

**Group – E**

8. (a) What are the possible sources of errors in filled-in thermometers and how are they minimized?  
 (b) What is the basis of classification of hazardous area?  
 (c) Explain the following related to safety standards:  
 (i) IP  
 (ii) NEMA.

$4 + 2 + (3 + 3) = 12$

9. Write a short notes of any two of the followings.  
 (i) Radiation Pyrometer  
 (ii) Intrinsic Safety  
 (iii) Bimetallic Thermometer  
 (iv) Gas filled Thermometer.

$6 + 6 = 12$

**INDUSTRIAL INSTRUMENTATION  
(AEIE 3103)**

**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) The law of intermediate metals in thermocouples allows to  
 (a) use reference junction compensation  
 (b) use meters for measurement without disturbing the circuit conditions  
 (c) use extension wires of materials other than thermocouple materials  
 (d) both (b) and (c).
- (ii) A Reynold's number of 1000 indicates  
 (a) turbulent flow  
 (b) laminar flow  
 (c) a flow which can either be turbulent or laminar  
 (d) none of the above.
- (iii) An example of a positive displacement flow meter is  
 (a) Vortex flow meter (b) Rotary vane type meter  
 (c) Turbine type meter (d) Ultrasonic flow meter.
- (iv) The meter which is suitable for flow totalization is  
 (a) turbine meter (b) venturimeter  
 (c) ultrasonic flow meters (d) orifice plate.
- (v) The fluid flow through an electromagnetic flow meter generates an emf which is proportional to  
 (a) diameter of the pipe (b) magnetic field strength  
 (c) flow velocity (d) all of (a), (b) and (c) .
- (vi) Output of a bimetallic element will be \_\_\_\_\_  
 (a) Displacement (b) Pressure  
 (c) Strain (d) Voltage.

- (vii) Which of the following is used as an indicating instrument in liquid expansion system?  
 (a) Ammeter (b) Voltmeter  
 (c) Bourdon Tube (d) Thermometer.
- (viii) Which of the following devices convert pressure to displacement?  
 (a) Diaphragm (b) Capsule  
 (c) Pirani Gauge (d) Both Diaphragm and capsule.
- (ix) The direct method of measurement of liquid level is  
 (a) pressure and force operated method (b) method using float  
 (c) buoyant head method (d) electric transducer method.
- (x) Eccentric orifice plates are used for measurement of flow rates of  
 (a) Clean fluids only (b) fluid containing solids only  
 (c) Clean fluids and fluid containing solids (d) none of (a), (b) and (c).

**Group – B**

2. (a) Draw a labeled sketch of a C-type Bourdon pressure gauge and explain its principle of operation.  
 (b) What are the errors occurred during the pressure measurement by a C-type Bourdon tube and how can they be removed?  
 (c) The dimensions of a C type bourdon tube made of Monel metal are as follows: Radius of curved tube = 36.5mm, cross sectional length of tube = 16mm, cross sectional width of tube = 3mm, tube wall thickness = 0.35mm. Calculate the displacement of the free end if a pressure of 1500kPa is applied. The modulus of elasticity for Monel metal is 180GN/m<sup>2</sup>.

**4 + 4 + 4 = 12**

3. (a) What will be the gauge pressure and the absolute pressure at the depth of 35 meters in a water tank?  
 (b) Describe with a proper diagram how absolute pressure and gauge pressure can be measured using diaphragm element.

**(2 + 2) + (4 + 4) = 12****Group – C**

4. (a) How volumetric flow rate (Q) is measured by a Rotameter?

- (b) The following data relate to an inclined venturimeter; Determine the rate of flow in the pipeline.  
 Diameter of the pipeline= 400mm  
 Inclination of the pipeline with the horizontal=30°.  
 Throat diameter=200mm  
 The distance between the mouth and throat of the meter= 600mm  
 Sp. gravity of oil flowing through the pipeline=0.7  
 Sp. gravity of heavy liquid (U-tube)=13.6  
 Reading of the differential manometer=50mm  
 The coefficient of the meter=0.978.

**5 + 7 = 12**

5. (a) Define Reynolds number.  
 (b) How are laminar and non-laminar flows related to Reynolds number?  
 (c) Describe with neat sketch, the working principle of Doppler type ultrasonic flowmeter and derive how its frequency shift is proportional to flow rate.  
 (d) 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 10cm. The induced voltage of the electromagnetic flow meter is recorded as 0.2mV.

**1 + 2 + 6 + 3 = 12****Group – D**

6. (a) Explain with a neat sketch the working principle of microwave time of flight method for level measurement.  
 (b) Describe the different electrical methods for measurement of liquid level. Compare their advantages and disadvantages.

**5 + (5 + 2) = 12**

7. (a) Describe how capacitive level sensor works for a conducting and non-conducting liquid.  
 (b) How will you measure the level of a liquid in a pressurized tank containing vapours which are likely to condense, using a differential transmitter?

**(4 + 4) + 4 = 12**