22420

21819
3 Hours / 70 Marks

Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: 10

a) Define active and passive transducers.

b) List any four units of pressure.

c) Define laminar and turbulent flow.

d) List any two non-contact type level measurement methods.

e) State any two advantages of ultrasonic flow meters.

f) State seeback and peltier effect.

g) What is Pt-100?

P.T.O.

Marks

2. Attempt any THREE of the following: 12

a) State the selection criteria for transducers (any eight points).

b) Draw constructional details of C-types Bourdon tube and explain its working

c) What is piezo electric effect? Name two piezo electric materials.

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

3. Attempt any THREE of the following: 12

a) Compare orifice plate with venturi tube with reference to:

(i) Working principle

(ii) Construction

(iii) Cost

(iv) Pressure loss

b) Draw and explain block diagram of instrumentation system.

c) Write one example of each type:

(i) Active transducer

(ii) Primary transducer.

(iii) Electrical transducer.

(iv) Digital transducer.

d) Draw the following and write one application of each:

(i) Well type manometer

(ii) Bellows.

Marks

4. Attempt any THREE of the following: 12

a) Explain the principle of operation of Doppler type ultrasonic flow meter with a neat labeled sketch.

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.

c) Compare RTD and thermistor on the basis of:

(i) temperature coefficient

(ii) linearity

(iii) temperature

(iv) range and cost

d) State any two advantages and disadvantages of electromagnetic flow meter.

e) 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.

Marks

5. Attempt any TWO of the following: 12

a) Draw constructional diagram of LVDT. State its working principle. What is residual voltage, explain with neat diagram.

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

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.

6. Attempt any TWO of the following: 12

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

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

c) Compare between:

(i) Ultrasonic and Radar type level measurement (any three points)

(ii) U-tube and well type manometer (any three points)

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:	1. **Active Transducer: -** ---------- **(1 Mark)** • 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. 2. **Passive Transducer: -** ---------- **(1 Mark)** • 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:	(Any four units expected: 1/2 marks each) • The following are units of Pressure 1. Pascals (Pa or N/m2)—N stands for *newton* which is SI unit of pressure 2. Psi - Pounds per square inch (PSI) 3. Bar – 105 Pascals 4. mm Hg-millimeters of Mercury 1mm of Hg = 1 Torr

5. Torr – 133.32 Pa

6. cm H2O – 1 cmH2O = 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)

• 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: (Any Two points expected: 1 marks each)

Advantages of ultrasonic level measurement:

1. Offer no obstruction to the flow
2. o/p is insensitive to variation in viscosity, density and temperature
3. No moving parts
4. Linear relationship between o/p and i/p
5. Used for bidirectional flow
6. Excellent dynamic response
7. Good accuracy +-2%
8. o/p is electrical
9. It is used as non-contact method of flow measurement.

f) State seeback and peltier effect.

Ans: **See beck Effect:-** ---------- **(1 M**

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.

Peltier Effect:- ---------- **(1 Mar**

The Peltier effect is a temperature difference created by applying a voltage between two electrodes connected to a sample of semiconductor material.

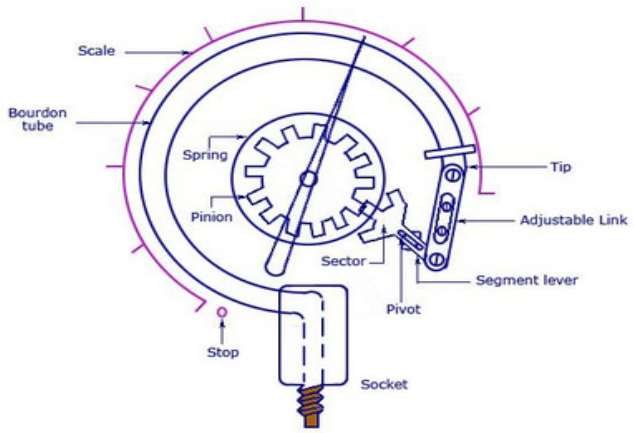
OR

The Peltier effect: Heat is given out or absorbed when an electric current pass across a junction between two materials.

g) What is Pt-100?

Ans: **Pt-100:-** ---------- **(2 Marks)**

A platinum resistance temperature detector (RTD) Pt100 is a device with a typical resistance of 100 Ω at 0°C (it is called Pt100).

	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:	(Any Eight points expected: 1/2 marks each) 1. Operating range 2. Operating principle 3. Sensitivity 4. Accuracy 5. Frequency response and resonant frequency 6. Errors 7. Environmental compatibility 8. Usage and ruggedness. 9. Electrical aspect. 10. Stability and Reliability 11. Loading effect 12. Static characteristics 13. Noise immunity
b)	**Draw constructional details of C-types Bourdon tube and explain its working**
Ans:	**Constructional details of C-types Bourdon tube :** (Figure: 2 Mark & Explanation :2 Mark)  **or equivalent figure** **Explanation:-** 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)

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. The materials used for Bourdon tubes are brass, phosphor bronze, beryllium copper, and steel

c) What is piezo electric effect? Name two piezo electric materials.

Ans: **Piezoelectric Effect: ----------** **(2 Marks**

When pressure or force is applied on piezoelectric crystals such as quartz crystal then an electric charge is generated across that crystal.

OR

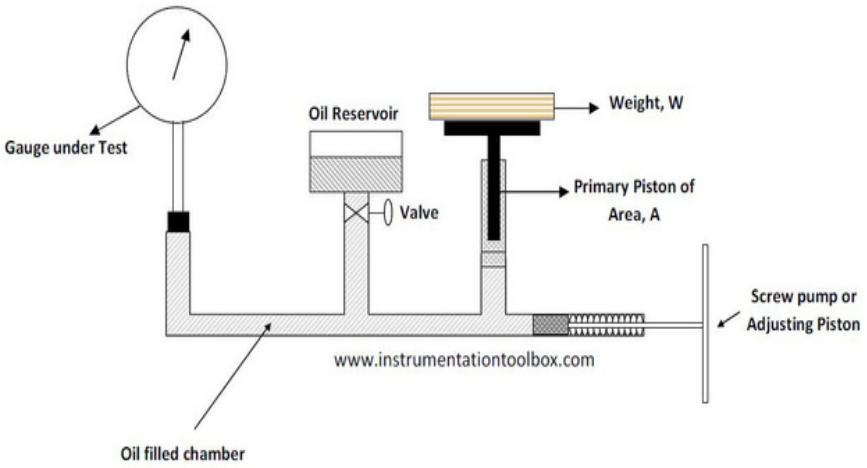
Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress.

Piezoelectric Materials: - **(Any Two Material expected: 1 marks each)**

1. Barium Titanate.
2. Rochelle salts.
3. Quartz crystal.
4. Topaz
5. Tourmaline
6. lead titanate
7. lead zirconate titanate
8. lithium sulphate

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

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



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.

PRESSURE = FORCE/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. Cheap & easy to install. Homemade orifice plate possible
3	cost	Expensive, carefully fabricated, purchase from proper manufacture	High
4	Pressure loss	Low	

b) Draw and explain block diagram of instrumentation system.

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

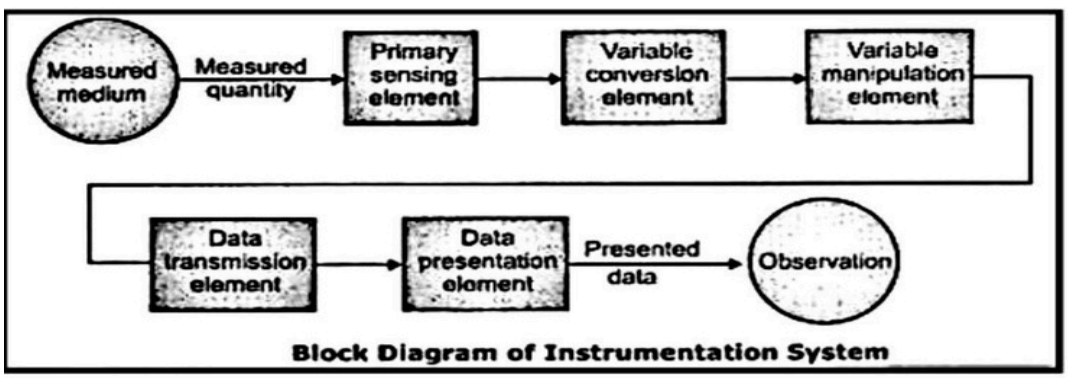
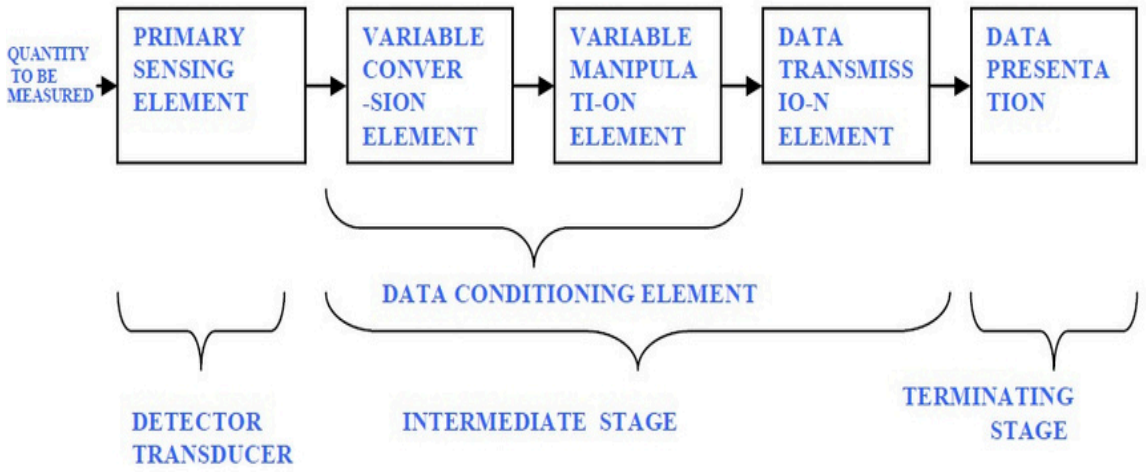


Fig. Block diagram of instrumentation system

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**.**

4. Data Transmission Element:-

- 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

5. Data presentation Element:

- 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

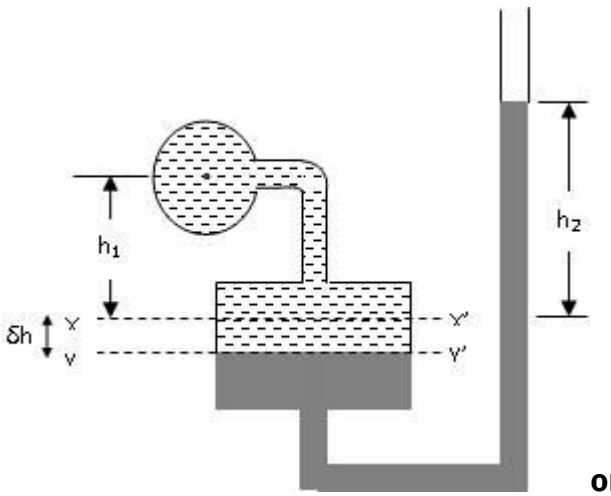
c) Write one example of each type: (i) Active transducer (ii) Primary transducer. (iii) Electrical transducer. (iv) Digital transducer.

Ans: (Each Point: 1 Mark)

(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 taco generator

d) Draw the following and write one application of each: (i) Well type manometer(ii) Bellows.

Ans: (i) Well type manometer: - ---------- **(1 Mark)**



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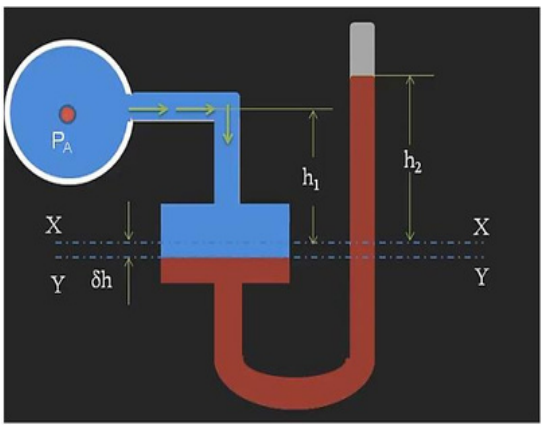


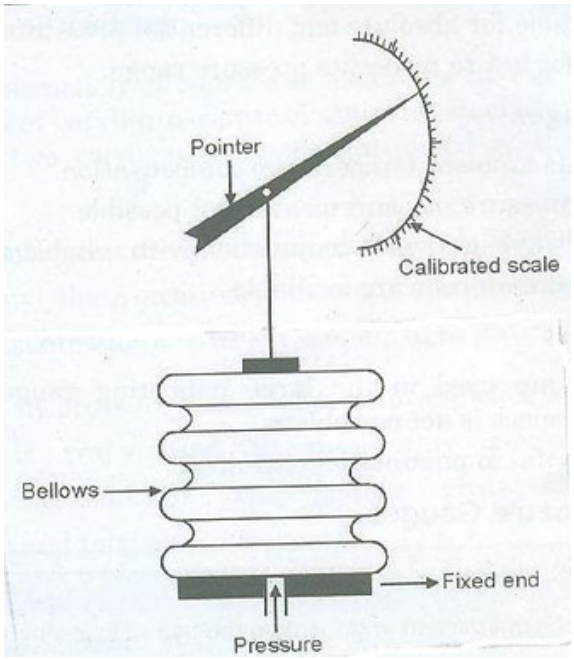
or equivalent figure

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)**



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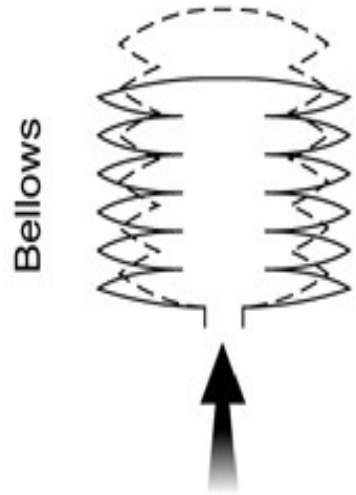


or equivalent figure

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

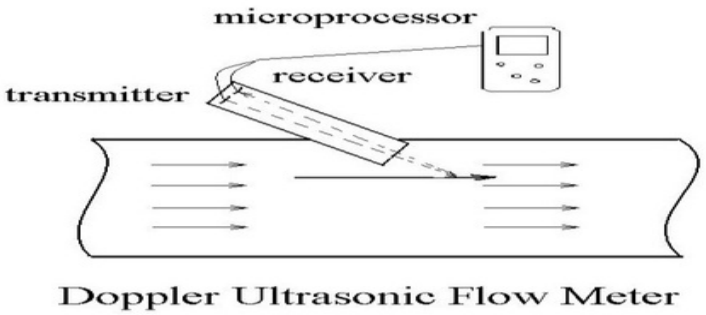
- **Measuring gauge , absolute, atmospheric and differential pressures.**
- **Vacuum measurement.**
- **low pressure gauges are suitable for chemical, petrochemical, plant construction, pneumatic systems and cleanrooms.**

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:

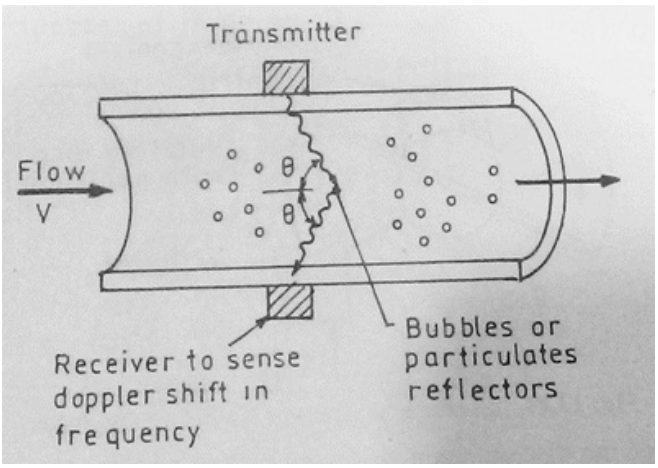
(Figure: 2 Mark & Explanation :2 Mark)

Sketch of Doppler type ultrasonic flow meter



Doppler Ultrasonic Flow Meter

or



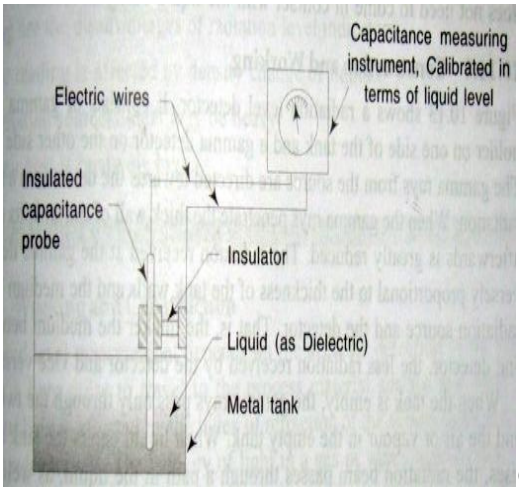
or equivalent figure

- 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 *Doppler Effect*.
- 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 protentional 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: (Figure: 2 Mark & Explanation :2 Mark)



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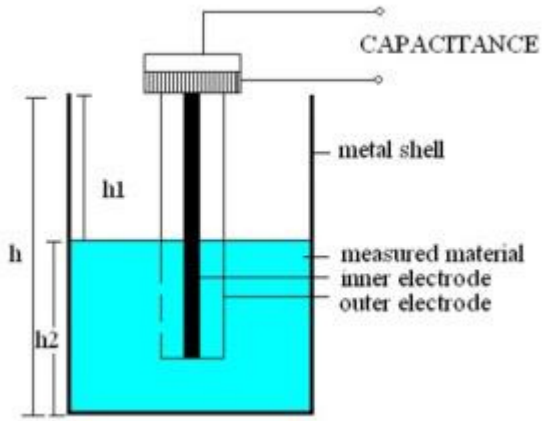


equivalent figure

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

(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 **T**emperature 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: **Advantages of Magnetic Flowmeter: - ----------** **(2 Marks)**

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 flow
7. It can be used as bidirectional meter.

Disadvantage of Magnetic Flowmeter: - ---------- **(2 Marks)**

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) 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.

Ans: (Each Point: 1 Mark)

i. Level control of liquid, powders and fine grained solids within mining:-

Capacitive Transducer, Radar level (microwave) Transducer, laser beam type

ii.**Chemical processing and food industries:-**

Capacitive Transducer, Radar level meter

iii. Tank level monitoring in chemical, water treatment:-

Ultrasonic level transducer, load cell type

iv. **Oil level in transformer: -**

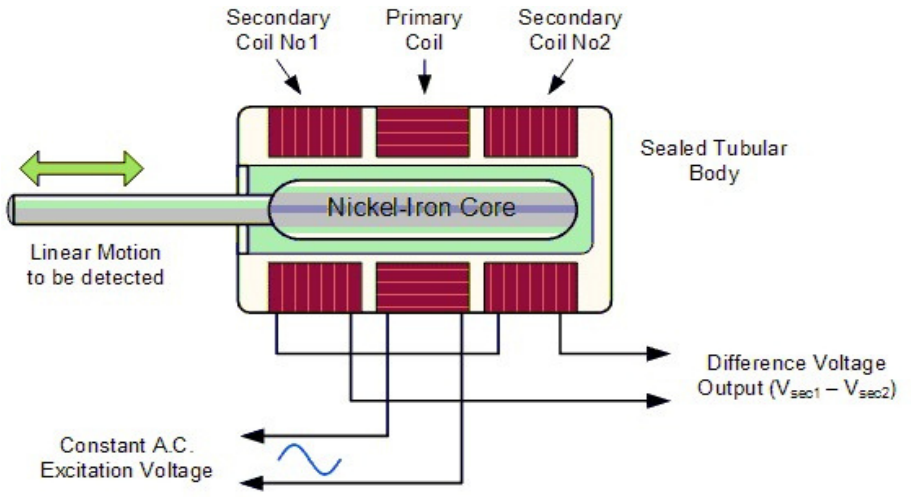
sight Glass , optical sensor (LDR), Float type level transducer

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:

(constructional diagram of LVDT: - 2 Marks)

Diagram of LVDT:



or equivalent figure

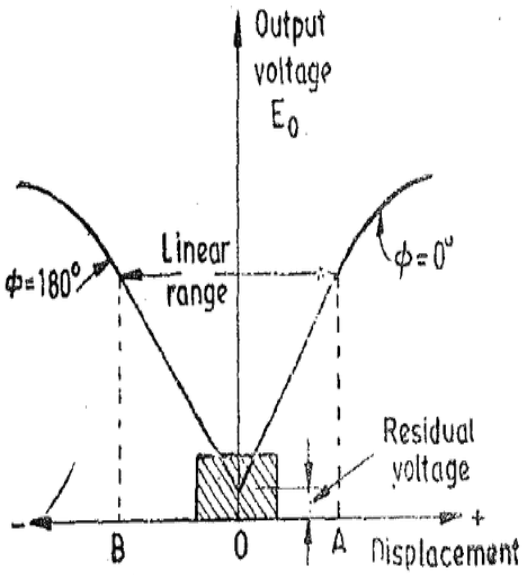
Working:- ---------- (2 Marks)

- 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 (Vo1 & Vo2) are equal but they have opposite polarities. Output voltage Vo 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 Vo1 > Vo2 and the output voltage of LVDT Vo will be positive
- Similarly if the core is displaced toward sec2 then the Vo2 > Vo1 and the output voltage of LVDT Vo 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

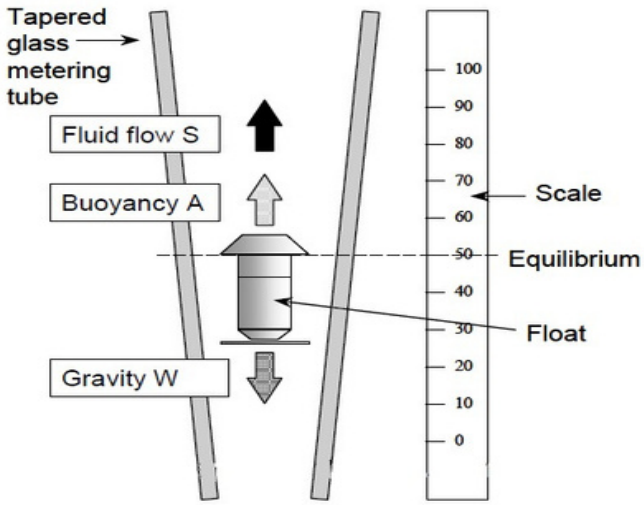
b) Why Rotameter is called variable area flowmeter? Explain the working of rotameter with neat diagram. State its one advantage and one disadvantage.

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	➢ Scaling of inner wall of the pipe so that signal does not reach in proper direction ➢ Scaling causes attenuation and refraction of the signal	➢ Required regular maintenances of meter ➢ Perform calibration
2	➢ In case of doppler type instrument Does not work with pure liquids.	➢ 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)**

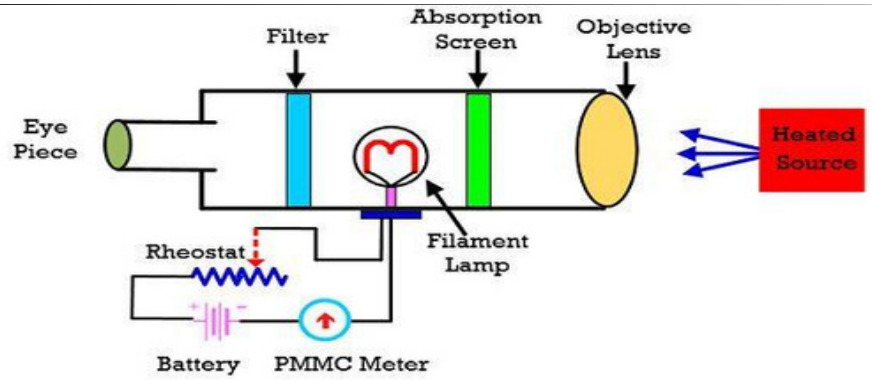
POSSIBLE CAUSES	CORRECTIVE ACTION OR REMEDIES
➢ **Doppler meters will tend to track bubbles over solids** ➢ **Air bubbles will rise faster than the slurry**	➢ Check minimum % of solids (~5%) ➢ Check minimum particle size (~ >100 um) ➢ Perform calibration and check if Accuracy is +/- 5% unless calibrated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



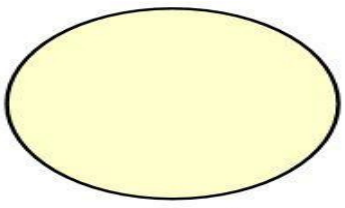
Disappearing Filament Type Optical Pyrometer

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

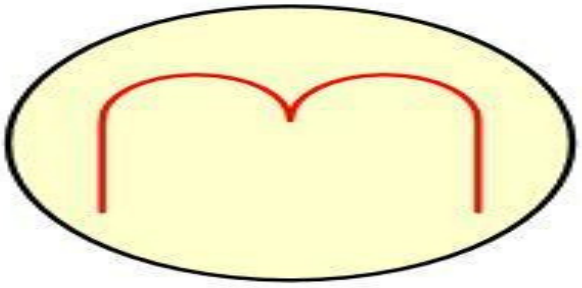
1. Case 1:-Equal brightness
   - The magnitude of the current is adjusted until the brightness of the filament is similar to the brightness of the object.
   - When the brightness of the filament and the brightness of the object are same, then the outline of the filament is completely disappeared.



Equal Brightness

2. Case 2:- Filament looks bright

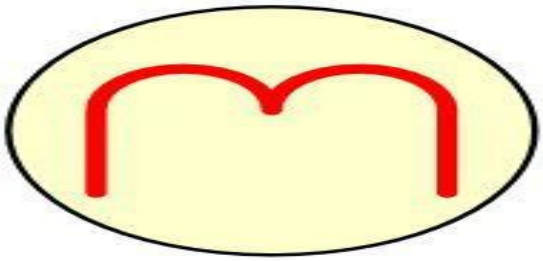
   - The filament looks bright when their temperature is more than the temperature of the source.



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)**

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

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

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

2. Kelvin temperature scale: (˚K) ---------- **(2 Marks)**

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

K=366.483

3. Rankine temperature scale: ---------- **(2 Marks)**

- (˚R) Relation between ˚R & ˚F is given by,

$$^{\circ}R = {}^{\circ}F + 459.69$$

$$^{\circ}R = 200 + 459.69$$

$$^{\circ}R = 659.69$$

OR

- Relation between ˚R & ˚K is given by,

$$^{\circ}R = \left(\frac{9}{5}\right)^{\circ}K$$

$$^{\circ}R = \left(\frac{9}{5}\right)366.483$$

$^{\circ}R = 659.669$

c) Compare between: (i) Ultrasonic and Radar type level measurement (any three points) (ii) U-tube and well type manometer (any three points)

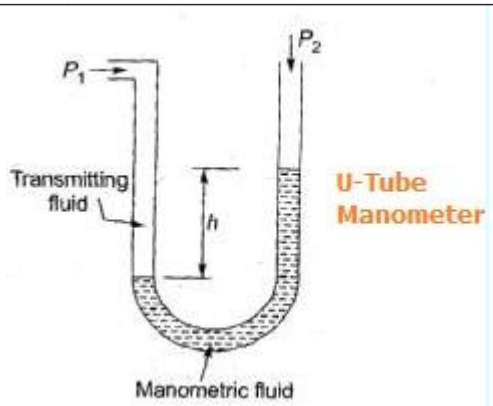
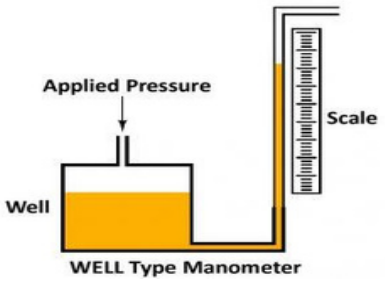
Ans: **(i) Ultrasonic and Radar type level measurement: -**

(Any Three points expected: 1 mark each)

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 ~~Overall performance~~	Effect measurement performance	Not effected
5		Performance is based on strength of reflection or echo received	Performs well independent of process conditions ~~Moderate cost~~
6	Cost	High cost	

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 2	Both leg having same cross section area	Both leg having different cross section area
		
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.

----------END----------

22420

11920
3 Hours / 70 Marks

Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: 10

a) State necessity of instrument calliberation.

b) Give classification of transducer on any two factors

c) List any two specifications of electrical pressure transducer.

d) Define Atmospheric pressure and Absolute pressure.

e) Define laminar flow and turbulent flow.

f) Give classification of level measurement methods.

g) Convert 45°C into Farhenite.

2. Attempt any THREE of the following: 12

a) Draw symbol and characteristic of LDR. Give material used for it.

b) Compare Bellows and diaphragm w.r.to construction, sensitivity, working principle and application.

c) Draw and explain Doppler type flow measurement.

d) Explain calliberation of capacitive type level measurement.

P.T.O.

Marks

3. Attempt any THREE of the following: 12

a) Give one application each of following transducer.

(i) LVDT

(ii) RVDT

(iii) Capacitive

(iv) Piezoelectric

b) Compare U tube manometer and well type manometer on any four points.

c) Compare Nuclear Radiation type and Ultrasonic level measurement.

d) Draw and explain filled system thermometer.

4. Attempt any THREE of the following: 12

a) List any two advantages and two applications of Bellows.

b) State Seeback effect and Petlier effect.

c) List any two advantages and applications of RADAR type level measurement.

d) Name the material used and the sensitivity of following thermocouple type.

(i) J

(ii) K

(iii) R

(iv) S

e) Explain with neat labelled diagram measurement of flow using venturimeter.

Marks

5. Attempt any TWO of the following: 12

a) Draw neat sketch of Rotameter and explain its working principle.

b) Draw optical type pyrometer and list its advantages.

c) State function of strain gauge. Give its types and explain working of any one type of it.

6. Attempt any TWO of the following: 12

a) Draw and explain the construction and working of Dead Weight Tester.

b) List any two direct methods of level measurement. Explain Hydrostatic method of level measurement. Give one advantage and one disadvantage of it.

c) Related to ultrasonic flow meter:

(i) Give any two types of it.

(ii) Write any two specifications.

(iii) Write two advantages over rotameter.

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)	**State necessity of instrument calibration.**	
Ans:	(Any Two points expected: 1 Mark each) **Necessity of instrument calibration: -** ➢ To ensure reading from an instrument are consistent with other measurements. ➢ To determine the accuracy of the instrument reading. ➢ To establish the reliability of the instrument i.e. it can be trusted. ➢ Determining the precision, deviation, and reliability of the measurements, which is important for manufacturers as part of design qualification. ➢ instrument Calibration Keeps Processes Safe ➢ Calibration Maintains Certification ➢ Reduce Costs from Manufacturing Errors	
b)	**Give classification of transducer on any two factors**	
Ans:	(Any Two points expected: 1 Mark each) **The transducers can be classified as: -** 1. Active and passive transducers. 2. Analog and digital transducers.	

3. On the basis of transduction principle used.
4. Primary and secondary transducer
5. Transducers and inverse transducers

c) List any two specifications of electrical pressure transducer.

Ans: (Any Two points expected: 1Mark each)

Specifications of electrical pressure transducer: -

1. Root Sum Squares (RSS)
2. Non-Linearity
3. Hysteresis
4. Non-Repeatability
5. Long-Term Stability
6. Zero Offset
7. Span Offset
8. Thermal Effects
9. Size
10. associated circuit
11. sensitivity
12. self-generated or external power source
13. Miscellaneous

d) Define Atmospheric pressure and Absolute pressure.

Ans: ➢ **Atmospheric pressure (Barometric Pressure):-** ----------(1Mark)

It is defined as pressure exerted by the air surrounding to the earth i.e

$P\_Atmospheric = P\_Absolute - P\_Gauge$

➢ **Absolute pressure** ----------(1M

It is defined as total pressure including atmospheric pressure acting on a surface area

$P\_Absolute = P\_Atmospheric + P\_Gauge$

e) Define laminar flow 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**

I. 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

II. When all the molecules of flow are scattered without fixed position it is called Turbulent flow.

OR

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.

f) Give classification of level measurement methods.

Ans:

Classification of Liquid Level Measurement:

- Direct method ----------(1Ma
  1. Hook type
  2. Sight glass type
  3. Float type
  4. Dip stick
- Indirect method ----------(1Ma
  1. Hydrostatic pressure type
  2. Electrical type:
     a) Capacitance level indicator
     b) Radiation level detector
     c) Ultrasonic level gauge
  3. Radar type

g) Convert 45°C into Farhenite.

Ans: For $45^{o}C$ into °F

$$\frac{°C}{100} = \frac{°F - 32}{180} \text{ ----------(1 Mark)}$$

$$\frac{45}{100} = \frac{°F - 32}{180}$$

$$\frac{45}{100} * 180 = °F - 32$$

$$°F = \left(\frac{45}{100} * 180\right) + 32$$

$$°F = 113$$

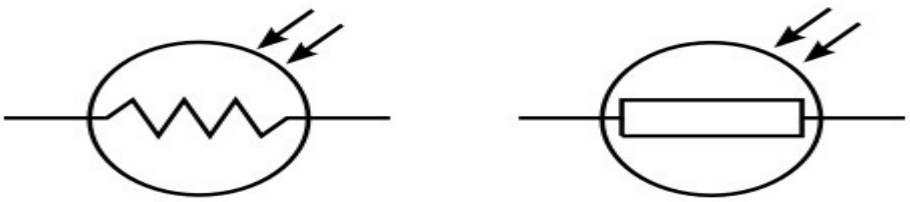
45°C=113°F----------(1 Mark)

Q. 2 Attempt any THREE of the following 12 Marks

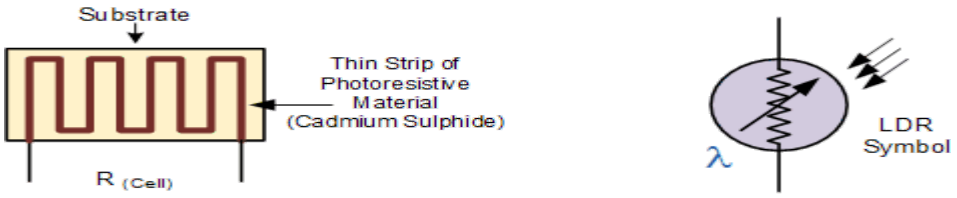
a) Draw symbol and characteristic of LDR. Give material used for it.

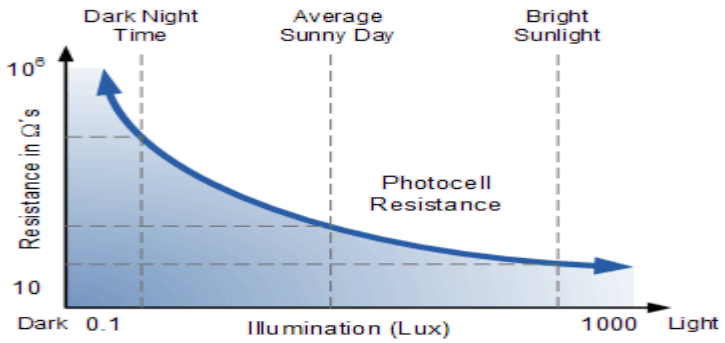
Ans: **(Symbol: - 1 Mark, characteristic: - 2 Marks, Material: -1 Mark)**

Symbol of LDR: -



Characteristic of LDR: -





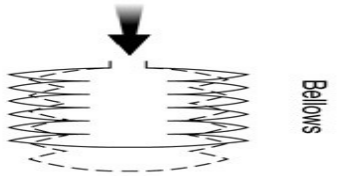
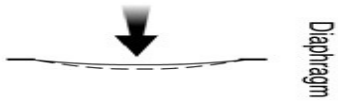
Material used for LDR

1. Light Dependent Resistor (LDR) is made from a piece of exposed semiconductor material such as cadmium sulphide.
2. Materials used as the semiconductor substrate include, lead sulphide (PbS), lead selenide (PbSe), indium antimonide (InSb) which detect light in the

b) Compare Bellows and diaphragm w.r.to construction, sensitivity, working principle and application.

(Each Point: 1 Mark)

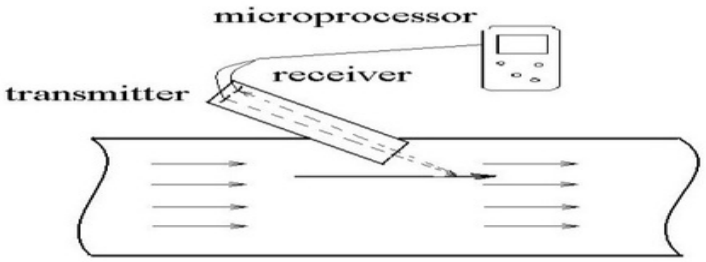
Ans:

Sr. No	Points	Bellows	diaphragm
1.	construction		
2	sensitivity	Less sensitive as compared to diaphragm	More sensitive as compared to diaphragm
3.	working principle	When there is no pressure applied to the bellows there is no any movement of the wall elements, as soon as pressure is applied inside the bellows there is expansion on the wall of bellows.	Change in pressure causes change in the dimension of diaphragm, which is transmitted to the rotary pointer through an mechanical linkage. The pointer gives the reading proportional to applied pressure
4.	Application	I. These are used in the large indicating gauges, recorders where space is not a problem. ii. It is useful in pneumatic controllers. iii. low pressure gauges are suitable for chemical, petrochemical, plant construction, and cleanrooms	I. Diaphragm pressure gauges are used for relative pressure as well as for vacuum, compound and differential pressure applications. II. For corrosive gases and liquids

c) Draw and explain Doppler type flow measurement.

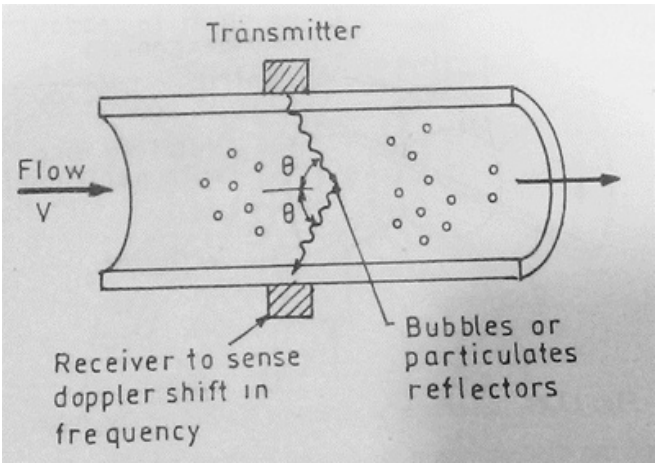
Ans: (Figure: 2 Mark & Explanation :2 Mark)

Doppler type ultrasonic flow meter



Doppler Ultrasonic Flow Meter

or



or equivalent figure

➢ **Explianation:**

- The Doppler Effect Ultrasonic Flow meter use reflected ultrasonic waves to measure the fluid velocity.
- There is a change in ultrasonic frequency (Fc ± Δf) received by the ultrasonic receiver as the ultrasonic wave is travelling through the fluid flowing. This change or shift in the ultrasonic frequency is called as doppler frequency.
- The resulting frequency shift is named the *Doppler Effect*.
- 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 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 their frequency, there will be a frequency shift at the receiver end which is protentional to the velocity

d) Explain calibration of capacitive type level measurement.

Ans: (Explanation: 4 Marks)

➢ **Calibration of capacitance type level transmitter**

1. Remove the level transmitter from the system(tank).
2. check whether transmitter shows zero reading by connecting with multimeter otherwise release the pressure.

➢ ***if the transmitter is smart***

1. connect control circuit to the level transmitter
2. multimeter to ma.
3. Fill the corresponding liquid in correct density and note down the readings. Fill liquid at 25%, 50%, 75% and 100% in both ascending and descending orders and note down the readings.
4. check for errors if there is zero and span adjust should be done.
5. for zero calibration: drain the liquid and check the multimeter if it is not 0 then go to sensor trim option in the HART then go to zero trim and the HART communicator will automatically trim the sensor in to zero
6. For span calibration: fill 100% and wait for some time then go to sensor trim and select span trim in HART communicator the 475 will automatically trim the sensor into 20ma.
7. After doing zero and span trimming again check the reading at 0%,25%,50%,75% and 100%.

➢ ***In case of non-smart capacitance type transmitter***

1. Connect a multimeter and rotate the zero pot and stop when multimeter shows 4ma.
2. Fill the chamber to maximum liquid level and rotate the span screw to 20ma.

	3. Repeat these steps and check all readings
Q.3	**Attempt any THREE of the following** **12 Marks**
a)	**Give one application each of following transducer: (i) LVDT (ii) RVDT (iii) Capacitive (iv) Piezoelectric**

Ans:

(One application each of following transducer: -1 mark)

i) LVDT

- LVDT used to measure force
- LVDT used to measure strain
- LVDT used to measure weight
- LVDT used to measure tension
- LVDT used to measure pressure
- The LVDT can be used for displacement measurement ranging from fraction of mm to few cm.
- Testing of soil strength
- PILL making Machine
- "Brain Probing" medical device
- Robotic Cleaner
- Dollar bill thickness in ATM Machine.
- Hydraulic cylinder Displacement
- temperature transducers,
- valve control,
- servo valve displacement sensing

ii) RVDT

- Hydraulic pump control
- Valve position
- Rotary actuator feedback
- Arm position
- Throttle lever position feedback
- Reeler / Dereeler

- Fuel Valves as well as Hydraulic
- Modern machine tools
- Controls Fuel
- Brake with cable systems
- Engines bleed air-systems
- Robotics

iii) Capacitive

- The capacitive transducers are used to measure humidity in gases.
- It is used to measure volume, liquid level, density etc.
- It is used for measurement of linear and angular displacement.
- Capacitive displacement sensors are used for distance measurement
- Other typical applications are tolerance testing in mass production,
- Vibration measurement,
- Strain measurement,
- Thickness measurement and thickness control of thin metal foils,
- Thickness measurement of plastic foils during production,
- beveling and bending of wafers in semiconductor production and many more.

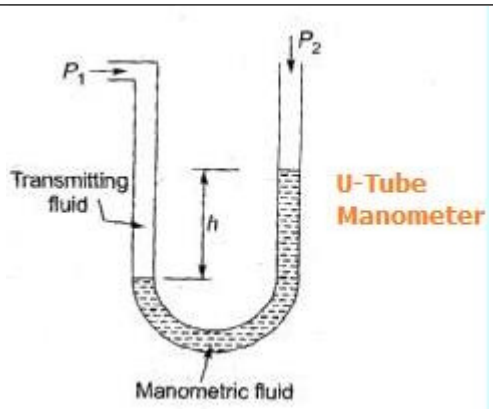
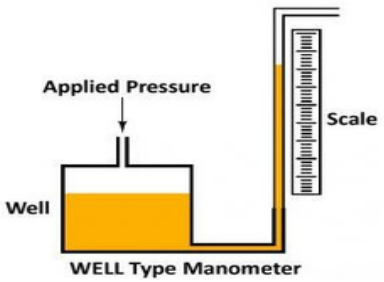
(iv) Piezoelectric

- Piezoelectric transducers are used in high frequency accelerometer.
- Piezoelectric materials are used in industrial cleansing apparatus.
- It is used in under water detection system i.e. SONAR.
- These are used in measurement of surface roughness in accelerometers and vibration picks ups.
- It is used in ultrasonic flow meters, non-destructive test (NDT) equipment's
- Piezoelectric materials are used in ultrasonic transducers.

b) Compare U tube manometer and well type manometer on any four points.

Ans: **U-tube and well type manometer (any three points)**

(Any Four points expected: 1 mark each)

Sr.No.	U-tube manometer	well type manometer
1 2	Both legs are having same cross section area	Both legs are having different cross section area
		
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. ~~Difference in heights in measured.~~	There is negligible change in the level of fluid in well because of large cross section area.
5		Single height is measured.

c) Compare Nuclear Radiation type and Ultrasonic level measurement.

Ans:

(Any Four points expected: 1 mark each)

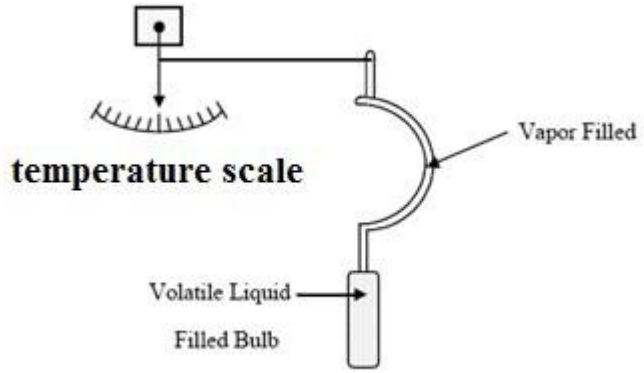
Sr. No	Nuclear Radiation	Ultrasonic level
1.	Can be installed in highly hazardous areas They can measure level in	Cannot be installed in highly hazardous areas Signal will be absorbed by foam, dust, mist,
2.	applications involving mist, foams and intense vapors too Can be used with agitated liquids	humidity
3	High cost of installation	Cannot be used with agitated liquids
. 4		Low cost of installation as compare with nuclear radiation Does not required licensing by a regulatory
5. .	Requires licensing by a regulatory agency	agency

	6.	Radiation safety is very involved	More safety as compare with Nuclear Radiation
	7.	Measurements can be skewed by density	Measurements cannot be skewed by density

d) Draw and explain filled system thermometer.

Ans: (Diagram: 2 Marks & Explanation :2 Marks)

➢ **Filled system thermometer**



or equivalent figure

Explanation:-

- Many physical properties change with temperature, such as the volume of a liquid, the length of a metal rod, the electrical resistance of a wire, the pressure of a gas kept at constant volume, and the volume of a gas kept at constant pressure. Filled-system thermometers use the phenomenon of
- thermal expansion of matter to measure temperature change.

The filled thermal device consists of a primary element that takes the form of

- a reservoir or bulb, a flexible capillary tube, and a hollow Bourdon tube that actuates a signal-transmitting device and/or a local indicating temperature dial. A typical filled-system thermometer is shown in Figure.

In this system, the filling fluid, either liquid or gas, expands as temperature

- increases. This causes the Bourdon tube to uncoil and indicate the temperature

on a calibrated dial.

- The filling or transmitting medium is a vapor, a gas, Liquid like, Mercury, ethyl, alcohol, tolune, xylene or another liquid. The liquid-filled system is the most common because it requires a bulb with the smallest volume or permits a smaller instrument to be used.

- The gas-filled system uses the perfect gas law, which states the following for an ideal gas:

  T = kPV ----------1

  Where T =temperature, K= constant, P= pressure, V= volume

- If the volume of gas in the measuring instrument is kept constant, then the ratio of the gas pressure and temperature is constant, so that

  $$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$ ----------2

- The only restrictions on Equation 1, 2 are that the temperature must be expressed in degrees Kelvin and the pressure must be in absolute units.

- As the temperature changes ,volume of liquid changes by following equation

  V1=V0(1+BT)--------3

  Where V1 is original volume

  V0 is New volume

  B is coefficient of volumetric expansion

T is rise in temperature

Q.4	**Attempt any THREE of the following**	**12 Marks**

a) List any two advantages and two applications of Bellows.

Ans:

Advantages: - ----------(Any Two points expected: 1 mark each)

1. It is used to measure absolute & differential pressure.
2. It is used to measure low or medium pressure rang.
3. Bellow joints do not require access; i.e. They can be direct buried, however a telltale is recommended
4. No maintenance is required.
5. Low cost

Applications: ----------(Any Two points expected: 1 mark each)

1. These are used in the large indicating gauges, recorders where space is not a problem.
2. It is useful in pneumatic controllers.
3. low pressure gauges are suitable for chemical, petrochemical, plant construction, and cleanrooms

b) State Seeback effect and Petlier effect.

Ans:

See back Effect: - ---------- **(2 Mar**

When a pair of dissimilar metals are joined at one end (junction, J1) , and there is a temperature difference between the joined ends and the open ends (junction , J2), thermo-emf is generated, which can be measured in the open ends (J2 or cold junction).

Peltier Effect: - ---------- **(2 Mar**

The Peltier effect is a temperature difference created by applying a voltage between two dis-similar metals connected to a sample of semiconductor material.

OR

The Peltier effect: Heat is given out or absorbed when an electric current pass across a junction between two materials.

c) List any two advantages and applications of RADAR type level measurement.

Ans:

➢ **Advantages: ----------(Any Two points expected: 1 mark each)**

1. This is non-contact technology,
2. High accuracy for measurements in storage tanks and some process vessels.
3. Used on difficult 'hard-to-handle' applications
4. High accuracy
5. Non-contact
6. Can measure level through plastic tanks
7. Used to monitor contents of boxes or other multi-media material
8. Detect obstructions in chutes or presses

➢ **Application ----------(Any Two points expected: 1 mark each)**

1. Non -contact level measurement of liquids and bulk solids
2. Heavy bulk solids with absolute reliability,
3. Radar level transmitters can measure in:
4. Liquids
5. Pastes
6. Powders
7. Bulk solids
8. Ice cream "Premix" mixer
9. Storage tanks for toxic liquids

d) Name the material used and the sensitivity of following thermocouple type: (i) J (ii) K (iii) R (iv) S

Ans:

Material used and the sensitivity of following thermocouple:

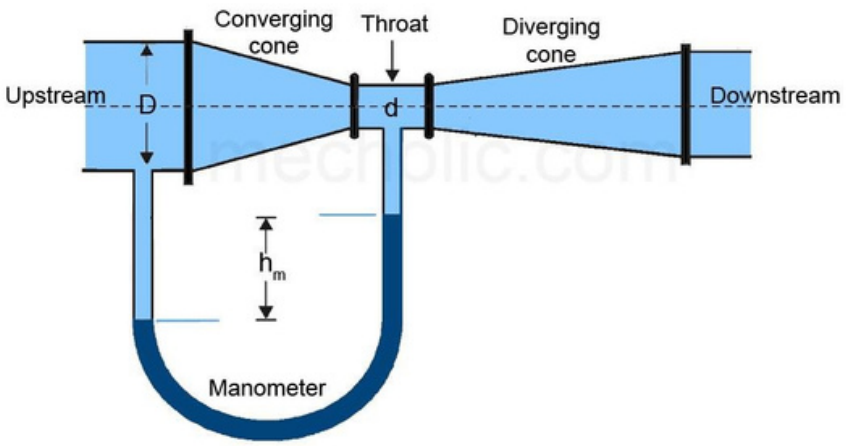
(for each thermocouple Material: - 1/2 mark &
for each thermocouple Sensitivity: -1/2 mark)

Sr No	Thermocouple type	Materials used	Sensitivity µV/0 C
1.	J	Iron/Constantan	45 – 57
2.	K	Chromel/Alumel	40 – 55
3.	R	Platinum/Platinu m 13% Rhodium	5 – 12
4.	S	Platinum/Platinu m 10% Rhodium	5-12

e) Explain with neat labelled diagram measurement of flow using venturi meter.

Ans: (Diagram: 2 Marks & Explanation :2 Marks)

Diagram:



or equivalent figure

Explanation:

It is a primary element of differential pressure Flow meters.

1) It consists of a straight inlet section, a converging conical inlet section, a cylindrical throat and diverging recovery cone.
2) Straight inlet section has same diameter as pipe. In converging conical inlet section, the cross-section of stream decreases & velocity increases.
3) In cylindrical throat, flow velocity will be maximum & static pressure will be minimum.
4) In diverging recovery cone flow velocity decreases
5) The pressure taps are located at straight edge section and at cylindrical throat where pressure is minimum thus the maximum Pressure Gauges across this point.
6) As it has no sharp edges and does not project into fluid stream, it can be used to handle fluids with solid, slurries, etc.
7) The cross-sectional area of fluid does not increase or decreases abruptly, so permanent pressure loss or energy loss is very low as compared to orifice plate.

Q.5 Attempt any TWO of the following 12 Marks

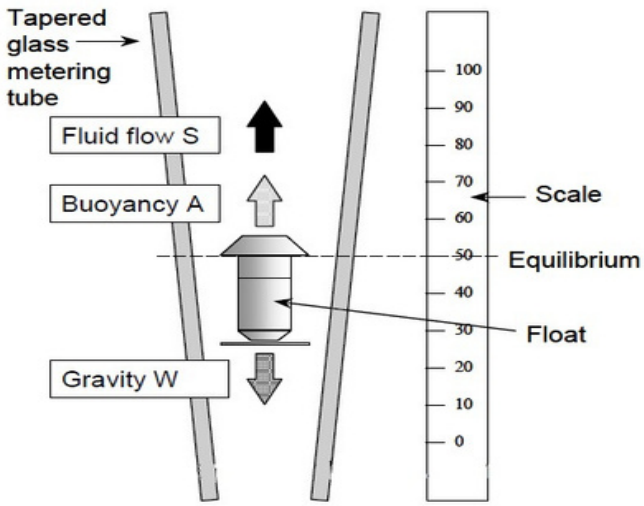
a) Draw neat sketch of Rotameter and explain its working principle.

Ans: (Diagram: 3 Marks & Working :3 Marks)

Rotameter: -

A 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

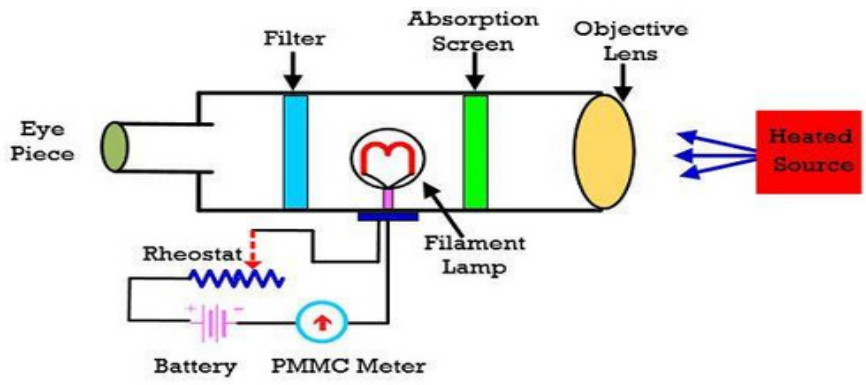
A= Buoyancy effect

- 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

b) Draw optical type pyrometer and list its advantages.

Ans: (Diagram: - 3 Marks, any three advantages expected: 1 Mark each)

- **Diagram of optical pyrometer**



Disappearing Filament Type Optical Pyrometer

or equivalent figure

➢ **Advantages: -**

1) Flexibility

2) Portability

3) Monitor the temperature of moving object

4) Simple assembling of the device enables easy use of it.

5) Provides a very high accuracy with +/-5 degree Celsius.

6) The temperature is measured without contacting the heated body.

7) Fast response.

8) High output signal and moderate cost.

c) State function of strain gauge. Give its types and explain working of any one type of it.

Ans:

(Function: -2 Marks, Types of Strain Gauge: -2 Marks, any one strain Gauge Diagram: - 1 Marks, Explanation: -1Marks)

Function of strain gauge: -

- The strain gauge is a passive, resistive transducer which converts the mechanical elongation and compression into a resistance change.
- This change in resistance takes place due to variation in length and cross-sectional area of the gauge wire, when an external force act on it.

OR

- A Strain gauge is a sensor whose resistance varies with applied force; It converts force, pressure, tension, weight, etc., into a change in electrical resistance which can then be measured

Types of strain gauge: -

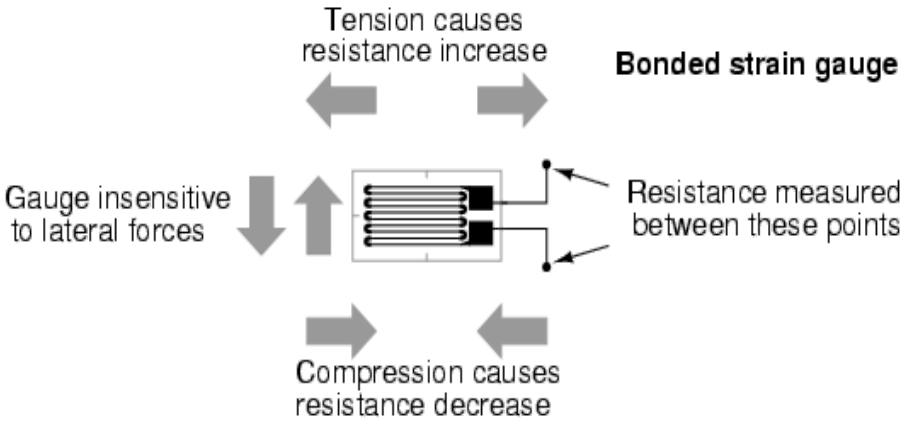
The type of strain gauge are as

- Wire gauge
  1. Bonded strain gauge
  2. Unbonded strain gauge
  3. Foil type strain gauge
- Semiconductor gauge

1. Bonded Resistances wire Strain Gauge

- STRAIN is defined as change in length divided by original length
- This change in resistance takes place due to variation in length and cross-sectional area of the gauge wire, when an external force act on it.
- When a strain produced by a force is applied on the wires, L increase and A decrease.
- Two main parameters are changes
- The change in gauge resistances
- The change in length
- A resistance wire strain gauge consist of a grid of fine resistance wire. The grid is cemented to carrier which may be a thin sheet of paper Bakelite or Teflon.
- The wire is covered on top with a thin sheet of material so as to prevent it from any mechanical damage.

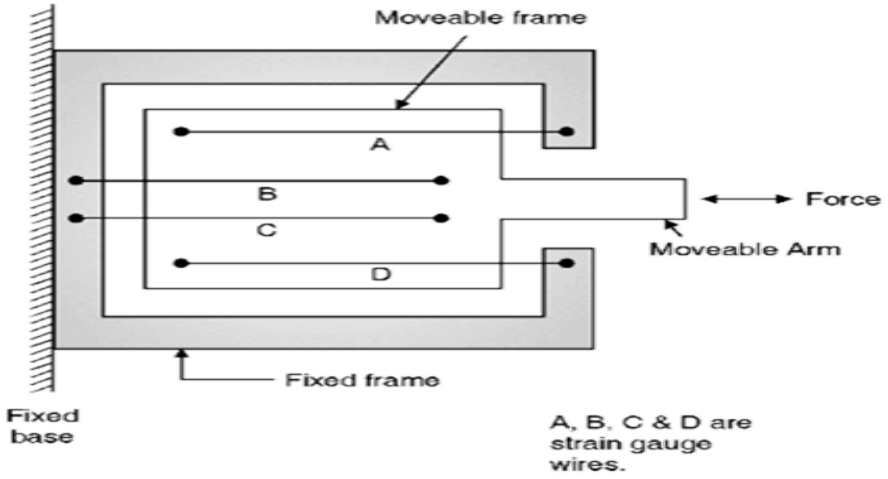
➢ Typical resistances of strain gauges are 120 Ω, 350 Ω and 1000 Ω



or equivalent figure

OR

2. Unbonded strain gauge



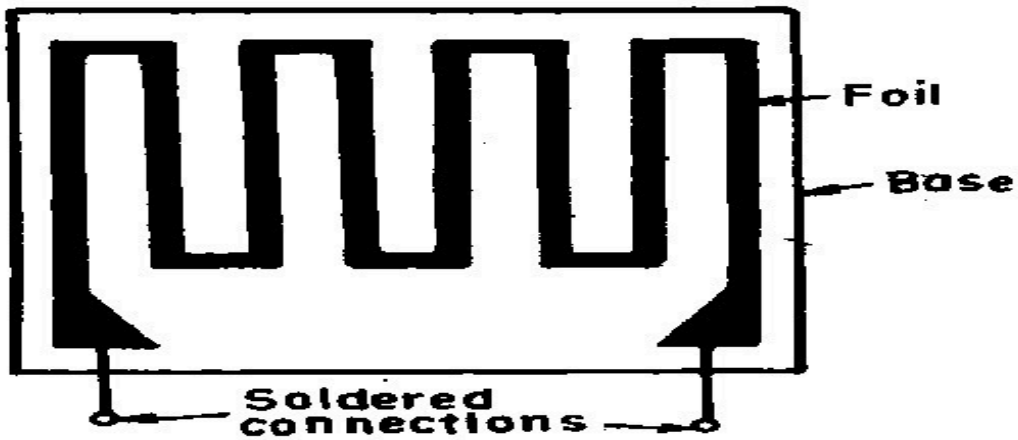
or equivalent figure

- ➢ This gauge consists of a wire stretched between two points in an insulating medium such as air.
- ➢ The wires are of copper nickel, chrome nickel or nickel iron alloys.
- ➢ The wires are tensioned to avoid buckling when they experience a compressive force
- ➢ The diameter of the wire used is about 0.003mm, having gauge factor of 2 to 4
- ➢ The length of wire is 25μm or less
- ➢ The bridge is balanced with no load applied
- ➢ At initial preload, the strain & resistances of four arm are normally equal, therefore the o/p voltage of bridge is zero
- ➢ When an external force is applied, the resistance of the strain gauge changes causing an unbalance of the bridge
- ➢ The unbalances of the bridge producing an o/p voltage

- This voltage is proportional to the strain (applied pressure or force)
- A displacement of 50μm can be detected with this strain gauge

OR

3. Foil type strain gauge(



Bonded metal foil gauge.

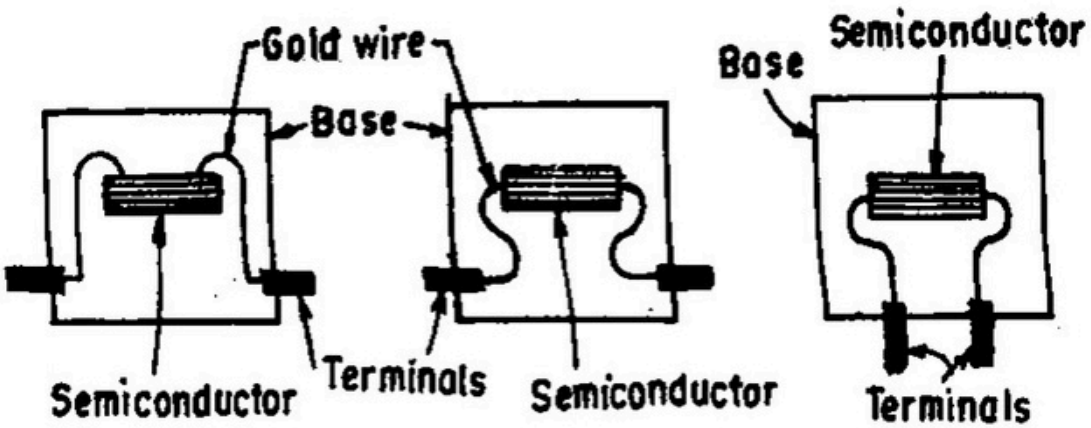
or equivalent figure

- It consists of following parts:

1. Base (carrier) Materials: several types of base material are used to support the wires. Impregnated paper is used for room temp. applications.
2. Leads: The leads should be of such materials which have low and stable resistivity and also a low resistance temperature coefficient
3. This change in resistance takes place due to variation in length and cross-sectional area of the gauge wire, when an external force act on it.
4. This class of strain gauge is only an extension of the bonded metal wire strain gauges.
5. The bonded metal wire strain gauge has been completely superseded by bonded metal foil strain gauges.
6. Metal foil strain gauge use identical material of wire strain gauge
7. These metal foils are used for most general-purpose stress analysis application and for many transducers

OR

4. Semiconductor gauge



Semi-conductor strain gauge.

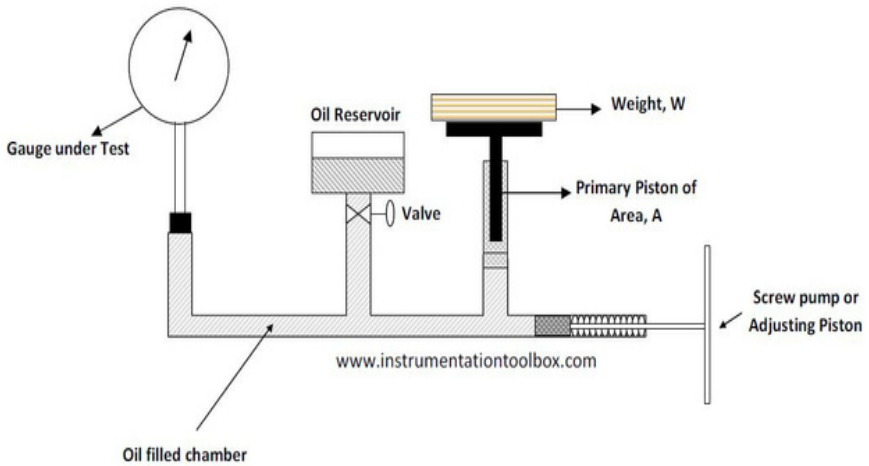
or equivalent figure

1. Semiconductor gauge are used in application where a high gauge factor is desired. A high gauge factor means relatively higher change in resistance that can be measured with good accuracy.
2. The resistance of the semiconductor gauge change as strain is applied to it. The semiconductor gauge depends for their action upon the piezo-resistive effect i.e. change in value of resistance due to change in resistivity.
3. Silicon and germanium are used as resistive material for semiconductor gauges

Q.6 Attempt any TWO of the following 12 Marks

a) Draw and explain the construction and working of Dead Weight Tester.

Ans: (Figure: 2 Mark & C**onstruction: -2 Marks, Working** :2 Marks)



or equivalent figure

Construction:-

Deadweight Tester (DWT) is used for calibration of pressure gauges . 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.

PRESSURE = FORCE/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)

Working:-

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 (Kg) 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.

Calculate the error at each gauge reading and ensure that it is within the acceptable accuracy limits.

b)	**List any two direct methods of level measurement. Explain Hydrostatic method of level measurement. Give one advantage and one disadvantage of it.**
Ans:	**(Direct methods of level measurement: -2 Marks, Diagram: -1 Mark , Explanation: -1Mark, any one advantages expected: 1 Mark, any one disadvantages expected: 1 Mark)**

➢ **Direct methods of level measurement**

Direct methods

1. Hook type
2. Sight glass type
3. Float type
4. Dip stick

➢ **Hydrostatic method of level measurement.**

➢ A liquid in a tank at rest exerts a force on the walls of the tank.

➢ This force in a liquid at rest, is known as "hydrostatic pressure", and is proportional to the depth (or height) of liquid in the tank.

➢ Hydrostatic pressure methods used for liquid level measurement are listed below:

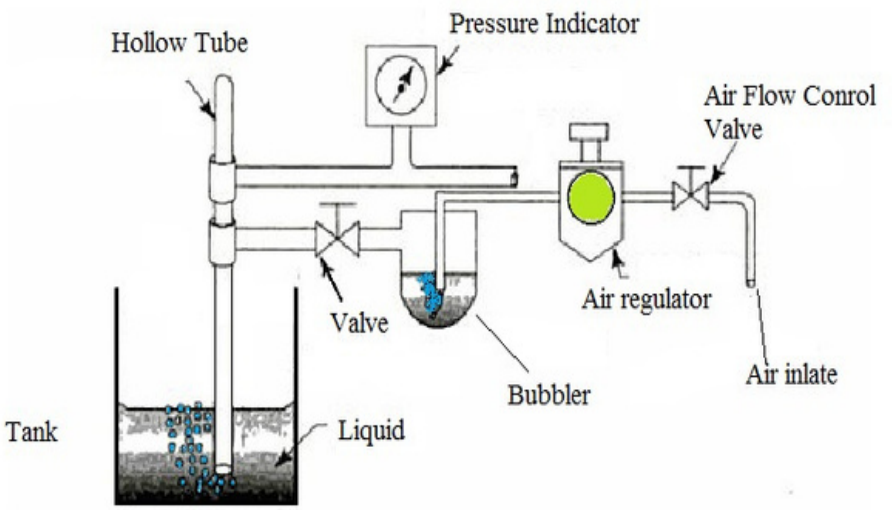
(i) Pressure gauge method

(ii) Air bellows

(iii) Air purge system

(iv) Liquid purge system

Air Purge Method (Bubbler Level Measurement)



or equivalent figure

Explanation: -

- It is consisting of a hollow tube which is inserted in the liquid of the tank.
- Two connection are made with the bubbler tube one to the pressure gauge and another to the regulated air supply, calibrated in terms of liquid level.
- A bubbler is connected in the series with air supply line which simply as a visual check to the flow of the supply of the air.
- A level recorder may be connected with the pressure gauge to keep continues record of liquid level as shown in fig.
- When there is no liquid in the tank or the liquid in the tank is below the bottom end of the bubbler tube and the pressure gauge indicates zero.
- In other words, if there is no back pressure because the air escapes to the atmosphere.
- As the liquid level in the tank increases, the air flow is restricted by the depth of liquid and the air pressure acting against liquid head appears as back pressure to the pressure gauge.
- This back pressure causes the pointer to move on a scale, calibrated in terms of liquid level.
- The full range of head pressure can be registered as level by keeping the air pressure fed to the tube the range of the device is determined by the length of the tube.
- Because air is continuously bubbling from the bottom of the tube, the tank liquid does not enter the bubbler tube and hence the tube is said to be purging
- The common purging fluid is air, but, if air reacts with the tank fluid or is absorbed, different gases are chosen depending on the liquid properties.

Advantage: -

1. The purge gas (compressed air) provides complete isolation from the measured liquid.

2. Minimum Maintenance
3. The instrument panel can be located up to several hundred feet from what is being measured.
4. They are very cost effective.
5. It is most suitable for measuring the corrosive or abrasive liquid.
6. Design and construction are very simple.
7. Pressure gauge can be placed above or below the tank level and can be kept as far away as 50 ft (12.7m) from the tank with the help of piping

➢ **Disadvantage: -**

1. Their calibration gets changed according to variations in product density.
2. Require compressed air.

c) Ans: **Related to ultrasonic flow meter: (i) Give any two types of it. (ii) Write any two specifications. (iii) Write two advantages over rotameter.**

(i) Two types of ultrasonic flow meter: ----------(2 Marks)

➢ Transit time flow meters (time differences)
➢ Doppler type.

(ii) Write any two specifications: - ---(**Any two Specifications expected: 1 Mark** each)

1. Accuracy
2. Linearity
3. Repeatability
4. Weight
5. Mounting Type
6. End Fittings
7. Media Temperature
8. Velocity Flow Rate
9. Gas Volumetric Flow Rate
10. Liquid Volumetric Flow Rate
11. Operating Temperature
12. Operating Pressure
13. Electrical Output

(iii) Advantages over rotameter: ------- **(Any Two advantages expected: 1 Mark** Marks)

1. They have no moving parts.
2. Used for both solid and liquid level measurement.
3. It is a non-disturbance technique.
4. Offer no obstruction to the flow

	5. o/p is insensitive to variation in viscosity, density and temperature 6. Linear relationship between o/p and i/p 7. Used for bidirectional flow 8. Excellent dynamic response 9. Good accuracy +-2% 10. o/p is electrical

----------END----------