MODEL ANSWER

SUMMER– 19 EXAMINATION

Subject Title: INDUSTRIAL MEASUREMENTS

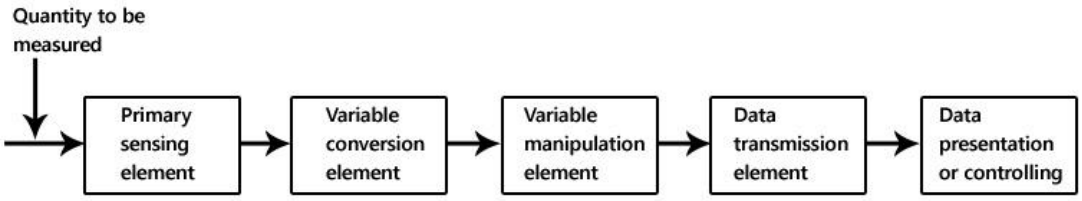
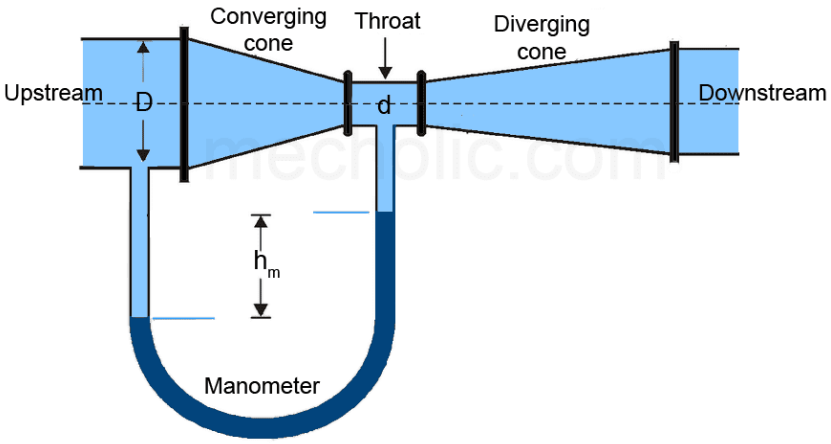
Subject Code: 17434

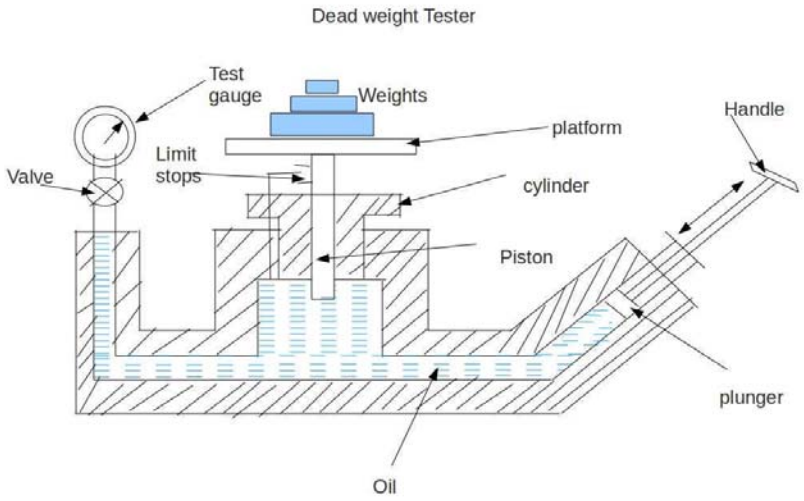
Important Instructions to examiners:

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 anyequivalent 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		**Attempt any SIX of the following :**	**12M**
	i)	**List the four different units of pressure.**	**2M**
	Ans:	Pressure Measured in 1. Pascal (Pa). 2. Pounds per square inch(psi) 3. Kilogram per square of centimeter (Kg/cm^2). 4. Newton's per square meter (N/m^2). 5. Liquid columns. MmHg or mmWc.	**Any four (2M)**
	ii)	**Define transducer. Give two examples.**	**2M**
	Ans:	**Definition**: Transducer is defined as one which convert one form of energy into another form. **Examples:** a)Thermocouple b)Piezoelectric transducer c) strain gauge d)Bellows e) Diaphragm	**1M** **Any two examples** **2M**

	iii)	**State seeback and peltier effect.**	**2M**
	Ans:	**Seeback effect:** 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 another is subjected to low temperature then e.m.f is induced proportional to the temperature difference between two junctions. **Peltier effect:** Peltier effect state that for two dissimilar metals closed loop, if current is forced to flow through the closed loop then one junction will be heated and other will become cool**.**	**1M Each effect**
	iv)	**Why rotameter is called variable area meter?**	**2M**
	Ans	Rotameter is called as a variable area flow meter because in rotameter the area is varied i.e, bottom area is small and it increases towards top, to maintain steady pressure difference.	**2M**
	v)	**Define :** **1) Absolute Humidity** **2) Relative Humidity**	**2M**
	Ans:	**1) Absolute Humidity** It is defined as a mass of water vapour present per unit volume. **2) Relative Humidity** It is defined as a ratio of moisture content of gas to the maximum moisture the gas can contain at that temperature	**1M** **1M**
	vi)	**State the working principle of thermocouple.**	**2M**
	Ans	Thermocouple is a temperature transducer that develops an emf which is a function of temperature between hot junction and cold junction.	**2M**
	vii)	**State the different types of flow.**	**2M**
	Ans	**Three different types of fluid flow are:--** **1. Laminar flow** Occurs when the fluid flows in parallel layers, with no mixing between the layers. The flow is laminar when Reynolds number is less than 2300. **2. Turbulent flow:** In turbulent flow occurs when the liquid is moving fast with mixing between layers. The speed of the fluid at a point is continuously undergoing changes in both magnitude and direction. The flow is turbulent when Reynolds number greater than 4000. **3. Transitional flow** Transitional flow is a mixture of laminar and turbulent flow, with turbulence flow in the centre of the pipe and laminar flow near the edges of the pipe. Each of these flows behaves in different manners in terms of their frictional energy loss while flowing and have different equations that predict their behaviour.	**2M**

		The flow is transitional when Reynolds number is in between 2300 and 4000.	
	viii)	**Draw the block diagram of instrumentation system.**	**2M**
	Ans	Diagram Of instrumentation System:-- 	**2M**
b		**Attempt any TWO of the following :**	**8M**
	(i)	**Describe working of venturimeter with neat sketch.**	**4M**
	Ans:	**Diagram:** 	**2M**
		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 adiverging 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	**2M**

		permanent pressure loss or energy loss is very low as compared to orifice plate.	
	(ii)	**Explain the working of dead weight tester with neat diagram.**	**4M**
	Ans:	**Diagram:**  **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 turned 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.	**2M** **2M**
	(iii)	**With neat diagram explain working of capacitance level measurement.**	**4M**
	Ans:	**Diagram:Capacitance level measurement**	**2M**

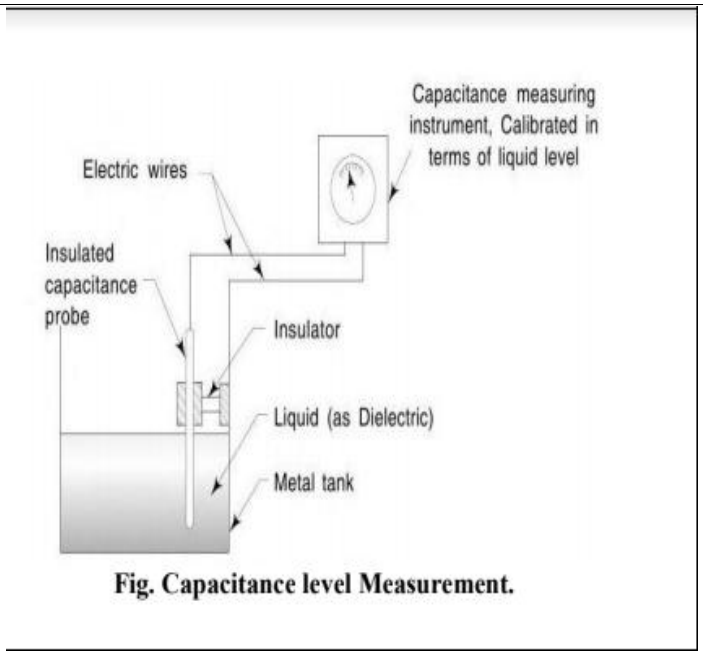


Fig. Capacitance level Measurement.

2M

Working:-

The principle of operation of capacitance level measurementis based upon the capacitance equation of a parallel plate capacitor given by:

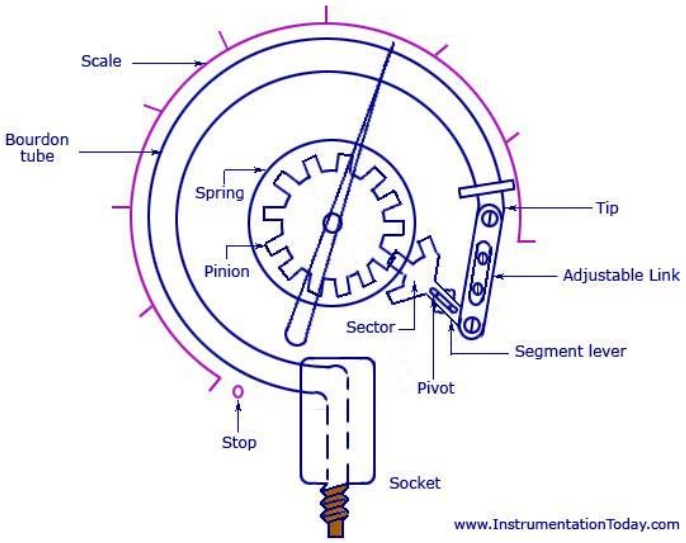
$$C = K(A) / (D)$$

C = Capacitance in picoFarads
K = Dielectric constant of material
A = Area of plates in square inches
D = Distance between the plates in inches

Working-

1.It consists of an insulated capacitance probe (which is metal electrode) firmly fixed near and parallel to the metal wall of the tank.
2.If 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.
3. If liquid is conductive, the capacitance probe and liquid form the plate of the capacitor and the insulation of the probe act as the dielectric.
4.A capacitance measuring device is connected with the probe and the tank wall, which is calibrated in terms of the level of liquid in the tank.
5.When the level of liquid in the tank rises, the capacitance increases, when liquid level in the tank decreases, the capacitance also decreases.
6.This increase and decrees in the capacitance is measured and is displayed on the indicator calibrated in terms of liquid level.

Q.2		**Attempt any FOUR of the following :**	**16M**
	a)	**Draw the constructional detail of 'C' type Bourdon tube and explain its working.**	**4M**
	Ans:	**Diagram: 'C' type Bourdon tube**	**2M**



Bourdon Tube Pressure Gauge

Explanation:

Working-

1 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.

2 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.

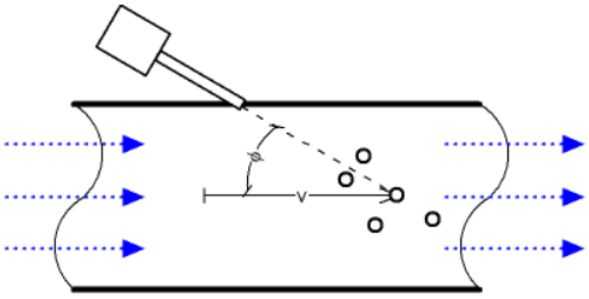
3 The cross section view of C type bourdon tube under normal condition and pressurized condition is as shown in figure.

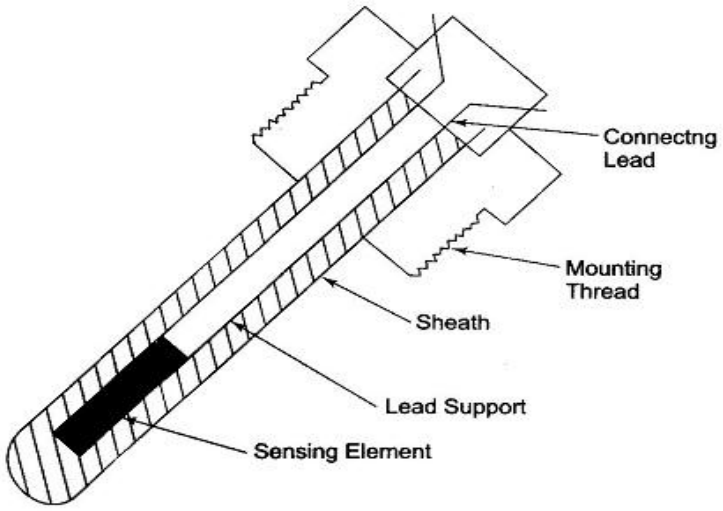
4 The pressure which is to be measured is applied to the bourdon tube through open end. When this pressure enters the tube, the tube tends to straighten out proportional to applied pressure.

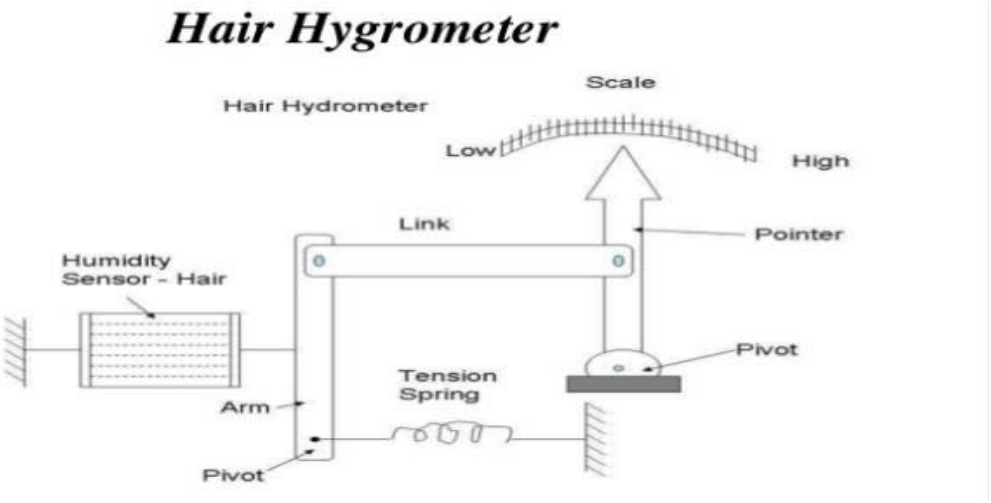
5 This causes the movement of the free end and the displacement of this end is given to the pointer through mechanical linkage i.e. geared sector and pinion.

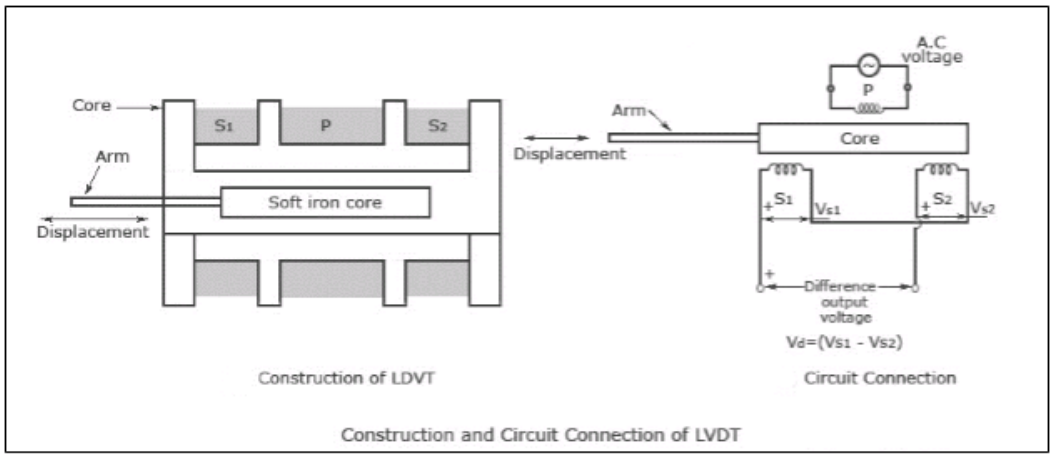
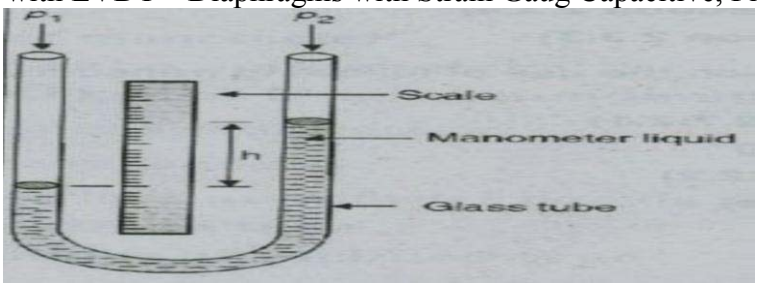
6 The pointer moves on the calibrated scale in terms of pressure. The relationship between the displacement of the free end and the applied pressure is nonlinear.

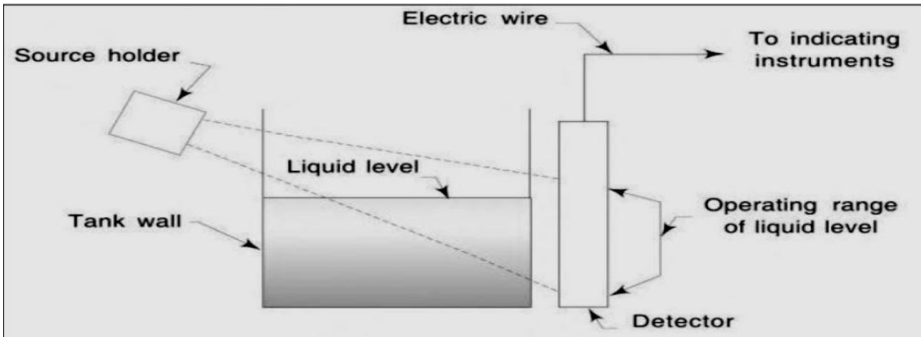
2M

b)	**Describe the principle of operation of Doppler type ultrasonic flow meter with diagram.**	**4M**
Ans:		**2M**
	Explanation :-- 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	**2M**

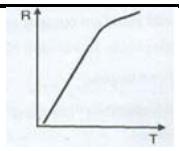
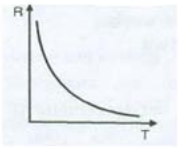
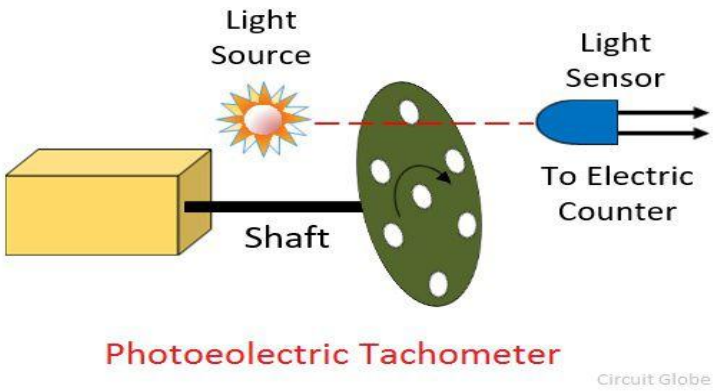
		receiver, and the fluid carrier, the relative velocity is measured. The resulting frequency shift is named the *Doppler Effect*. It consists of transmitter and receiver. Tramsmitter transmits the sound frequency and receiver receives it. Fluid velocity can be calculated as $v = c\,(f_r - f_t) / (2\,f_t \cos\Phi)$ *where* f_r = *received frequency* f_t = *transmitted frequency* v = *fluid flow velocity* Φ = *relative angle between the transmitted ultrasonic beam and the fluid flow* c = *velocity of sound in the fluid* This method requires some reflecting particles in the fluid. The method is not suitable for clear liquids.	
c)		**Give construction working principle of RTD with a neat sketch.**	**4M**
Ans:		**Diagram**  	**2M**
		Working: An RTD (resistance temperature detector) is a temperature sensor that operates on the measurement principle that a material's electrical resistance changes with temperature. Temperature sensitive materials used in the construction of RTDs include platinum, nickel, and copper; platinum being the most commonly used. RTD operates on the principle that the electrical resistance of a metal changes predictably in an essentially linear and repeatable manner with changes in temperature. RTD has positive temperature coefficient (resistance increases with temperature). The resistance of the element at a base temperature is proportional to the length of the element and the inverse of cross sectional area. A typical electrical circuit designed to measure temperature with RTD's actually measures a change in resistance of the RTD, which is then used to calculate change in temperature.	**2M**

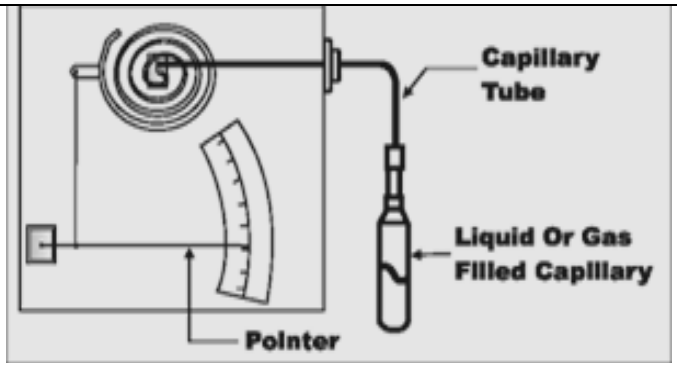
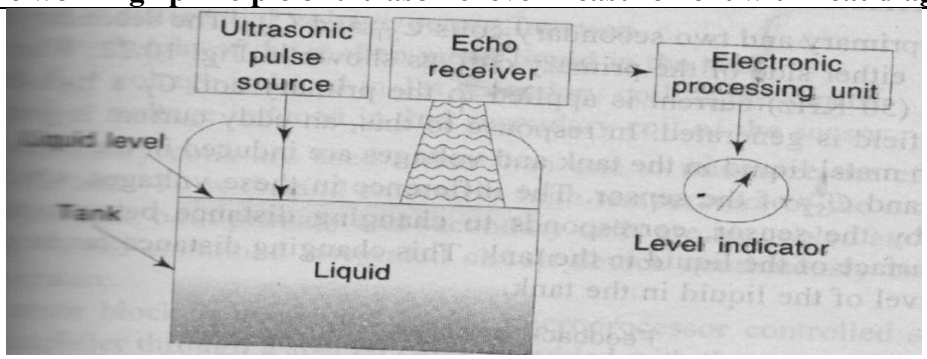
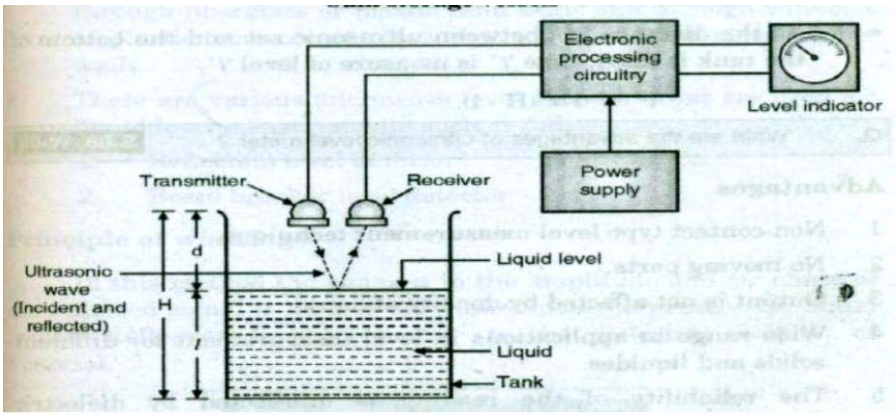
	d)	**List the advantages and disadvantages of float type level guage.**	**4M**
	Ans	**Advantages:--** i)Can be used for corrsive liquid ii) If attached with potentiometric arrangement o/p can be measured in voltage. iii) Simple and ecconomical approch to measure liquid level indication. iv) Use for tank storage **.** **Disadvantages:-** **i)** Use for low pressure and stable liquid measurement. **ii)** Maintainance is required in order to float clean. **iii)** Calibration required considered.	**2M** **2M**
	e)	**State the selection criteria for transducer(any eight points).**	
	Ans	Transducer is a device which transforms energy from one form to another. The following points should be considered while selecting a transducer for particular application. 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. General selection criteria	**Any eight 4M**
	f)	**Describe how humidity is measured by using hair hygrometer.**	**4M**
	Ans	**Diagram:**  **Explanation:** 1.It consists of bunch of human hair which increases mechanical strength of the instrument, arm with pivot joints and points scale assembly. 2.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.	**2M**

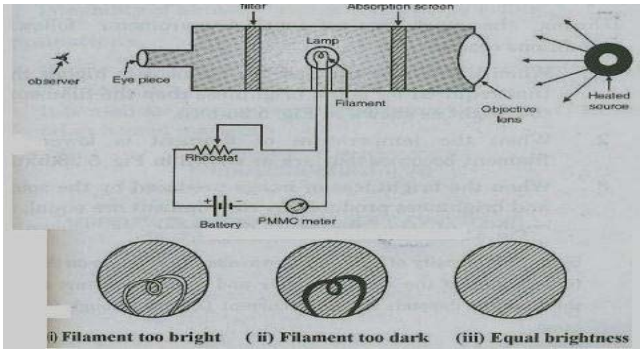
		3. The indicator scale is directly calibrated to give a direct indication of humidity. The pointer or recording pen is operated through mechanical linkage. 4. As the relative humidity surrounding to that of hygrometer increases, length of hair strands increases, which move the pointer on the calibrated scale for maximum value.	**2M**
Q.3		**Attempt any FOUR of the following :**	**16-Total Marks**
	a)	**Draw Construction diagram of LVDT with label. Also state the application of LVDT.**	**4M**
	Ans:	**Diagram:**  Construction and Circuit Connection of LVDT **Application of LVDT:** 1) L.V.D.T as a primary transducer can be used for displacement measurement ranging from fraction of a mm to a few cm 2) Acting a secondary transducer, used to measure force, weight and pressure.	**2M** **2M**
	b)	**What are the different pressure measurement method? State the working principle of U tube manometer.**	**4M**
	Ans:	**Classification of Pressure measuring device** 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 Gaug Capacitive, Piezoelectric  This manometer consists of a U shaped tube in which the manometeric liquid is filled. The manometer is used to measure the pressure which is unknown by the balancing gravity force and acceleration due to gravity, g = 9.81 m/sec2 The unknown pressure is applied in the one arm of the tube and the mercury in the tube or manometeric liquid filled in the tube moves in the tube or rises to the constant region and then	**1M** **1M** **2M**

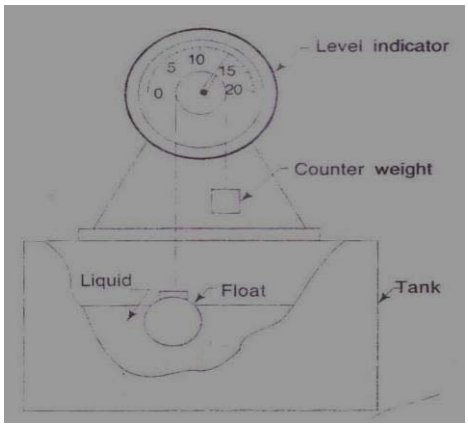
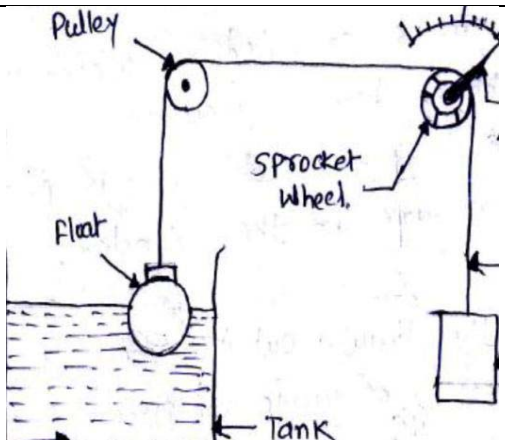
		the movement is stopped. The height of the liquid is measured and noted. The pressure is calculated by using the formula, The fundamental relationship for pressure expressed by a liquid column is P1-P2=(ρ- ρ1)(h1-h2)g • Thus P=(ρ- ρ1)hg • Where, ρ is density of fluid in u tube, ρ1is density of fluid whose pressure is to be measured , h=difference in liquid level , g acceleration due to gravity	
	c)	**Describe the radiation type level measurement technique.**	**4M**
	Ans:	**Diagram:-**  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:** 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. 6. Thus, when liquid level rises, the amount of radiation received is reduced and vice versa.	**2M** **2M**
	d)	**Compare NTC and PTC (any four points).**	**4M**
	Ans:		**1M Each**

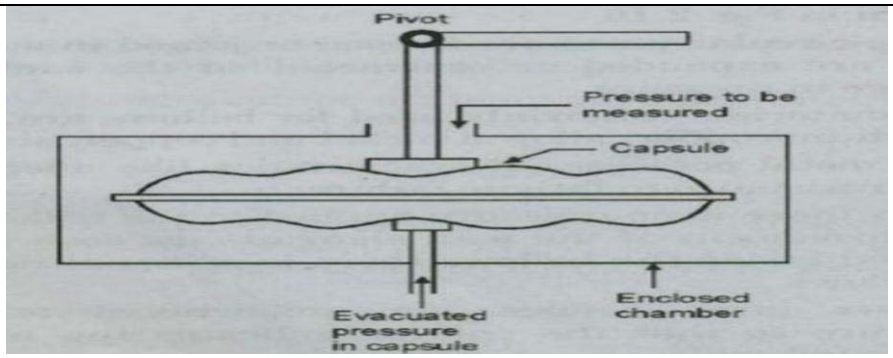
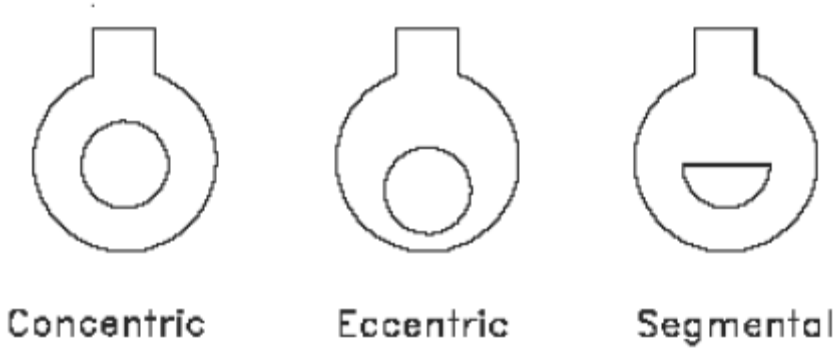
Sr no.	PTC	NTC
1	It is positive temperature coefficient	It is negative temperature coefficient
2	As temperature increases resistance also increases Rα T	As temperature increases resistance also Decreases Rα 1/T
3	PTC manufactured from barium titanate, titanium oxide, and powdered	NTC composed of metal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

		4			
		5	Examples of materials with PTC include barium titanate, titanium oxide and powdered barium carbonate	Examples of materials with NTC include metal oxides such as Manganese, nickel, cobalt, copper, iron and uranium.	
	e)	**Describe how speed in measured by photo electric method with neat diagram.**			**4M**
	Ans:	**Diagram:-**  **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** **2M**
	f)	**Describe with neat diagram how temperature is measured by liquid filled thermometer.**			
	Ans	**Diagram:-**			**2M**

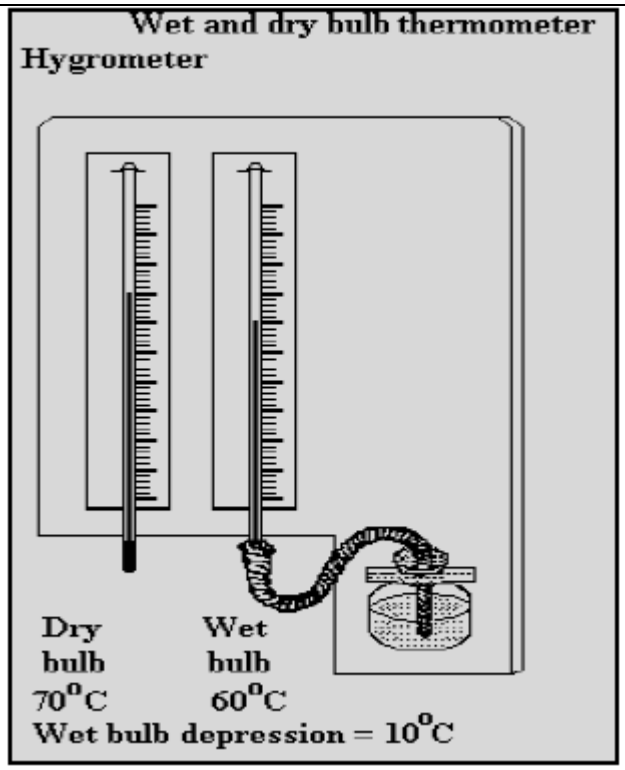
		 **Description:-** Filled-system temperature measurement instruments consists of a bulb, connecting tubing known as "capillary," and a pressure sensing element, usually a **bourdon tube**. The bulb volume varies over a range of 100 to 1 depending on the fill fluid, the temperature span, and the capillary length. Capillary tubing is small-diameter tubing, usually of stainless steel. Filled-system temperature measurement methods depend upon the well-known physical phenomena that A liquid will expand or contract in proportion to its temperature and in accordance to the liquid's coefficient of thermal/volumetric expansion	**2M**
Q.4		**Attempt any FOUR of the following:**	**16-Total Marks**
	a)	**Describe the working principle of ultrasonic level measurement with neat diagram.**	**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	**2M** **2M**

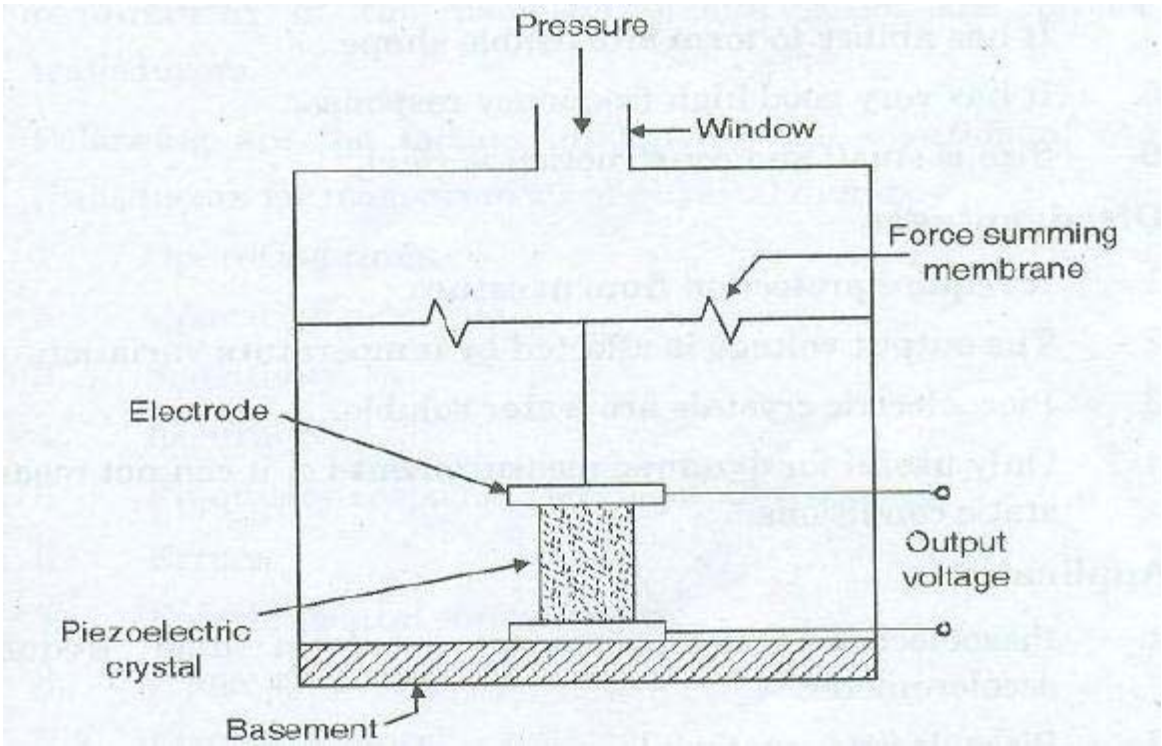
		pulse which will pass through liquid and reflect back after certain time depend on level of liquid and base which will capture by receiver. Time will be measure between generation pulse and echo which then calibrated in term of distance.	
	b)	**What is piezoelectric effect? Name two piezoelectric materials.**	**4M**
	Ans:	**Piezoelectric effect**:- **Piezoelectric effect can be stated as follows**: when a pressure or force or vibration is applied to crystalline material like quartz crystal or crystalline substances, then an e.m.f. is generated across the material or vice versa". **Piezoelectric Materials**: 1) Natural crystal: Quartz crystal ,Rochelle salt 2) Synthetic crystals : Barium Titanate, Lithium sulphate	**2M** **2M**
	c)	**What is pyrometry? Describe working of optical pyrometer with neat diagram.**	**4M**
	Ans:	**Pyrometer: -** When physical contact with the medium to be measured is not possible or impractical due to very high temperature (above 1400oC) pyrometers are used for temperature measurement. (Or) Pyrometry is the technique of measuring temperature of a body without actual physical contact.  **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	**1M** **1M** **2M**

		source and brightness produced by the filament are equal, the outline of the filament disappear.	
	d)	**Explain contact type level transducer.**	**4M**
	Ans	 **OR**  Above figure shows the simplest form of float operated mechanism for the continuous liquid level measurement. In this case, the movement of the float is transmitted to the Pointer by stainless steel or phosphor-bronze flexible cable wound around a pulley, and the pointer indicates liquid level in the tank. The float is made of corrosion resisting material (such as stainless steel) and rests on liquid level surface between two grids to avoid error due to turbulence. With this type of instrument, liquid level from ½ ft. (152mm) to 60 ft. (1.52m) can be easily measured	**2M** **2M**
	e)	**List applications of thermometer and thermistor**	**4M**
	Ans	**Applications of thermometer** Thermometers utilize a range of physical effects to measure temperature. Temperature sensors are used in a wide variety of scientific and engineering applications, especially measurement systems. Application of Thermistor 1. Climate Control Systems Such As Air Conditioners, 2. Freezers, 3. Heaters, 4. Refrigerators 5. Water Heaters.	**2M** **2M**
	f)	**What is capsule? How it is used for pressure measurement?**	**4M**

	Ans	 A capsule is made up of two identical corrugated diaphragms so as to form a leak- proof chamber and also referred to as an aneroid. • The fluid under measurement is entered in to the chamber. • One diaphragm is rigidly held while other deflects and results in twice the displacement of single diaphragm. • The central part of diaphragm consists of a round disc which serves on one side to communicate the displacement. The opening is provided in other diaphragm to apply the pressure.	**2M** **2M**
Q.5		**Attempt any FOUR of the following:**	**16-Total Marks**
	a)	**Describe the construction of orifice plate flow meter.**	**4M**
	Ans:	**Diagram:--**  **Working Principle:** An orifice plate is a thin plate with a hole in it, which is usually placed in a pipe. When a fluid (whether liquid or gaseous) passes through the orifice, its pressure builds up slightly upstream of the orifice but as the fluid is forced to converge to pass through the hole, the velocity increases and the fluid pressure decreases. A little downstream of the orifice the flow reaches its point of maximum convergence where the velocity reaches its maximum and the pressure reaches its minimum. Beyond that, the flow expands, the velocity falls and the pressure increases. By measuring the difference in fluid pressure across tappings upstream and downstream of the plate, the flow rate can be obtained from Bernoulli's equation	**2M** **2M**
	b)	**Calculate the o/p resistance of PT 100 RTD for temperature values 35^0 C 85^0C.**	**4M**
	Ans:	**a)For 35^0 C temperature:** **For PT 100:** R_0= 100 Ω at t_0= 0^0 C **Relation between resistance & temperature for resistance thermometer is**	**2M**

		$R_t=R_0(1+\alpha\Delta t)$ assume $\alpha = 0.385*10^{-2}/^0$ C **Resistance at $t=35^0$ C,** **$R_t=R_0(1+\alpha\Delta t)$** =100[1+0.00385*35} **$R_t=113.475\ \Omega$** **b) For 85^0 C temperature:** **For PT 100:** R_0= 100 Ω at $t_0= 0^0$ C Rt=?, at $t=85^0$ C **Relation between resistance & temperature for resistance thermometer is** **$R_t=R_0(1+\alpha\Delta t)$** **assume $\alpha = 0.385*10^{-2}/^0$ C** **Resistance at $t=85^0$ C,** **$R_t=R_0(1+\alpha\Delta t)$** =100[1+0.00385*85] **$R_t=132.725\ \Omega$**	**2M**
	c)	**Write examples of each type:** **(i) Primary transducer** **(ii) Secondary transducer** **(iii) Active transducer** **(iv) Electrical transducer**	**4M**
	Ans:	**(i) Primary transducer :- Bourdon tube** **(ii) Secondary transducer:- LVDT** **(iii) Active transducer:- Thermocouple** **(iv) Electrical transducer: RTD** **Note: any other suitable example can be considered.**	**(1M each)**
	d)	**List two applications and two advantages of ultrasonic flow type transducer.**	**4M**
	Ans	**Applications :--** • Mostly used for liquids without any pressure loss. • Mainly used for liquid flow. **Advantages: --** • It has no moving parts. • Its velocity (Output relationship is linear) • Excellent dynamic response	**2M** **2M**
	e)	**Describe working of dry and wet bulb thermometer.**	**4M**

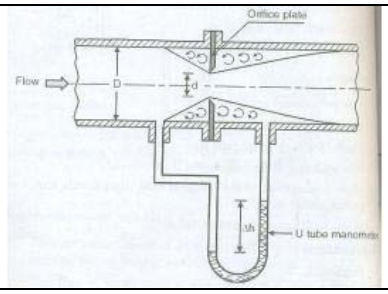
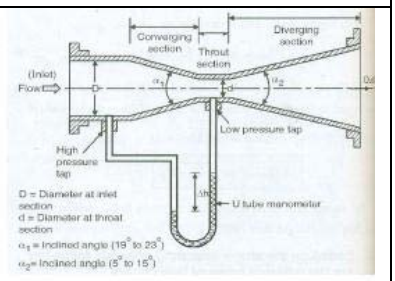
	Ans	 **Explanation:-** A psychrometer, or wet-and-dry-bulb thermometer, consists of two thermometers, one that is dry and one that is kept moist with distilled water on a sock or wick. The two thermometers are thus called the dry-bulb and the wet-bulb. At temperatures above the freezing point of water, 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. 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)	**State advantages and disadvantages of photoelectric tachometer.**	**4M**
		(Advantages- 2 M, Disadvantages- 2 M, Each Point-1 M) **Advantages(any 2 points)** 1) It is digital instrument so high accuracy. 2) Simple electric circuit 3) Pulse amplitude are constant **Disadvantages(any 2 points)** 1) Light source must be replaced time to time. 2) The accuracy depends on the error represented by one pulse. 3) High cost	**2M** **2M**

Q.6		**Attempt any FOUR of the following:**	**16M**
	a)	**Draw experimental setup to measure pressure in terms of voltage. And also discuss which type of transducer used in it.**	**4M**
	Ans:	**Type 1M, Diagram 3M (NOTE: Consider any relevant transducer example.)** **Piezoelectric transducer use to convert Pressure in to voltage**  	**4M**
	b)	**Compare active passive transducer.**	**4M**

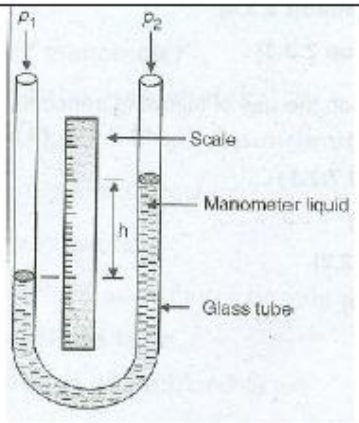
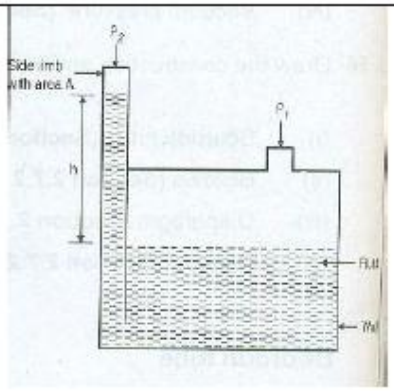
Ans

Sr No	**Parameters**	**Active Transducer**	**Passive Transducer**
1	Working Principle	Operate under energy conversion principle.	Operate under energy controlling principle.
2	Example	Thermocouple, Piezoelectric Transducer etc.	thermistors, Strain Gauges etc.
3	Advantage	Do not require external power supply for its operation.	Require external power supply for its operation.
4	Application	Used for measurement of Surface roughness in accelerometers and vibration pickups.	Used for measurement of Power at high frequency

(1M Each`)

<table>
<tr><td></td><td>c)</td><td colspan="3">Compare orifice plate with venture tube with ref. to working principle, construction maintenance, cost.</td><td>4M</td></tr>
<tr><td></td><td>Ans:</td><td>PARAMETER</td><td>ORIFICE PLATE</td><td>VENTURI TUBE</td><td>1M Each</td></tr>
<tr><td></td><td></td><td>Working principle</td><td>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.
Or
It works on the principle of restriction with known size plate having very small opening.</td><td>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.
Or
It works in the principle of restriction with change in diameter of flow pipe.</td><td></td></tr>
<tr><td></td><td></td><td>Construction</td><td> 
</td><td> 
</td><td></td></tr>
<tr><td></td><td></td><td>Maintenance</td><td>High</td><td>Low</td><td></td></tr>
<tr><td></td><td></td><td>Cost</td><td>Low</td><td>High</td><td></td></tr>
<tr><td></td><td>d)</td><td colspan="3">Compare between U tube and well type manometer.</td><td>4M</td></tr>
</table>

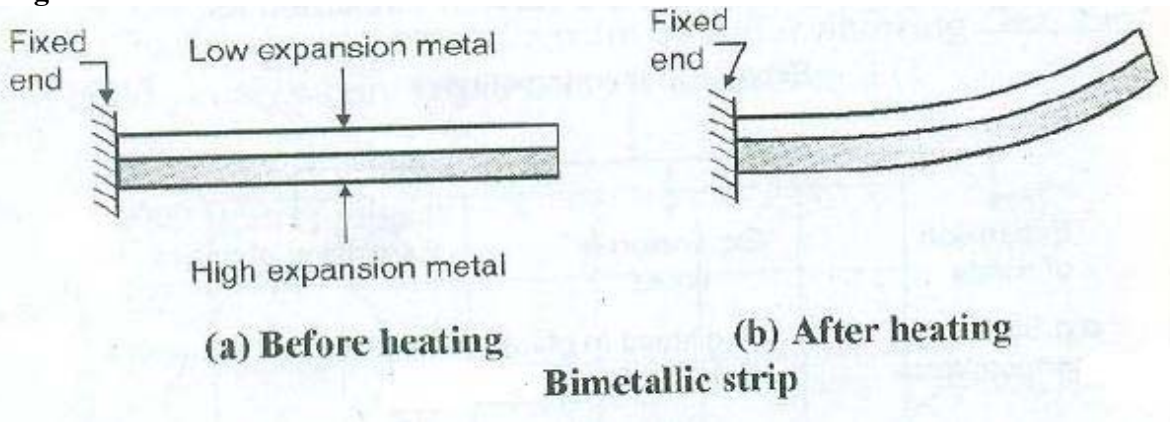
Ans:

Sr.No	U tube manometer	Well type manometer
1	 **Fig: U- Tube manometer** P_1 = High pressure P_2= Low pressure h= Difference in level liquid.	 **Fig: Well- type manometer**
2	U shape tube	Well shape with small capillary
3	It has two limb	It has only one limb
4	P_2=ρh	P_2- P_1= d $(1+A_1/A_2)H$

1M Each

e) Explain working principle of bimetallic thermometer. **4M**

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



		Construction and working : Figure shows construction of bimetallic thermometer, 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. 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 as shown in figure. The length of metal will change according to the individual expansion rate. As one end of bimetallic strip is fixed, the strip will bend at free end towards the side that of 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 is inversely proportional to the thickness of the metal. Pointer is attached to the free end to indicate the temperature.	**2M**
	f)	**List two advantages of capsule and bellows**	**4M**
	Ans:	**Advantages of capsule :--** 1. High accuracy 2. Suitable for low pressure measurement. **Advantages of bellows :--** 1. Good for low to moderate pressure range. 2. Adaptable for absolute and differential pressure.	**2M** **2M**