MODEL ANSWER

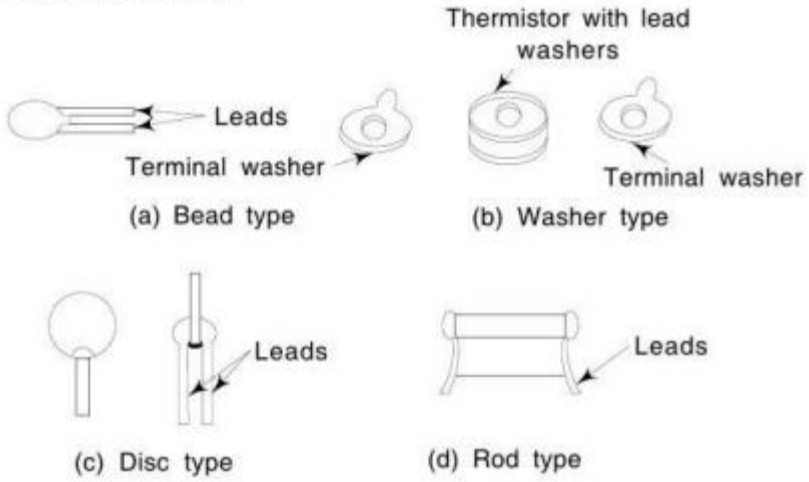
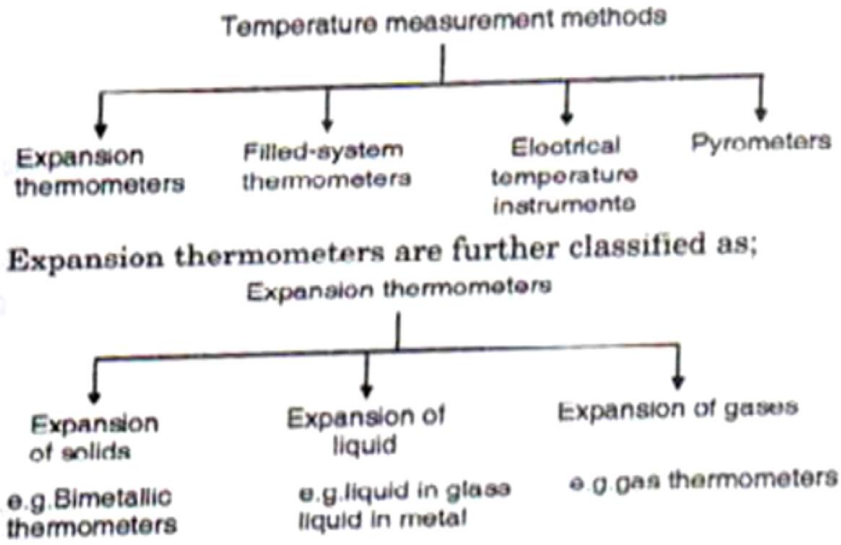
WINTER– 17 EXAMINATION

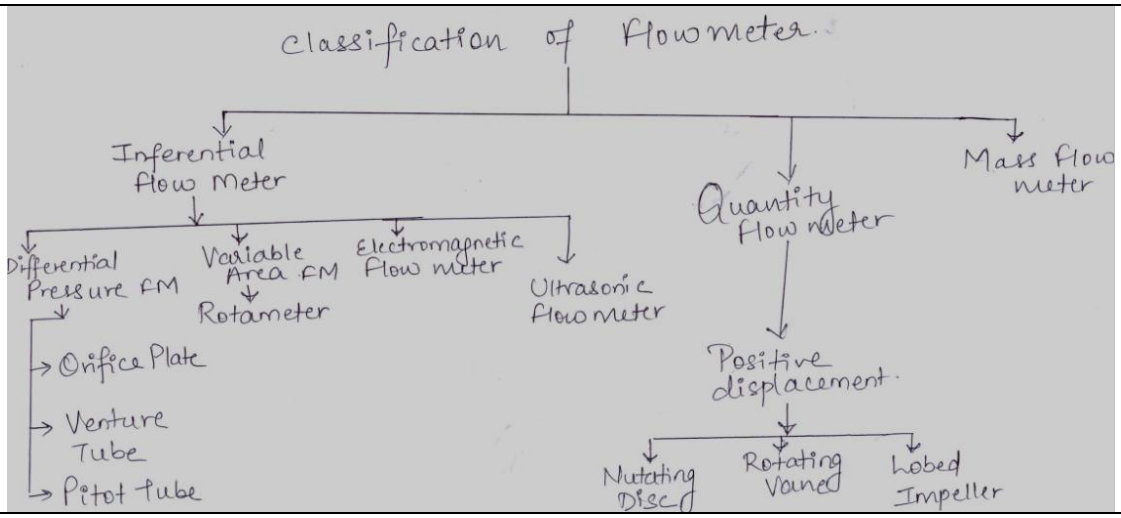
Subject Title: Industrial Measurements Subject Code: 17434

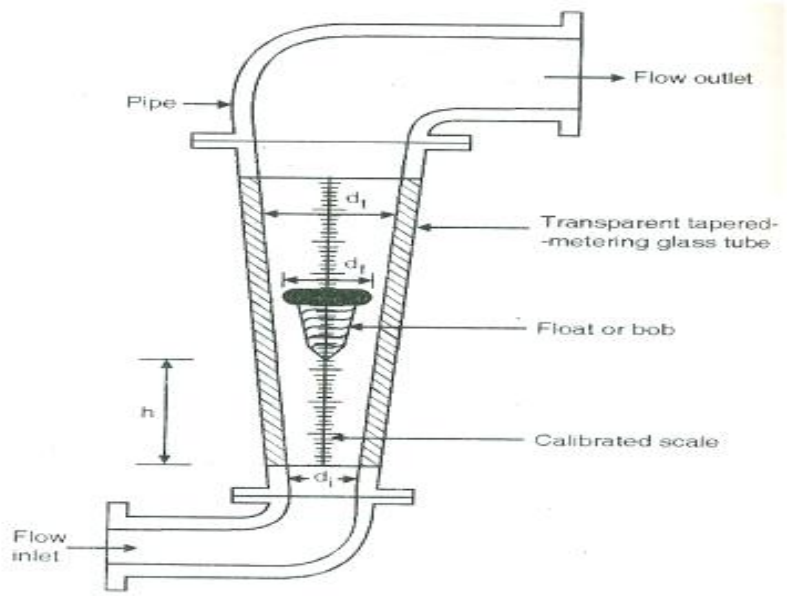
Important Instructions to examiners:

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 principal components indicated in the 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 of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	**(A)**	**Attempt any SIX-**	**12-Total Marks**
	(a)	**List the four different units of pressure.**	**2M**
	Ans:	**Different units of pressure.** **1)** Measured in pascal(Pa). **2)** Measured in pounds per square inch(psi) **3)** Measured in kilogram per square of centimeter (Kg/cm2). **4)** Measured in newton per square meter (N/m2). **5)** Measured in terms of liquid columns. mmHg or mmWc	**½ M each** **Any 4**
	(b)	**List any two piezoelectric materials.**	**2M**
	Ans:	1) Natural Crystals- Quartz crystal, Rochelle salt 2) Synthetic Crystal-Barium Titanium	**1M each**
	(c)	**Draw the different shapes of thermistors.**	**2M**

	Ans:	**Types of thermistors:**  	**1M each**
	(d)	**Define laminar and turbulent flow.**	**2M**
	Ans:	• Laminar Flow: When all the molecules of flow are parallel to each other, it is called laminar flow. • Turbulent flow: When the flow molecules are scattered without any fixed pattern, it is called Turbulent Flow.	**1M each**
	(e)	**Define humidity. State its units.**	**2M**
	Ans:	Humidity: Amount of water vapour present in the atmosphere. Units: 1) gm/ml3 2) grams of water vapour per cubic meter volume of air.	**1M- Definition** **1M- Units**
	(f)	**Classify the temperature measuring transducers.**	**2M**
	Ans:	 	**2M**

		OR **1.Expansion thermometers**: • Bimetallic thermometers • Bimetal Helix Thermometer • Spiral Bimetallic thermometers **2. Filled system thermometers**: • Liquid filled thermometers • Gas filled thermometers • Vapour pressure thermometers **3. Electrical Temperature Instruments:** • RTD • Thermistors • Thermocouples **4. Pyrometers:** • Radiation Pyrometers • Infrared Pyrometers • Optical Pyrometers	**½ M each**
	(g)	**State classification of flow meters.**	**2M**
	Ans:		**2M**
	(h)	**State two advantages of electrical transducers.**	**2M**
	Ans:	**Advantages of electrical transducers-(Any Two)** **1)** The electrical systems can be controlled with a very small level of power. **2)** The electrical output can be easily used, transmitted and processed for the process of measurement. **3)** The output can be indicated and recorded remotely from the sensing element. **4)** Friction effect is minimized.	**1M each (Any other relevant answer)**

	B)	**Attempt any TWO:**	**8M**
	a)	**With the help of neat sketch, state working principle of rotameter.**	**4M**
	Ans:	**Diagram-** 	**2M**
		Explanation- • When there is no flow through the Rota meter, the float rest at the bottom of metering tube. • When fluid enters the tube, the float moves up and the flow area increases. The float moves up until the lifting force produce by flow and gravitational force acting on the float becomes equilibrium. • Thus, the differential pressure and lifting force increase with rise in flow rate. • A calibrated scale is printed on the tube. With the help of float position and calibrated scale, we can measure the flow rate.	**2M**
	b)	**Describe how calibration of pressure gauges is done by using dead weight tester.**	**4M**
		Diagram-	**2M**

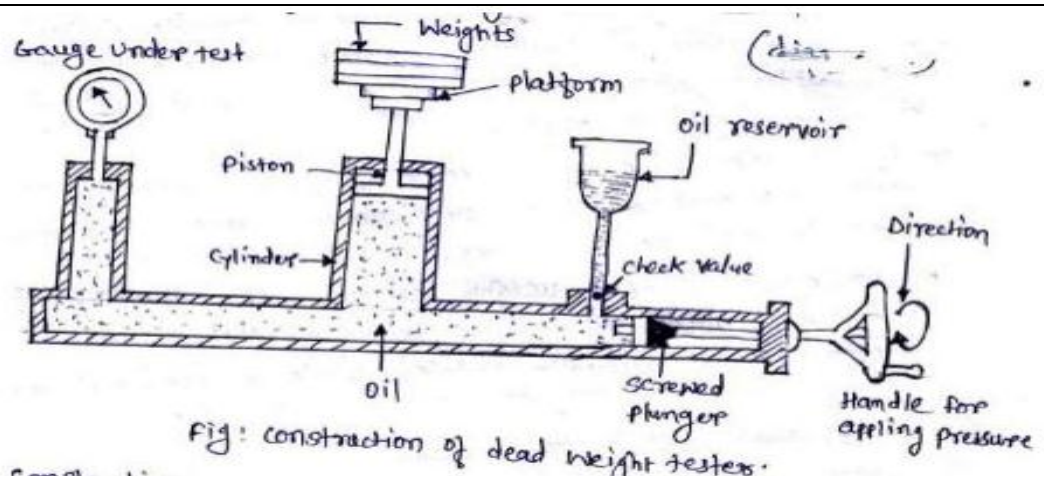


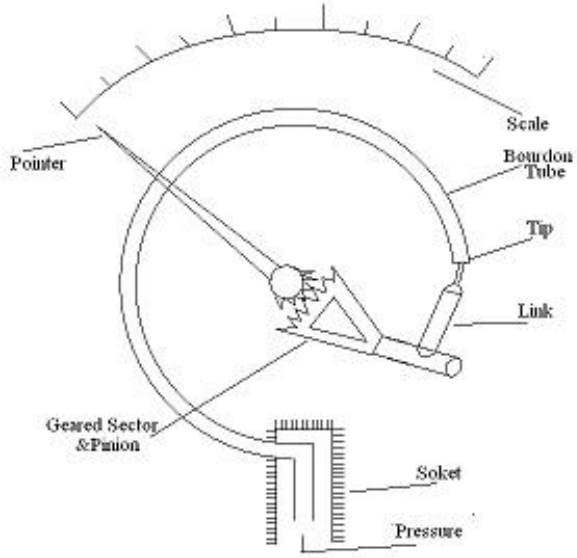
Fig: Construction of dead weight testers.

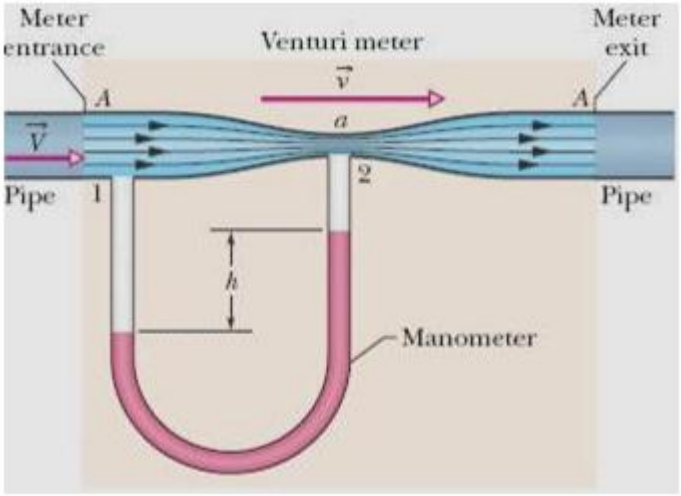
2M

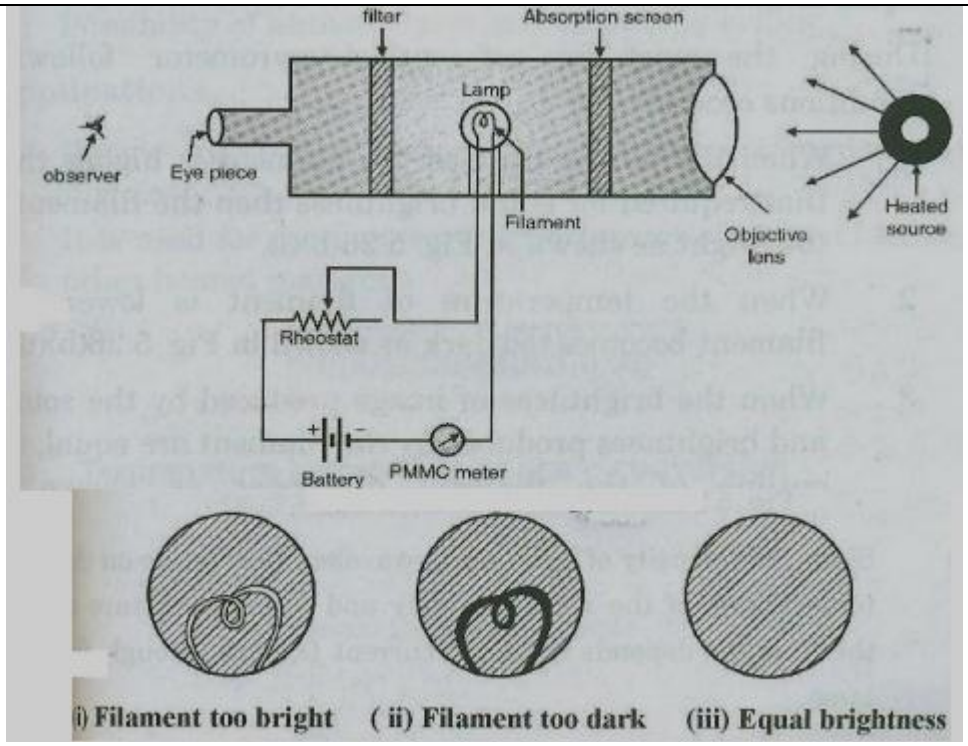
Explanation-

- The handle is fully drawn out and the oil is allowed to enter in the cylinder (i.e. gauge and piston).
- A known accurate weight is placed on the platform. The area of piston is also known; hence we can calculate the pressure. Now the handle is turn to press in clockwise direction so that the pressure will buildup on the gauge side as well as platform side.
- Increase the pressure by rotating the handle clockwise until enough pressure is developed inside the cylinder and lifts the platform with weights placed on it and it floats freely within the limit stops.
- Repeat the same procedure for different weights. In the same way most of the pressure gauge are calibrated against dead weight testers.
- An error in dead weight tester is less than 0.1% in order to reduce the friction between the piston and cylinder, the piston is gradually rotated while a reading being taken.

	c)	**What is need of level measurement? Give classification of level measurement methods with two examples of each.**	**4M**
	Ans:	In almost all industries, vast quantities of liquid such as water solvents, chemicals etc. are used in number of processes. It is widely employed to monitor as well as measure quantitatively the liquid content in the tanks, containers and vessels et . Liquid level affects both pressure and rate of flow in and out of the container and therefore its measurement becomes important in a variety of processes encountered in modern manufacturing plants.	**1M- Need**
		Classification of Liquid Level Measurement: **Direct method** 1. Hook type 2. Sight glass type 3. Float type 4. Dip stick **Indirect method** 1. Hydrostatic pressure type 2. Electrical type:	**3M**

		a) Capacitance level indicator b) Radiation level detector c) Ultrasonic level gauge 3. Radar type	
Q 2		**Attempt any FOUR:**	**16M**
	(a)	**State working principle of 'C' type bourdon tube with neat diagram.**	**4M**
	Ans:	**Diagram-**  **C type bourdon tube** **Explanation-** • C type bourdon tube is made up of an elliptically flattened tube bent in such a way as to produce the C shape as shown in the fig. One end free end of this tube is closed or sealed and the other end (fixed end) opened for the pressure to enter. The free end connected to the pointer with the help of geared sector and pinion. Calibrated scale and pointer is provided to indicate the pressure. • The cross section view of C type bourdon tube under normal condition and pressurized condition is as shown in figure. • The pressure which is to be measured is applied to the bourdon tube through open end. When this pressure enters the tube, the tube tends to straighten out proportional to applied pressure. • This causes the movement of the free end and the displacement of this end is given to the pointer through mechanical linkage i.e. geared sector and pinion • The pointer moves on the calibrated scale in terms of pressure. The relationship between the displacement of the free end and the applied pressure is nonlinear.	**2M** **2M**
	(b)	**Describe working of venture meter with neat sketch.**	**4M**

	Ans:	**Diagram-**  **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 taps are located at. 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 have no sharp edges or warner 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. 8) Venture tube are usually made up of cast iron or steel and built up in several forms such as. a) Long from or classic venture tube. b) Short from where outlet cone is shortened. c) Eccentric from to minimize the buildup of heavy materials. d) Rectangular from which is used in air-duct work.	**2M** **2M**
	(c)	**Describe working principle of optical pyrometer with neat diagram.**	**4M**
	Ans:	**Diagram-**	**2M**



Explanation-

The working principle of optical pyrometer state that the brightness of light of a given color emitted by a hot source, gives an indication of temperature.

Working:

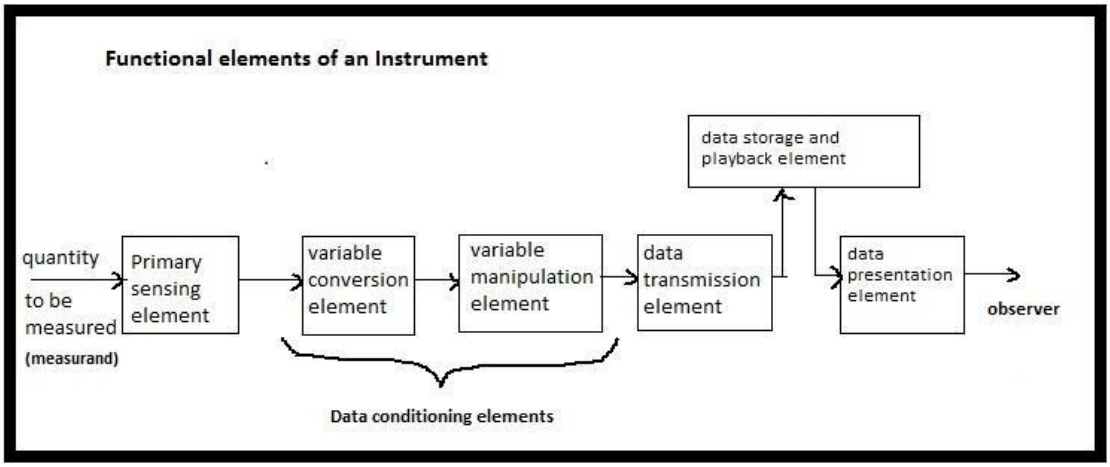
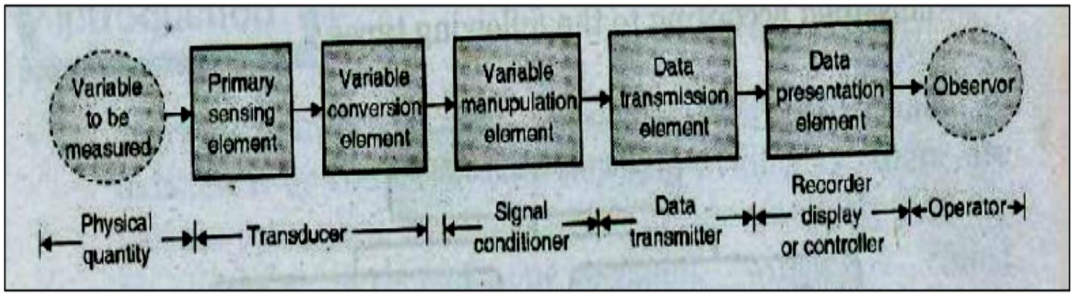
- It consists of a tube, one end of this tube has objective lens and other end has a sighting eye piece to observe the filament.
- The filament is viewed through filter and eye piece. The lens side of tube is projected towards the hot body whose temperature is to be measured.
- An image of radiating source is produced by a lens and made to coincide with the filament of an electric lamp.
- The current through the lamp filament is made variable so that lamp intensity can be adjusted.
- The current through filament is adjusted until the filament and the image are of equal brightness.
- During the operation of optical pyrometer following conditions occurs.

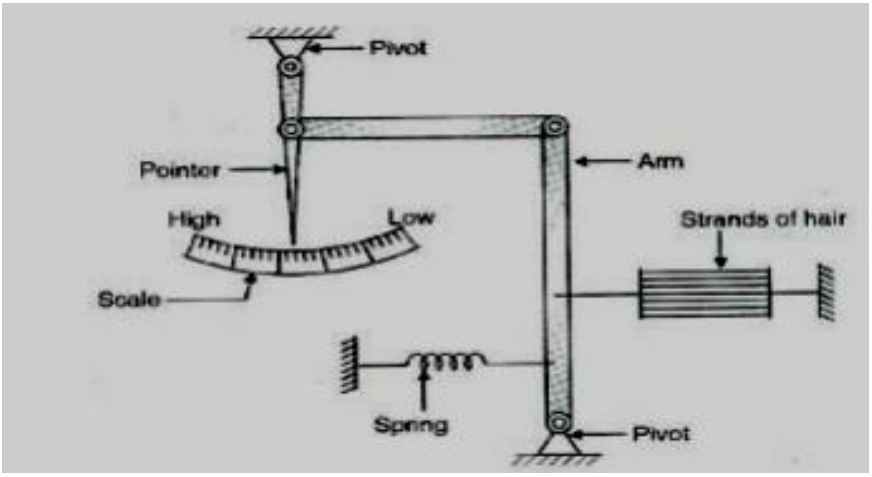
1. When the temperature of the filament is higher than that required for equal brightness then the filament is too bright as shown in the figure.

2. When the temperature of filament is lower, the filament becomes too dark as shown in figure. When the brightness of image produced by the source and brightness produced by the filament are equal, the outline of the filament disappear.

2M

	(d)	**Write two advantages and applications of ultrasonic level measurement.**	**4M**
	Ans:	**Advantages of Ultrasonic Method of Level Measurements:** 1) Ultrasonic gauge needs to physical contact with the liquid.	**2M**

		2) It is a non-disturbance technique. 3) Used for both solid and liquid level measurement. 4) They have no moving parts. **Applications of Ultrasonic Method of Level Measurements:** 1) Ultrasonic level measuring device is used for both continuous and point measurement. 2) The point measuring ultrasonic detectors are used for measurement of gas/liquid, liquid/liquid or gas/solid interface. 3) It is used for level measurement of hazardous liquids and solids.	**2M**
	(e)	**Draw block diagram of instrumentation system. Explain function of each block.**	**4M**
	Ans:	**Diagram-**  **OR**  **Explanation-** **Functions of each block:** **1) Primary sensing element:** This first receives energy from the measured medium and produces an output depending on measured quantity. **2) Variable conversion element:** Converts the output signal of the primary sensing element into a more suitable variable or condition useful to the function of the instrument. **3) Variable manipulation element:** Manipulates the signal represented by some	**2M** **2M**

		physical variable, to perform the intended task of an instrument. In the manipulation process, the physical nature of the variable is preserved. **4) A data transmission unit:** Transmits the data from one element to the other. **5) A data presentation element:** Performs the translation function, such as the simple indication of a pointer moving a scale or the recording of a pen moving over chart.	
	(f)	**Describe how humidity is measured by using hair type hygrometer.**	**4M**
	Ans:	**Diagram-**  **Explanation:** • It consists of bunch of human hair which increases mechanical strength of the instrument, arm with pivot joints and points scale assembly. • The element is maintained at slight tension by a spring. The hair strands are generally arranged parallel to each other with sufficient space between them for giving free access to the air sample whose humidity is to be measured. • The indicator scale is directly calibrated to give a direct indication of humidity. The pointer or recording pen is operated through mechanical linkage. • As the relative humidity surrounding to that of hygrometer increases, length of hair strands increases, which move the pointer on the calibrated scale for maximum value.	**2M** **2M**
Q. 3		**Attempt any FOUR:**	**16M**
	a)	**Give two examples of each of the following:** **(i) Active transducer(ii) Digital transducer** **(iii) Analog transducer(iv) Electrical transducer**	**4M**
	Ans:	**i)Active Transducer** -1)Piezo electric transducer 2) Thermocouple 3)Rotary encoder **[any two 1M]** **ii) Digital Transducer**-1)Optical encoder,2)Digital temperature sensor 3)digital accelerometer**[any other transduce]** **iii) Analog Transducer**: 1)LVDT 2) thermister 3)thermocouple 4) RTD **[Any two 1M, any other can be given mark]** **iv) Electrical Transducer:**1) resistive 2) capacitive 3)inductive**[Any two 1 M, any other can be given mark]**	**1M each for any two examples**

	b)	**List different elastic pressure transducers and draw constructional details of anyone.**	**4M**
	Ans:	The commonly used elastic pressure transducers are : 1)Bourdon Tube: 1)C-Type 2)Spiral 3)Twisted 4)Helical 2)Bellows 3)Diaphragms 4) Capsule	**1M for list And 3M for any constructional detail**

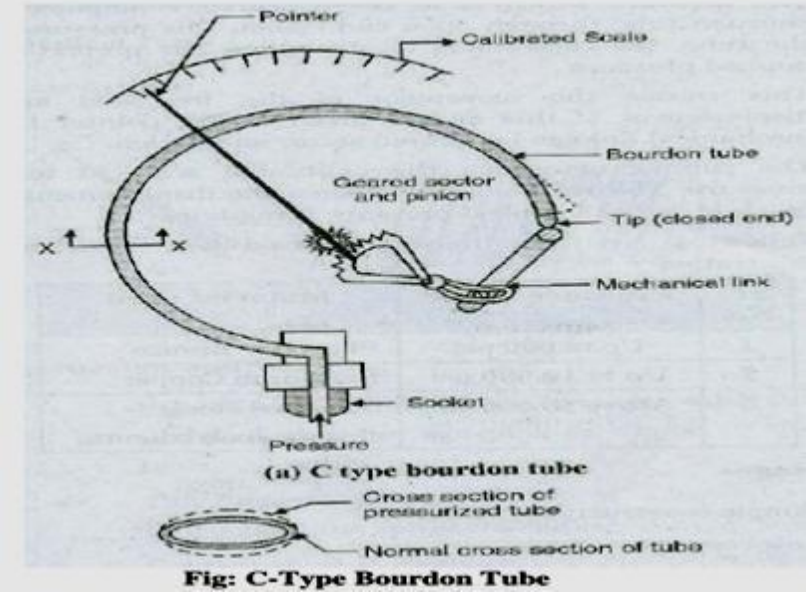
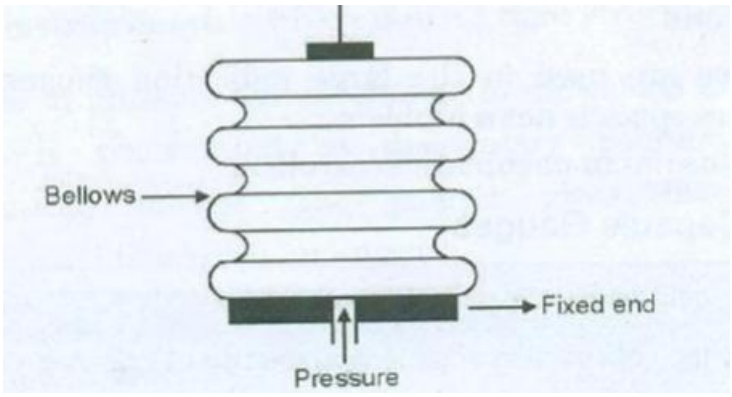


Fig: C-Type Bourdon Tube

OR

Bellows



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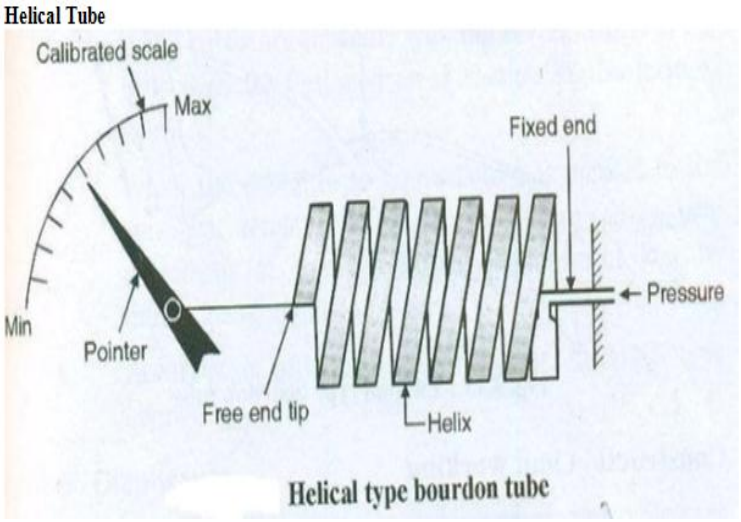
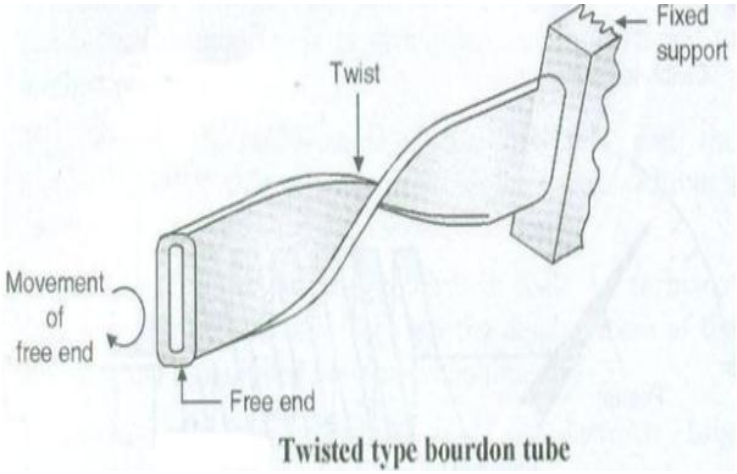
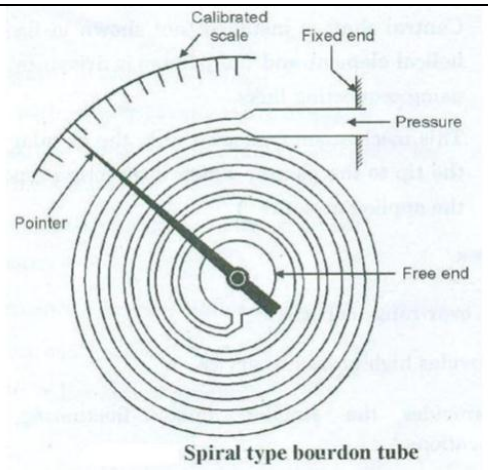

Helical Tube
Calibrated scale
Max
Fixed end
Pressure
Min
Pointer
Free end tip
Helix
Helical type bourdon tube

OR


Fixed support
Twist
Movement of free end
Free end
Twisted type bourdon tube

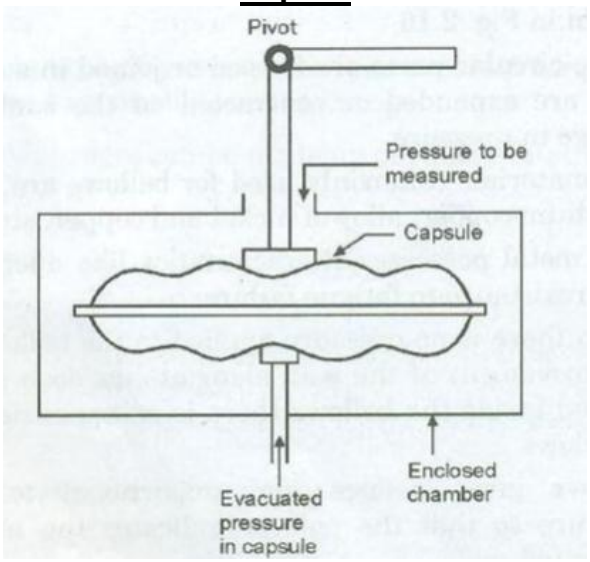
OR



Spiral type bourdon tube

OR

Capsule



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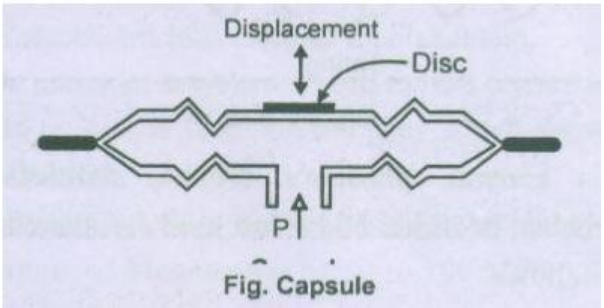


Fig. Capsule

OR

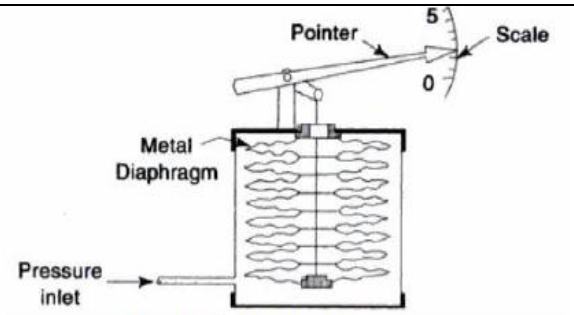
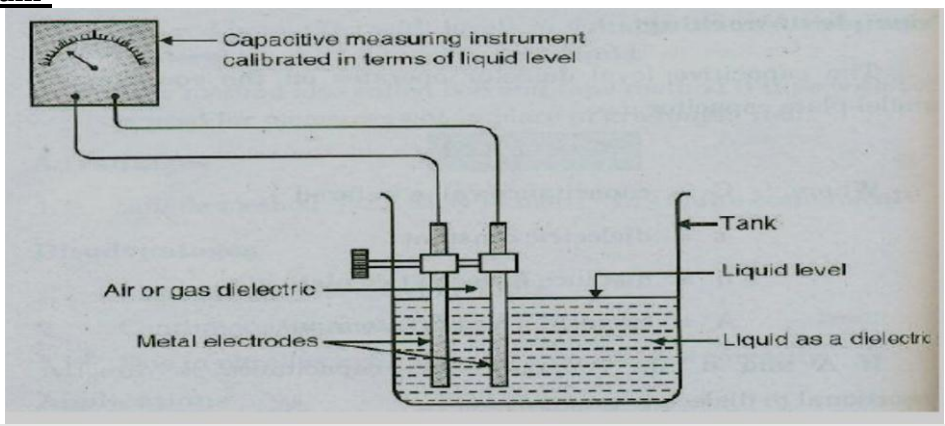


Fig. Metallic Diaphragm

c) **With neat diagram, explain working of capacitance level measurement.** **4M**

Ans: **Diagram-** **2M**



Explanation: **2M**

It consists of two probes firmly fixed parallel to each other and acts as plates of capacitor. This system is used for non-conducting liquid which act as an dielectric material.

A capacitance measuring instrument is connected to the probes to measure the capacitance and it is calibrated in terms of liquid level in the tank.

When the liquid in the tank increases, the capacitance also increases and when the liquid level decreases the capacitance decreases.

This value of capacitance is measures by capacitance measurement instrument and displayed on the indicator calibrated in terms of liquid level.

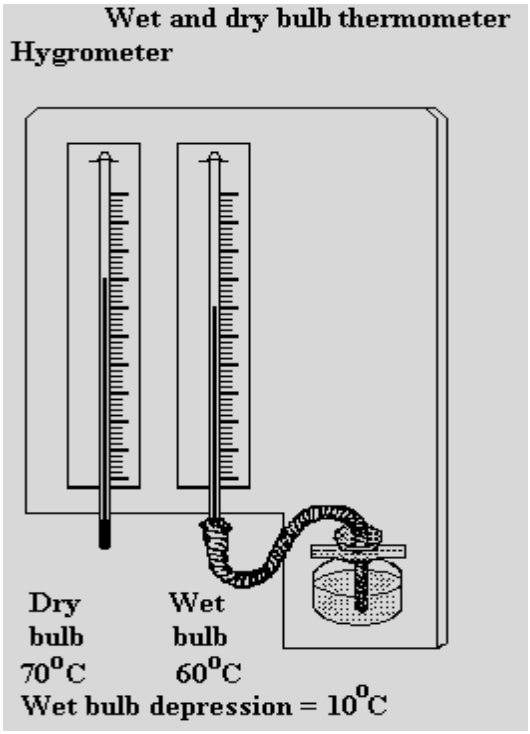
d) **Compare between RTD and thermistor with respect to:**
(i) Size (ii) Cost
(iii) Material of construction (iv) Temperature range **4M**

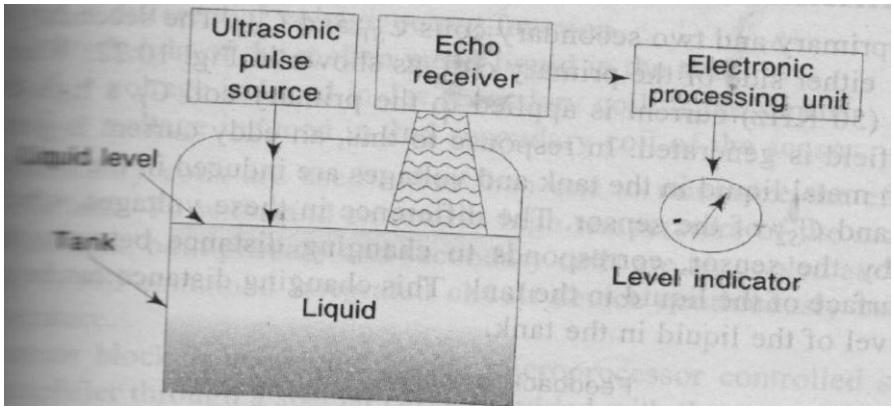
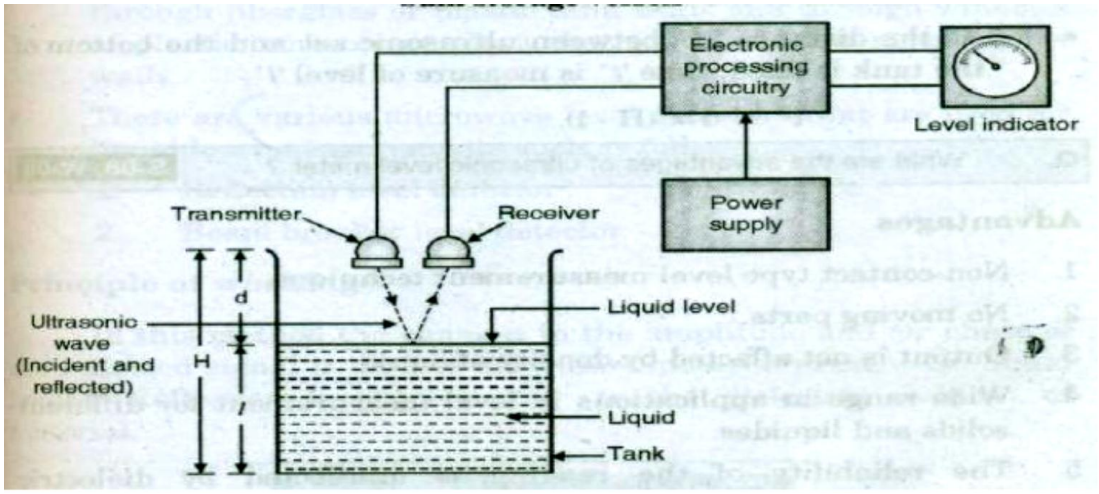
Ans:

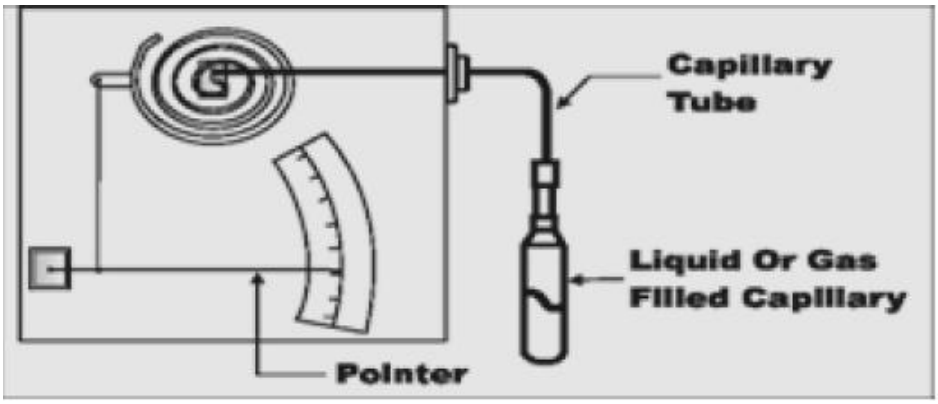
Sr	Parameter	RTD	Thermister
1	**size**	Large	Small
2	**Cost**	More	Less
3	**Material**	Teen, Nickel, Copper, Platinum	Manganese, Copper, Iron, Cobalt
4	**Temperature Range**	-200^{o}C to 650^{o}C	-150^{o}C to 300^{o}C

1M for each Parameter

e) **With the help of suitable diagram, explain how humidity is measured with dry** **4M**

		and wet bulb thermometer.	
	Ans:	**Diagram-**  **Explanation:-** 1. A psychrometer, or wet-and-dry-bulb thermometer, consists of two thermometers, one that is dry and one that is kept moist with distilled water on a sock or wick. The two thermometers are thus called the dry-bulb and the wet-bulb. At temperatures above the freezing point of water, evaporation of water from the wick lowers the temperature, so that the wet-bulb thermometer usually shows a lower temperature than that of the dry-bulb thermometer. When the air temperature is below freezing, however, the wet-bulb is covered with a thin coating of ice and may be warmer than the dry bulb. 2 .Relative humidity is computed from the ambient temperature as shown by the dry-bulb thermometer and the difference in temperatures as shown by the wet-bulb and dry-bulb thermometers. Psychrometers are commonly used in meteorology, and in the HVAC industry for proper refrigerant charging of residential and commercial air conditioning systems.	**2M** **2M**
	f)	**Convert 200°F (Fahrenheit) into Celsius, Kelvin, Reaumur, Rankine scale.**	**4M**
	Ans:	1) $^0C = 5/9\ (0F - 32) = 5/9(200-32) = 93.33$ 2) $^0R = {}^0F + 459.7 = 200+459.7 = 659.7^oR$ 3) $K = {}^0C + 273.15 = 93.33+273 = 366.33^oK$ 4) $Re=(^oF-32)/2.25) = 378^oRe$	**1 M for each scale**
Q. 4		**Attempt any FOUR:**	**16M**

	(a)	**Describe working principle of ultrasonic method of level measurement with neat sketch.**	**4M**
	Ans:	**Principle :** It operates by generating on ultrasonic pulse and measuring the time it takes for the echo to return. In below diagram ultrasonic pulse source which is acts as transmitter. It will generate pulse which will pass through liquid and reflect back after certain time depend on level of liquid and base which will capture by receiver. Time will be measure between generation pulse and echo which then calibrated in term of distance. **Diagram-**  **OR**  ***Note-Any other suitable diagram***	**2M for explanation** **2M for any diag.**
	(b)	**Describe any four selection criterion of transducers.**	**4M**
	Ans:	1. Operating range :Range is specified user or manufacturer 2. Operating principle : Depend on principle measurement 3. Sensitivity: it must sensitive to small variation in input. 4. Accuracy: It must be accurate to given tolerance 5. Frequency response and resonant frequency : It should operate constant in given	**Any four 1 M each**

		band width 6. Errors : Minimum 7. Environmental compatibility: It should compatible to given enviroment 8. Usage and ruggedness. 9. Electrical aspect. 10. Stability and Reliability 11. Loading effect 12. Static characteristics 13. General selection criteria	
	(c)	**Describe with neat diagram, how temperature is measured by Gas filled thermometer.**	**4M**
	Ans:	**Diagram-**  **Explanation:-** If volume of a gas is maintained at constant and If a certain volume of inert gas is enclosed in a bulb, capillary and bourdon tube, the most of the gas in the bulb, then the pressure increases with increase in temperature and that pressure is indicated by the bourdon tube may be calibrated in terms of the temperature of the bulb **In other words** Working of Gas thermometer is depend upon ideal gas law which state that the volume of the gas increases with increase in temperature if pressure maintained constant. **Name of the gases used in Gas filled thermometers.** 1. Nitrogen 2. Helium 3. Inert Gas	**2M** **2M**
	(d)	**Draw the construction and explain the working of photoelectric pick-up type speed measuring transducer.**	**4M**
	Ans:	**Diagram-**	**2M**

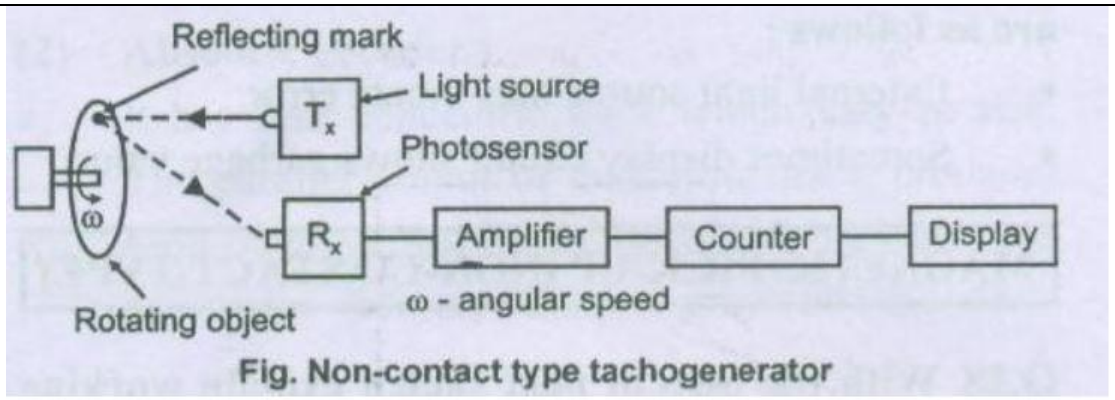
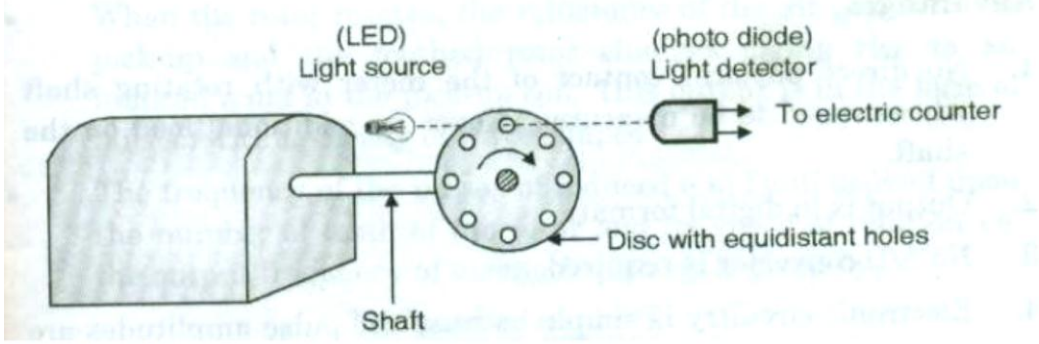


Fig. Non-contact type tachogenerator

OR



Working:-

Photo electric pick-up or tachometer is noncontact type device which is used to measure speed in rpm. It consists of a source light which directs the light beam towards rotating object. A reflecting mark is affixed to the rotating object. The photosensor is focused on the area toward the mark. When the object rotates, it modulates light by reflecting mark, producing a tray of pulses, whose frequency is proportional to the speed. The number of pulses counts the number of revolutions of object. The output of photosensor is amplified. The counter is used to count the number of pulses. A display device is used to read out the output. It may be CRO or seven segment display or analog meter. The external light may produce error if simple LED and photosensor is used. Therefore to avoid this, IR (Infra-Red), LED and photosensor is used. The frequency at which the pulses are produced depends on the number of holes in the disc and its speed of rotation. Hence the speed is given by

N= f/Hs

where

N=speed

f=frequency

Hs=holes on the disc

2M

	(e)	**State Seeback effect and Peltier effect. Write material used in different thermocouples.**	**4M**
	Ans:	**Seeback effect:- 1M** Seeback effect states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and	**2M for any two type and**

another is subjected to low temperature then e.m.f is induced proportional to the temperature difference between two junctions.

Peltier effect:- 1M

Peltier effect states that for two dissimilar metals closed loop, if current forced to flow through the closed loop then one junction will be heated and other will become cool.

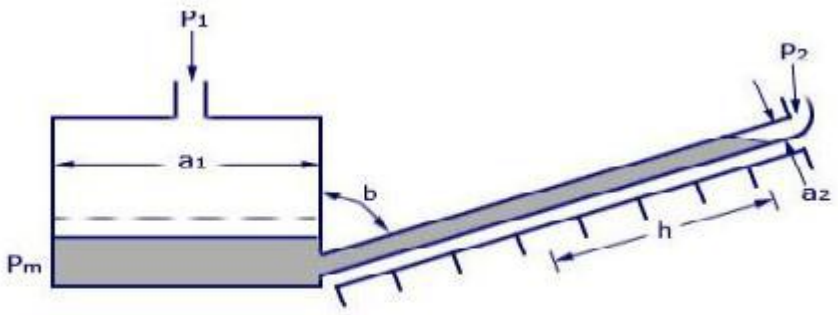
List of thermocouple-

SR	TYPE	Material
1	T	Copper/constantan
	E	Chromel/ constantan
	J	iron/ constantan
	K	Chromel/alumel
	R	Platinum/platinum/13%Rhodium
	S	Platinum/platinum/10%Rhodium
	B	Platinum6%/platinum/30%Rhodium
	G	Tungsten/Tungesten/Rhodium26%
	C	Tungsten 5%Rhodium/Tungesten/Rhodium25%

material 1M for (seebeck and peltier effect each)

(f) **Sketch constructional diagram of inclined tube manometer. State its advantages and disadvantages.** **4M**

Ans: **Diagram-** **2M**



Inclined Tube manometer

Advantages:

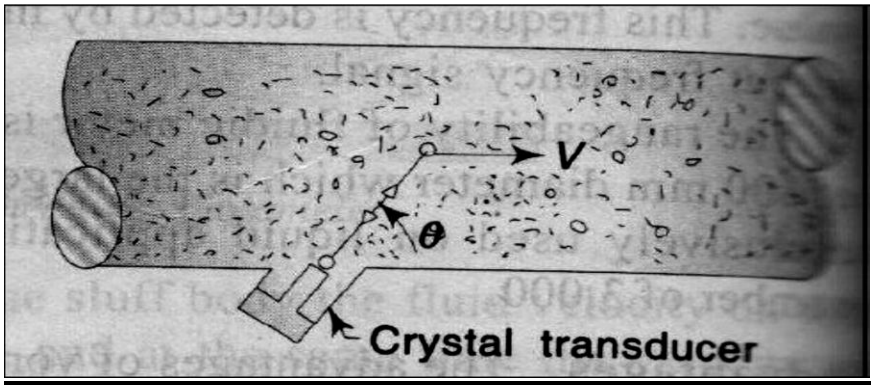
1) High sensitivity and accuracy
2) Used to measure small pressure difference

1M

Disadvantage:

1)Large and bulky
2) No over range protection
3)Need of leveling

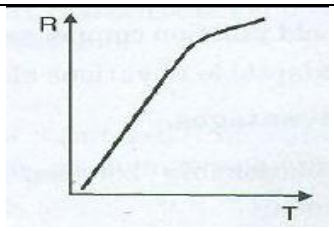
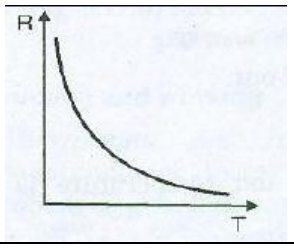
1M

		[Note-Any other relevant advantage and disadvantage can be consider l	
Q.5		**Attempt any FOUR:**	**16M**
	a)	**Explain working principle of Doppler type ultrasonic flow meter. Give its two advantages and disadvantages.**	**4M**
	Ans:	**Diagram:**  **Working Principal:** • In Doppler flow meter an ultrasonic wave is projected at an angle through the pipe wall into the liquid by a transmitting crystal in a transducer mounted outside the pipe. • Part of the ultrasonic wave is reflected by bubbles or particles in the liquid and is returned through the pipe wall to a receiving crystal. • Since the reflector (bubbles) are travelling at the fluid velocity the frequency of the reflected wave is shifted according to the Doppler principal. The velocity of the fluid is given. $V = \frac{\Delta f c_t}{2 f_0 \cos\emptyset} = \Delta f k$ Δf =difference between transmitted and received frequency c_t= Velocity of sound in the transmission $\emptyset$ = angle of transmitter and receiver crystal with respect to the pipe axis. K= constant $f_{0=}$ Frequency of transmitter **Advantages:** • It has no moving parts. • Its velocity (Output relationship is linear) • Excellent dynamic response. **Disadvantages:** • Complex circuit	**1M** **2M** **1M**

- Relative high cost

b) State comparison between PTC and NTC. **4M**

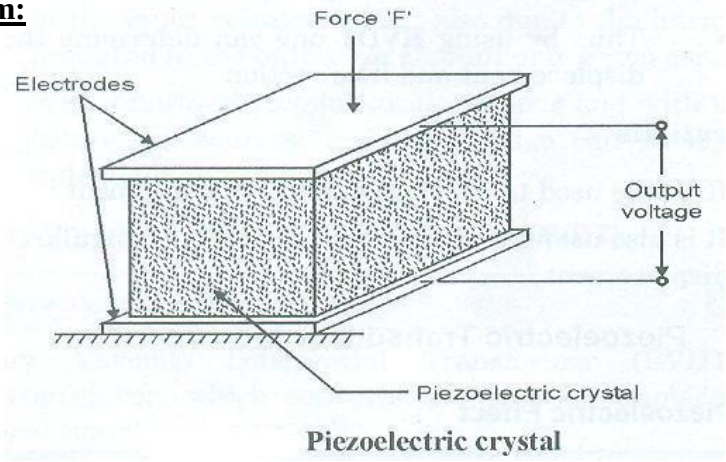
Ans: **Each point 1M**

Sr NO.	PTC	NTC
1	It is positive temperature coefficient	It is negative temperature coefficient
2	As temperature increases resistance also increases Rα T	As temperature increases resistance also decreases Rα 1/T
3	PTC manufactured from barium titanate, titanium oxide, and powdered	NTC composed of metal oxides such as manganese, nickel, cobalt, copper, iron and uranium.
4		

c) Is piezoelectric transducer active or passive? Give reason. Also state the principle of operation of piezoelectric transducer. **4M**

Ans: **1M**

Diagram:

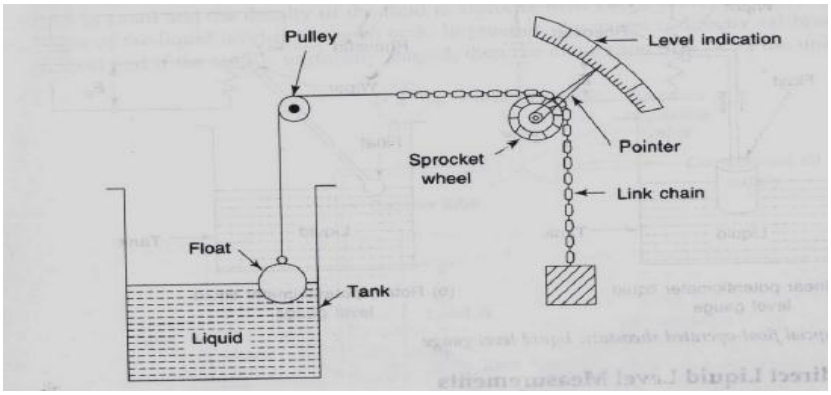
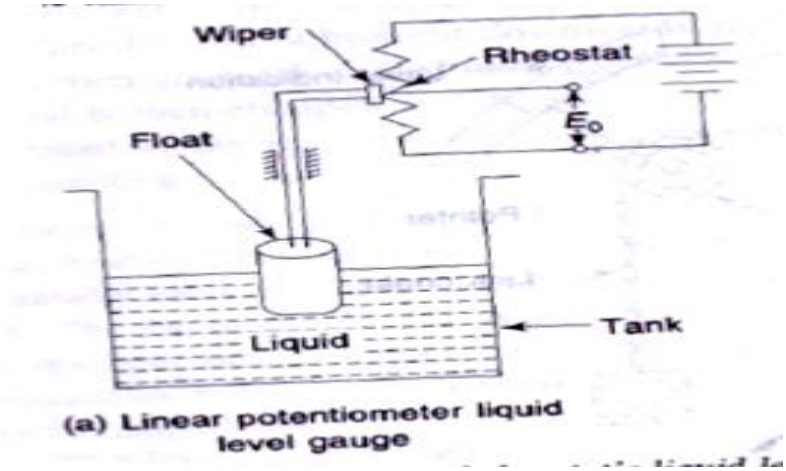


Piezoelectric crystal

It is passive transducer

Working principle: **3M**

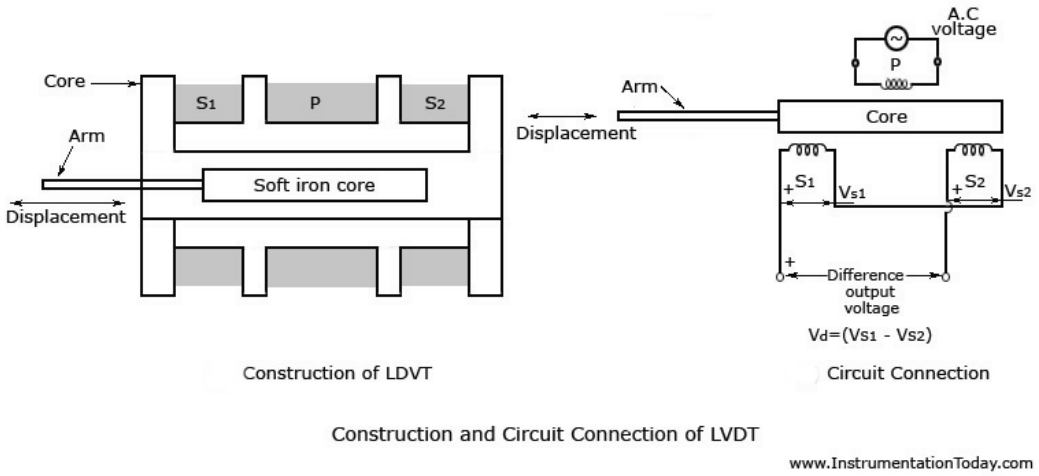
When force or pressure is applied to the piezoelectric material like quartz crystal or barium titanate, then an e.m.f. is generated across the material or vice versa.
The piezoelectric element used for converting mechanical movement into electrical signals. The mechanical deformation generates a charges and this charges appears as a voltage across the electrodes.

		The voltage is given by , $V = Q / C$ Where V = e.m.f across electrode Q = Charges C = capacitance	
	d)	**Draw a neat setup diagram to measure level of liquid in a tank using a float and potentiometer. Also identify the primary sensor and secondary transducer in this setup.**	**4M**
	Ans:	• **Float type liquid level indicator-** **Diagram:**  **Fig 1** • **Linear potentiometer liquid level gauge.** **Diagram:**  (a) Linear potentiometer liquid level gauge **Fig 2** As shown in fig 1 and fig 2 float acts as primary transducer that convert liquid level into displacement. This displacement is sensed by secondary transducer such as resistive type i.e. angular or linear potentiometer. The resistance of POT is directly proportional to the liquid level in the tank.	**2M** **2M**
	e)	**Compare contact type and non-contact type speed measurement methods.**	**4M**

	Ans:		**Each point 1M**

Sr. No	Contact type speed measurement	Non-contact type speed measurement
1	Physical contact is present between meter and shift	No physical contact between meter and rotating shaft.
2	As output is electrical signal to indicate reading.	As the output are digital pulses,no need of A/D converter.
3	Due to contact with rotating parts maintenance is high	As there is no contact structure maintenance free
4	e.g. A.C> Tachometer, D.C. Tachometer	e.g. Magnetic picup meter,

	f)	**Define pressure. Give the detailed classification of pressure measuring devices.**	**4M**
	Ans:	**<u>Define:</u>** Pressure is defined as the amount of force applied to a surface or distributed over it and is measured as force per unit area**.** **<u>Classification of Pressure measuring device</u>** **1) Non elastic Pressure transducer/manometer** • U Tube manometer • Well type • Inclined type **2) Elastic Pressure Transducer/Mechanical** • Bourdon tube • Bellows • Diaphragms **3) Electronics Pressure Transducer** • Bourdon tube with LVDT • Diaphragms with Strain Gauge(Resistive) • Capacitive, Piezoelectric	**1M** **3M**
Q.6		**Attempt any FOUR:**	**16M**
	a)	**Describe the construction, working of an inductive transducer used as a displacement transducer.**	**4M**
	Ans:	**<u>Diagram:</u>**	**1M**



1M

Explaintion:

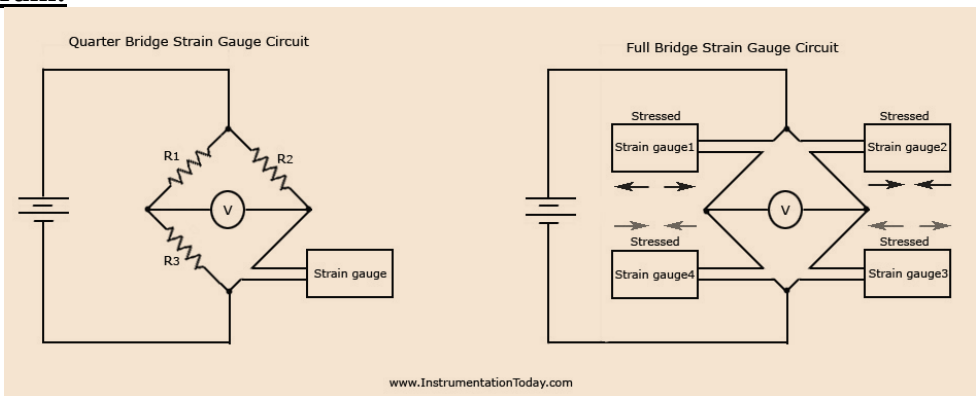
LVDT is the example of inductive transducer, in LVDT any physical displacement of the core cause the voltage of any secondary winding to increase while simultaneously reducing the voltage in the other secondary winding. The difference of the two voltages appears across the output terminal of the transducer and gives a measurement of the physical position of the core.

2M

Construction of LVDT:

- A differential transducer consists of a primary winding and two secondary winding.
- The windings are arranged concentrically and next to each other.
- They are wound over a narrow bobbin which is usually of a non- magnetic and insulating material.
- A core in the shape of road is attached to the transducer sensing a shaft.
- An AC source is applied across the primary winding and core varies the coupling between it and two
  secondary windings.
  .: $E_0=E_1-E_2$

b)	**How strain gauge is used for pressure measurement? Explain.**	**4M**
Ans:	**Diagram:**	**2M**



Working Principle:

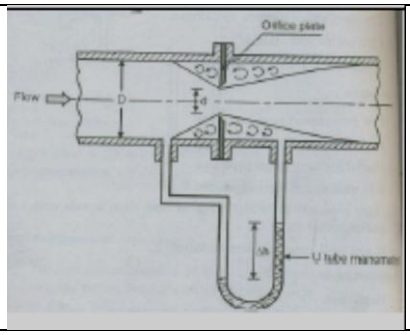
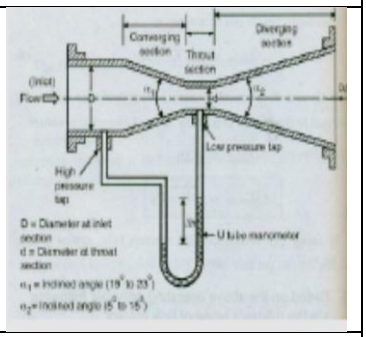
1) Strain gauge is a passive type resistance pressure transducer whose electrical resistance changes when it is stretched or compressed. It can be attached to a pressure sensing diaphragm as shown in fig a.
2) When diaphragm flexes due to the process pressure applied on it the strain gauge stretches or compresses due to this its resistance changes.
3) As soon as the pressure is applied the strain gauge stretches or compresses accordingly and the bridge circuit in fig(b) is unbalanced due to the change in resistance of the strain gauges
4) Thus a current flows in the galvanometer ,Which is measured by the deflection of the galvanometer, this change in output voltage may be calibrated for the pressure change.

2M

c) Compare orifice plate and venture tube with reference to:
(i) Working principle (ii) Construction
(iii) Maintenance cost (iv) Use

4M

Ans:

Parameter	Orifice plate	Venture tube
Working principle	It is the variable area flow meter in which differential pressure is developed by using orifice plate by inserting it in the path of fluid flow.	Venturi tube operates on the principle that when the restriction is placed in the path of flow, it produces differential pressure across the restriction which is proportional to the flow rate
Construction		
Maintenance cost	high	low
Use	Low flow measurement	High flow measurement

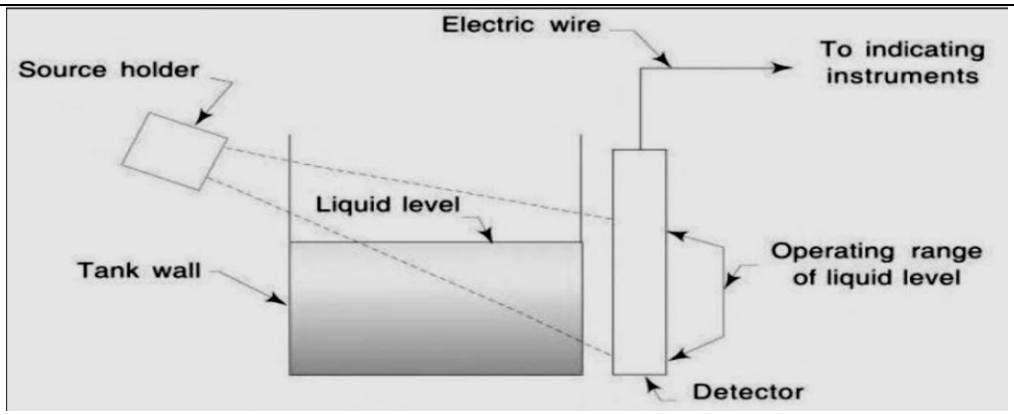
Each parameter 1M

d) Describe the working of radiation type level measurement. List two advantages of it.

4M

Ans: **Diagram:**

1M



Radiation level measurement is non-contact type liquid level measurement technique. Radiation detectors are used where other electrical methods would not survive.

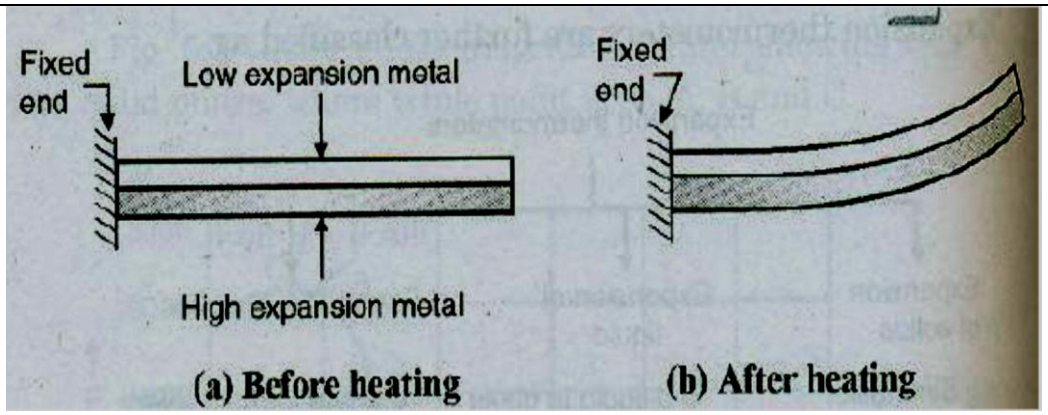
Construction and working: **2M**

1. It consists of gamma ray source holder on one side of the tank and a gamma detector on the other side of the tank.
2. The gamma rays from source are directed towards the detector in a thin band of radiation.
3. When gamma rays penetrate the thick wall of the tank, its energy level afterwards is greatly reduce
4. The radiation received at the gamma detector is inversely proportional to the thickness of the walls and the medium between the radiation source and detector.
5. The amount of radiation received is inversely proportional to the amount of liquid between the radiation source and detector. The difference in the amount radiation received by detector, corresponds to the liquid level in the tank. **1M**
6. Thus, when liquid level rises, the amount of radiation received is reduced and vice versa.

Advantage:

1) It is used for higher temperature measurement.
2) It is used for the non -contact type method.

e)	**Explain working principle of bimetallic thermometer.**	**4M**
Ans:	**Diagram:**	**1M**



1) All metals expand or contracts with change in temperature.
2) The temperature co- efficient of expansion is not same for all metals therefore their rate of expansion or contraction is not same. The difference in thermal expansion rate produces deflections proportional to the change in temperature.
It consists of bimetallic strip usually in the form of a cantilever beam, which is prepared from two thin strips of different metals having different coefficient of thermal expansion

Working Principle: **3M**

- The bonding of two strips is done by welding such that they can not move relative to each other.
- Brass is used as a high expansion metal and Invar (alloy of iron nickel) is used as low expansion metal.
- As the temperature applied to the strip increases, there is deflection of the free end of the strip. The length of metal will change according to the individual expansion rate.
- As one end of bimetallic strip is fixed, the strip will bends at free end towards the side that to low coefficient of thermal expansion metal.

The deflection of the free end is directly proportional to the square of the length of the metal strip, as well as to the total change in temperature, and inversely proportional to the thickness of the metal

- Pointer is attached to the free end to indicate the temperature.

f) Compare between U tube and well type manometers. (any four points) **4M**

Ans:

Sr No	U tube manometer	Well type manometer
1	U shape tube	Well shape with small capillary
2	It has two limb	It has only one limb
3	$P_2 - P_1 = d\,(1+A_1/A_2)H$	$P_2=\rho h$
4	U tube manometer is for differential pressure measurment	Direct pressure measurement

Each point 1M

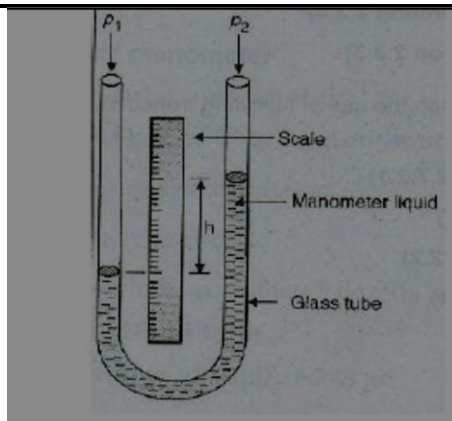


Fig: U- Tube manometer

P_1 = High pressure

P_2= Low pressure

h= Difference in level liquid.

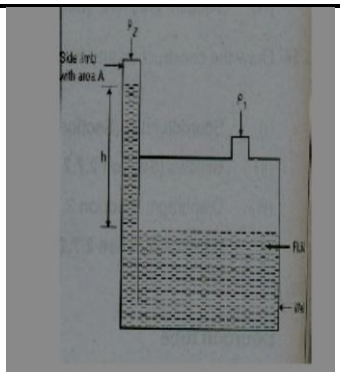


Fig: Well- type manometer