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: 1 Mark 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** ----------**(1Mark)** 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----------**(1Mark)** 1. Hook type 2. Sight glass type 3. Float type 4. Dip stick ➢ Indirect method----------**(1Mark)** 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

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

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

$$\frac{45}{100} * 180 = °F - 32$$

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

$$°F = 113$$

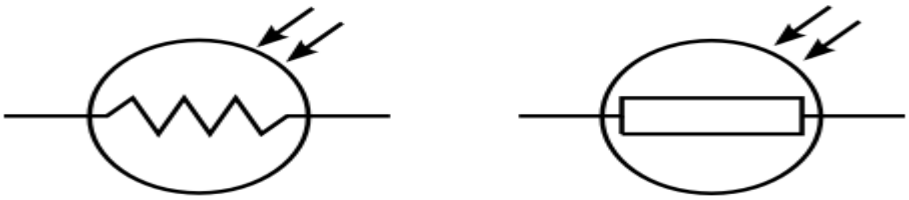
$$45°C = 113°F \text{ ---------- (1 Mark)}$$

Q. 2 Attempt any THREE of the following 12 Marks

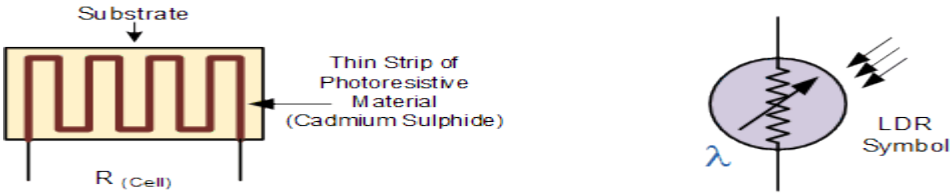
a) Draw symbol and characteristic of LDR. Give material used for it.

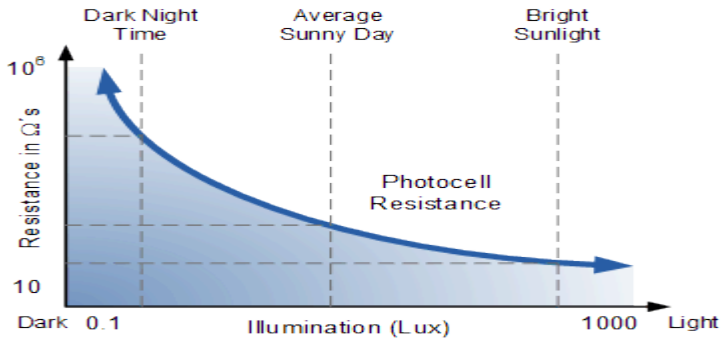
Ans: **(Symbol: - 1 Mark, characteristic: - 2 Marks, Material: -1 Mark)**

Symbol of LDR: -



Characteristic of LDR: -





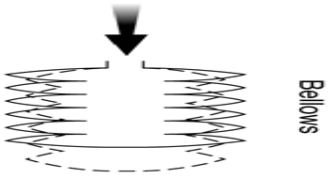
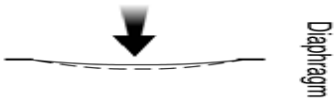
➢ **Material used for LDR**

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.

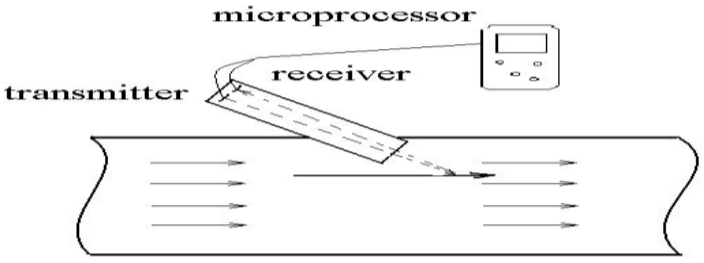
Ans:

(Each Point: 1 Mark)

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 an expansion on the wall of bellows.	Change in pressure causes change in dimension of diaphragm, which is transmitted to the rotary pointer through 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

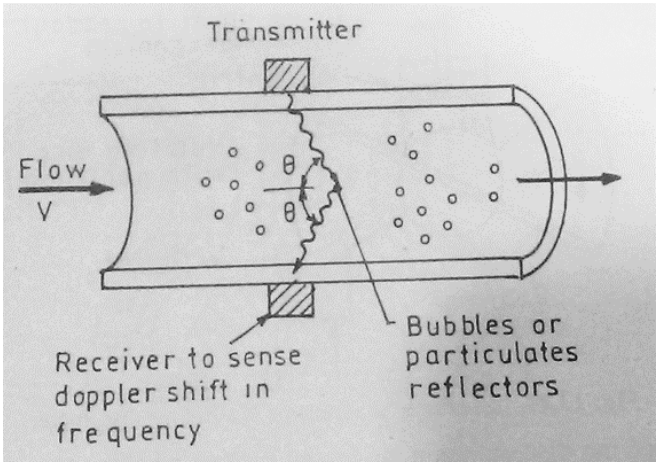
c)	Draw and explain Doppler type flow measurement.
Ans:	(Figure: 2 Mark & Explanation :2 Mark)

Doppler type ultrasonic flow meter



Doppler Ultrasonic Flow Meter

or



or equivalent figure

➢ **Explanation:**

- 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.

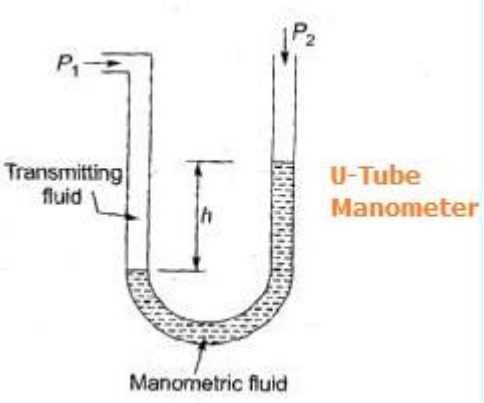
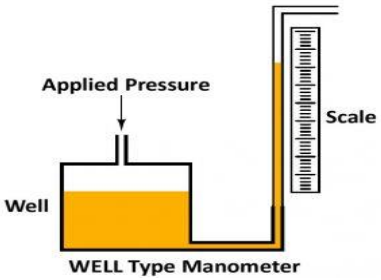
(iv) Piezoelectric

- 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	Both legs are having same cross section area	Both legs are 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.

c) Compare Nuclear Radiation type and Ultrasonic level measurement.

Ans:

(Any Four points expected: 1 mark each)

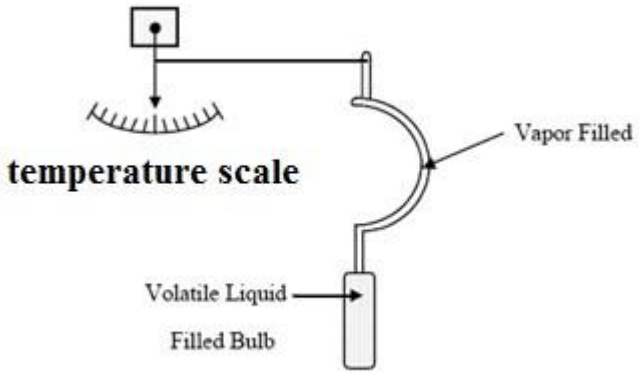
Sr. No	Nuclear Radiation	Ultrasonic level
1.	Can be installed in highly hazardous areas	Cannot be installed in highly hazardous areas
2.	They can measure level in applications involving mist, foams and intense vapors too	Signal will be absorbed by foam, dust, mist, humidity
3.	Can be used with agitated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

$$T = kPV \text{ ----------1}$$

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

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

- 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

$$V1=V0(1+BT)\text{--------3}$$

Where V1 is original volume

V0 is New volume

B is coefficient of volumetric expansion

T is rise in temperature

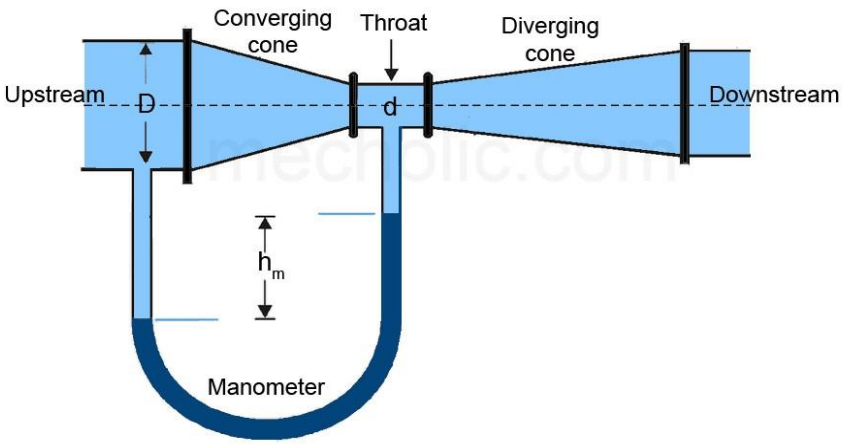
Q.4	**Attempt any THREE of the following**	**12 Marks**
a)	**List any two advantages and two applications of Bellows.**	
Ans:	**Advantages: - ----------(Any Two points expected: 1 mark each)** 1. It is used to measure absolute & differential pressure. 2. It is used to measure low or medium pressure rang. 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 Marks)** 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 Marks)** 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.

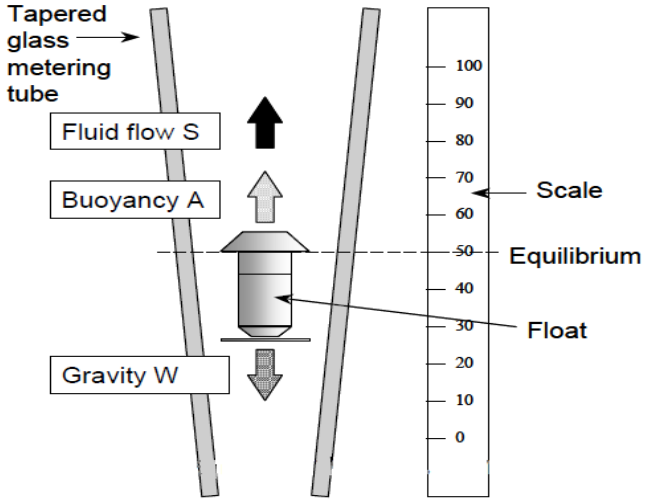
1) It consists of a straight inlet section, a converging conical inlet section, a cylindrical throat and diverging recovery cone.
2) Straight inlet section has same diameter as pipe. In converging conical inlet section, the cross-section of stream decreases & velocity increases.
3) In cylindrical throat, 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

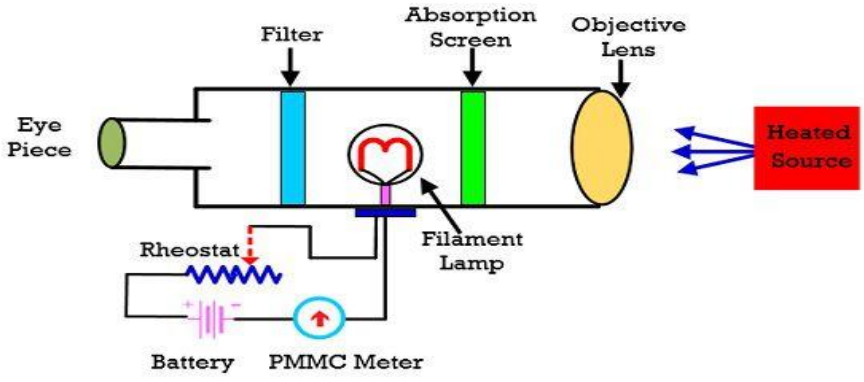
A= Buoyancy effect

- 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

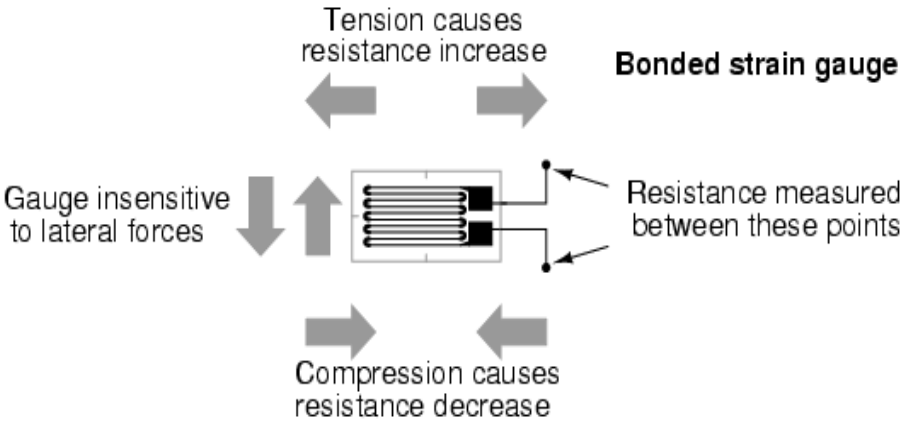
or equivalent figure

- **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.

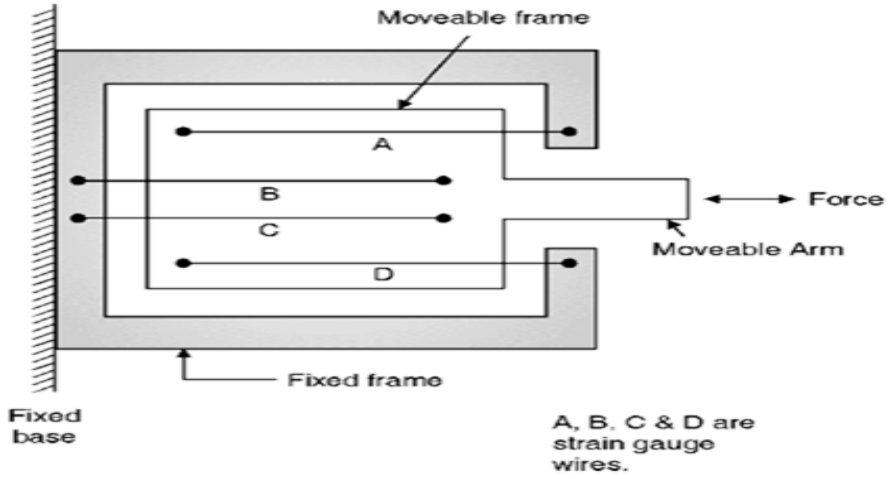
- Typical resistances of strain gauges are 120 Ω, 350 Ω and 1000 Ω



or equivalent figure

OR

2. Unbonded strain gauge



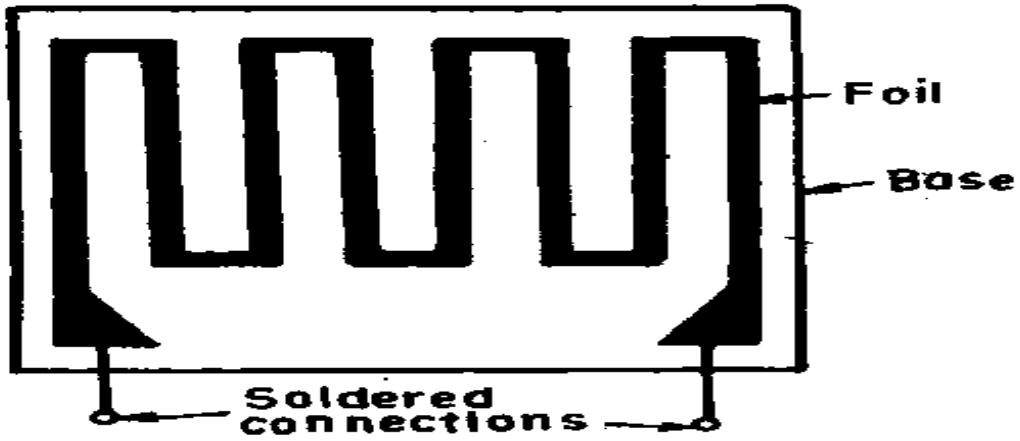
or equivalent figure

- 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.

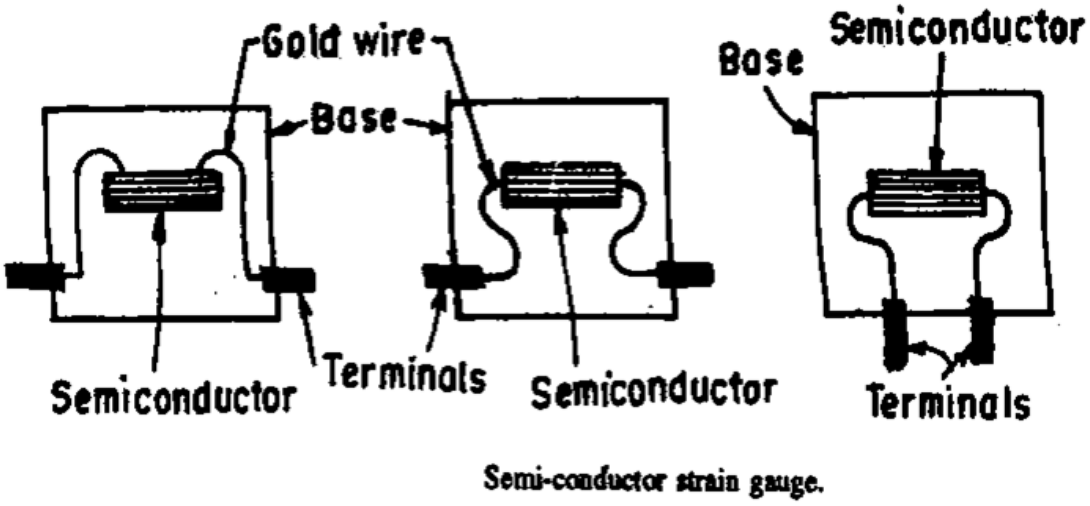
or equivalent figure

- 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



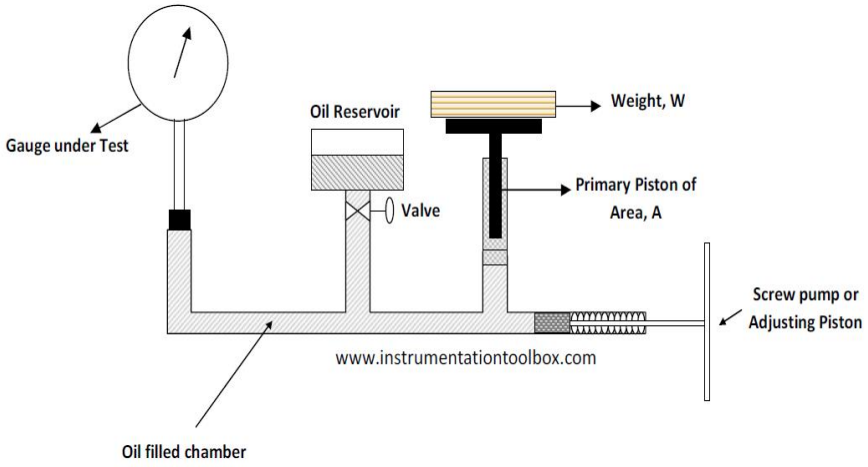
Semi-conductor strain gauge.

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 & Construction: -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) ∝ 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:

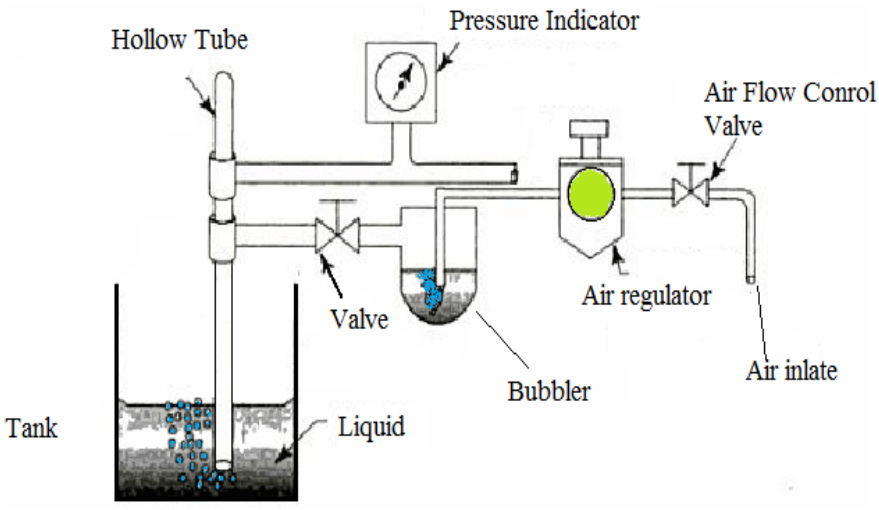
  (i) Pressure gauge method

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

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