INDUSTRIAL INSTRUMENTATION
(AEIE 2202)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

    Choose the correct alternative for the following

    (i)   1 psi equal to
           (a) 6.895 pa   (b) 6.895 kpa
           (c) 68.95 kpa   (d) 68.95 pa

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

    (iii) The difference between atmospheric pressure and gauge pressure is
           (a) Vacuum   (b) Zero
           (c) Atmospheric   (d) None of these.

    (iv)   The pneumatic flow transmitter's output signal range is
           (a) 3 -15 psia   (b) 3-15 psig
           (c) 0 -15 psia   (d) 0 – 15 psig.

    (v)   Magnetic flow meters are based on_____.
           (a) Faraday's Laws of electromagnetic Induction
           (b) Bernoulii's principle
           (c) Both (a) and (b)
           (d) None of these.

    (vi)   Dead weight tester is used for
           (a) Producing high pressure
           (b) Measuring process pressure accurately
           (c) Calibrating pressure instruments
           (d) All of these.

    (vii) The principle of operation for float type level meter is
           (a) Conductivity   (b) Capacitance
           (c) Buoyancy   (d) Pressure.

(viii) The shape of the rotameter float is inverted cone type to eliminate the
(a) Density   (b) Pressure
(c) Viscocity   (d) Turbulance

(ix) Water vapour absorbs electromagnetic radiation primarily in the range of
(a) X-Rays   (b) UV-Rays
(c) IR- Rays   (d) Visible Rays

(x) SI unit of conductivity is
(a) Ohm -meter   (b) Siemen/meter
(c) 1/ Ohm -meter   (d) Siemen-meter.

Fill in the blanks with the correct word

(xi) A rotameter is called as a _____meter.

(xii) Ionization gauge is used to measure _____.

(xiii) For a laminar flow, the Reynold's number is _____.

(xiv) Range of pH scale is _____.

(xv) Material used as a hygroscopic coating for moisture measurement is _____.

Group - B

2. (a) What is a flapper-nozzle system? What is its function? Draw the transfer characteristics of the flapper-nozzle system. What are the live and dead zeros of a pneumatic transmitter? What is the supply pressure to this system?
[(CO1)(Remember/LOCQ)]

(b) In a Bourdon gauge, draw the arrangement to convert the linear movement to angular movement. *[(CO1)(Understand/LOCQ)]*

(c) The pressure is an ionisation gas thermometer is 10^{-4} torr. If the plate current is 10^{-6} A, what should be the grid current for a sensitivity of 100/torr.
[(CO1)(Apply/IOCQ)]
(2 + 1 + 2 + 1 + 1) + 2 + 3 = 12

3. (a) Write the working equation of a dead weight tester. How can the diameter of the weight carrying piston be determined from a complete calibration set-up of a dead weight tester? *[(CO1)(Analyse/HOCQ)]*

(b) In an inclined tube well type manometer, if the angle of inclination is made 90^0 (deg.) what will be the consequences? *[(CO1)(Apply/IOCQ)]*

(c) In a two wire current transmitter, why is 4 mA, the only non-zero current value, considered as a standard live zero? A current signal is preferred rather than a voltage signal during remote transmission. Justify. *[(CO1)(Apply/LOCQ)(CO5)(Apply/IOCQ)]*
(2 + 3) + 2 + (3 + 2) = 12

Group - C

4. (a) A rotameter was in line to measure water flow rate. Now the management has decided to use the line to measure the flow of Carbon dioxide. Will the

rotameter give correct flow information? Justify. To make the measurement independent of viscosity variation what is to be done? *[(CO2)(Analyse/HOCQ)]*

(b) Is a turbine flow meter applicable for steam flow measurements? Justify. *[(CO2)(Remember/LOCQ)]*

(c) State the underlying principle of electromagnetic flow meter. Because of an installation problem, the angle between the flow direction and magnetic field is 60^0. What will be the effects on flow measurements? *[(CO5)(Apply/IOCQ)]*

(4 + 1) + 3 + (1 + 3) = 12

5. (a) A Venturimeter is installed in a boiler feed water line used to measure both speed and all-day consumption of water by a boiler. The cross-sectional areas of impulse tapping points are 10 cm² and 5 cm². The height difference of the manometric liquid is 61.2 cm. Take water density as 1000 kg/m³. Calculate
   (i) What may be the best fit manometric liquid?
   (ii) What is the speed of the water at upstream tapping point? *[(CO2)(Analyse/IOCQ)]*

(b) In a Pitot tube, HP leg pressure is 200 Barg and LP leg pressure 150 Barg. Calculate static and dynamic pressures. What is the function of a square root extractor? Is it applicable in case of a Pitot tube? *[(CO2)(Understand/IOCQ)]*

(c) "Vortex flow meter has an elevated zero", Justify. What is the function of the drive coil in a Coriolis mass flow meter? *[(CO2)(Applyr/IOCQ)]*

(1 + 3) + (2 + 1 + 1) + (2 + 2) = 12

Group - D

6. (a) Is it possible to apply Bernoulii's principle to a static liquid? Justify your answer providing a practical example. *[(CO3)(Analyse/HOCQ)]*

(b) State the operating principle of a float type level meter. Why the zero of the graduated scale used for level indication starts from top of the tank in industrial environment? *[(CO34)(Remember/LOCQ)]*

(c) What is a five-valve manifold in a differential pressure transmitter to measure the level of liquid in a tank? State the function of each valve. *[(CO3)(Remembery/IOCQ)]*

(1 + 3) + (2 + 1) + (1 + 4) = 12

7. (a) A two-wire level transmitter of range 0-10 kg/cm² is used for measuring the level of water in an open tank. Calculate the output current from a level transmitter if the water level in the tank is 5 meter when the level transmitter is installed at (i) Just at the bottom of the tank, (ii) 5 meter below the bottom of the tank, and (iii) 5 meter above the bottom of the tank. Density of water is 1000 kg/m³. *[(CO3)(Analyse and Apply/HOCQ)]*

(b) Suppose a storage tank holds a liquid with unpredictable density. Identify the best fit level measurement technology. Explain the working of that technology with a neat and labelled diagram. *[(CO3)(Apply/IOCQ)]*

6 + (1 + 5) = 12

Group - E

8. (a) What is the underline science in a pH meter? How does temperature affect pH measurement? Why do the pH measurements need buffer solutions?

   [(CO4)(Remember/HOCQ)]

   (b) What does a conductivity meter's cell constant mean? Why are there probes with different values of cell constants? *[(CO4)(Remember/HOCQ)]*

   (c) Using four electrodes, demonstrate an electrical circuit of a conductivity analyzer. What is the full form of TDS in a TDS meter? *[(CO6)(Apply/IOCQ)]*

   (2 + 2) + (2 + 2) + (3 + 1) = 12

9. (a) Draw a labelled electronic circuit and show the fault path in the circuit. Show the placement of such a circuit in a flame proof environment. *[(CO6)(Analyse/HOCQ)]*

   (b) Explain the roles of various components of a Zener safety barrier circuit. How would you specify the components? *[(CO2)(Remember/LOCQ)]*

   (c) For the instruments' safety enclosures, what is the difference between IP code and NEMA? *[(CO2)(Remember/LOCQ)]*

   (3 + 1)+ (3 + 3) + 2 = 12

_____

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.96	42.71	33.33

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.