B.TECH/AEIE/4TH SEM/AEIE 2202/2022

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

(ii) Which of the following represents the lower and upper range of standard industrial pressures?
(a) 0-10 psi (b) 0-15 psi
(c) 3-10 psi (d) 3-15 psi.

(iii) An example of a positive displacement flow meter is
(a) orifice meter (b) rotary vane type meter
(c) turbine type meter (d) ultrasonic flow meter.

(iv) What type of manometer is best for measuring low pressures?
(a) Well type (b) Inclined type
(c) U-tube type (d) Multiple tube type.

(v) In 4 – 20 mA signal that corresponds to 0 – 100% scale, what would be the current at 50%?
(a) 4 mA (b) 8 mA
(c) 12 mA (d) 16 mA.

(vi) For a V-notch weir, relationship between flow and measured head can be expressed as
(a) $Q = 2.48\ tan\frac{1}{2}\theta H^{2.5}$ (b) $Q = 3.33(L - 0.2H)H^{1.5}$
(c) $Q = 3.367\ LH^{1.5}$ (d) $Q = 3.97\ tan\frac{1}{2}\ LH^{1.547}$.

(vii) Mass flowmeter works on
(a) magnetic effect (b) coriollis effect
(c) photoelectric effect (d) none of these.

(viii) In case of capacitance level measurement, capacitance will _____ with the increase of level.
(a) increase (b) decrease
(c) exponentially decrease (d) remain same

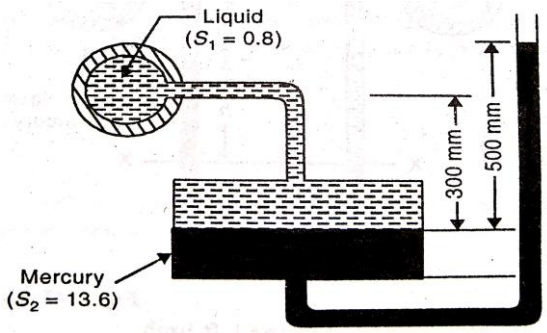
(ix) In a rotating cylinder viscometer, the viscosity is determined by the measurement of
(a) torque (b) speed
(c) both torque and speed (d) none of the above.

(x) Electromagnetic flow meters are used to measure the
(a) flow of non-conducting fluid
(b) flow of non-conducting fluid in a metallic pipe
(c) wind
(d) flow of non-conducting fluid in a plastic pipe.

Group - B

2. (a) Define absolute pressure, gauge pressure and differential pressure [(CO1)(Remember/LOCQ)]

(b) A single column manometer (shown in figure) connected to a pipe containing liquid of specific gravity 0.8. The ratio of area of the reservoir to that of the limb is 100. Find the pressure in the pipe. (Specific gravity of mercury as 13.6)



[(CO1)(CO5)(Evaluate/HOCQ)]

(c) Briefly explain with proper diagram, the operating principle of pneumatic force-balance system with flapper and nozzle. [(CO1)(Analyse/IOCQ)]

3 + 4 + 5 = 12

3. (a) Explain with neat sketches, the working principle of a hot cathode ionization gauge. When the sample pressure falls below 10^{-8} torr what modification can be done for minimizing the error? [(CO1)(Analyze/IOCQ)]

(b) The volume of bulb and measuring capillary of a McLeod gauge is equal to 110×10^{-6} m^3 and measuring capillary diameter is of 1.1 mm.

i. If an approximation formula is employed, calculate the pressure when the measuring capillary reading shows 28 mm.
ii. What is the error if you apply the exact formula to measure pressure? [(CO1,CO5)(Apply/IOCQ)]

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

Group - C

4. (a) Discuss the construction of different kinds of orifice plates and their respective uses. [(CO2)(Remember/LOCQ)]
   (b) In orifice flow metres, what are the different tapping positions for the fluid flow line? [(CO2)(Remember/LOCQ)]
   (c) What is the working principle of Pitot tube? Derive the expression of volumetric flow rate for Pitot tube. [(CO2)(Remember/LOCQ)]

3 + 4 + (3 + 2) = 12

5. (a) What is Coriolis principle? Prove that, the torque experienced by the flow meter tube is directly proportional to mass flow rate of the fluid. [(CO2)(Understand/LOCQ)]
   (b) In an ultrasonic flow meter, the beat frequency is 100cps, the angle between the transmitters and receivers is 45º and the sound path is 125mm. Calculate the fluid velocity in m/sec. [(CO2)(CO5)(Apply/IOCQ)]

(2 + 6) + 4 = 12

Group - D

6. (a) Describe with a neat sketch how displacer can be used to measure interface level between two dissimilar liquids. [(CO3)(Remember/LOCQ)]
   (b) Describe the level measurement technique of high pressure tank using sight glass or gauge glass with suitable diagram. [(CO3)(Understand/LOCQ)]
   (c) A displacer with area of cross section 5 cm^2, length 8 m and specific gravity 6 is used for measuring water level in a tank of maximum level 8 meters. The displacer is weighed with a spring balance directly. Also the displacer is used to measure the level from bottom of the tank. Find out levels when the spring balance reads 23 kg. [(CO3,CO5)(Analyze/IOCQ)]

5 + 4 + 3 = 12

7. (a) Describe how capacitive level sensor works for a conducting and non-conducting liquid. [(CO3,CO6)(Understand/LOCQ)]
   (b) Describe, with neat sketch, the working principle of float type level switch. [(CO3)(Understand/LOCQ)]
   (c) Why air purge method is so popular in industrial liquid level measurement? [(CO3)(Analyze/IOCQ)]

6 + 4 + 2 = 12

Group - E

8. (a) What is dew point? Explain how to measure dew point temperature using a diagram. [(CO4)(Remember/LOCQ)]
   (b) Differentiate ‘viscosity’ and ‘consistency’ with reference to a flowing fluid. [(CO4)(Understand/LOCQ)]

(c) A fluid is contained between a fixed plate of large area and a movable plate of 100 cm^2 area separated by a distance of 10 cm. Calculate the absolute viscosity of the fluid in centipoises if 2 kgf force is required to move the movable plate over the fluid surface at the rate of 20 cm/sec. [(CO4,CO5)(Apply/IOCQ)]

(2 + 4) + 2 + 4 = 12

9. (a) Differentiate 'Newtonian' and 'Non-Newtonian' fluids. [(CO4)(Remember/LOCQ)]

(b) What are the factors which should be considered as possible sources of error in humidity measurements? [(CO4,CO6)(Understand/LOCQ)]

(c) Why 'grounding' is important in electronic equipment? [(CO6)(Remember/LOCQ)]

(d) Draw and describe a proper method of grounding in hazardous area equipment. [(CO4,CO6)(Remember/LOCQ)]

2 + 3 + 2 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	65	31	4

Course Outcome:

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