

**INDUSTRIAL INSTRUMENTATION  
(AEIE 2202)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which of the following quantities can be measured using bellows?  
(a) Absolute pressure (b) Gauge pressure  
(c) Differential pressure (d) All of the mentioned.
- (ii) Which of the following is a type of pressure measurement based on the principle of hydrostatics?  
(a) Manometer (b) Pitot tube (c) Rotameter (d) Venturi meter.
- (iii) The sensitivity of an ionization gauge is defined as  
(a)  $\frac{I_i}{pI_e}$  (b)  $\frac{p}{I_i I_e}$  (c)  $\frac{I_e}{pI_i}$  (d) none of the above.  
where,  $I_i$  = ion content,  $I_e$  = electron current and  $p$  = gas pressure.
- (iv) The size of a venturimeter is expressed as 300 mm × 150 mm. It means that:  
(a) the diameter of the downstream pipe is 300 mm and that of upstream pipe 150 mm  
(b) the diameter of the upstream pipe is 300 mm and that of downstream pipe 150 mm  
(c) the diameter of the pipe is 300 mm and that of throat is 150 mm  
(d) the diameter of the pipe is 150 mm and that of throat is 300 mm.
- (v) What is the purpose of a pressure regulator in a pneumatic system?  
(a) To maintain a constant pressure (b) To increase the pressure  
(c) To decrease the pressure (d) To measure the pressure.
- (vi) Which flow meter that works on the constant pressure drop principle?  
(a) Venturimeter (b) Rotameter  
(c) Turbine flowmeter (d) Vortex flowmeter.
- (vii) Which of the following factors can affect the accuracy of flow measurements?  
(a) Fluid properties (b) Pipe diameter  
(c) Temperature (d) All of the above.

- (viii) The Reynolds number for flow in a pipe is given by  
(a)  $\frac{vd\mu}{\rho}$                       (b)  $\frac{vd}{\rho\mu}$                       (c)  $\frac{vd\rho}{\mu}$                       (d)  $\frac{vd\mu}{\rho}$ .
- (ix) Annubar tubes can be used for measurement of flow rates of  
(a) liquids, gases and steam                      (b) gases only  
(c) liquids and gases                      (d) liquids only.
- (x) In ultrasonic level gauge, the ultrasonic source is placed at the  
(a) bottom of the vessel containing the liquid  
(b) top of the vessel containing the liquid  
(c) middle of the vessel containing the liquid  
(d) far from the vessel containing the liquid.

### **Group - B**

2. (a) Why mercury is mostly used as manometric fluid? [[CO1](Remember/LOCQ)]  
(b) In a pipeline water is flowing. A manometer is used to measure the pressure drop for flow through the pipe. The difference in level was found to be 20 cm. If the manometric fluid in CCL<sub>4</sub> find the pressure drop in S.I units (density of CCL<sub>4</sub> = 1.596 g/cm<sup>3</sup>). If the manometric fluid is changed to mercury ( $\rho=13.6$  gm/cm<sup>3</sup>) what will be the difference in level? [[CO1](CO5)(Evaluate/HOCQ)]  
(c) Explain the working principle of metallic diaphragm subjected to pressure with neat sketch. How can the sensitivity of a diaphragm be increased?  
[[CO1](Analyze/IOCQ)]  
2 + 5 + 5 = 12
3. (a) Explain with neat sketches, the construction and working of McLeod gauge, both non-linear and linear types. Also, establish the corresponding relationships. [[CO1](Analyze/IOCQ)]  
(b) Why is a McLeod gauge considered to be a standard for measurement of pressure in the vacuum range? [[CO1](Understand/LOCQ)]  
(c) How low pressure can be measured by Pirani gauge. Explain with a neat sketch. [[CO1](Analyze/IOCQ)]  
6 + 2 + 4 = 12

### **Group - C**

4. (a) Describe the working of Rotameter with schematic diagram. Find the expression for flow through it. [[CO2](Analyze/IOCQ)]  
(b) What modification should be done if the liquid is denser than float? [[CO2](Analyze/IOCQ)]  
(d) A rotameter uses a cylindrical float of 3.5 cm height, 3.5 cm dia and density of 3900 kg/m<sup>3</sup>. The maximum inside diameter of the metering tube is 5 cm. Determine the maximum flow rate handling capacity of the rotameter if the fluid is water. Consider  $c_d$  is unity. [[CO2](CO5)(Apply/IOCQ)]  
6 + 2 + 4 = 12

5. (a) What are the different types of ultrasonic flowmeter? Show that ultrasonic flow measurement system by measuring frequency shift is independent of sonic velocity. [[CO2](Analyze/IOCQ)]
- (b) Describe with a neat sketch, the working principle of an electromagnetic flowmeter. What are its advantages and disadvantages? [[CO2](Understand/LOCQ)]
- (c) Determine the velocity of flow in an electromagnetic flow meter for the following conditions. The flux density in the liquid has an average value of 0.08 Weber/m<sup>2</sup>. The diameter of the pipe is 10 cm. The induced voltage of the electromagnetic flow meter is recorded as 0.2 MV. [[CO2,CO5](Apply/IOCQ)]
- (1 + 4) + 5 + 2 = 12**

### **Group - D**

6. (a) How will you measure interface level between two dissimilar liquids using differential transmitter? [[CO3](Analyze/IOCQ)]
- (b) Determine the height of the liquid column in a closed tank if the hydrostatic pressure is given as 1.6 kg/cm<sup>2</sup> and the external pressure on liquid in the tank is 0.5 kg/cm<sup>2</sup>. Assume density of water is 1000 kg/m<sup>3</sup>. [[CO3,CO5](Apply/IOCQ)]
- (c) A displacer is being used to measure the change in water level. The displacer diameter is 15 cm. If the force on the displacer changes by 27.6 N, then calculate the change in water level. Specific weight of water is 9.807 kN/m<sup>3</sup>. [[CO3,CO5](Apply/IOCQ)]
- 6 + 3 + 3 = 12**
7. (a) A differential pressure transmitter of 1 meter water gauge range is used to measure the boiler drum water level. Lower tapping and higher tapping are taken 50 cm equidistant from the centre of the drum. If the transmitter used is a 4-20 mA transmitter and the indicator is calibrated for -50 cm to +50 cm water level then what will be the transmitter output at the +25 cm level and at the -25 cm level? Also find the level if the transmitter output is 12 mA. [[CO3,CO5](Analyze/IOCQ)]
- (b) Describe with neat sketch how to measure level using radar level techniques. [[CO3](Remember/LOCQ)]
- (2 + 2 + 2) + 6 = 12**

### **Group - E**

8. (a) The absolute viscosity of a fluid under test is 1000 centipoises. The density of the fluid is 0.8 gm/cm<sup>3</sup>. Calculate the following for the above fluid
- (i) Fluidity in 'rhe'.
- (ii) Kinematic viscosity in 'stokes'.
- (iii) Relative viscosity in 'centipoises'.
- (iv) Absolute viscosity in 'PAS'. [[CO4,CO5](Apply/IOCQ)]
- (b) What is psychrometer? Where does it find its application? [[CO4](Understand/LOCQ)]
- (2 + 2 + 2 + 2) + (2 + 2) = 12**

9. (a) What is the basis of classification of hazardous area? Give examples of Class I, II and III classification of hazardous area. [[CO4](Remember/LOCQ)]
- (b) What is difference between IP code for the enclosures and NEMA enclosures? [[CO4](Understand/LOCQ)]
- (c) What is the advantage of using intrinsically safe circuit? [[CO4](Understand/LOCQ)]
- 4 + 5 + 3 = 12**
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<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	32.29	62.5	5.21

**Course Outcome (CO):**

After the completion of the course students will be able to

1. Explain the working principles of pressure measuring devices and apply acquired knowledge for selection and installation of application specific pressure sensing instruments.
2. Interpret the working principles, selection criteria and installations of application specific industrial flow measuring instruments
3. Demonstrate different level measuring devices and apply the knowledge towards the choice of proper sensing industrial instruments.
4. Illustrate various analytical instruments to measure pH, conductivity, moisture, humidity etc. and hazardous area instrumentation.
5. Formulate industrial process parameters towards the analysis of process data
6. Design electronic instrumentation system for the acquisition of measurement data produced by measuring instruments for flow, level, and pressure.

*\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*