

## Instrumentation.

(20)

TE/Chem/IV/CBSE/INST

QP Code: 6281

[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 temperature sensor can measure temperatures from 32 °F to 212 °F. A measurement results in a value of 78 °F. Calculate the error if the accuracy is  
 i)  $\pm 0.5\%$  of full scale value  
 ii)  $\pm 0.75\%$  of span  
 iii)  $\pm 0.8\%$  of reading.

What are the possible temperatures in each case?

- b) A stepper motor has a 20-teeth gear which moves by 1 tooth in 2 steps. For a desired rotational speed of 300 rpm, what input pulse rate (in pulses per second) is required? What is the angle of turn per step?  
 c) Write a short note on control valve characteristics.

2. a) A piezoelectric sensor is made up of quartz. The voltage sensitivity for quartz is about  $0.075 \text{ V}/(\text{m.Pa})$ . How much pressure in bars should be applied, to create a potential difference of 15 V, if the thickness of the material is 4 cm?  
 b) Write short notes on  
 i) Relief valve  
 ii) Thermistors  
 iii) Electromagnetic flowmeter

3. a) Design a Programmable Logic Control (PLC) for turning an electric motor ON/OFF using a START/STOP switch.  
 b) A diaphragm has an effective area of  $25 \text{ cm}^2$ . If the pressure difference across the diaphragm is 5 psi, what force is exerted on the diaphragm?

[P.T.O.]

MD-Con. 7334-15.

- c) Write short notes on 10
- i) SIL classification
  - ii) Layers of protection analysis (LOPA) methods
4. a) An equal percentage valve has a maximum flow of  $50 \text{ cm}^3/\text{s}$  and a minimum of  $2 \text{ cm}^3/\text{s}$ . If the full stem travel is 2 cm, what is the flow rate (in lit/hr) at a 7.5 mm opening? If the flow rate is  $40 \text{ cm}^3/\text{s}$ , determine the stem travel from fully open position. 6
- b) Write a short note on calibration of pressure sensors using dead weight piston gauge. 6
- c) A DAQ card of 8 bit resolution and 10-50 mA analog current loop is used to record temperatures above  $30^\circ\text{C}$ . The least count for temperature measurement is  $1^\circ\text{C}$ . What is the maximum temperature that can be measured? What is the analog input in mA for a measured value of  $150^\circ\text{C}$ ? 8
5. a) Select the appropriate valve size for the following application:- 10
- Process fluid: Liquid Propane  
 Specific gravity: 0.5  
 Volumetric flow rate: 3028 lpm  
 Pressure drop: 1.7 bar  
 Piping geometry factor: 0.9
- | $N_1$  | Flow unit              | Pressure Unit |
|--------|------------------------|---------------|
| 0.0865 | $\text{m}^3/\text{hr}$ | kPa           |
| 0.865  | $\text{m}^3/\text{hr}$ | bar           |
| 1.0    | GPM                    | psi           |
- | $C_v$               | 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   |

[P.T.O.]

**MD-Con. 7334-15.**

3

QP Code : 6281

- b) Explain how a capacitive sensing element can be used to measure the level of liquid in a container. 5

c) Suggest a sensor that could be used to determine the difference in levels between liquids in two containers..

6. Write short notes on (any four) 20

  - a) Signal conditioning
  - b) Static characteristics of an instrument
  - c) Hot wire anemometer
  - d) Linear variable differential transformer (LVDT)
  - e) Diaphragm pressure gauge