

**Important Instructions to examiners:**

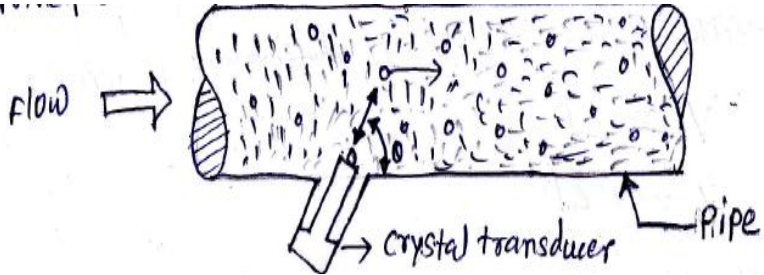
- 1) The answers should be examined by keywords and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling 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.	Question & its Answer	Remark	Total Marks
Q.1	Attempt any Six of following		12
i)	List any four different units of pressure		02
Ans	1. Measured in pascal(Pa). 2. Measured in pounds per square inch(psi) 3. Measured in kilogram per square of centimeter(Kg/cm ²). 4. Measured in newtons per square meter(N/m ²). 5. Measured in terms of liquid columns. mmHg or mmWc.	1/2 mark each	
ii)	Draw the block diagram of instrumentation system and label it		02
Ans	Diagram.	2 mark	



<p>iii)</p>	<p>State Seebeck and peltier effect</p>		<p>02</p>
<p>Ans</p>	<p>Seebeck effect: Seebeck 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.</p> <p>Peltier effect: Peltier effect state 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.</p>	<p>01 mark each</p>	
<p>iv)</p>	<p>List the types of orifice plates.</p>		<p>02</p>
<p>Ans</p>	<ol style="list-style-type: none"> 1. Concentric orifice plates. 2. Eccentric orifice plates. 3. Segmental orifice plates. 4. Quadrant edge orifice plates. 	<p>1/2 mark for each point</p>	
<p>v)</p>	<p>List two methods for measuring humidity.</p>		<p>02</p>
<p>Ans</p>	<ol style="list-style-type: none"> 1. Hair Hygrometer. 2. Sling type Hygrometer. 3. Capacitive type Hygrometer. 	<p>1 mark each point</p>	
<p>vi)</p>	<p>State the working principle of thermocouple</p>		<p>02</p>
<p>Ans</p>	<p>Thermocouple is a temperature transducer that develops an emf which is a function of temperature between hot junction and cold junction.</p>	<p>2 mark</p>	
<p>vii)</p>	<p>Classify the following flowmeters as variable head or variable area type.</p>		<p>02</p>



Ans	1. Orifice plate – Variable Head type. 2. Rotameter - Variable area type. 3. Venture - Variable Head type. 4. Pitot tube - Variable Head type.	1/2 mark each	
viii)	Define residual voltage in LVDT.		02
Ans	Residual voltage: Ideally the output voltage at null position should be zero but in actual practice small voltage drop occurs at zero displacement. It is called residual voltage	02 marks	
B)	Attempt any two of following;		08
i)	Describe the principle of operation of Doppler type ultrasonic flow meter for flow measurement with a neat labeled sketch		04
Ans	<p>Operating principle: Operating principle of this flow meter is based on Doppler principle.</p> <p>Diagram:</p>  <p>Construction and working:</p> <ul style="list-style-type: none">• Figure shows construction of Doppler flow meter, in which one crystal transducer emits an ultrasonic wave and the wave is projected at an angle through the pipe wall into the liquid.• The transducer is basically piezoelectric crystal with a heavy backing to attenuate the unwanted rear movement.• Some parts of the ultrasonic wave are reflected by the liquid particles and bubbles in the liquid and it is returned through the pipe wall towards the transducer.• As the liquid flows through the pipe the particles and bubbled in the liquid also moves these particles act as	01 mark for diagram	
		03 marks for worki ng	

	<p>reflectors for the ultrasonic wave.</p> <ul style="list-style-type: none"> The particles and bubbles moving with the velocity of the fluid, the frequency of the reflected wave is shifted according to particle velocity, it is given by Doppler principle. <p>Hence $V \propto \Delta f$.</p>		
<p>ii)</p>	<p>Describe how calibration of pressure measurement is done by using dead weight tester.</p>		<p>04</p>
<p>Ans</p>	<p>Diagram</p> <p>Working:</p> <ul style="list-style-type: none"> 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 	<p>02 marks for diagram</p> <p>02 marks for working</p>	



	<p>enough pressure is developed inside the cylinder and lifts the platform with weights placed on it and it floats freely within the limit stops.</p> <ul style="list-style-type: none">• 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.		
iii)	<p>Draw a neat setup diagram to measure level of a liquid in a tank using a float and potentiometer. Also identify the primary sensor and secondary transducer in the setup.</p>		04
Ans	<p>Float type liquid level indicator</p> <p>Diagram.</p> <p>2 - <u>float type liquid level indicator</u></p> <p>Fig. (1)</p> <p>OR</p>	02 marks for diagram	

Linear potentiometer liquid level gauge.

Diagram.

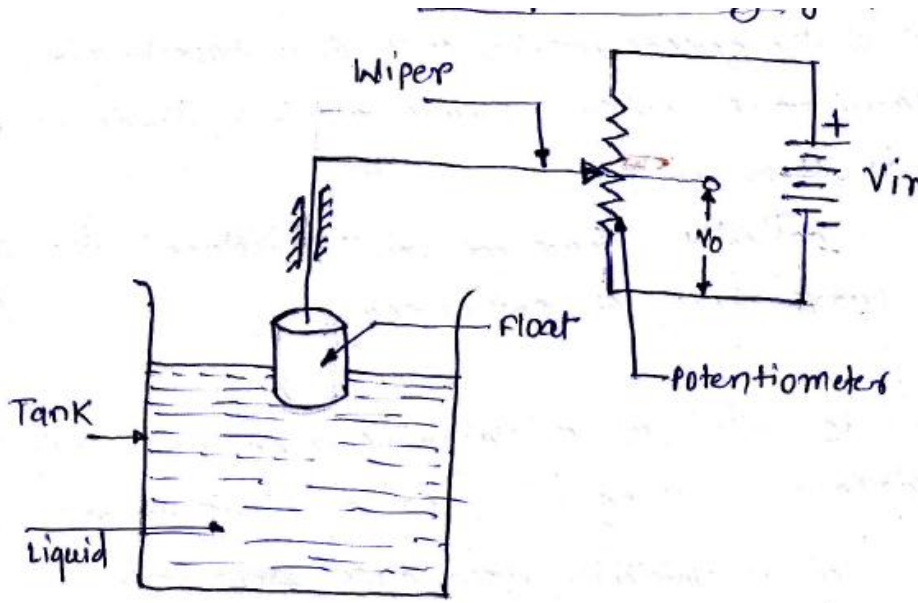


Fig. (2).

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.

**02
marks
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ng**

02 Attempt any four of following 16

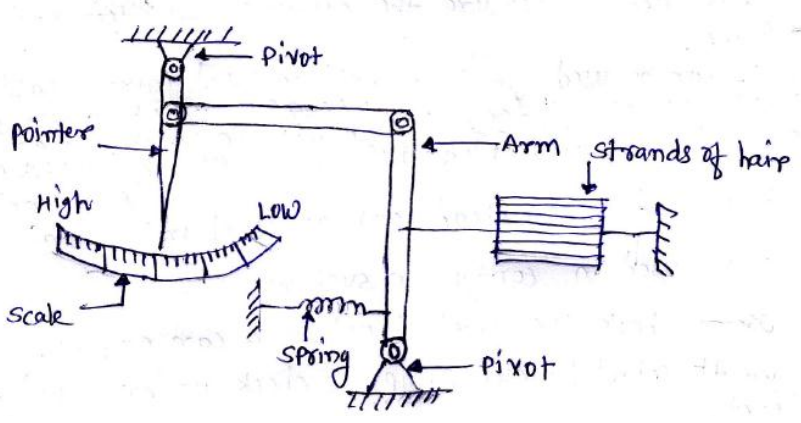
a) Draw the input-output characteristics of LVDT. Why is it called as differential transformer? 04

Ans Input-Output characteristics of LVDT:

	<p style="text-align: center;"><u>input-output characteristics of LYDT</u></p> <p style="text-align: center;">Fig. Relationship between input displacement and output voltage of LYDT.</p> <p>Explanation:</p> <p>A differential transformer consist of one primary winding & two secondary winding.</p> <p>The winding arranged concentrically and next to each other. When core at center displaced two unequal voltage introduced in secondary winding. To obtain single voltage at o/p these two winding are connected in series opposition. Hence o/p will be difference of these two voltage</p> <p>Therefore $V_0 = V_1 - V_2$.</p> <p>Hence it is differential transformer.</p>	<p>02 marks for diagram</p> <p>02 marks for explanation</p>	
<p>b)</p>	<p>Why rotameter is called as variable area flow meter? State the advantage of using a spherical float in rotameter.</p>		<p>04</p>
<p>Ans</p>	<p>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.</p> <p>Advantage of using a spherical float in rotameter(Any two)</p> <ol style="list-style-type: none"> 1) Float has higher density than the fluid. 2) It gives direct visual indication on a linear scale. 	<p>02 marks for definition</p> <p>02 marks (1 mark)</p>	

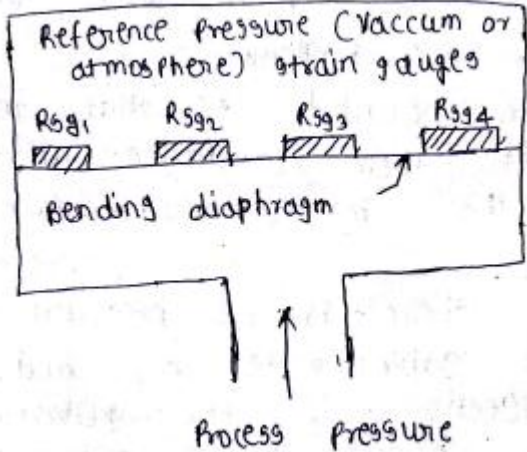
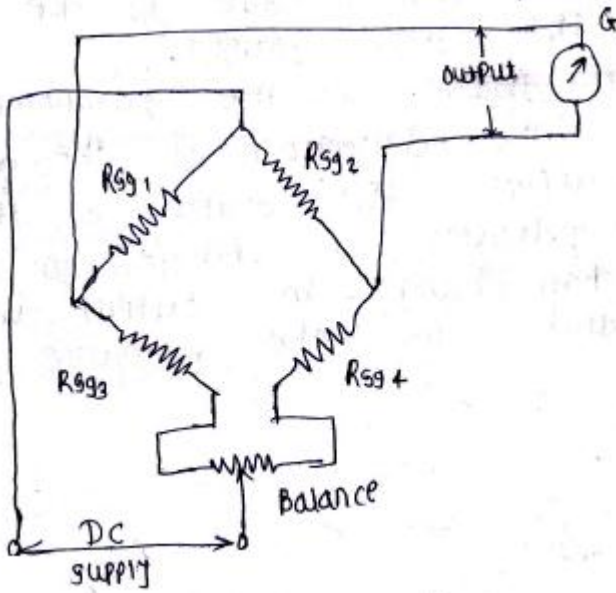


	3) It has good rangeability. 4) It has low pressure drop.			for each point)	
c)	Compare RTD with thermistor with reference to: (i) Working principle (ii) Materials (iii) Cost (iv) Range of measurement				04
Ans	Parameter	RTD	Thermistor	1 mark each for comparison	
	(i) Working principle	As temp of substance increases resistance also increases.	As temp of substance increases resistance decreases.		
	(ii) Materials	Material used in the RTD are platinum, copper, nickel, tungsten etc.	Material used in thermistor are manganese, copper, cobalt, iron oxides etc.		
	(iii) Cost	High cost	Low cost		
	(iv) Range of measurement	-200 ⁰ C to 650 ⁰ C.	-150 ⁰ C to 300 ⁰ C.		
d)	List of applications of (any 4 each) (i) Ultrasonic level measurement (ii) Float type level gauge				04
Ans	<u>Applications of (i) Ultrasonic level measurement</u> 1) It is used for level measurement of hazardous liquids and solids. 2) It can be used for both continuous and point measurements 3) It is used for level measurements containing liquid & solid with large & hard particles.			1/2 mark each	

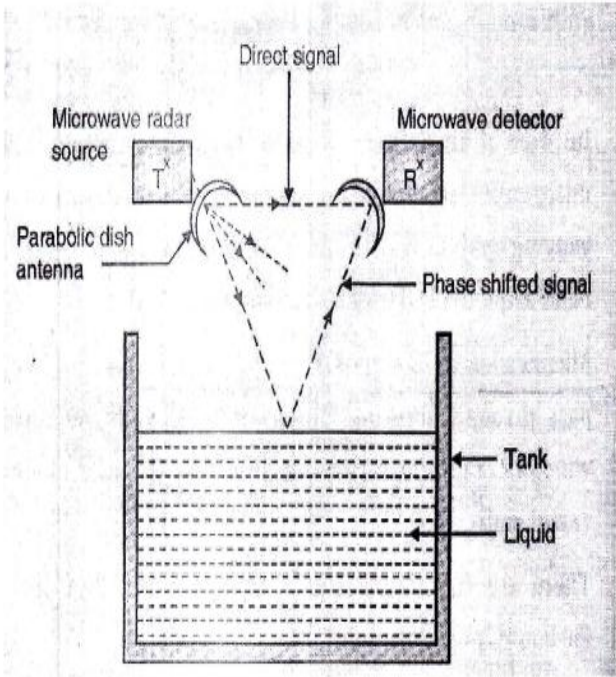
	<p>4) The point measuring devices used for gas/liquid, liquid/liquid or gas/solid interfaces.</p> <p><u>Applications of (ii) Float type level gauge:</u></p> <p>1) It is used in overhead tank as level indicator.</p> <p>2) It is used in continuous level measurement system.</p> <p>3) Use to check the level of oil in a car engine.</p> <p>4) Use at petrol/ diesel pumps to check underground tank level.</p>	<p>1/2 mark each</p>	
<p>e)</p>	<p>Define:(i) Gauge pressure (ii) Vaccum pressure</p>		<p>04</p>
<p>Ans</p>	<p>(i) Gauge pressure: It is defined as the difference between absolute pressure and atmospheric pressure.</p> <p style="text-align: center;">Gauge pressure = $P_{\text{Absolute}} - P_{\text{Atmospheric}}$</p> <p>(ii) Vaccum pressure: It is defined as the pressure below zero or negative pressure. It also called as differential pressure.</p> <p style="text-align: center;">$P_{\text{vaccum}} =$ pressure below zero or negative pressure</p>	<p>02 mark</p> <p>02 mark</p>	
<p>f)</p>	<p>With the help of neat labeled diagram describe principle of operation of hair hygrometer.</p>		<p>04</p>
<p>Ans</p>	<p>Diagram:</p>  <p>Construction and Working:</p> <p>1) Fig shows construction of hair hygrometer, it consists of bunch of</p>	<p>02 marks for diagram</p> <p>02</p>	



	<p>human hair which increases mechanical strength of instrument, arm with pivot joints and pointer scale assembly.</p> <p>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.</p> <p>3) The indicator scale is directly calibrated to give a direct indication of humidity. The pointer or recording pen is operated through mechanical linkage.</p> <p>4)As the relative humidity surrounding to that of hygrometer increases, length of hair strands increase , which move the pointer on the calibrated scale for maximum value.</p>	marks for working	
Q 3	Attempt any FOUR of following		16
a)	Write TWO examples of (i)Active transducer (ii)Resistive transducer (iii) Inductive transducer (iv)Digital transducer		04
Ans	Any two examples of each (i)Active transducer: a)Thermocouple b)Piezoelectric transducer c)Photovoltaic cells d) Tachogenerators (ii)Resistive transducer: a)Strain-gauge b) Potentiometer c)RTD (iii) Inductive transducer: a)LVDT b)RVDT (iv)Digital transducer: a) Rotary Encoder	01 mark for each	

	b)Optical Encoder		
b)	Draw pressure measurement setup diagram using strain gauge & state its working principle.		04
Ans.	 <p>Fig a. strain gauge transducer with diaphragm element</p>  <p>Fig b. strain gauge bridge circuit.</p> <p>Working Principle:</p> <p>1) Strain gauge is a passive type resistance pressure transducer</p>	02 marks for diagram	



	<p>whose electrical resistance changes when it is stretched or compressed. It can be attached to a pressure sensing diaphragm as shown in fig a.</p> <p>2) When diaphragm flexes due to the process pressure applied on it , the strain gauge stretches or compresses due to this its resistance changes .</p> <p>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.</p> <p>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.</p>	<p>02 mark for principle</p>	
<p>c)</p>	<p>Draw the diagram of radar level measurement .Write 1 advantage and disadvantage of it.</p>		<p>04</p>
<p>Ans.</p>	 <p>Fig: Radar Level Detector</p> <p>Advantages:</p>	<p>02 marks for diagram</p> <p>01 mark for advantage</p>	



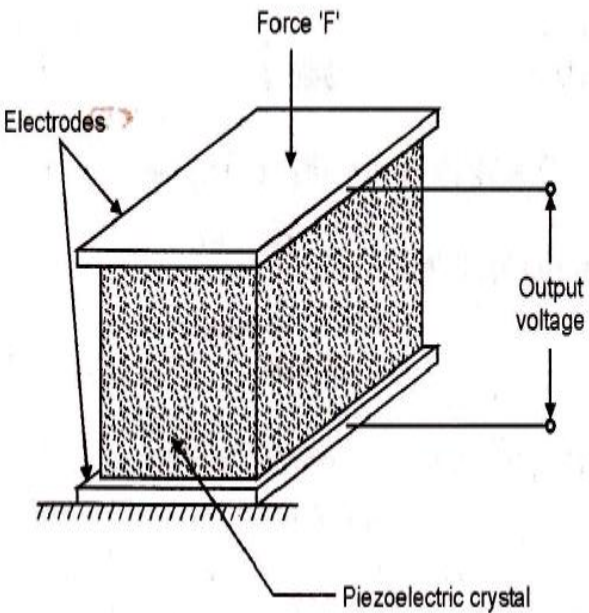
	<p>1) This is non contact technology.</p> <p>2) High accuracy for measurements in storage tanks and some process vessels.</p> <p>Disadvantages:</p> <p>1) Fairly expensive technology.</p>	01 mark for disadv antage	
d)	<p>An electric resistance bulb is made up of platinum wire, its resistance at 0°C is 100Ω. Determine the value at:</p> <p>(i)-100°C</p> <p>(ii)+250°C</p> <p>(Assumption temperature co-efficient = $0.385 \times 10^{-2}/^{\circ}\text{C}$).</p>		04
Ans	<p>(i) Resistance at -100°C</p> <p>$R_0 = 100\ \Omega$, $t_0 = 0^{\circ}\text{C}$, $R_t = ?$, $t_1 = -100^{\circ}\text{C}$</p> <p>Relation between resistance & temperature for resistance thermometer is</p> $R_t = R_0(1 + \alpha \Delta t)$ $= 100[1 + 0.00385(-100)]$ <p><u>$R_t = 61.5\ \Omega$</u></p> <p>(ii) Resistance at 250°C</p> <p>$R_0 = 100\ \Omega$, $t_0 = 0^{\circ}\text{C}$, $R_t = ?$, $t_1 = 250^{\circ}\text{C}$</p> <p>Relation between resistance & temperature for resistance thermometer is</p> $R_t = R_0(1 + \alpha \Delta t)$ $= 100[1 + 0.00385 \times 250]$ <p><u>$R_t = 196.25\ \Omega$</u></p>	02 marks	02 marks



e)	Define terms: (i) Absolute humidity (ii) Relative humidity		04
Ans	(i) Absolute humidity: <ul style="list-style-type: none">It is defined as a mass of water vapour present per unit volume.Absolute humidity = $\frac{\text{Mass of water vapour}}{\text{Mass of dry air}}$Absolute humidity changes as air pressure changesUnit of absolute humidity is Kg/m³ or g/m³. (ii) Relative humidity: <ul style="list-style-type: none">It is defined as a ratio of moisture content of gas to the maximum moisture the gas can contain at that temperature.Unit of relative humidity-It is expressed in percentage(%).Relative humidity = $\frac{\text{moisture content of gas}}{\text{Fully saturated air}}$	02 marks 02 marks	
f)	Calculate the output resistance of PT 100 RTD for temperature values 30⁰ C and 75⁰ C		04
Ans	a) For 30 ⁰ C temperature: For PT 100: R ₀ = 100 Ω at t ₀ = 0 ⁰ C Relation between resistance & temperature for resistance thermometer is $R_t = R_0(1 + \alpha \Delta t)$ assume $\alpha = 0.385 \times 10^{-2} / ^\circ \text{C}$ Resistance at t = 30⁰ C, $R_t = R_0(1 + \alpha \Delta t)$ $= 100[1 + 0.00385 \times 30]$	02 marks	



	<p style="text-align: center;"><u>$R_t=111.55 \Omega$</u></p> <p>b) For 75⁰ C temperature:</p> <p>For PT 100:</p> <p>$R_0= 100 \Omega$ at $t_0= 0^0$ C</p> <p>$R_t=?$, at $t=75^0$ C</p> <p>Relation between resistance & temperature for resistance thermometer is</p> $R_t=R_0(1+\alpha\Delta t)$ <p>assume $\alpha =0.385*10^{-2}/^0$ C</p> <p>Resistance at $t=75^0$ C,</p> $R_t=R_0(1+\alpha\Delta t)$ $=100[1+0.00385*75]$ <p style="text-align: center;"><u>$R_t=128.87 \Omega$</u></p>	02 marks									
Q 4	Attempt any FOUR of the following	16									
a)	Compare ultrasonic and radar level measurement with respect to working principle and construction.	04									
Ans	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%; text-align: center;">S r n o</th> <th style="width: 15%; text-align: center;">Paramet er</th> <th style="width: 35%; text-align: center;">Ultrasonic level measurement</th> <th style="width: 45%; text-align: center;">Radar level measurement</th> </tr> </thead> <tbody> <tr> <td style="height: 100px;"></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	S r n o	Paramet er	Ultrasonic level measurement	Radar level measurement					02 marks for each compa rison	
S r n o	Paramet er	Ultrasonic level measurement	Radar level measurement								

1	Working principle	It operates by generating an ultrasonic wave or pulse and measuring time it takes for the echo to return.	In this method the changes in the amplitude and/ or phase of the reflected signal is used to determine material present i.e liquid height.	
2	Construction	This gauge consist of an Ultrasonic transducer which has a set of transmitter and receiver	The microwave signal is generated by the source which is directing constant amplitude/frequency modulated microwave signal.	
b) Explain the principle of piezoelectric transducer. Name two piezoelectric materials.				04
Ans	<p>Principle of operation: When a pressure or force or vibration applied to the crystalline material like quartz crystal or crystalline substances then an e.m.f. is generated across the material or vice versa.</p>  <p style="text-align: center;">Fig. Piezoelectric Crystal</p>			02 marks



	Materials: 1) Natural Crystals- Quartz crystal, Rochelle salt 2) Synthetic Crystal-Barium Titanium	02 marks																																																													
c)	List different thermocouples with: i)Type ii) Material iii) Range iv)Sensitivity (Any four types)		04																																																												
Ans	<table border="1"><thead><tr><th>S</th><th>Ther</th><th>Materials used</th><th>Temperature</th><th>Sensitiv</th></tr><tr><th>er</th><th>mo-</th><th></th><th>range/⁰ C</th><th>ity</th></tr><tr><th>n</th><th>couple</th><th></th><th></th><th>$\mu V/^0 C$</th></tr><tr><th>o</th><th>type</th><th></th><th></th><th></th></tr></thead><tbody><tr><td>1</td><td>T</td><td>Copper/Constantan</td><td>-200 to 400</td><td>15 -60</td></tr><tr><td>2</td><td>E</td><td>Chromel/Constantan</td><td>0 to 850</td><td>40 – 55</td></tr><tr><td>3</td><td>J</td><td>Iron/Constantan</td><td>-200 to 900</td><td>45 – 57</td></tr><tr><td>4</td><td>K</td><td>Chromel/Alumel</td><td>-200 to 1250</td><td>40 – 55</td></tr><tr><td>5</td><td>R</td><td>Platinum/Platinum 13% Rhodium</td><td>0 to 1600</td><td>5 – 12</td></tr><tr><td>6</td><td>S</td><td>Platinum/Platinum 10% Rhodium</td><td>0 to 1500</td><td>5-12</td></tr><tr><td>7</td><td>B</td><td>Platinum 6% Rhodium / Platinum 30% Rhodium</td><td>30 to 1800</td><td>0.3 – 0.8</td></tr><tr><td>8</td><td>G</td><td>Tungsten/Tungsten 26%</td><td>15 to 2800</td><td>3 – 20</td></tr></tbody></table>	S	Ther	Materials used	Temperature	Sensitiv	er	mo-		range/ ⁰ C	ity	n	couple			$\mu V/^0 C$	o	type				1	T	Copper/Constantan	-200 to 400	15 -60	2	E	Chromel/Constantan	0 to 850	40 – 55	3	J	Iron/Constantan	-200 to 900	45 – 57	4	K	Chromel/Alumel	-200 to 1250	40 – 55	5	R	Platinum/Platinum 13% Rhodium	0 to 1600	5 – 12	6	S	Platinum/Platinum 10% Rhodium	0 to 1500	5-12	7	B	Platinum 6% Rhodium / Platinum 30% Rhodium	30 to 1800	0.3 – 0.8	8	G	Tungsten/Tungsten 26%	15 to 2800	3 – 20	01 marks for each type	
S	Ther	Materials used	Temperature	Sensitiv																																																											
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		Rhenium				
9	C	Tungsten 5% Rhenium / Tungsten 25% Rhenium	0 to 2750	10 - 20		
d)	State two advantages and two disadvantages of photoelectric pick up type speed measurement method.					04
Ans	Advantages (any two points) 1. No direct physical contact of the meter with rotating shaft whose speed to be measured. Hence no additional load on the shaft. 2. Output is in digital format 3. No A/D converter is required. 4. Electronic circuitry is simple because the pulse amplitudes are constant. 5. Continuous measurement is possible. Disadvantages: 1. Life span of light source is limited. 2. The accuracy of meter is depends on the error represented by one pulse.					02 marks 02 marks
e)	Describe the working principle of bimetallic thermometer. State its two merits and demerits.					04
Ans	Working principle: Bimetallic thermometers used two fundamental principles: 1. All metals expand or contracts with change in temperature. 2. The temperature coefficient of expansion is not same for all					02 marks

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.

3. Bimetallic strip is made up of two different metals 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.

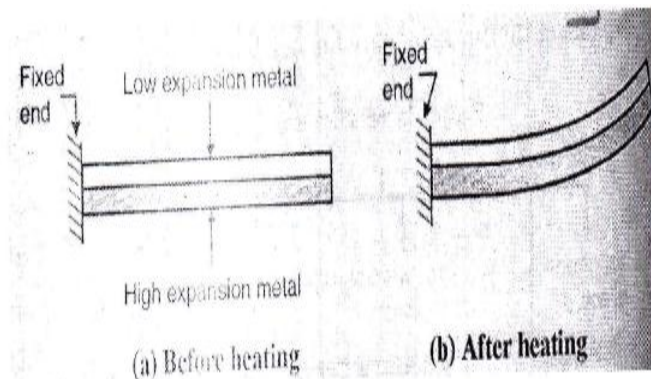


Fig. Bimetallic Thermometer

Merits : (Any two points)

1. Easily installed and maintained.
2. Accuracy is good.
3. Wide temperature ranges are available.
4. Cost is very low.
5. Nearly linear response.

Demerits: (Any two points)

1. Calibration is disturbed if roughly handled.
2. Indicators are used to display.
3. It is suitable at local mounting only.

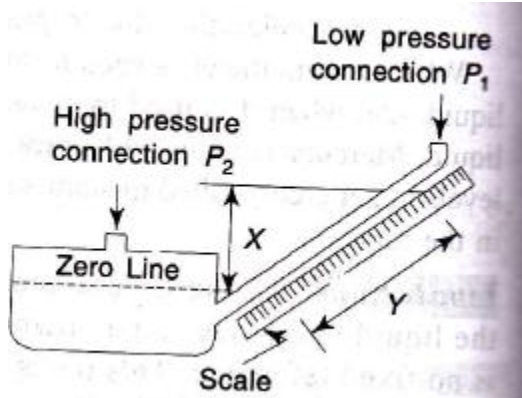
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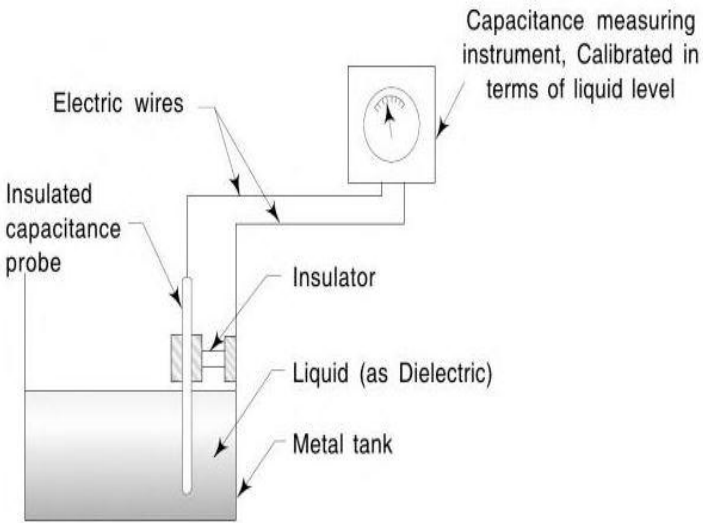
f)

Sketch constructional diagram of inclined manometer. State its advantages and disadvantages.

04

<p>Ans</p>	<div data-bbox="441 289 959 684" data-label="Image">  </div> <p style="text-align: center;">Fig: Inclined Manometer</p> <p>Advantages: (Any two points)</p> <ol style="list-style-type: none"> 1. Simple and time proven. 2. High accuracy and sensitivity. 3. Wide range of filling fluids of varying specific gravities is available. 4. Its cost is reasonable. 5. Suitable for low pressure and low differential pressure applications. <p>Disadvantages: (Any two points)</p> <ol style="list-style-type: none"> 1. Large and bulky. 2. Need leveling. 3. Not portable. 4. Measured fluid must be compatible with manometer fluid. 5. No over range protection. 	<p>02 marks for Diagram</p> <p>01 mark (1/2 mark for each)</p> <p>01 mark (1/2 mark for each)</p>	
<p>05</p>	<p>Attempt any FOUR of the following:</p>		<p>16</p>
<p>a)</p>	<p>Draw labeled diagram of Electromagnetic flow meter.</p>		<p>04</p>
<p>Ans</p>	<p>Diagram:</p>		

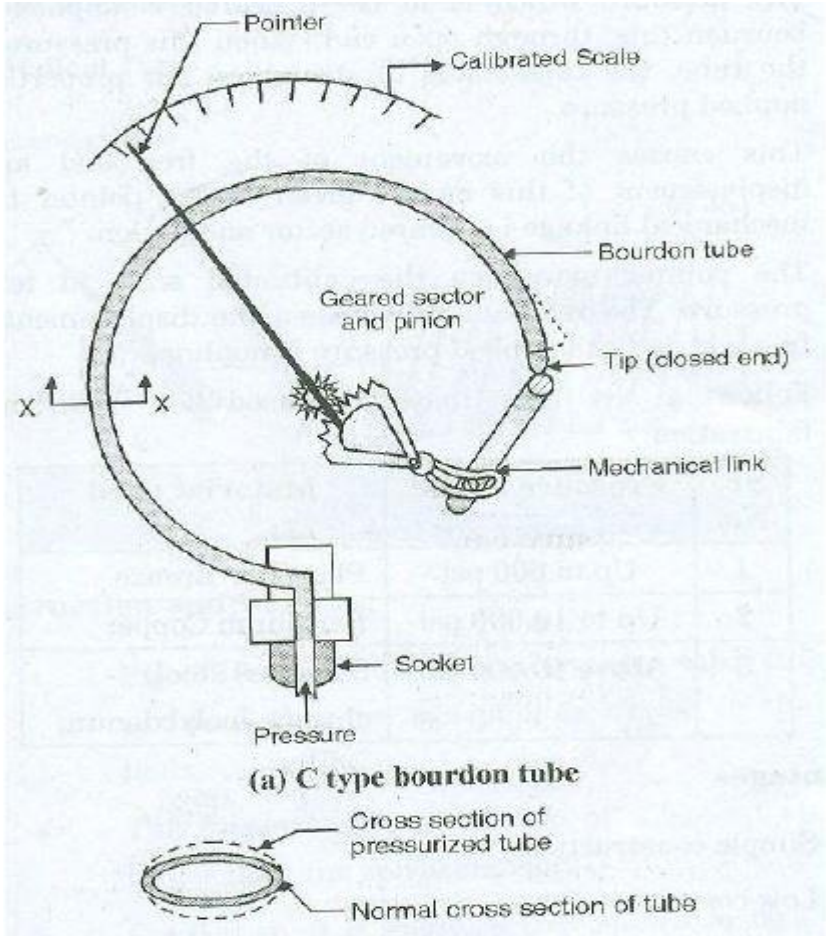
	<p style="text-align: center;">Fig: Electromagnetic Flow meter</p>	<p>2 Marks for diagram</p> <p>2 marks for Labeling</p>	
<p>b)</p>	<p>Mention different temperature scales and give conversation formulae.</p>		<p>04</p>
<p>Ans</p>	<p>Different temperature scales are(Any four)</p> <p>Conversion Formulae-(Any four)</p> <p>Fahrenheit to Celsius: $^{\circ}C = \frac{5}{9} (^{\circ}F - 32)$</p> <p>Celsius to Fahrenheit: $^{\circ}F = \frac{9}{5} C + 32$</p> <p>Kelvin to Celsius: $K = ^{\circ}C + 273.15$</p> <p>Celsius to Kelvin: $^{\circ}C = K - 273.15$</p> <p>Fahrenheit to Kelvin: $K = ^{\circ}F + 457.87$</p> <p>Kelvin to Fahrenheit: $^{\circ}F = K - 457.87$</p> <p>Rankine to Fahrenheit: $^{\circ}R = ^{\circ}F + 459.69$</p> <p>Rankine to Celsius: $^{\circ}R = 9/5 ^{\circ}C + 491.69$</p>	<p>02 Marks (1/2 mark for each)</p> <p>02 Marks (1/2 mark for each)</p>	

c)	List any eight points for selection of transducer.		04
Ans	<p>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.</p> <ol style="list-style-type: none"> 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 	04 marks (1/2 mark for each)	
d)	With neat diagram, explain working of capacitance level measurement.		04
Ans	 <p style="text-align: center;">Fig. Capacitance level Measurement.</p>	02 Marks for diagram	

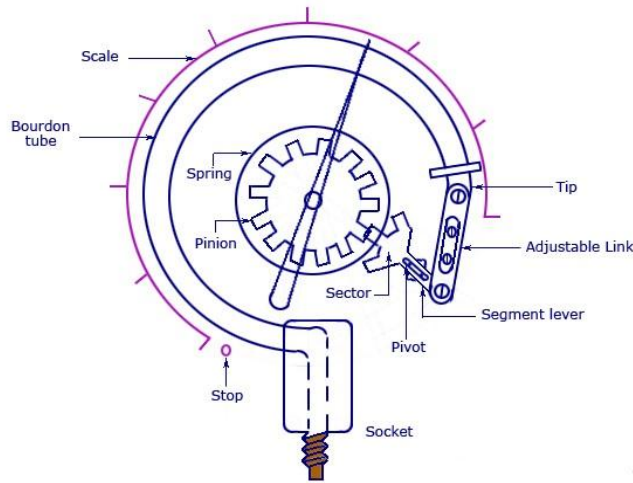


	<p>The principal of operation of capacitance level measurement based upon the familiar capacitance equation of a parallel plate capacitor given by:</p> $C = K \frac{A}{D}$ <p>where, C = Capacitance, in farad K = Dielectric constant A = Area of plate, in m^2 D = Distance between two plates, in m</p> <p>Working-</p> <ul style="list-style-type: none">• It consist of an insulated capacitance probe (which is metal electrode) firmly fixed near and parallel to the metal wall of the tank.• If liquid in the tank is non-inductive, the capacitance probe and the tank wall form the plates of a parallel plate capacitor and liquid in between them acts as the dielectric.• If liquid is conductive, the capacitance probe and liquid form the plate of the capacitor and the insulation of the probe act as the dielectric.• A capacitance measuring device is connected with the probe and the tank wall, which is calibrated in terms of the level of liquid in the tank.• When the level of liquid in the tank rises, the capacitance increases, when liquid level in the tank decreases, the capacitance also decreases.• This increase and decrees in the capacitance is measure and is displayed on the indicated calibrated in terms of liquid level.	02 Marks For Worki ng	
e)	Which arenon-contact type tachometer? Compare them on the basis of any two factors.		04
Ans	<p>Non-contact type tachometer-</p> <ul style="list-style-type: none">• A non-contact tachometers are those in which there is no direct contact between the instrument and the rotating shaft.• This type of tachometer produces pulses remotely, either influenced by magnetic and optical signal.• The different types of non-contact type tachometers are-<ol style="list-style-type: none">1. Photo pick-up type2. Magnetic pick-up type3. Capacitive pick-up type4. Optical type <p>Comparison(Any two)</p>	2 Marks for types	



Sr. No.	Photo pick-up	Magnetic pick-up		2 Marks (1 mark for each Comparison)	
1	It works on principle of light reflection by reflected mark.	It works on the principal of change in magnetic field due to rotation.			
2	Light source and photodetector is used.	Rotor teeth & magnetic pickup sensor is used for measurement.			
3	External light may affect measurement.	External magnetic field may affect measurement.			
f)	Draw the constructional detail of C type Bourdon tube and explain its working.			04	
Ans	 <p>Fig: C-Type Bourdon Tube</p>		2 Marks for Diagram		

OR



Bourdon Tube Pressure Gauge

Fig: C-Type Bourdon Tube

Working-

- 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.

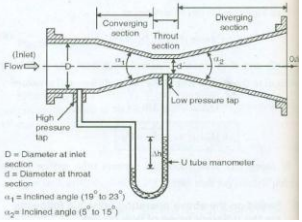
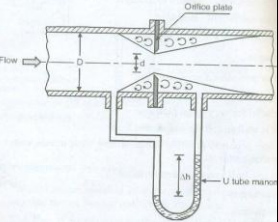
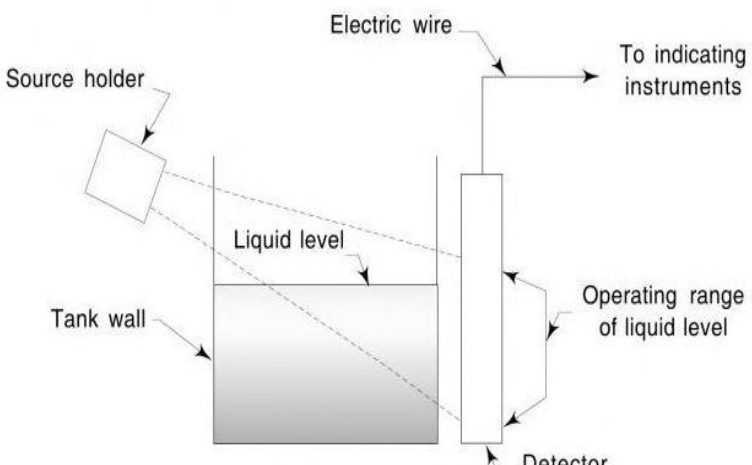
**2
Marks
For
Worki
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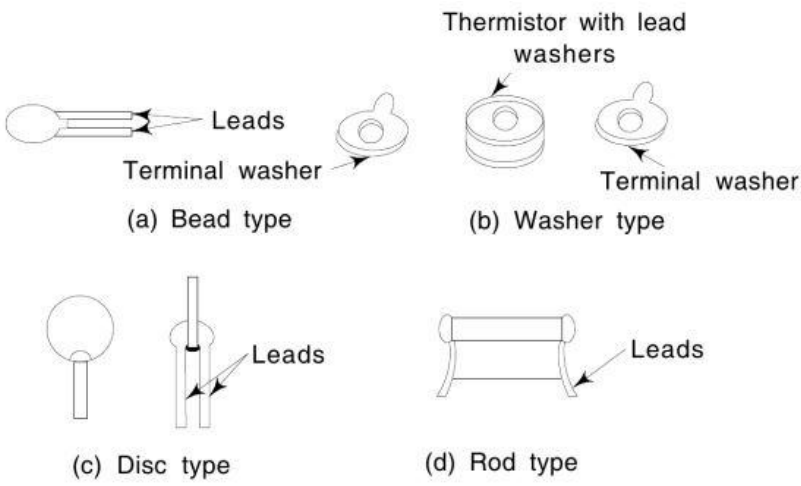
Q. 6 Attempt any FOUR of the following:

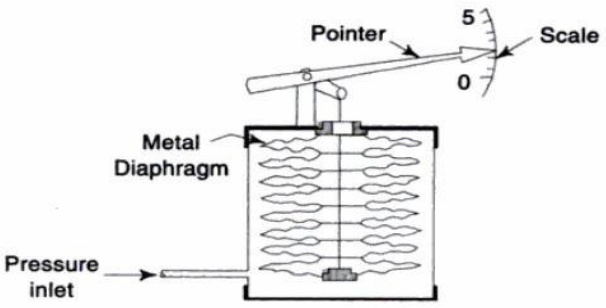
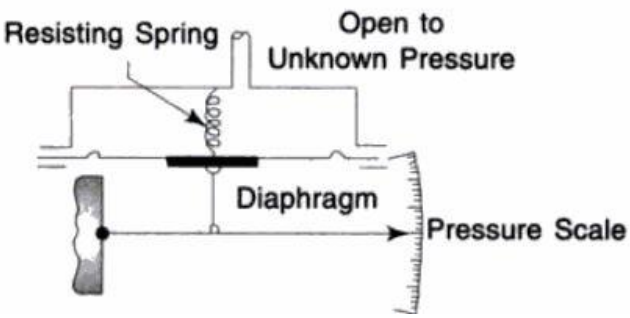
16



a)	List application of angular potentiometer and capacitive transducer.		04						
Ans	<p>Angular potentiometer:</p> <ol style="list-style-type: none"> 1. Used as secondary transducer in Level measurement. 2. Position and angular displacement measurement. <p>Capacitive transducer- (any two)</p> <ol style="list-style-type: none"> 1. Used for measurement of linear and angular displacement. 2. Used to measure humidity in gases. 3. Used to measure volume, density. 4. Used in liquid level measurement. 5. Used for dimension measurement. e.g. thickness. 	<p>2 Marks (1 mark for each point)</p> <p>2 Marks (1 mark for each point)</p>							
b)	Express the pressure of 260 mm Hg vacuum in absolute and gauge pressures.		04						
Ans	<p>Vacuum pressure = 260 mmHg. Here vacuum pressure is given therefore absolute pressure is less than atmospheric pressure. We know that Atmospheric pressure = 760 mm Hg. Therefore, Absolute pressure = Atmospheric pressure – Vacuum Pressure $= 760 - 260$ <u>Absolute pressure = 500 mm Hg.</u></p> <p>The negative gauge pressure is also called as vacuum pressure. <u>Gauge pressure = 260 mm Hg.</u></p>	<p>2 Marks</p> <p>2 Marks</p>							
c)	Differentiate between ventury and orifice plate type of flowmeters on the basis of pressure recovery, construction, application and cost.		04						
Ans	<table border="1" data-bbox="240 1793 1052 1871"> <thead> <tr> <th>parameters</th> <th>Ventury tube</th> <th>Orifice Plate</th> </tr> </thead> <tbody> <tr> <td>Pressure</td> <td>Ventury tube operates</td> <td>It is variable area</td> </tr> </tbody> </table>	parameters	Ventury tube	Orifice Plate	Pressure	Ventury tube operates	It is variable area	<p>1 Mark for each</p>	
parameters	Ventury tube	Orifice Plate							
Pressure	Ventury tube operates	It is variable area							

recovery	on the principle that when restriction is placed in the path of flow, it produces differential pressure across the restriction which is proportional to the flow rate.	flow meter in which the differential pressure is developed by using orifice plate by inserting it in the path of the fluid flow.	point of comparison			
Construction	 <p>D = Diameter at inlet section d = Diameter at throat section α_1 = Inclined angle (19° to 23°) α_2 = Inclined angle (5° to 15°)</p>					
Application	Used to measure volume flow of blood through vessels, waste water applications	Useful in chemical, feed, milling mineral, paint industry.				
Cost	High	Low				
d)	Determine working principle of radiation level measurement with neat diagram.			04		
Ans	<p>Radiation level measurement is non-contact type liquid level measurement technique. Radiation detectors are used where other electrical methods would not survive.</p> <p>Diagram-</p>  <p>Fig: Radiation type Level Measurement.</p>		2 Marks for Diagram			

	<p>Construction and working-</p> <ul style="list-style-type: none"> • It consist of gamma ray source holder on one side of the tank and a gamma detector on the other side of the tank. • The gamma rays from source are directed towards the detector in a thin band of radiation. • When gamma rays penetrate the thick wall of the tank, its energy level afterwards is greatly reduced. • 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. • 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. • Thus, when liquid level rises, the amount of radiation received is reduced and vice versa. 	<p>2 Marks For Worki ng princi ple</p>	
e)	<p>What is thermistor? State types of thermistor. State any four advantages of thermistor.</p>		04
Ans	<p>Thermistor:</p> <ul style="list-style-type: none"> • Thermistor is a contraction of term “Thermal Resistor”. • They are essentially semiconductors which behave as resistors with a high negative temperature co-efficient of resistance. • Thermistors are widely used in such applications especially in the temperature range of -60 °C to+ 15 °C. <p>Types of thermistors:</p>  <p>(a) Bead type: A small bead with two leads and a terminal washer.</p> <p>(b) Washer type: A washer with two leads and a terminal washer.</p> <p>(c) Disc type: A disc with two leads.</p> <p>(d) Rod type: A rod with two leads.</p>	<p>1 Mark</p> <p>1 Mark</p> <p>2</p>	

	<p>Advantages of thermistors(Any two)</p> <ol style="list-style-type: none"> 1. They have small size and fast response. 2. They are suitable for narrow span. 3. Their cost is low. 4. Greater sensitivity. 5. Due to large resistance, the contact or lead-wire resistance is considered as negligible. 6. Compensation is not required. 7. Stability of the instrument increases with age. 8. They are adaptable to various electrical read out. 	<p>Marks (1/2 mark for each)</p>	
<p>f)</p>	<p>Explain with neat diagram, diaphragm gauge pressure transducers. Write the range of pressure that can be measured by diaphragm gauge.</p>		<p>04</p>
<p>Ans</p>	<p>Diagram:</p>  <p>Fig. Metallic Diaphragm</p> <p style="text-align: center;"><u>OR</u></p>  <p>Fig. Slack Diaphragm Gauge</p> <p>Explanation:</p>	<p>1 Mark for Diagram</p> <p>2 Marks</p>	



<ul style="list-style-type: none">• The diaphragms can be in the form of flat, corrugated or dished plates.• In high precision instruments the diaphragms are generally used in a pair, back-to-back, to form an elastic capsule.• Two types of diaphragms are<ol style="list-style-type: none">1. Metallic Diaphragm Gauge.2. Slack Diaphragm Gauge.• It consist of a thin flexible diaphragm made of materials such as brass or bronze.• A pointer is attached to the diaphragm, the force of pressure against the effective area of the diaphragm causes a deflection of diaphragm.• In some cases the deflection of the diaphragm is opposed by the spring to limit the deflection.• The motion of the diaphragm operates an indicating or a recording type of instrument. <p>Pressure range(Any one)</p> <ol style="list-style-type: none">1. Metallic diaphragm- 40 millibar to 600 millibar2. Slack Diaphragm- 0.01 – 0.40 mm Hg (torr).	<p>1 Mark</p>	
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