**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.

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>Sub Q. N.</th>
<th>Answers</th>
<th>Marking Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Attempt any SIX:</td>
<td>12- Total Marks</td>
</tr>
<tr>
<td></td>
<td>a</td>
<td>Define transducer. Give two examples.</td>
<td>2M</td>
</tr>
<tr>
<td></td>
<td>Ans:</td>
<td><strong>Definition:</strong> Transducer is defined as a device which converts energy from one form to another i.e. physical to physical, physical to electrical or electrical to physical.</td>
<td>Definition 01 M</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1) Thermocouple</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) RTD</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Thermistor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Bimetallic strips</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5) Bourdon Tube</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6) Rotameter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7) Ventury tube</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8) Orifice plate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>State classification of flow meters.</td>
<td>2M</td>
</tr>
<tr>
<td></td>
<td>Ans:</td>
<td>2 Marks</td>
<td></td>
</tr>
</tbody>
</table>
c Define laminar flow and turbulent flow.

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.

2M

01 M each

---

d Draw only diagram of capsule.

Ans:

02 Marks
### e) List four electric pressure transducer.

**Ans:**

List of electric pressure measuring devices:

1. Diaphragm with strain gauge
2. Bourdon Tube with LVDT
3. Differential Pressure cell
4. Piezoelectric type pressure transducer
5. Capacitance pressure transducer
6. Optical Pressure transducer
7. Resistive pressure transducer

### f) State the necessity of transducer.

**Ans:**

**Necessity of Transducer:**

Input quantity for most of the Instrumentation systems is non-electrical quantity. To convert non-electrical quantities like heat, pressure, level, flow rate, humidity, temperature, etc. into electrical quantity in order to use electrical methods and techniques for measurement, manipulation and control, transducers are required.

### g) Define (i) Absolute Humidity (ii) Relative Humidity.

**Ans:**

**i) Absolute Humidity:** It is defined as the mass of water vapour present per unit volume.

\[ H_a = \frac{m}{V_g} \]

Its unit is gram per cubic meter \( (g/m^3) \)

**ii) Relative Humidity:** It is defined as a ratio of moisture content of the gas to the maximum moisture the gas can contain at that temperature.

\[ \% H_r = \frac{\rho_g}{\rho_s} \times 100 \]

Where,

\( \rho_g = \) moisture content of gas

\( \rho_s = \) fully saturated air

**OR**

Relative Humidity is defined as a ratio of the amount of water vapour actually present to the maximum amount of water vapour the gas can contain at that temperature.
h List the four different units of pressure.  
 Ans: The different units of pressure:
1) \( \text{N/M}^2 \) (Newton's Per meter Square)
2) Pascal (Pa)
3) Bar
4) Torr
5) mm Hg (Millimeter of Mercury column)
6) mmWC (Millimeter of Water Column)
7) PSI (Pounds per Square inch)
8) Psia (Pounds Per Square inch absolute)
9) Psig (Pound Per Square inch gauge)

B Attempt any TWO:  
8- Total Marks

a What is piezoelectric effect? Name two piezoelectric material.
 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

b Describe principle of operation of Doppler type ultrasonic flow meter with diagram.
 Ans: Diagram:

Working:
- The flow meter consists of a crystal transducer mounted outside the pipe in which flow is to be measured. This transducer is a piezoelectric crystal which emits an ultrasonic wave and the wave is projected at an angle through the pipe wall into the liquid.
- As the liquid flows through the pipe the particles and bubbles in the liquid also move and
these particles act as reflectors for the ultrasonic wave.

- Part of the ultrasonic wave is reflected by the particles and bubbles in the liquid and is returned through the pipe wall to the transducer.
- The particles and bubbles move with the velocity of the fluid, so the frequency of the reflected wave is shifted to particle velocity, according to Doppler principle.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>Draw the constructional detail of C type bourdon tube and explain its working.</td>
</tr>
</tbody>
</table>

**Ans:**

**Constructional Diagram:**

[Diagram of C type bourdon tube with labeled parts: pointer, calibrated scale, bourdon tube, geared sector and pinion, socket, mechanical link, pressure symbol, X+X.]

**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. The free end of this tube is closed or sealed and the other end (fixed end) is opened for the pressure to enter.
- The free end is connected to the pointer with the help of geared sector and pinion. Calibrated scale and pointer is provided to indicate the pressure.
- 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.
**SUMMER– 18 EXAMINATION**

Subject Name: Industrial Measurements  
**Model Answer**

<table>
<thead>
<tr>
<th>Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>16- Total Marks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>.</th>
<th>N.</th>
<th>Attempt any FOUR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td>4M</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>a</th>
<th>Draw block diagram of instrumentation system. State function.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ans</td>
<td>Diagram:</td>
</tr>
</tbody>
</table>

![Block diagram of instrumentation system](image)

**Fig: Block diagram of instrumentation system.**

**Functions of each block:**

- **Primary sensing element:** This first receives energy from the measured medium and produces an output depending on measured quantity.
- **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.
- **Variable manipulation element:** Manipulates the signal represented by some physical variable, to perform the intended task of an instrument. In the manipulation process, the physical nature of the variable is preserved.
- **A data transmission unit:** Transmits the data from one element to the other.
- **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.

**NOTE:** marks may be awarded to any other relevant block diagram of instrumentation system.

<table>
<thead>
<tr>
<th>b</th>
<th>Draw the experimental setup to measure pressure in terms of voltage. Also discuss which types of transducer used in it.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ans</td>
<td>Diagram:</td>
</tr>
</tbody>
</table>

![Experimental setup](image)

03 M
Types of Transducer used:

1) Natural crystals: Quartz crystal
2) Synthetic crystals: Barium Titanate

State comparison between PTC and NTC.

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>PTC</th>
<th>NTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It is positive temperature coefficient</td>
<td>It is negative temperature coefficient</td>
</tr>
<tr>
<td>2</td>
<td>As temperature increases, resistance increases</td>
<td>As temperature increases resistance decreases</td>
</tr>
<tr>
<td></td>
<td>$R \propto T$</td>
<td>$R \propto \frac{1}{T}$</td>
</tr>
<tr>
<td>3</td>
<td>Examples of materials with PTC include barium titanate, titanium oxide and powdered barium carbonate</td>
<td>Examples of materials with NTC include metal oxides such as Manganese, nickel, cobalt, copper, iron and uranium.</td>
</tr>
<tr>
<td>4</td>
<td><img src="image.png" alt="Graph" /></td>
<td><img src="image.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
**Subject Name:** Industrial Measurements  
**Model Answer**

<table>
<thead>
<tr>
<th>Q</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
</table>
| d | What is pressure calibration? State stepwise procedure to test the accuracy of pressure gauge with dead weight tester. | **Pressure Calibration:**  
It is the process of adjusting the instrument’s output signal to match a known range of pressures.  
Calibration of a given pressure gauge can be done with the help of dead weight pressure gauge tester. In this method, the output of the given faulty or uncalibrated pressure gauge is compared with pre calibrated dead weight pressure and corrected.  
**Diagram For Dead weight Pressure gauge tester:**  
![Diagram 1½ M](image)

**Stepwise procedure:**  
- The handle of the dead weight tester 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 the piston is also known; hence we can calculate the pressure.  
- Now the handle is turned in clockwise direction so that the pressure will buildup on the gauge side as well as platform side.  
- The pressure is increased by rotating the handle clockwise until enough pressure is developed inside the cylinder to lift the platform with weights placed on it and it floats freely.  
- The procedure is repeated for different weights (increase weights in steps). In the same way most of the pressure gauges are calibrated against dead weight testers.  

| e | Differentiate between float type measurement and capacitive type measurement for level measurement. | 4M |
### Question 1

**Sr.No.** | **Float Type level Measurement** | **Capacitive type Level Measurement**
--- | --- | ---
1 | This method provides non electrical output signal | This method provides an electrical output signal
2 | Diagram: | Diagram: |
3 | Range for conducting type liquid: 100ft (30m) | Range for conducting type liquid: 12ft
4 | Range for Non conducting liquid: 200ft (60m) | Range for Non conducting liquid: 8 ft.
5 | Comparatively less costly method | Comparatively more costly method

### Question 2

**Ans:**

**What is pyrometry?** Describe working of optical pyrometer with neat diagram.

**Ans:**

**Pyrometer:**

When physical contact with the medium to be measured is not possible or impractical due to very high temperature (above 1400°C) pyrometers are used for temperature measurement.

(Or)

Pyrometry is the technique of measuring temperature of a body without actual physical contact.

**Diagram of Optical Pyrometer:**

![Diagram of Optical Pyrometer]
The working principle of optical pyrometer can be stated 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(i).
2) When the temperature of filament is lower, the filament becomes too dark as shown in fig(ii)
3) When the brightness of image produced by the source and brightness produced by the filament are equal, the outline of the filament disappears figure (iii)
**Attempt any FOUR:**

**a** With neat diagram, explain working of capacitance level measurement.

**Ans:**

**working:**

The capacitive level detector operates on the equation of parallel plate capacitor, i.e. $C = \varepsilon \frac{A}{d}$. It consists of an insulated capacitance probe (which is a 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 plates of the capacitor and insulation of the probe acts as the dielectric. A capacitance measuring device is connected with the probe and the tank wall, which is calibrated in terms of the level of 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 decrease in the capacitance is measured and is displayed on the indicator calibrated in terms of liquid level.
b) Explain working principle of bimetallic thermometer.

Ans:

![Bimetallic Thermometer Diagram](image)

**Working principle:**

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.

<table>
<thead>
<tr>
<th>c</th>
<th>State two advantages and two disadvantages of radiation type level measurement.</th>
<th>4M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ans:</td>
<td><strong>Advantages:</strong></td>
<td>Advantages-2M</td>
</tr>
<tr>
<td></td>
<td>1. Quite suitable for large reservoirs of 30-40 m diameter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Continuous measurement is possible.</td>
<td></td>
</tr>
</tbody>
</table>
### State two advantages and two drawbacks of liquid filled and gas filled thermometer.

#### Liquid filled thermometer

**Advantages:**

1. They are comparatively cheaper than other temperature measurement devices.
2. They are handy and convenient to use.
3. Unlike electrical thermometers, they do not necessitate power supply or batteries for charging.

**Disadvantages:**

1. Limited to applications where manual reading is acceptable, e.g. a household thermometer.
2. Have a limited usable temperature range.

#### Gas filled thermometer

**Advantages:**

1. Gas thermometers have wide range of temperature.
2. Permanent gases have close resemblance with perfect gas. Therefore, the thermometers filled with Permanent gases give the reading close to thermodynamic scale.

**Disadvantages:**

1. Larger bulb size.
2. Generates less deflection force for controlling device.
e. Explain the need of level measurement.

Ans:

Need of level measurement:
In almost all industries, vast quantities of liquids such as water, solvents, chemicals etc. are used in number of processes. Liquid level measurements are widely employed to monitor as well as measure quantitatively the liquid content in the tanks, containers, vessels, reservoirs or liquid columns. The liquid level affects both pressure and rate of flow in and out of the container and therefore its measurement/control becomes important in maintaining the overall process conditions. Hence improved level measurement accuracy makes it possible to reduce chemical-process variability, resulting in higher product quality, reduced cost, and less waste.

f. Compare RTD and thermistor on the basis of temperature coefficient, linearity, temperature range and cost.

Ans:

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Parameters</th>
<th>RTD</th>
<th>Thermistors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Temperature</td>
<td>It has positive temperature</td>
<td>It has both positive and negative</td>
</tr>
<tr>
<td></td>
<td>coefficient</td>
<td>Coefficient (PTC) of Resistance.</td>
<td>Temperature Coefficient (PTC and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NTC) of Resistance.</td>
</tr>
<tr>
<td>2</td>
<td>linearity</td>
<td>It is Linear</td>
<td>It is non Linear</td>
</tr>
<tr>
<td>3</td>
<td>Temperature</td>
<td>-270oC to 2800oC</td>
<td>-150oC to 300oC</td>
</tr>
<tr>
<td></td>
<td>range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Cost</td>
<td>High cost</td>
<td>Low cost</td>
</tr>
</tbody>
</table>

q. No. Sub Q. N. | Answers | Marking Scheme |
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Attempt any FOUR:</td>
<td>12- Total Marks</td>
</tr>
<tr>
<td>a</td>
<td>Draw construction diagram of LVDT with label. Also state the application of LVDT.</td>
<td>4M</td>
</tr>
</tbody>
</table>
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 as a secondary transducer, used to measure force, weight and pressure.

b) State two advantages and two disadvantages of photoelectric pick-up speed measurement method.

**Advantages:**

1) It is a digital instrument so high accuracy.
2) Pulse amplitudes are constant.
3) This simplifies the electronic circuitry.

**Disadvantages:**

1) Light source must be replaced time to time.
2) The accuracy depends on the error represented by one pulse.

c) Describe working of venturimeter with neat sketch.

**Ans:**

Diagram-2M

Advantages-2M

Disadvantages-2M

Diagram-2M
Venturi meter consists of three sections that is converging section, throat section and diverging section.

The flow is introduced to the meter through the inlet with diameter ‘D’. The inclined angle of the converging section is $\alpha_1$ which may be between 19° to 23°.

The flow is then passed through the throat section which have the diameter ‘$d$’.

Two pressure taps (one at inlet section and second is at middle of throat section) are provided to measure the pressure difference by using U-tube manometer as shown in figure.

The diversion section has inclined angle $\alpha_2$ which may be between 5° to 15°.

Flow rate is proportional to the square root of the differential pressure.

Flow rate $\propto \sqrt{P_1 - P_2}$

**What is tachometer? Explain photo electric pick-up.**

**Ans:**

Tachometer is an instrument which is used to measure angular speed. It is measured in revolutions per minutes (RPM).
**Working:**

Working principle: The light passes through the holes available on the rotating disc with a specific interval, depends on the angular speed of disc having equidistant holes. The frequency of this light pulses is measure of angular speed of the disc.

It consists of an opaque disc on the rotating shaft. The disc has a number of equidistant holes on its periphery. At one side of the disc a light source is fixed like LED and on other side of the disc, and on the line of the light source, a light sensor like phototube or some photosensitive semiconducting device is placed.

When a hole appears between two, the light following upon the sensor produces an output pulse.

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

\[ N = \frac{f}{H_s} \]

- **N** = speed
- **f** = frequency
- **Hs** = holes on the disc

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>e) What is a psychometer? Draw neat diagram of sling type hygrometer.</td>
<td>Psychrometers are instruments used for measuring relative humidity.</td>
</tr>
</tbody>
</table>

**Diagram:**

[Diagram of rotating disc with holes, LED, photodetector, and counter illustration.]
Describe working principle of ultrasonic level detector with diagram.

**Ans:**

**Working principle**

It operates by generating an ultrasonic wave or pulse and measuring the time it takes for the echo to return. An ultrasonic transmitter receiver along with the necessary signal conversion unit is mounted on top of tank for measurement of level of either solids or liquids as shown in figure. The ultrasonic waves generated by transmitter are directed towards the liquid surface in the tank which is to be measured. These waves
get reflected from the surface of the liquid and are received by the receiver. The time taken by the wave during its travel is a measure of the distance travelled by the wave. Therefore the time ‘t’ between transmitting and receiving a wave is proportional to the distance ‘d’ between ultrasonic set and surface of the liquid in the tank. As the distance ‘H’ between ultrasonic set and the bottom of the tank is fixed time ‘t’ becomes a measure of level ‘l’ i.e,

\[ t \propto d \propto (H-l) \]

### Q. No. 5

**Attempt any FOUR:**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Active Transducer</th>
<th>Passive Transducer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operate under energy conversion principle.</td>
<td>Operate under energy controlling principle.</td>
</tr>
<tr>
<td>2</td>
<td>Ex. Thermocouple, Piezoelectric Transducer</td>
<td>Ex. Thermistors, Strain Gauges</td>
</tr>
<tr>
<td>3</td>
<td>Do not require external power supply for its operation.</td>
<td>Require external power supply for its operation.</td>
</tr>
<tr>
<td>4</td>
<td>They produce an electrical signal proportional to the input physical quantity.</td>
<td>They produce an output signal in the form of some variation in resistance, capacitance or any other electrical parameter, which has to be converted to an equivalent current or voltage signal.</td>
</tr>
</tbody>
</table>

**a**

**Compare active and passive transducer. (any 4 points)**

**Ans:**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Active Transducer</th>
<th>Passive Transducer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operate under energy conversion principle.</td>
<td>Operate under energy controlling principle.</td>
</tr>
<tr>
<td>2</td>
<td>Ex. Thermocouple, Piezoelectric Transducer</td>
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<tr>
<td>3</td>
<td>Do not require external power supply for its operation.</td>
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<td>They produce an electrical signal proportional to the input physical quantity.</td>
<td>They produce an output signal in the form of some variation in resistance, capacitance or any other electrical parameter, which has to be converted to an equivalent current or voltage signal.</td>
</tr>
</tbody>
</table>

**b**

**Convert 280 mm of Hg pressure level in bars, psi, kilopascal and microns.**

**Ans:**

1 psi = 51.71484 mm of Hg
Or, 1 mmHg = 0.019336 psi
Therefore, 280 mm of Hg = 5.414 psi

1 bar = 750.063 mm of Hg
Or, 1 mmHg = 0.0013332 bar
Therefore, 280 mm of Hg = 0.3733 bar

1 mmHg = 0.133322387415 kilopascals
Therefore, 280 mmHg = 37.33 kilopascals
1 mmHg = 1000 microns, Therefore, 280 mmHg = 280,000 microns
c What is capsule? How it is used for pressure measurement?

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 into 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.

2 M-diagram

---

d Compare contact type and non-contact type speed measurement method.

Ans :

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Contact type method</th>
<th>Non contact type method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical contact between meter and shaft</td>
<td>No Physical contact between meter and shaft</td>
</tr>
<tr>
<td>2</td>
<td>Consists of moving parts</td>
<td>Does not consist of moving parts</td>
</tr>
<tr>
<td>3</td>
<td>Output is electrical signal</td>
<td>Output has to be converted to electrical signal</td>
</tr>
<tr>
<td>4</td>
<td>Optical transducer is not used</td>
<td>Optical transducer is used</td>
</tr>
<tr>
<td>5</td>
<td>ADC is required</td>
<td>ADC is not required</td>
</tr>
<tr>
<td>6</td>
<td>Maintenance is more due to the moving parts</td>
<td>Maintenance is less</td>
</tr>
<tr>
<td>7</td>
<td>Ex.AC / DC tachometer</td>
<td>Ex. Rotary Encoder, Photo electric tachometer</td>
</tr>
</tbody>
</table>

Any 4 points-1 mark each

---

e Compare thermo-couple and thermistor.

4M
### Ans:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Thermocouple</th>
<th>Thermistor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials</td>
<td>Two dissimilar metals</td>
<td>Metal oxides</td>
</tr>
<tr>
<td>Response</td>
<td>Linear</td>
<td>Nonlinear</td>
</tr>
<tr>
<td>Range of temperature</td>
<td>-200 °C to 2000 °C</td>
<td>-150°C to 300°C</td>
</tr>
<tr>
<td>Size</td>
<td>Large as compared to thermistor</td>
<td>Small in size</td>
</tr>
<tr>
<td>Whether active or passive</td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>Transduction principle</td>
<td>Thermo electric effect</td>
<td>Resistive transducer</td>
</tr>
</tbody>
</table>

#### Question:
**Sketch constructional diagram of the operation of electromagnetic flow meter.**

**State its two limitations.**

**Answer:**

- It is used only for liquids.
- It is not suitable for low velocity.
- It is more expensive.
- It is suitable for fluids having conductivity greater than 20 micro ohm/cm.
- Gas inclusion cause errors.
- Difficulties in on site calibration.

---

**Q. No.** | **Sub Q. N.** | **Answers** | **Marking Scheme**
---|---|---|---
| 6 | Attempt any FOUR: | | 16- Total Marks |
| a | Compare between U tube and well type manometers. (any 4) | | 4M |
**Ans:**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>U tube manometer</th>
<th>Well type manometer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1.png" alt="U tube manometer" /></td>
<td><img src="image2.png" alt="Well type manometer" /></td>
</tr>
</tbody>
</table>
|        | **Fig: U- Tube manometer**  
|        | $P_1$ = High pressure  
|        | $P_2$ = Low pressure  
|        | $h$ = Difference in liquid level | **Fig: Well- type manometer**  
|        | $P_1$ = High pressure  
|        | $P_2$ = Low pressure  
|        | $h$ = Difference in liquid level.  
|        | $a_1$ and $a_2$ are the areas of the well and the capillary |
| 2      | U shape tube      | Well shape with small capillary |
| 3      | It has two limbs  | It has only one limb  |
| 4      | $(P_1-P_2) = \rho gh$  
|        | $P_1 - P_2 = \rho gh \left(1 + \frac{A_2}{A_1}\right)$ |

**b** Calculate the output resistance of PT 100 RTD for temperature value 30 °C and 75 °C.

**Ans:**

For 30°C,
Assume $\alpha = 0.00392/° C$
Resistance at $t = 30° C$,
$R_t = R_0(1 + \alpha \Delta t)$
$= 100[1 + 0.00392*30] = 100*1.1176 = 111.76 \Omega$

For 75°C,
Assume $\alpha = 0.00392/° C$
Resistance at $t = 75° C$,
$R_t = R_0(1 + \alpha \Delta t)$
$= 100[1 + 0.00392*75] = 100*1.294 = 129.4 \Omega$

**c** Draw neat sketches of linear and rotary potentiometer liquid level gauges.

**Ans:**

Diagram of Linear potentiometer liquid level gauge:
Diagram of rotary potentiometer liquid level gauge:

\[ \theta = f(h) \]
\[ V = f(\theta) \]
\[ \therefore V = f(h) \]

Note: Any other relevant diagram may be considered.

| d     | Draw neat diagram of gas filled thermometer. State its operating range and material used. | 4M |
### Ans:

Operating range: \(-268^\circ C\) to \(760^\circ C\).

Material used to fill the thermometer: Nitrogen or Helium

---

**e.** Draw a diagram of radar level measurement. Write an advantage and disadvantage of it.

#### Ans:

#### Advantages:
- This is a non-contact method.
- High accuracy for measurements in storage tanks and process vessels.

#### Disadvantages:
- Expensive technology.
- Reading is affected by change in density of liquid.

---

**f.** With the help of neat sketch, state working principle of rotameter.

#### Advantages:
- This is a non-contact method.
- High accuracy for measurements in storage tanks and process vessels.

#### Disadvantages:
- Expensive technology.
- Reading is affected by change in density of liquid.
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. When there is no flow through the Rotameter, the float rests 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 produced by flow and gravitational force acting on the float reach an 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.