

PAGE-1VI / CHEM / INSTR.C B G S

Instrumentation.

(28)

OP Code: 5145

[Total Marks: 80]

(3 Hours)

N. B. : (1) Question No. 1 is compulsory.

(2) Solve any three questions out of remaining five questions.

(3) Assume suitable data if required.

1. a) A PT-100 sensor has a resistance of 100Ω at 0°C and an interval of 38.5Ω between 0°C and 100°C , assuming a linear relationship between temperature and resistance. 8
The actual relation is given by Callendar equation as follows:- muADDA.com

$$T = \left(\frac{R_T - R_0}{R_{100} - R_0} \right) \times 100 + \delta \left(\frac{T}{100} - 1 \right) \left(\frac{T}{100} \right)$$

where R_T = Resistance at $T^\circ\text{C}$ R_0 = Resistance at 0°C R_{100} = Resistance at 100°C $\delta = 1.5$ Calculate the error in temperature measurement at an output resistance of 121.56Ω .

- b) The output of a temperature measuring device that can measure temperatures from -50°C to 50°C is to be monitored using a computer. The least count of the instrument is 0.5°C . The output is in the form of voltage ranging from $0-10\text{ V}$. What is the voltage resolution in mV? What must be the word length of the analog-to-digital converter used? muADDA.com 6
- c) Write a short note on Dispiragm pressure gauge. 6
2. a) A stepper motor turns 10° per step and must rotate at 250 rpm . What input pulse rate, in pulses per second, is required? For the same input pulse rate, if the rotation is 300 rpm , what is the angle of turn per step? 5
- b) Write short notes on 15
- SIL classification
 - Linear Variable Differential Transformer (LVDT)
 - Hot-wire anemometer

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JP-Con. 8488-15.

3. a) A valve must allow 150 gallons per minute (GPM) of ethyl alcohol having a specific gravity of 0.8. The maximum allowable pressure drop across the valve is 50 psi. The piping geometry factor is 1.0. Determine the valve sizing coefficient and select the required valve size from the following table:- 6

C_v	0.3	3	14	35	55	108	174
Valve size (inches)	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	3	4

- b) An iron-constantan thermocouple has a sensitivity of $51 \mu V/^{\circ}C$. Temperature compensation is to be provided by a nickel resistance element with a resistance of 10Ω at $0^{\circ}C$ and a temperature coefficient of resistance of $0.0067 K^{-1}$. If the supply voltage is 2 V, determine the value of the resistance. 6
- c) Write short notes on 8
- Static characteristics of an instrument.
 - Relief valve
4. a) Explain how a capacitive sensing element can be used to measure the level of liquid in a container. 5
- b) The output of a thermocouple measuring temperatures from $20^{\circ}C$ to $180^{\circ}C$ is linearly represented by the standard current range of 4-20 mA. 5
- What is the current at $165^{\circ}C$?
 - What temperature does a current of 8.2 mA represent?
- c) Design a Programmable Logic Control (PLC) for a tank which is to be filled up to a certain level of liquid by operating a valve. 5
- d) An equal percentage valve has a maximum flow of $50 cm^3/s$ and a minimum of $2 cm^3/s$. If the full stem travel is 3 cm, what is the flow rate at a 1 cm opening? If the flow rate is $30 cm^3/s$, determine the stem travel from fully closed position. 5

PAGE-3VI / CHEM / INSTR
CBGS

3

QP Code : 5145 . . .

5. a) Suggest a sensor that could be used to determine the difference in levels between liquids in two containers. 5
- b) A DAQ card of 16 bit resolution and 10-50 mA analog current loop is used to record above atmospheric pressures. Even a slight change in pressure (~ 1 Pa) needs to be detected. What is the maximum absolute pressure that can be measured? What is the analog input in mA for a pressure change of 10 kPa? 8
- c) Write a short note on control valve characteristics. 7
6. a) A temperature sensor can measure temperatures from 30°C to 200°C . A measurement results in a value of 120°C . Calculate the error if the accuracy is: 5
- i) $\pm 0.5\%$ of full scale value
- ii) $\pm 0.75\%$ of span
- b) What is the flow rate in m^3/hr , if an electromagnetic flow meter generates an e.m.f of 10 V, for water flowing through a pipe of 40 cm diameter. Magnetic induction is $5 (\text{V}\cdot\text{s})/\text{m}^2$. 5
- c) A piezoelectric sensor is made up of quartz. The voltage sensitivity for quartz is about $0.055 \text{ V}/(\text{m}\cdot\text{Pa})$. How much pressure in bars should be applied, to create a potential difference of 11 V, if the thickness of the material is 5 cm? 5
- d) Write a short note on Layers of Protection Analysis (LOPA) methods. 5

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