

**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) Bourdon tube is never made of
 - (a) phosphor bronze
 - (b) monel metal
 - (c) Stainless Steel
 - (d) Cast Iron
- (ii) 1 psi equals to:
 - (a) 6.895 Pa
 - (b) 68.95 Pa
 - (c) 6.895 kPa
 - (d) 68.95 kPa
- (iii) The desirable property of a manometric fluid is
 - (a) high viscosity
 - (b) low vapour pressure
 - (c) high co-efficient of thermal expansion
 - (d) corrosiveness and sickness
- (iv) A pitot-static tube measures
 - (a) static pressure
 - (b) dynamic pressure
 - (c) total pressure
 - (d) difference between total and static pressure
- (v) Which of the following quantities can be measured using bellows?
 - (a) absolute pressure
 - (b) gauge pressure
 - (c) differential pressure
 - (d) all of the mentioned
- (vi) Discharge coefficient is minimum for
 - (a) turbine meter
 - (b) orifice meter
 - (c) ultrasonic flow meter
 - (d) venturi meter
- (vii) Which of the following meters is used to measure open channel flow rate?
 - (a) orifice Meter
 - (b) venturi meter
 - (c) pitot tube
 - (d) rotameter

- (viii) Dead weight tester is used for
 (a) testing dead weight (b) producing high pressure
 (c) calibrating pressure instruments (d) measuring process pressure accurately
- (ix) Which of the following is represented by ratio of density of substance to density of water at 40°C?
 (a) mass density (b) weight density
 (c) specific gravity (d) specific density
- (x) A flow transmitter with a 4-20 mA output has a calibrated range of 1.0 – 6.0 m³/sec. What flow rate is indicated by a current of 12 mA?
 (a) 7.0 m³/sec (b) 3.5 m³/sec
 (c) 4.5 m³/sec (d) 3.6 m³/sec

Group – B

2. (a) Explain the advantage of inclined manometer with a suitable diagram.
 (b) A U-tube manometer is used to measure the pressure of oil of specific gravity 0.85 flowing in a pipe line. Its left end is connected to the pipe and the right limb is open to the atmosphere. The centre of the pipe is 100 mm below the level of mercury (specific gravity = 13.6) in the right limb. If the difference of mercury level in the two limb is 160mm, determine the absolute pressure of the oil in the pipe.
 (c) Briefly explain the operating principle of pneumatic motion-balance system with flapper & nozzle. Draw necessary diagrams.

2 + 5 + 5 = 12

3. (a) Describe with a schematic diagram how dead weight tester can be used for pressure instrument calibration.
 (b) The diaphragm element of a pressure gauge is a circular foil of steel (young's modulus $E = 2 \times 10^{11} \text{ N/m}^2$, Poisson's ratio ($\mu = 0.3$) which is firmly clamped around its circumference. The radius α and thickness t of the element are 2.5 mm and 1.1 mm respectively. On the application of uniform pressure p , the deflection y at any radial position r , measured from the centre, is given by the expression

$$y = \frac{3p(1 - \mu^2)(\alpha^2 - r^2)^2}{16Et^3}$$

Find the maximum design pressure if the allowable deflection of the element is limited to 0.3 times its thickness.

6 + 6 = 12**Group – C**

4. (a) The internal diameter of the tapered metering glass tube of rotameter at the bottom of its range is 15mm. The float is made of aluminium (relative density = 2.6) and has a volume of 550 mm³ with an effective diameter of 10mm.

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Assume the vertical range of movement of float is 200 mm, taper angle for the tube is 5° and Coefficient of discharge C_d as unity. Calculate:

- (i) The range of flow which can be measured using a liquid of relative density 0.8.
- (ii) The float height at which the mean flow rate would occur.

- (b) A pitot tube with a coefficient of 0.98 is used to measure the velocity of water in a pipe. The differential pressure head is 900mm. What is the velocity?

$$(6 + 3) + 3 = 12$$

5. (a) A venture tube of throat diameter 6 cm is placed in a water pipe of diameter 10 cm to measure the volumetric flow of rate which is found to be $0.08 \text{ m}^3/\text{s}$. If the density and viscosity of water are 103 kg/m^3 and $10 \times 10^{-4} \text{ Pa-s}$, respectively, determine the Reynolds number for these conditions.

Also given that the discharge coefficient is 0.99, determine the upstream-to-throat differential pressure developed.

- (b) Explain advantages and disadvantages of different types of excitation used in electromagnetic flow meter.

- (c) How is the K-factor or calibration factor of a vortex flow meter defined?

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

Group – D

6. (a) A two-wire pressure transmitter of range $0\text{-}2\text{kg/cm}^2$ is used for measuring the level of water in a tank. The pressure transmitter is installed 5 meters above the bottom of the tank. The space above the level is filled with water vapour of 1kg/cm^2 pressure.

(i) Calculate the output current of the transmitter if the water level in the tank is 5 meters.

(ii) If some more water is added to raise the level and the vapour pressure in the tank released and brought to 0.2 kg/cm^2 . If the transmitter gives an output 8 mA, calculate the water level in the tank.

- (b) Describe, with neat sketch, the working principle of resistance type level measurement system.

- (c) What is actuation depth?

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

7. (a) State the types of level switches. Describe, with neat sketch, the working principle of conductivity level switch.

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

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

Group – E

8. (a) When a gas sample of fixed volumetric flow rate is passed through electrolytic hygrometer cell, an isolation current of $250\mu\text{A}$ is measured. After sometime the ionisation current has increased to $350\mu\text{A}$. Calculate the percentage of moisture content increased in the sample.
- (b) What does IP65 signify? What its NEMA equivalent?
- (c) Write a short note on intrinsic safety.

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

9. (a) What is p-H value? Describe the working of p-H meter.
- (b) What is kinematic viscosity?
- (c) In a rotating cylinder viscometer, the radii of the cylinders are 32 mm and 30 mm and the outer cylinder is rotated steadily at 200 r.p.m. For a certain liquid filled in the annular space to a depth 80 mm, the torque produced on the inner cylinder is 0.9×10^{-4} Nm. Calculate the viscosity of the liquid. Assume the velocity distribution to be linear.

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

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/MzExNTU1OTM2OTYy/a/MzczNjY3MTQ1NjU0/details