Ref No: EX/Che/PC/B/Elec/T/321/2023

B. E. CHEMICAL ENGINEERING 3RD YEAR 2ND SEMESTER EXAMINATION, 2023

SUBJECT: - PRINCIPLES OF MEASUREMENTS AND INSTRUMENTATION

Time: Three hours | Full Marks: 100 (50 marks for each part)

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
1.	***Answer question:-1 and any two from the rest.*** ***Distinguish in brief between the following two(any four):-*** a) Principle of general pressure and vacuum pressure measurement. b) Level measurement and transmission using force balance and pneumatic balance method c) Working principle of volumetric flow sensor and positive displacement type flow sensor. d) Obstruction type flow sensor and variable area type low sensor. e) Vacuum pressure measurement using Pirani gauge and thermocouple gauge.	**4X5=20**
2.	a) Illustrate a suitable scheme for level measurement and transmission system using pneumatic bellow. b) Describe the working principle of Diaphragm type level sensor. c) Compare the performance between resistive type and capacitive type level sensors.	**5+5+5**
3.	a) Derive the expression of flow rate for a compressible fluid in terms of necessary correction factors. b) Derive the expression of flow rate for a turbine type flow meter. What is the significance of meter constant? Show the waveform of electrical signal obtained from the magnetic pick up attached to this flow meter.	**7+8**
4.	a) Outline the basic principle of variable area type flow sensors with the help of suitable diagram.	

[Turn over

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	b) Referring to the principle of mass flow type flow meter, outline briefly the working principle of reciprocating piston type flow meter c) Explain how liquid level control can be incorporated using spring operated diaphragm and valve.	5+5+5
5.	**Write short notes on any three of the following:** d) McLeod gauge e) Differential pressure transmitter f) Thermal ionization and flame ionization detector g) Dead weight tester h) Bourdon gauge	**3X5=15**

Fluid in terms of usual parameter

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PART – II

Answer any THREE questions. TWO marks are reserved for neatness.

1. a) Describe a scheme employing Wheatstone bridge arrangement for measurement of resistance strain gauge output, employing half bridge configuration with two active gauges and derive an expression for its sensitivity. Show that this sensitivity becomes double for a bridge arrangement employing full bridge configuration with four active gauges. 6+4
   b) Describe Siemen's 3-lead arrangement used in conjunction with RTDs. 6

2. a) Derive the transfer function of a general second-order instrument. Hence derive the frequency-response relation of it and sketch the frequency-response characteristics. 5+4
   b) What is the importance of Planck's Distribution Equation in developing the principle of selective radiation pyrometer? Describe the operating principle of a disappearing filament optical pyrometer with a neat diagram. 7

3. a) Give a detailed description of how an electronic analog PID controller be implemented in parallel form, employing four op-amps? How can this realization be simplified to employ one op-amp to provide the combined effect of proportional and integral terms of the PID controller? 6+4
   b) Describe the operating principle of a 'manual balance' type constant-temperature anemometer, employed for measurement of average flow velocity. 6

4. a) How can you classify errors in measurements? What are the important objectives for applying statistics to measurement data? How can you calculate dispersion of measurement data? 8
   b) Why do we employ pulse type excitation voltages for bridge measurements in conjunction with RTDs? Describe in detail the implementation of such a scheme. 5
   c) In the context of thermocouples, explain the "law of intermediate metals" and the "law of intermediate temperatures". 3

5. Write short notes on any TWO: 8 × 2
   a) Step response and frequency response of first-order instrument;
   b) Base metal and rare metal thermocouples;
   c) Total Radiation Pyrometer;
   d) Constant current type hot wire anemometer.