



Important suggestions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
- 4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1	Attempt any FIVE of the following	10 Marks
a)	Define active and passive transducers.	
Ans:	<p>1. Active Transducer: - ----- (1 Mark)</p> <ul style="list-style-type: none">• These transducers do not need any external source of power for their operation. Therefore, they are also called as self-generating type transducers.• The active transducer are self-generating devices which operate under the energy conversion principle. <p>2. Passive Transducer: - ----- (1 Mark)</p> <ul style="list-style-type: none">• These transducers need external source of power for their operation. So they are not self-generating type transducers.	
b)	List any four units of pressure.	
Ans:	<p>(Any four units expected: 1/2 marks each)</p> <ul style="list-style-type: none">• The following are units of Pressure <ol style="list-style-type: none">1. Pascals (Pa or N/m²) – N stands for <i>newton</i> which is SI unit of pressure2. Psi - Pounds per square inch (PSI)3. Bar - 10⁵ Pascals4. mm Hg-millimeters of Mercury 1mm of Hg = 1 Torr	



	5. Torr - 133.32 Pa 6. cm H ₂ O - 1 cmH ₂ O = 98.068 Pa
c)	Define laminar and turbulent flow.
Ans:	Laminar flow: - ----- (1 Mark) 1. Laminar flow occurs when the fluid flows in infinitesimal parallel layers with no disruption between them. For laminar flow Reynolds number $Re < 2300$ OR 2. The flow in which fluid flows smoothly such that fluid layers are parallel to each other OR 3. No streamlines intersect each other, such type of flow is known as laminar flow. OR 4. When all the molecules of flow are parallel to each other, it is called Laminar flow. Turbulent flow: - ----- (1 Mark) 1. Turbulent flow occurs when the fluid does not flow in parallel layers, the lateral mixing is very high, and there is a disruption between the layers. $Re > 4000$ OR 2. When all the molecules of flow are scattered without fixed position it is called Turbulent flow. OR 3. The flow in which fluid flows in zig-zag manner and fluctuate irregularly in such a way that its velocity changes irregularly, such type of flow is known as turbulent flow.
d)	List any two non-contact type level measurement methods.
Ans:	(Any Two types expected: 1 mark each) <ul style="list-style-type: none">The following are non-contact type level measurement methods 1. Ultrasonic type level measurement 2. Nuclear radiation type level measurement 3. Radar type level measurement 4. Capacitive level transducer. 5. Load cell type level transducer.



e)	State any two advantages of ultrasonic flow meters.
Ans:	<p style="text-align: right;">(Any Two points expected: 1 marks each)</p> <p>Advantages of ultrasonic level measurement:</p> <ol style="list-style-type: none">1. Offer no obstruction to the flow2. o/p is insensitive to variation in viscosity, density and temperature3. No moving parts4. Linear relationship between o/p and i/p5. Used for bidirectional flow6. Excellent dynamic response7. Good accuracy $\pm 2\%$8. o/p is electrical9. It is used as non-contact method of flow measurement.
f)	State seebeck and peltier effect.
Ans:	<p><u>See beck Effect:-</u> ----- (1 Mark)</p> <p>When a pair of dissimilar metals are joined at one end, and there is a temperature difference between the joined ends and the open ends, thermal emf is generated, which can be measured in the open ends.</p> <p><u>Peltier Effect:-</u> ----- (1 Mark)</p> <p>The Peltier effect is a temperature difference created by applying a voltage between two electrodes connected to a sample of semiconductor material.</p> <p style="text-align: center;">OR</p> <p>The Peltier effect: Heat is given out or absorbed when an electric current pass across a junction between two materials.</p>
g)	What is Pt-100?
Ans:	<p><u>Pt-100:-</u> ----- (2 Marks)</p> <p>A platinum resistance temperature detector (RTD) Pt100 is a device with a typical resistance of 100Ω at 0°C (it is called Pt100).</p>



	It changes resistance value as its temperature changes following a positive slope (resistance increases when temperature is increasing).
Q. 2	Attempt any THREE of the following 12 Marks
a)	State the selection criteria for transducers (any eight points).
Ans:	<p style="text-align: right;">(Any Eight points expected: 1/2 marks each)</p> <ol style="list-style-type: none">1. Operating range2. Operating principle3. Sensitivity4. Accuracy5. Frequency response and resonant frequency6. Errors7. Environmental compatibility8. Usage and ruggedness.9. Electrical aspect.10. Stability and Reliability11. Loading effect12. Static characteristics13. Noise immunity
b)	Draw constructional details of C-types Bourdon tube and explain its working
Ans:	<p>Constructional details of C-types Bourdon tube :</p> <p style="text-align: right;">(Figure: 2 Mark & Explanation :2 Mark)</p> <div style="text-align: center;"><p>The diagram illustrates the internal mechanism of a C-type Bourdon tube. It shows a C-shaped Bourdon tube connected to a socket. The tube is linked to a spring, which is connected to a pinion. The pinion meshes with a sector gear. The sector gear is connected to a segment lever, which is pivoted at one end. The other end of the segment lever is connected to an adjustable link, which is attached to a tip. A stop is also shown at the end of the Bourdon tube.</p></div> <p style="text-align: right;">or equivalent figure</p> <p>Explanation:-</p> <ol style="list-style-type: none">1. The Bourdon tubes are made out of an elliptically sectioned flat tube bent in such a way as to produce the above mentioned shapes.2. One end of the tube is sealed or closed and physically held.3. Other end of tube is held fixed at one end (the end connected to the pressure source)



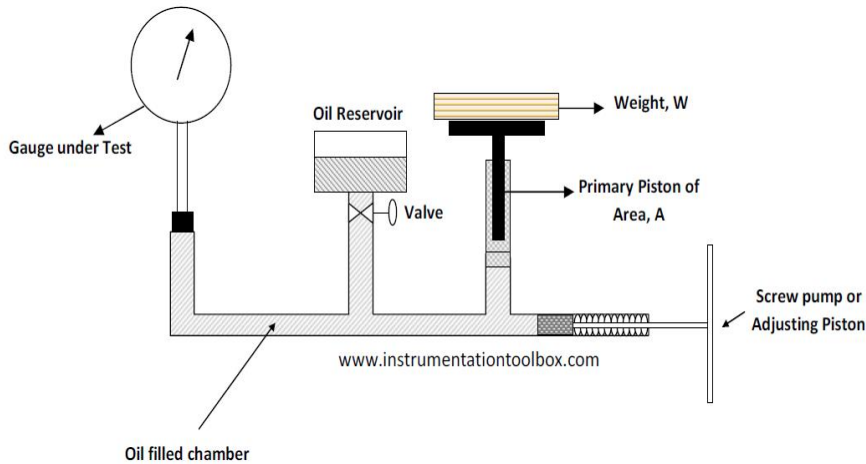
	<ol style="list-style-type: none">4. Whose pressure is to be measured enters the tube, the tube tends to straighten out on account of the pressure.5. This causes the movement of the free end which is measured.6. A pointer is mounted on the shaft. The needle moves over a circular scale that indicates the pressure. The position of the needle is determined by a balance between the Bourdon tube developed torque acting on the shaft and the torque due to the shaft mounted spring that opposes its movement.7. Bourdon tubes normally measure gauge pressure.8. <u>The materials used for Bourdon tubes are brass, phosphor bronze, beryllium copper, and steel</u>
c)	What is piezo electric effect? Name two piezo electric materials.
Ans:	<p>Piezoelectric Effect: ----- (2 Marks)</p> <p>When pressure or force is applied on piezoelectric crystals such as quartz crystal then an electric charge is generated across that crystal.</p> <p style="text-align: center;">OR</p> <p>Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress.</p> <p>Piezoelectric Materials: - (Any Two Material expected: 1 marks each)</p> <ol style="list-style-type: none">1. Barium Titanate.2. Rochelle salts.3. Quartz crystal.4. Topaz5. Tourmaline6. lead titanate7. lead zirconate titanate8. lithium sulphate



d) Explain the process of calibration of pressure gauge by Dead Weight Tester.

(Figure: 2 Mark & calibration process :2 Mark)

Ans:



or equivalent figure

Deadweight Testers (DWT) are the primary standard for pressure measurement. A dead weight tester is an instrument that calibrates pressure by determining the weight of force divided by the area the force is applied. Typically a dead weight tester consists of a base, screw press/regulator, piston/cylinder assembly, a fluid (oil) that transmits the pressure and a mass set of weights.

$$\text{PRESSURE} = \text{FORCE} / \text{AREA} = W / A$$

As the area of a piston of DWT is accurately known so that it is constant

Therefore PRESSURE(P) \propto FORCE (Weight)

CALIBRATION STAPES :-

1. Connect the pressure gauge to the test port on the dead weight tester as shown in the diagram above.
2. Ensure that the test gauge is reading zero, if not correct the zero error and ensure that the gauge is reading zero before proceeding with the calibration exercise.
3. Select a weight and place it on the vertical piston
4. Turn the handle of the adjusting piston or screw pump to ensure that the weight and piston are supported freely by oil.
5. Spin the vertical piston and ensure that it is floating freely



6. At steady state condition record the gauge reading and weight
7. increasing weights until the full range or maximum pressure is applied to the gauge and then decreasing weights until the gauge reads zero pressure.
8. Calculate the error at each gauge reading and ensure that it is within the acceptable accuracy limits.

Q.3 Attempt any THREE of the following **12 Marks**

a) Compare orifice plate with venturi tube with reference to: (i) Working principle (ii) Construction (iii) Cost (iv) Pressure loss

Ans: **(Each Point: 1 Mark)**

S.No	Points	Venturi Flow Meter	Orifice Plate Meter
1	Working principle	Works on venturi effect. The Venturi effect is the reduction in fluid pressure that results when a fluid flows through a constricted section of pipe.	When fluid passes through orifice, there is large drop in pressure that is indicative of flow rate
2	Construction	It has The venturi meter has a converging conical inlet, a cylindrical throat and a diverging recovery cone works on venturi effect:	An orifice meter is essentially a cylindrical tube that contains a plate with a thin hole in the middle of it.
3	cost	Expensive, carefully fabricated, purchase from proper manufacture	Cheap & easy to install. Homemade orifice plate possible
4	Pressure loss	Low	High

b) Draw and explain block diagram of instrumentation system.

Ans: block diagram of instrumentation system : **(Figure: 2 Mark & Explanation :2 Mark)**

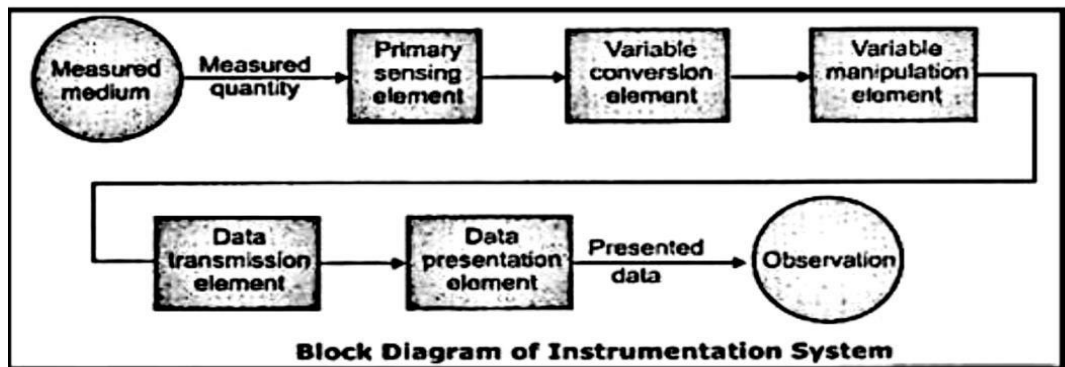
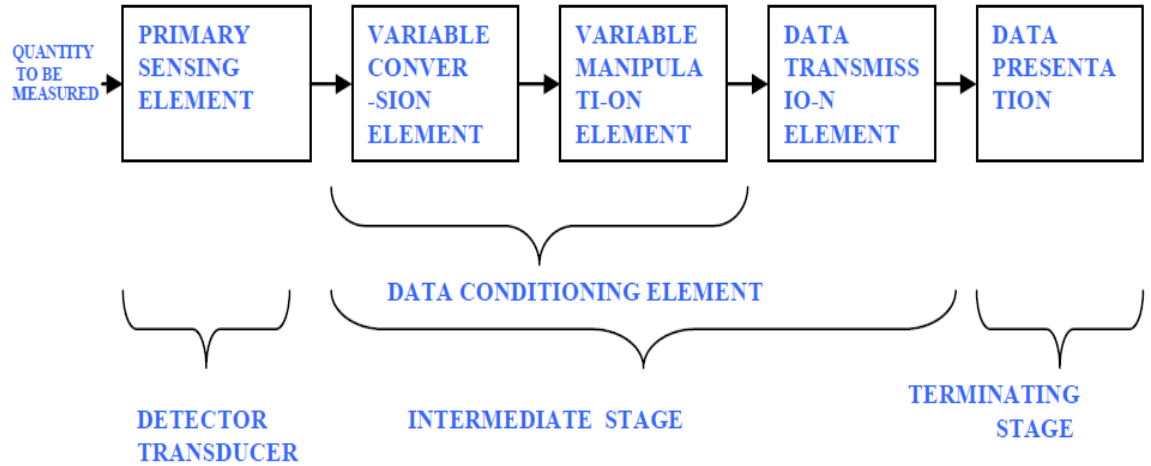


Fig. Block diagram of instrumentation system

OR



or equivalent figure

1. Primary Sensing Element:-

- It is also known as "First Sensing Elements" The Element (Part) of an instrument which makes first contact with the measure and is called the primary sensing element.
- For example, In Ammeter (which is used to measure current), the coil carrying the current to be measured is the primary sensing element

2. Variable conversion Element:-

- The output of the Primary sensing element may not be suitable for the actual measurement system.
- A variable conversion element merely converts the output signal of the primary sensing element into a more suitable variable or condition useful to the function of the instruments
- Also keep in mind, that the original information about the measurand must be retained during the process of such conversion

3. Variable Manipulation Element:-

- The level of the output from the Variable conversion element may not be enough for the next stage
- It manipulates the signal represented by some physical variable, to perform the intended task of an instrument.



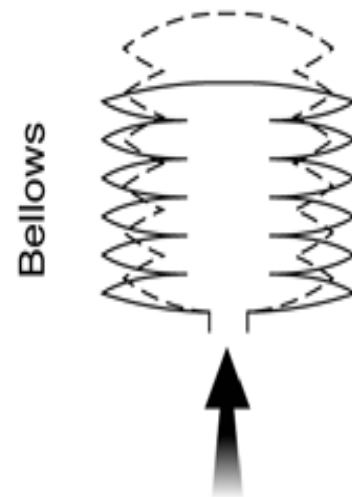
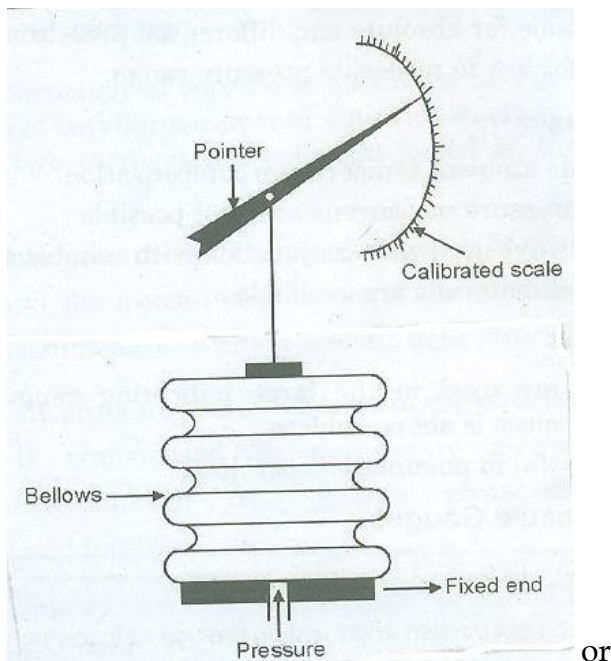
	<p>4. Data Transmission Element:-</p> <ul style="list-style-type: none">• If the elements of the system are physically separated, it is necessary to transmit the data from one stage to the other. So we need this Data Transmission element <p>5. Data presentation Element:</p> <ul style="list-style-type: none">• It performs the translation function, such as present the data in a suitable form so that it is easily understood by the observer and for this the Data Presentation Element is used
c)	<p>Write one example of each type: (i) Active transducer (ii) Primary transducer. (iii) Electrical transducer. (iv) Digital transducer.</p>
Ans:	<p style="text-align: right;">(Each Point: 1 Mark)</p> <p>(i) Active transducer:- Thermocouple, piezoelectric, photovoltaic cell (ii) Primary transducer:- Bourdon tube, bellows, (iii) Electrical transducer:- LVDT, RVDT, Hall effect, strain gauge, ultrasonic meter, optical pyrometer, radiation pyrometer (iv) Digital transducer:- Linear Encoder, digital tachometer generator</p>
d)	<p>Draw the following and write one application of each: (i) Well type manometer (ii) Bellows.</p>
Ans:	<p>(i) Well type manometer: - ----- (1 Mark)</p> <div style="display: flex; justify-content: space-around; align-items: center;"><div style="text-align: center;"><p>or equivalent figure</p></div><div style="text-align: center;"><p>or</p></div></div>



Application :- ----- (1 Mark)

- Measuring gauge, absolute, atmospheric and differential pressures.
- vacuum measurement
- leak testing and tank liquid level
- pressures at critical points in gas-train systems

ii) Bellows. ----- (1 Mark)

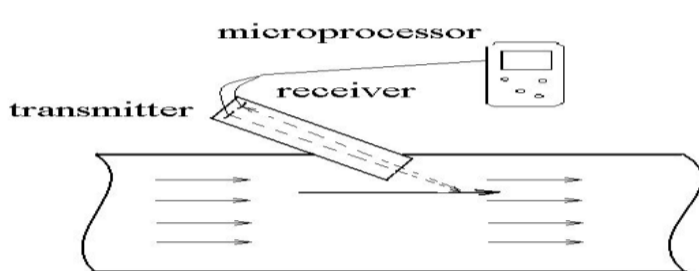
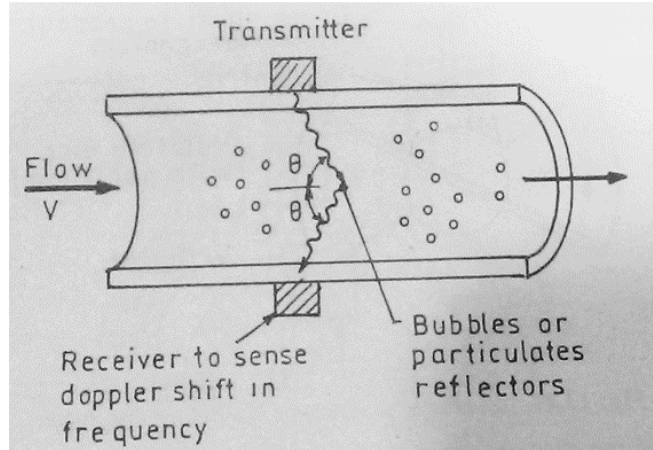


or equivalent figure

Application :- ----- (1 Mark)

- Measuring gauge , absolute, atmospheric and differential pressures.
- Vacuum measurement.
- low pressure gauges are suitable for chemical, petrochemical, plant construction, pneumatic systems and cleanrooms.



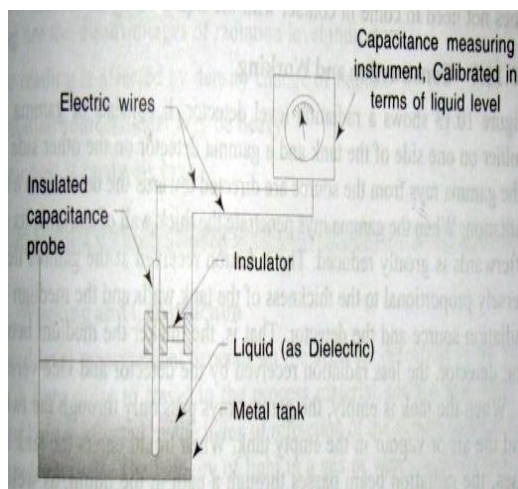
Q.4	Attempt any THREE of the following	12 Marks
a)	Explain the principle of operation of Doppler type ultrasonic flow meter with a neat labeled sketch.	
Ans:	<p style="text-align: right;">(Figure: 2 Mark & Explanation :2 Mark)</p> <p>Sketch of Doppler type ultrasonic flow meter</p>  <p style="text-align: center;">Doppler Ultrasonic Flow Meter</p> <p style="text-align: right;">or</p>  <p style="text-align: right;">or equivalent figure</p> <ul style="list-style-type: none">• The Doppler Effect Ultrasonic Flow meter use reflected ultrasonic sound to measure the fluid velocity.• By measuring the frequency shift between the Ultrasonic frequency source, The receiver, and The fluid carrier, the relative motion are measured.• The resulting frequency shift is named the <i>Doppler Effect</i>.• The fluid for which pipe flow rate is being measured must have material like particles or air bubbles that will reflect ultrasonic waves• A signal of known ultrasonic frequency (0.5 to 10MHz) is transmitted through fluid , which has uniform velocity (v)	



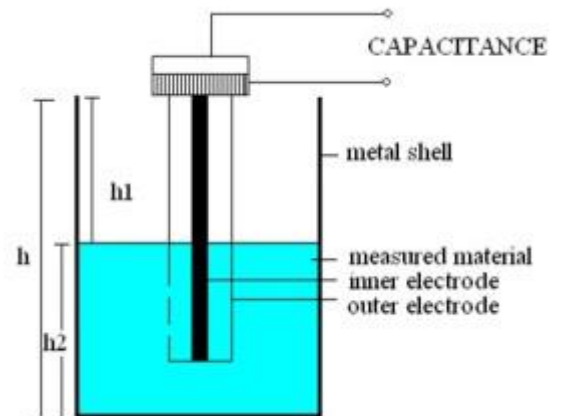
- Solids, bubbles or any discontinuity in liquid will reflect back to the receiver
- Because of the velocity of the liquid there frequency, there will be a frequency shift at the receiver end which is proportional to the velocity

b) **A capacitive type level sensor is to be used for measuring the level of water in the tank. With a neat labeled diagram. Explain the construction of this transducer. Also state the reason for change in capacitance with change in level of water.**

Ans:



or



(Figure: 2 Mark & Explanation :2 Mark)

equivalent figure

Capacitance level transducer :-

- The principle of operation of capacitance level indicator is based upon the familiar capacitance
- equation of parallel plate capacitor given by

$$C = K \cdot (A/D)$$

Where, C= capacitance, in farad

K= dielectric constant

A=area of plate, in meters square

D= distance between two plates, in meter.

- Therefore, it is seen from the above equation that if A & D are constant, then the capacitance of a capacitor is directly proportional to the dielectric constant, and this principle utilized in the capacitance level indicator.



Construction & working:-

- Fig. shows a capacitance type liquid level indicator. It consist of an insulated capacitance probe (which is a metal electrode) firmly fixed near and parallel to the metal wall of the tank.
- If the liquid in the tank is **non-conductive**, the capacitance probe and the tank wall form the plates of a parallel plate capacitor and liquid in between them acts as the dielectric.
- If the **liquid is conductive** the capacitance probe and liquid form the plates of the capacitor and the insulation of the probe acts as the dielectric.
- A capacitance measuring device is connected with the probe and the tank wall, which is calibrated in terms of the level of the liquid in the tank.
- When the level of liquid in the tank rises, the capacitance increases.
- When liquid level of the tank decreases, the capacitance also decreases.
- Change in the capacitance is measured and is displayed on the indicator calibrated in terms of liquid level

c) **Compare RTD and thermistor on the basis of: (i) temperature coefficient (ii) linearity (iii) temperature (iv) range and cost**

Ans:

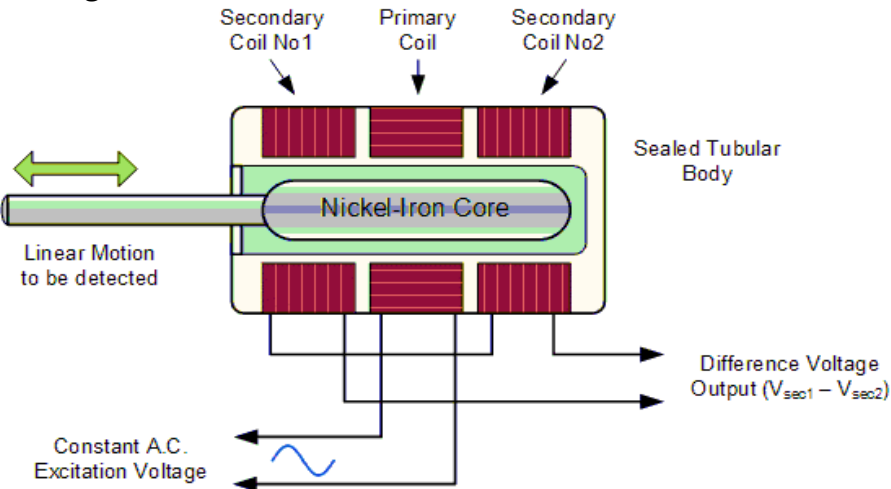
(Each Point: 1 Mark)

Sr.No.	Points	RTD	Thermistor
1	temperature coefficient	Positive temperature coefficient of resistance.	PTC and NTC both types are available
2	linearity	It has linear temperature versus resistance curve.	It has nonlinear temperature versus resistance curve.
3	temperature	Used in medium to high Temperature range: -100 C to 650 C.	Used in low to medium Temperature range: -50 C to 300 C
4	range and cost	Temperature range: -100 C to 650 C. Cost is high	Temperature range: -50 C to 300 C They are cheaper as compared to RTD



d)	State any two advantages and disadvantages of electromagnetic flow meter.
Ans:	<p>Advantages of Magnetic Flowmeter: - ----- (2 Marks)</p> <ol style="list-style-type: none">1. It can handle slurries and greasy materials.2. It can handle corrosive fluids.3. It has very low pressure drop.4. It is totally obstruction less.5. It is available in large pipe sizes and capacity as well as in sever construction materials.6. It is capable of handling low and very high-volume flow7. It can be used as bidirectional meter. <p>Disadvantage of Magnetic Flowmeter: - ----- (2 Marks)</p> <ol style="list-style-type: none">1. It is relatively expensive.2. It works only with fluids which are adequate electrical conductors.3. It is relatively heavy, especially in larger sizes.4. It must be full at all times.5. It must be explosion proof when installed in hazardous electrical areas
e)	<p>Suggest a suitable level transducer for following application: (i) Level control of liquid, powders and fine grained solids within mining (ii) Chemical processing and food industries (iii) Tank level monitoring in chemical, water treatment (iv) Oil level in transformer.</p>
Ans:	<p style="text-align: right;">(Each Point: 1 Mark)</p> <p>i. Level control of liquid, powders and fine grained solids within mining:- Capacitive Transducer, Radar level (microwave) Transducer, laser beam type</p> <p>ii. Chemical processing and food industries:- Capacitive Transducer, Radar level meter</p> <p>iii. Tank level monitoring in chemical, water treatment:- Ultrasonic level transducer, load cell type</p> <p>iv. Oil level in transformer: - sight Glass , optical sensor (LDR), Float type level transducer</p>



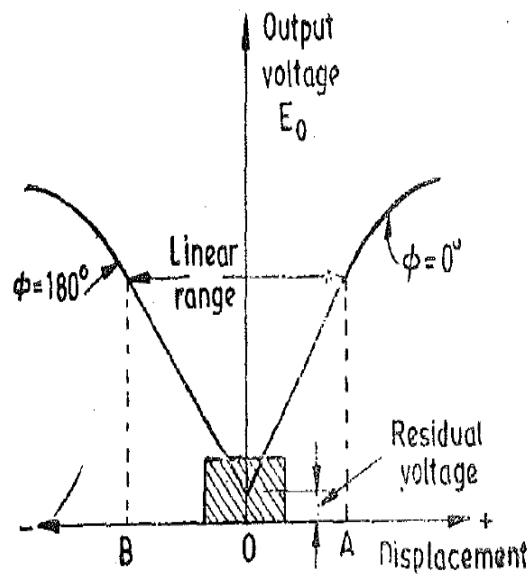
Q.5	Attempt any TWO of the following	12 Marks
a)	Draw constructional diagram of LVDT. State its working principle. What is residual voltage, explain with neat diagram.	
Ans:	<p style="text-align: right;">(constructional diagram of LVDT: - 2 Marks)</p> <p>Diagram of LVDT:</p>  <p style="text-align: right;">or equivalent figure</p> <p>Working:- ----- (2 Marks)</p> <ul style="list-style-type: none">• An LVDT transducer comprises a coil former on to which three coils are wound.• The primary coil is excited with an AC current, the secondary coils are wound such that when a ferrite core is in the central linear position, an equal voltage is induced in to each coil.• The secondary are connected in opposite so that in the central position the outputs of the secondary cancels each other out.• The excitation is applied to the primary winding and the armature assists the induction of current in to secondary coils.• When the core is exactly at the center of the coil then the flux linked to both the secondary winding will be equal. Due to equal flux linkage the secondary induced voltages (V_{o1} & V_{o2}) are equal but they have opposite polarities. Output voltage V_o is therefore zero. This position is called "null position"• Now if the core is displaced from its null position toward sec1 then flux linked to sec1 increases and flux linked to sec2 decreases. Therefore $V_{o1} > V_{o2}$ and the output voltage of LVDT V_o will be positive• Similarly if the core is displaced toward sec2 then the $V_{o2} > V_{o1}$ and the output voltage of LVDT V_o will be negative.	



Residual voltage: - ----- (1 Marks)

The output voltage is ideally zero, when core is at center or null position. harmonics in excitation voltage and capacitance coupling between primary and secondary coils usually results in small but non zero null voltage called residual voltage

Residual voltage Diagram: ----- (1 Marks)



or equivalent figure

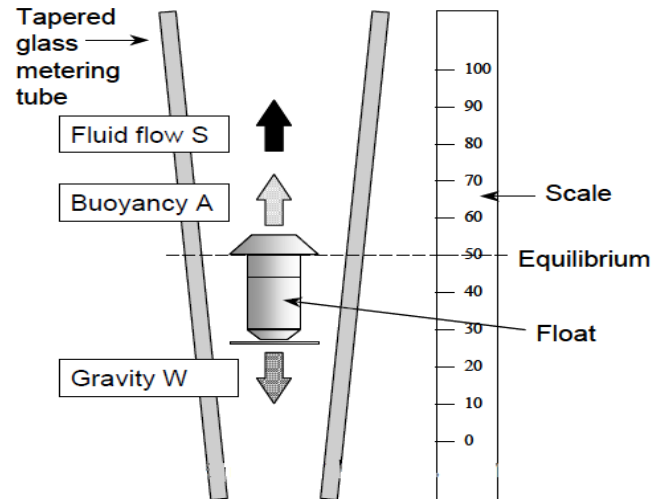
b) **Why Rotameter is called variable area flowmeter? Explain the working of rotameter with neat diagram. State its one advantage and one disadvantage.**

Ans: **(Rotameter: - 1 Mark, Figure: 1.5 Mark & Explanation :1.5 Mark, One Advantage: - 1 mark and One Disadvantage: -1 mark)**

Rotameter :-

An variable-area flowmeter is one where the fluid must pass through a restriction whose area increases with flow rate. The height of the float is directly proportional to the flowrate

Neat diagram of rotameter



or equivalent figure

Working of Rotameter: -

- It consists of a vertical tube with conical cone or shape.
- It is constant pressure drop variable flow meter in which float is free to move within it
the fluid flows through the tube from bottom to the top
- When no fluid is flowing the float reset at the bottom of the tube
- The float is made of such a diameter that it completely blocks the inlet section
- When a flow starts in a pipeline and the fluid reaches the float, the buoyancy effect of fluid makes the float lighter
- The float has a density greater than that of flowing material so that the buoyancy effect alone is not sufficient to lift the float
- The float remains close until the pressure of flowing material (fluid flow or Drag) + buoyancy effect of fluid exceeds the downward pressure due to the weight of the float

$$i. e W = S + A$$

where

W= Weight of float

S= Fluid flow or Drag

A= Buoyancy effect

- The float then rises and floats within the flowing medium (Pipe) in proportional to the flow rate



- The float reaches a stable position in the tube when the upward force exerted by the flowing fluid (i.e $S + A$) equals the downward gravitational force exerted by the weight of the float.
- Increase in the flow rate causes the float to rise higher in the tube
- Decrease in the flow rate causes the float come down to the lower level
- The float gives reading on a calibrated scale which is on glass tube and the flow rate can be determined by direct observation of the metering tube

Advantages: - (Any Two advantages are expected)

1. We can find the rate of flow by direct visual.
2. There is a low-pressure loss in it.
3. Cost of this equipment is less.
4. Easy in construction.
5. We can work on it directly, without any sample flows.
6. No external power or fuel for its operation

Disadvantages: - (Any Two disadvantages are expected)

1. This is not used where there is fast changes occur in measurements.
2. Low accuracy
3. Requirement for buoyancy correction in liquids
4. Subject to density, viscosity and temperature
5. The fluid must be clean, no solids content
6. Erosion of device (wear and tear)
7. Can be expensive for large diameters
8. Operate in the vertical position only

c) **Explain the following troubles and related remedies in ultrasonic flow meter:
(i) Meter does not show reading (ii) Meter show less value of flow measured.
(iii) Meter show high value of flow measured.**

Ans: **i) Meter does not show reading----- (2 Marks)**

S.No.	POSSIBLE CAUSES	CORRECTIVE ACTION OR REMEDIES
1	<ul style="list-style-type: none"> ➤ Scaling of inner wall of the pipe so that signal does not reach in proper direction ➤ Scaling causes attenuation and refraction of the signal 	<ul style="list-style-type: none"> ➤ Required regular maintenances of meter ➤ Perform calibration
2	<ul style="list-style-type: none"> ➤ In case of doppler type instrument Does not work with pure liquids. 	<ul style="list-style-type: none"> ➤ Requires minimum % of solids or bubbles (~5%)



ii) Meter shows less value of flow measured:----- (2 Marks)

S.No.	POSSIBLE CAUSES	CORRECTIVE ACTION OR REMEDIES
1	➤ Les measurement if the Flow has more than 10% solids/bubbles	➤ Flow material required less than 10% solid/bubbles
2	➤ If the pulsations are large, the instantaneous flow may temporarily exceed the rated flow range of the flow meter. In this situation, the flow displayed on the flow meter is smaller than the actual flow	➤ One possible way to reduce pulsations is by using a damper such as an accumulator

iii) Meter shows high value of flow measured----- (2 Marks)

POSSIBLE CAUSES	CORRECTIVE ACTION OR REMEDIES
➤ Doppler meters will tend to track bubbles over solids ➤ Air bubbles will rise faster than the slurry	➤ Check minimum % of solids (~5%) ➤ Check minimum particle size (~ >100 um) ➤ Perform calibration and check if Accuracy is +/- 5% unless calibrated on the pipe

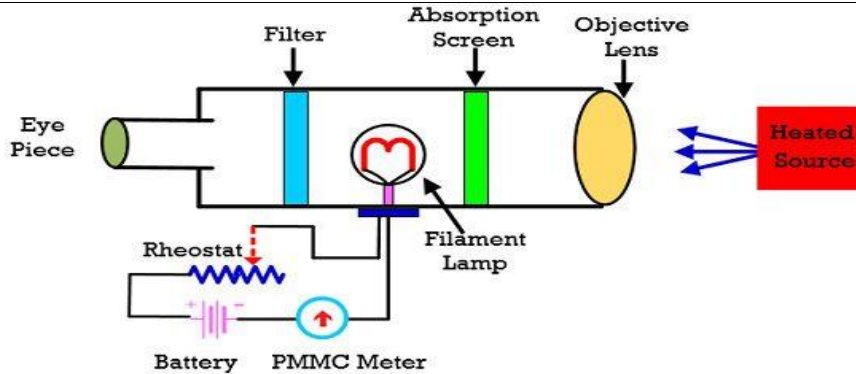
Q.6 Attempt any TWO of the following 12 Marks

a) What is pyrometry? Explain working of optical pyrometer with neat diagram. State its one application.

Ans: (Pyrometry: - 1 Mark, Figure: 2 Marks & Explanation :2 Marks, One Application: - 1 Mark)

Pyrometry: -

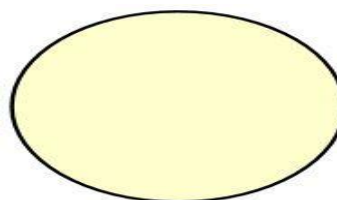
- When physical contact with the medium to be measured is not possible due to very high temperature, Pyrometers are used. Operation of pyrometer is based on thermal radiation. Radiation pyrometry measures the radiant heat emitted by hot body.
- Diagram of optical pyrometer



**Disappearing Filament Type Optical Pyrometer
or equivalent figure**

Working of Optical Pyrometer :-

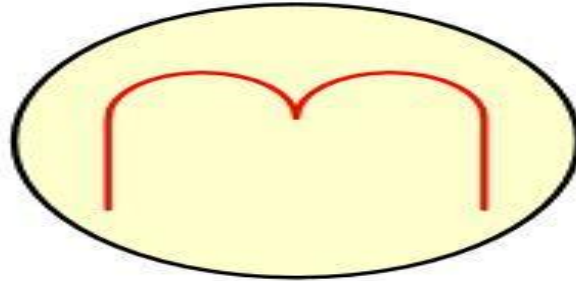
- The optical pyrometer is a non-contact type temperature measuring device.
 - It works on the principle of matching the brightness of an object to the brightness of the filament which is placed inside the pyrometer.
 - It consists the lens which focuses the radiated energy from the heated object and targets it on the electric filament lamp.
 - The intensity of the filament depends on the current passes through it.
 - Hence the adjustable current is passed through the lamp.
 - There are three condition of optical pyrometer
1. Case 1:-Equal brightness
 - The magnitude of the current is adjusted until the brightness of the filament is similar to the brightness of the object.
 - When the brightness of the filament and the brightness of the object are same, then the outline of the filament is completely disappeared.



**Equal
Brightness**

2. Case 2:- Filament looks bright

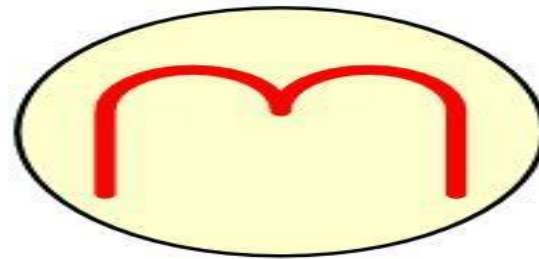
- The filament looks bright when their temperature is more than the temperature of the source.



Filament Too
Bright

3. Case 3 :- Filament looks bright

- The filament looks dark if their temperature is less than that required for equal brightness



Filament Too
Dark

Application :-

- The optical pyrometer is used for measuring the temperature of the furnaces, molten metals, and other overheated material or liquids.

b) Convert 200°F into Celsius (°C) Kelvin (°K) and Rankine (°R).

Ans: 1. Celsius temperature scale: (°C) ----- (2 Marks)

$$^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{C} = \frac{5}{9} (200 - 32)$$

$$^{\circ}\text{C} = 93.3333$$

2. Kelvin temperature scale: (°K) ----- (2 Marks)

$$^{\circ}\text{K} = ^{\circ}\text{C} + 273.15$$

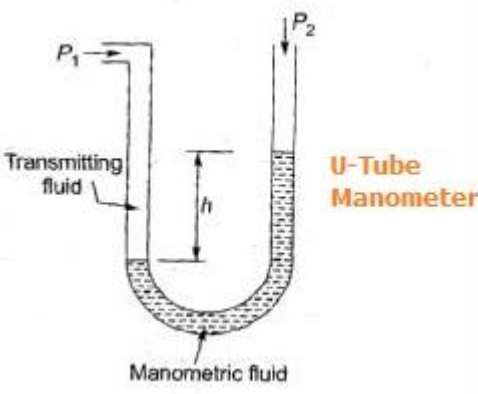
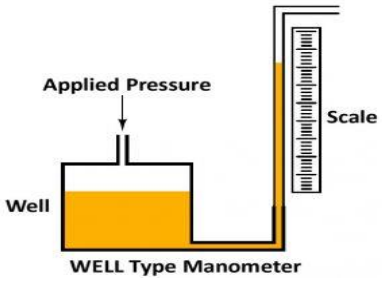


	K=366.483																												
	<p>3. Rankine temperature scale: ----- (2 Marks)</p> <ul style="list-style-type: none"> • (°R) Relation between °R & °F is given by, $^{\circ}\text{R} = ^{\circ}\text{F} + 459.69$ $^{\circ}\text{R} = 200 + 459.69$ $^{\circ}\text{R} = 659.69$ <p style="text-align: center;">OR</p> • Relation between °R & °K is given by, $^{\circ}\text{R} = \left(\frac{9}{5}\right) * ^{\circ}\text{K}$ $^{\circ}\text{R} = \left(\frac{9}{5}\right) * 366.483$ $^{\circ}\text{R} = 659.669$ 																												
c)	Compare between: (i) Ultrasonic and Radar type level measurement (any three points) (ii) U-tube and well type manometer (any three points)																												
Ans:	<p>(i) Ultrasonic and Radar type level measurement: - (Any Three points expected: 1 mark each)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Sr.No.</th> <th style="width: 20%;">Points</th> <th style="width: 30%;">Ultrasonic level measurement</th> <th style="width: 40%;">Radar level measurement</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>Measurement principle</td> <td>Sound waves</td> <td>High-frequency radar impulses or electromagnetic waves</td> </tr> <tr> <td style="text-align: center;">2</td> <td>Accuracy</td> <td>Low accuracy</td> <td>High accuracy</td> </tr> <tr> <td style="text-align: center;">3</td> <td>Operating limits</td> <td>Limited pressure and temperature limits</td> <td>Extreme temperature and pressure does not effect device performance</td> </tr> <tr> <td style="text-align: center;">4</td> <td>Environmental Condition</td> <td>Effect measurement performance</td> <td>Not effected</td> </tr> <tr> <td style="text-align: center;">5</td> <td>Overall performance</td> <td>Performance is based on strength of reflection or echo received</td> <td>Performs well independent of process conditions</td> </tr> <tr> <td style="text-align: center;">6</td> <td>Cost</td> <td>High cost</td> <td>Moderate cost</td> </tr> </tbody> </table>	Sr.No.	Points	Ultrasonic level measurement	Radar level measurement	1	Measurement principle	Sound waves	High-frequency radar impulses or electromagnetic waves	2	Accuracy	Low accuracy	High accuracy	3	Operating limits	Limited pressure and temperature limits	Extreme temperature and pressure does not effect device performance	4	Environmental Condition	Effect measurement performance	Not effected	5	Overall performance	Performance is based on strength of reflection or echo received	Performs well independent of process conditions	6	Cost	High cost	Moderate cost
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ii) U-tube and well type manometer (any three points)

(Any Three points expected: 1 mark each)

Sr.No.	U-tube manometer	well type manometer
1	Both leg having same cross section area	Both leg having different cross section area
2		
3	There are two tubes of equal cross section on either side.	There is a well on one side and a tube on other side.
4	Pressure drop is indicated by difference between heights of both tubes.	There is negligible change in the level of fluid in well because of large cross section area.
5	Difference in heights in measured.	Single height is measured.

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