B.TECH/AEIE/5TH SEM/AEIE 3103/2018
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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) A well-type manometer is used in preference to a simple U-tube manometer to obtain
(a) better accuracy   (b) better precision
(c) a constant zero   (d) higher sensitivity.

(ii) Thermistor, which has high temperature co-efficient of resistivity, is used as the sensing element in resistance thermometer. It is a/an
(a) insulator   (b) conductor
(c) solid semiconductor   (d) liquid semiconductor.

(iii) When a bare thermocouple is covered by a protective sheath, the response becomes
(a) slower and non-oscillatory   (b) faster and non-oscillatory
(c) faster and oscillatory   (d) slower and oscillatory.

(iv) The discharge over a V-notch weir is proportional to
(a) $H^{1.5}$ (b) $H^{1.5}$ (c) $H^{2.5}$ (d) $H^{3.5}$,
where H = head measured between the level in the stilling pond and the bottom of the V of a V-notch weir.

(v) Which of the following conversion takes place in Bourdon tubes?
(a) Pressure to displacement   (b) Pressure to voltage
(c) Pressure to strain   (d) Pressure to force.

(vi) A cold junction of a thermocouple is at room temperature of 15°C. A voltmeter connected to the thermocouple circuit indicates 10 mV. If the voltmeter is calibrated as 20°C/mV, the temperature of the hot source is:
(a) 185°C   (b) 200°C   (c) 35°C   (d) 215°C.

(vii) The sensitivity of an ionization gauge is defined as
(a) $\dfrac{I_i}{pI_e}$ (b) $\dfrac{p}{I_iI_e}$ (c) $\dfrac{I_e}{pI_i}$ (d) $\dfrac{I_iI_e}{p}$,
where I_i = ion content, I_e = electron current and p = gas pressure

(viii) In case of rotameter, the volumetric flow rate (Q) is related to the height (h) of the float from the inlet by the relationship
(a) Q directly proportional to h
(b) Q directly proportional to $h^{1/2}$
(c) Q directly proportional to $h^{1/3}$
(d) Q inversely proportional to h.

(ix) Rotameter is a
(a) drag force flow meter   (b) variable area flow meter
(c) variable head flow meter   (d) rotating propeller type flow meter.

(x) Variable head flow meters can be used for measurement of flow of
(a) liquids only   (b) liquids and gases
(c) slurries only   (d) liquids, gases and slurries.

Group – B

2. (a) Explain, the working principle of metallic diaphragm subjected to pressure with neat sketch. How can the sensitivity of a diaphragm be increased?

(b) Describe, with a proper diagram, how differential pressure can be measured using bellows element.

(4 + 2) + 6 = 12

3. (a) Describe low pressure measurement by Pirani gauge. Also mention its advantages and limitations.

(b) Draw a neat and labelled diagram of the installation of a DP transmitter across an orifice plate, using a 5-valve manifold. What is the utility of using such a manifold?

(5 + 2) + (3 + 2) = 12

Group – C

4. (a) Derive the expression for volumetric flow rate through restriction for incompressible fluids.

(b) What is discharge coefficient of a flow meter?

(c) A Venturi tube of throat diameter 10cm is placed in a pipe of diameter 20cm, to measure the volumetric flow. The volumetric flow rate through Venturi tube is 0.02m³/s. Determine the differential pressure developed between upstream to throat of the Venturi tube. Assume discharge coefficient of Venturi tube is 0.98 and density of water as 1000 kg/m³.

6 + 2 + 4 = 12

5. (a)   Why is pulsed DC excitation extensively used in electromagnetic flowmeter?

(b)   Calculate the induced EMF in an electromagnetic flow meter due to the flow of conductive fluid in a pipe with inner diameter of 2.75cm. The flux density is 60 mV. sec/ cm^2 and volume flow rate is 2500 cm^3/min.

(c)   Explain the working principle of a vortex flow meter with a neat diagram.

4 + 4 + 4 = 12

Group – D

6. (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.

(b)   Determine the displaced volume of the liquid at 20°C when the buoyancy effect on the object is 5000Kg.

(3+ 3 + 3) + 3= 12

7. (a)   Describe, with neat sketch, the working principle of float type level switch.

(b)   How a resistance tape is used in level measurement? What is actuation depth?

5 + (5 + 2) = 12

Group – E

8. (a)   Draw the schematic diagram for connection of 3-wire RTD. Explain why 3-wire RTD is advantageous over 2-wire RTD connection.

(b)   An experiment is conducted to calibrate a copper constant thermocouple. With cold junction at 0°C, EMF obtained at boiling point of water (100°C) and boiling point of sulphur (445°C) are 5 mV and 25 mV, respectively. If the relation is given by

$$e_{(t_1-t_2)} = a(t_1 - t_2) + b(t_1^2 - t_2^2)$$

(i)   Determine constants a and b.
(ii)   The above thermocouple indicates 2 mV with cold junction at 40°C. Determine the unknown hot junction temperature.
(iii)   If the cold junction is maintained at 40°C, what would the EMF be when hot junction temperature is at 500°C?

(3 + 3) + (2 +2 + 2) = 12

9. (a)   What do you mean by PT_{3000}?'
(b)   What are the various types of filled system thermometers?
(c)   What does IP654 signify? What its NEMA equivalent?
(d)   What is meant by intrinsic safety?

2 + 2 + (3 + 3) +2= 12