

**UNIVERSITY COLLEGE TATI (UC TATI)****FINAL EXAMINATION QUESTION BOOKLET**

COURSE CODE	: BCE 2293
COURSE	: INSTRUMENTATION
SEMESTER/SESSION	: 1-2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 5 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Figure 1 show manual and automatic level control systems. Based on Figure 1, classify each statement below as either **True** or **False**.

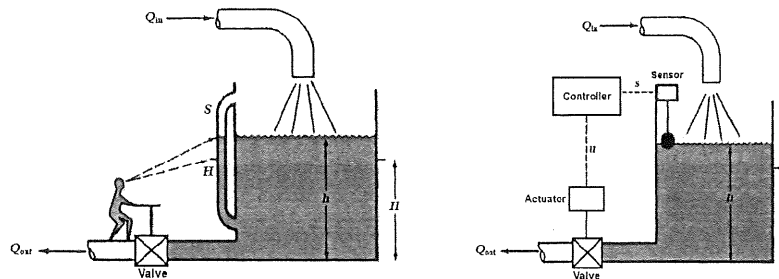


Figure 1

- i) In the manual system, changes in the inlet flow rate (Q_{in}) will not affect the water level (H) in the tank.
- ii) In the automatic control system, if the valve fails to respond to the actuator signal, the controller will automatically switch to manual mode.
- iii) The controller in the automatic system adjusts the valve position without human intervention to maintain the desired water level.
- iv) In both the manual and automatic systems, the flow rate of water out (Q_{out}) is controlled by adjusting the valve position.
- v) The actuator in the automatic system operates based on signals from the sensor alone, with no influence from the controller.
- vi) In a manual control system, a human operator is required to adjust the valve position based on the tank's water level.
- vii) In an automatic control system, the sensor continuously monitors the water level and sends feedback to the controller.
- viii) The operator in the manual system relies on real-time feedback from a sensor to adjust the water level in the tank.
- ix) If the sensor detects a water level above the setpoint, the controller signals the actuator to reduce Q_{out} .
- x) In an automatic control system, the setpoint is determined by the maximum capacity (H) of the tank.

(10 marks)

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b) At Pak Mat Western, the chef uses a temperature sensor in the kitchen to monitor cooking temperatures. The sensor is set to cover a temperature range of 20°C to 120°C , which is linearly scaled to a standard current range of 4 mA to 20 mA.

- i. If the temperature in the oven is 66°C , compute the resulting current reading?
- ii. Discover the cooking temperature that would correspond to a current of 6.5 mA on the sensor?

(6 marks)

QUESTION 2

a) At the Petrochemical Refinery Plant, a standard electronic pressure transmitter is installed to monitor the pressure within a processing pipeline. This transmitter is calibrated to operate within a pressure range of 0 bar to 10 bar. If the current pressure in the pipeline is measured at 6 bar, compute the corresponding output of the transmitter in milliamperes (mA)?

(7 marks)

b) In the Chemical Processing Plant, a pneumatic transmitter is utilized to monitor the temperature of a furnace within the facility. The transmitter has an output range of 3 to 15 psi and is calibrated for a temperature range of 400°C to 1000°C . When the temperature of the furnace reaches 700°C , discover the resulting output of the transmitter in psi?

(7 marks)

c) Construct a table of comparison for 3 (three) advantages and 3 (three) disadvantages between thermocouple and thermistor.

(6 marks)

QUESTION 3

- a) Figure 2 shows the interface using Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC). Label the components numbered (1) to (5) in the diagram and briefly describe the role of each component in the signal processing chain.

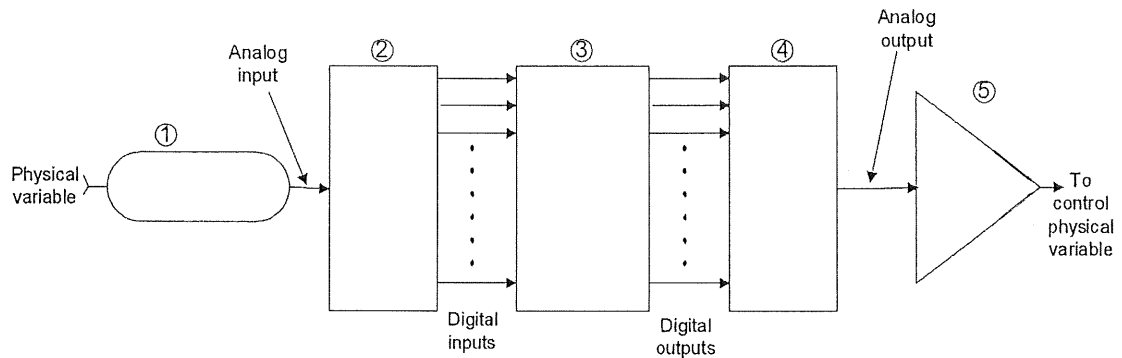


Figure 2

(12 marks)

- b) An 8-bit DAC has an output of 3.92 mA for an input of 01100010. Compute:

- i) the DAC's resolution
- ii) the full-scale output

(8 marks)

- c) Compute the largest value of output voltage from an 8-bit DAC that produces 1.0V for a digital input of 00110010?

(3 marks)

QUESTION 4

- a) Describe a Distributed Control System (DCS) and a Programmable Logic Controller (PLC). (3 marks)

- b) Build a table and show the comparison of DCS and PLC in terms of their suitability for process industries. Include factors such as scalability, response time, and ease of integration.

(6 marks)

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- c) Show the role of DCS in a chemical plant and describe how it helps in monitoring and controlling complex processes. Present the distillation column case.

(4 marks)

- d) In a situation where both DCS and PLC are used together in a plant, discover how they would typically complement each other. Employ an example where each system would be best suited.

(7 marks)

QUESTION 5

- a) Discover the role of final control element in process industry and demonstrate the function in maintaining process conditions.

(4 marks)

- b) Discover the working principle of an actuator and classify the difference between a solenoid actuator and a motor-driven actuator.

(10 marks)

- c) Valves are common final control elements in the process industry. Discover the role of a valve controller and explain how it interacts with a control system to regulate flow

(7 marks)

-----End of question-----

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ATTACHMENTS

Analog output = $K \times$ digital input

$$\% \text{ resolution} = \frac{\text{step size}}{\text{full scale (F.S.)}} \times 100\%$$

$$\text{Resolution} = \frac{I_{out}}{\text{Decimal Value of Input}}$$

Full scale output = Resolution x Maximum Value