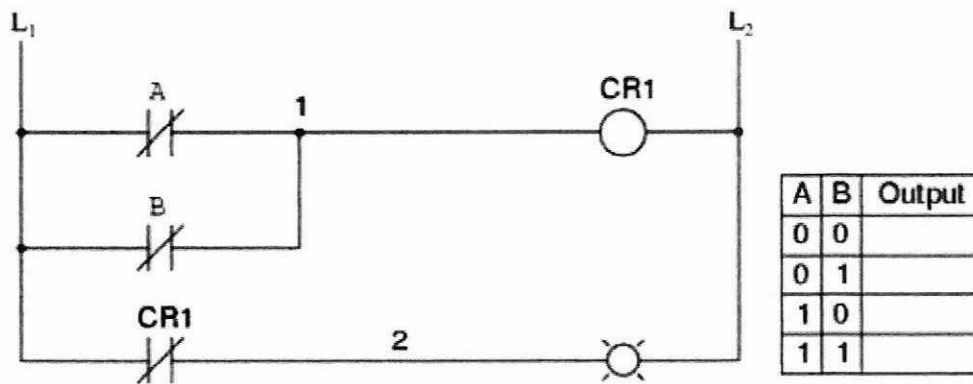


Figure Q4(a)

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