LABORATORY MANUAL

IV Year B. Tech I- Semester

MECHANICAL ENGINEERING

AY: 2024-25

MECHANICAL MEASUREMENTS AND INSTRUMENTATION LAB

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MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

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CONTENTS

1. CALIBRATION OF PRESSURE CELL

AIM:

Calibrate the given Pressure Cell with Pressure Gauge for its performance

APPARATUS REQUIRED:

Pressure cell

Hydraulic dead weight Pressure gauge Tester to develop the pressure

Digital pressure indicator

Dial type pressure indicator

THEORY BEHIND:

Pressure is defined as force per unit area and is measured in Newton per square meter (Pascal) or in terms of an equivalent head of some standard liquid.

Thus, a pressure gauge is connected to the hydraulic line and the gauge itself stands in atmospheric pressure.

Pressure transducer is basically an electro mechanical devices, especially manufactured and designed or wide range application in pressure measurement.

The pressure transducer comprises of diaphragm and an inputs to facilitate pressure measurement. The strain gauges are bonded directly to the sensing member to provide excellent linearity, low hysteresis and repeatability.

Fluid medium whose parameter has to be measured is allowed to deflect the diaphragm (sensing member), which is a single block material and forms an integral part of the pressure transducer.

Usually, the Pressure Transducers are made up non-magnetic stainless steel and thus has the advantage of avoids the yielding effects and leakage problems. The slight deflection of the diaphragms due to the pressure provides an electrical output.

The material most commonly used for manufacture of diaphragms are steel, phosphor bronze, nickel silver and beryllium copper. The deflection generally follows a linear variation with the diaphragm thickness.

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the Power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

PRESSURE INDICATOR: To indicate the Pressure in digital format with Zero knob facility.

SOFTWARE: Facilitates to do things in computer format.

PREPARATION OF EQUIPMENT:

1. Connect the pressure cell to the pressure indicator with given cable.
2. Connect the instrument to 1ph, 230V AC supply which is having proper earthing.
3. Adjust the zero pot of the indicator to indicate zero.
4. Close the release valve of pressure gauge tester and apply the 10kg dead weight on flange.

PROCEDURE:

1. Slowly rotate the screw road in clockwise direction with the help of handle until flange lift up (so that pressure is developed up to applied load). Now observed the digital reading. If it is not showing zero then make it zero by rotating ZERO knob. Now instrument is calibrated.
2. Apply the load up to 10Kgs one by one on the flange and give pressure by rotating the screw rod such that the dial gauge reads 1 to 10 with respect to load applied.
3. Note down the readings of dial gauge and pressure indicator, simultaneously in every step.
4. Calculate the error and % error.

TABULATIONS:

Sl. No	Pressure in Dial gauge, P_c kg / cm^2	Pressure in Digital indicator, P_g kg / cm^2	Correction $P_c – P_g$	Error $P_g – P_c$	% Error $(P_g – P_c)/ P_g$ *100

CONCLUSIONS OF THE RESULTS TABULATED:

Summarizing the entire operation

Describing the possible error factors

Techniques which can be adopted to minimize the errors in all aspects i.e., from startup to end.

LIMITATIONS

1. Range of Pressure Cell ---- Max. 10kg/cm^2

APPLICATIONS:

1. In compressors
2. In boilers

VIVA-VOCE QUESTIONS:

1. One atmospheric pressure is equivalent to?
2. A barometer is used to measures?
3. Piezometer tube is used to measure?
4. The stagnation(total) pressure at a point is measured by?
5. A U-tube differential manometer is used inverted when pressure difference is ------------
6. A well-type manometer is used in preference to a simple U-tube manometer to obtained-----
7. Which manometer is likely to have the highest sensitivity and accuracy?
8. Mercury is used in barometers because?
9. In a bourdon tube pressure gauge incorrect readings may be encountered due to?
10. Most common material chosen for the fabrication of bellows of a bellows pressure gauge is?
11. A dead weight tester is used for?

2. CALIBRATION OF LVDT

AIM:

Calibrate **Linear Variable Differential Transformer (LVDT)** for the performance using Micrometer.

APPARATUS REQUIRED:

LVDT

Digital LVDT indicator

MICROMETER

THEORY BEHIND:

LVDT is an inductive transducer used to translate the linear motion into electrical signal LVDT consists of a single primary winding ‘P’ and two secondary windings (S1 & S2) wounds on a cylindrical armature. An AC source is connected to the primary winding. A movable soft iron core attached with an arm placed inside the armature.

The primary winding produces an alternating magnetic field which induces alternating voltage in the secondary windings. Single voltage is obtained by connecting the two secondary windings in series. Thus, the output voltage of the transducer is the difference of the two voltages.

When the core is at null position, the flux linking with both the secondary windings is equal. Since both the secondary winding have equal number of turns, M the induced emf is same in them. The output voltage is the difference of the two emf say E1 & E2. When they are equal, the voltage is zero at null position.

When the core is moved to the left side from null position more flux links with S1. The output voltage is V=E2-E1, is greater, the V value is negative (–ve). Means the voltage is read in terms of mm length on the display board indicates the negative value. When the core is moved to the right side of the null position, more flux links with S2 induces voltages which is +ve. The display board indicates the +ve value in mm of length.

The voltage output is linear and is depending on the position of the core. Hence LVDT can be conveniently used to measure the thickness ranging from fraction of mm to a few cms. Normally LVDT can give better result up to 5mm.

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

LVDT INDICATOR: To indicate the Distance moved.

SOFTWARE: FACILITATES TO DO THINGS IN COMPUTER FORMAT.

PREPARATION OF EQUIPMENT:

1. Make the Micrometer to Read 10mm on the scale. (ZERO POSITION of LVDT)
2. Connect the instrument to 1ph, 230V AC supply which is having proper earthing.

LIMITATIONS

Range of Pressure LVDT: -10mm to +10mm

PROCEDURE:

1. Slowly rotate the screw head of the micrometer either clockwise or anticlockwise to measure 1mm on it.
2. Note the Reading on the LVDT indicator
3. Repeat step 1 and step 2 until 10mm on either side.
4. Note down the readings of Micrometer, simultaneously in every step.
5. Calculate the error and % error.

Note: Clockwise will give readings in –ve direction and Anticlockwise will give in +ve direction.

TABULATIONS:

Sl. no	Actual Reading, 'R_a' mm	Measured Reading, 'R_m' mm	Error 'E'	% Error

RESULT: -----------------------

Note: Plot a graph between Ra Vs Rm

APPLICATIONS:

1.In pressure cells
2.In force cells
3.In accelerometers

VIVA-VOCE QUESTIONS:

1. The abbreviation LVDT stands for?
2. What is the difference between active and passive transducers?
3. What information is needed to describe a transducer for a particular measurement?
4. What are the major considerations which govern the selection of an instrument transducer?
5. Define displacement?
6. What is the use of wire wound potentiometer for the measurement of linear and rotary Transducers?

7. What are the advantages of wire wound potentiometer?

8. What are the disadvantages of wire wound potentiometer?

9. What are the advantages of capacitive transducers?

10. What are the disadvantages of capacitive transducers?

3. CALIBRATION OF STRAIN GAUGE

AIM:

To determine the elastic constant (modulus of elasticity) of a **Cantilever beam** subjected to concentrated end load by using **STRAIN GUAGES**.

APPARATUS REQUIRED :

Load Cell with Strain Gauge

Digital Strain indicator

Weights

THEORY BEHIND:

A body subjected to external forces is in a condition of both stress and strain. Stress can be directly measured but its effect i.e., change of shape of the body can be measured. If there is a relationship between stress and strain, stresses occurring in a body can be computed if sufficient strain information is available. The constant connecting the stress and strain in elastic material under the direct stresses is the modulus of elasticity,

i.e., $E = \sigma / \epsilon$

the principle of the electrical resistance strain gauge was discovered by Lord Kelvin, when he observed that a stress applied to a metal wire, besides changing resistance strain gauges are made into two basic forms, bonded wire and bonded foil. Wire gauges are sandwiched between two sheets thin paper and foil gauges are sandwiched between two thin sheets of epoxy.

The resistance factor 'R' of a metal depends on its electrical resistively, ρ, its area, a and the length l, according to the equation $R = \rho l / a$.

Thus, to obtain a high resistance gauge occupying a small area, the metal chosen has a high resistively, a large number of grid loops and a very small cross-sectional area. The most common material for strain gauge is a copper - -nickel alloy known as Advance.

The strain gauge is connected to the material in which it is required to measure the strain, with a thin coat of adhesive. Most common adhesive used is Eastman, Deco Cement, etc. as the test specimens extends or contracts under stress in the direction of windings, the length and cross-sectional area of the conductor alter, resulting in a corresponding increase or decrease in electrical resistance.

GAUGE FACTOR:

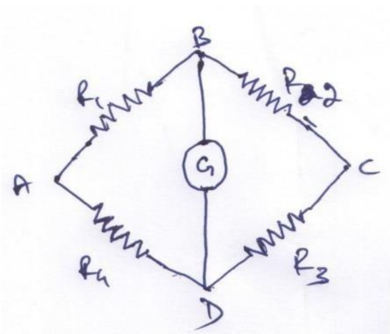
The dimension less relationship between the change in gauge resistance and change in length is called Gauge factor of the strain, which is expressed mathematically,

Gauge Factor, $\delta g = (\Delta R/R) / (\Delta l/l)$

In this relationship R and I represent, respectively the initial resistance and initial length of the strain gauge filament, while ΔR & Δl represents the small change in resistance and length, which occurs as the gauge is strained along with the surface to which it is bonded. This gauge factor of a gauge is a measure of the amount of resistance change for a given strain. The higher the gauge factor greater the electrical output for indication or recording purpose. The gauge factor is supplied by the manufacturer and may range from 1.7 to 4.

The usual method of measuring the change of resistance in a gauge element is by means of Wheatstone bridge as shown in figure. It consists of Galvanometer, 4 resistor & a battery. Resistance R_1 is the strain gauge is used for strain measurement, which is mounted on the specimen. The three resisters R_2, R_3 and R_4 are internal to the device.

Let us assume that the resistance has been adjusted so that the bridge is balanced.



i.e. Voltage $\mathbf{E_{bd} = 0}$.

The most common bridge arrangements are single arm, two arm and four arm mode.

Single Arm Mode (Quarter bridge).

This bridge arrangement consists of a single active gauge in position, say R_1 and three resistor are internal to the device. Temperature compensation is possible only if a self temperature compensating strain gauge is used.

Two Arm Mode (Half bridge).

In this mode, two resistors are internal to the device and the remaining two are strain gauges. One arm of this bridge is commonly labeled as active arm and the other as compensating arm. The bridge is temperature compensated.

Four Arm Mode (Full Bridge).

In this bridge arrangement, four active gauges are placed in the bridge with one gauge in each of the four arms. If the gauges are placed on a beam in bending as shown in fig of the elastic constant by bending test experiment, the single from each of the four gauges will add. This bridge arrangement is temperature compensated.

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the Power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

STRAIN INDICATOR: To indicate the Distance moved.

SOFTWARE: FACILITATES TO DO THINGS IN COMPUTER FORMAT.

PREPARATION OF EQUIPMENT:

1. Connect the instrument to 1ph, 230V AC supply which is having proper earthing.
2. Switch on the Console
3. Select the BRIDGE Mode
4. Connect the Strain wires accordingly in the table below
5. 5. Make the Indicator to Read Zero. (ZERO POSITION)
6. Prepare the Loads to be added

Sl. No	Bridge Mode	Color	No of Wires	Connect To
1	Quarter	ORANGE	2	A & B
2	Half	ORANGE	2	A & B
		GREEN	2	B & C
3	FULL	WHITE	2	A & D
		ORANGE	2	A & B
		GREEN	2	B & C
		BLACK	2	C & D

LIMITATIONS

Range of Load cell: 10kg

PROCEDURE:

1. For the Bridge selected and connected wires, slowly add the Weights in steps of 1kg.
2. Note the Reading on the Strain indicator
3. Repeat step 1 and step 2 until 10kg is loaded.
4. Note down the weights added, simultaneously in every step.
5. Calculate the error and % error
6. Modulus of Elasticity of the given load cell.

TABULATIONS:

Sl. No	Load Applied W (N)		Strain Indicator Reading Є – micro strain	Measured Strain $Є_m$=є*10^{-6} / No. of Bridge	Bending stress. σ = 6wl / bh^2	Modulus of elasticity. E = σ / $Є_m$ (N/nm^2)
	W	N				

CONCLUSIONS OF THE RESULTS TABULATED:

Summarizing the entire operation

Describing the possible error factors

Graph Plotting

Techniques which can be adopted to minimize the errors in all aspects i.e, from startup to end.

APPLICATIONS:

1.In the ropes
2.In in the beams

VIVA-VOCE QUESTIONS:

1. Define strain?
2. Define gauge factor of a resistance strain gauge?
3. What are the various types of strain gauges for different applications?
4. What is the difference between bonded and unbounded type of resistance strain gage?
5. What are the advantages of semi-conductor strain gauges?
6. Whar are the requirements of materials for strain gauge?
7. What do you mean by resistance strain gauges?

8. Mechanical strain gauges can measure----------

9. The gauge factor of a resistance strain gauge depends upon--------

10. The wire material of strain gauges should have----------

11. Which gauge can be detached from the test specimen and used again?

4. MEASUREMENT OF ANGULAR DISPLACEMENT

AIM: Measurement of angular displacement using capacitive transducer.

APPARATUS REQUIRED:

CAPACITIVE ANGULAR DISPLACEMENT CELL

Digital ANGULAR indicator

STEPPER MOTOR ASSEMBLY with Controller

THEORY BEHIND:

Capacitance is well known to be a function of effective area of the conductors, separation between them, the dielectric strength of the material in the separation. Capacitive transducers convert the physical quantity to be measured into a change of capacitance which is processed by the measuring circuit of the transducer. The capacitance of a parallel plate capacitor may be changed by varying the separation between the plates, varying the effective area of the plates or varying the dielectric.

Capacitive type transducers are used essentially for displacement or positioning measurements. But they are more susceptible to environmental factors such as dust or moisture in the atmosphere than inductive type transducers.

The meshing area between two stator and rotor plates of the capacitor goes on changing as the shaft capacitor is rotated. The arrangement is used to demonstrate the measurement of angular displacement.

The transducer is mounted on to the face of a protractor which indicates the angle of displacement and the readout display the amount of displacement.

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the Power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

ANGULAR INDICATOR: To indicate the Distance moved.

STARTER: To Start the Motor and to Select the Mode of Operation

INCREMENTAL: To Give Step input to the Motor according to mode selected.

SOFTWARE: FACILITATES TO DO THINGS IN COMPUTER FORMAT.

PREPARATION OF EQUIPMENT:

1. Connect the instrument to 1ph, 230V AC supply which is having proper earthing
2. Press the STARTER switch and select MANUAL MODE.
3. Set ZERO position on the Manual Indicator by pressing the INCREMENTAL Button.

LIMITATIONS

1. Range of ANGULAR DISPLACEMENT: Up to 360deg
2. In AUTO Mode the Incremental will be in steps of 22.5deg.

PROCEDURE:

1. After the Preparation of equipment, Now press the INCREMENTAL button so the stepper motor sets accordingly with the selected mode of previously.
2. Note the Reading on the Angular Displacement indicator
3. Repeat step 1 and step 2 until required.
4. Note down the readings of Manual Angular, simultaneously in every step.
5. Calculate the error and % error.

Note: Rotation will be in Clockwise direction only.

TABULATIONS:

Sl. no	The displacement protractor reading	Measured displacement meter reading	Deviation

CONCLUSIONS OF THE RESULTS TABULATED:

Summarizing the entire operation

Describing the possible error factors

Graph Plotting

Techniques which can be adopted to minimize the errors in all aspects i.e., from startup to end.

APPLICATIONS:

1.In the rotating shafts

VIVA-VOCE QUESTIONS:

1.What is the difference between speed counter and tachoscope?

2.What is the difference between tachoscope and tachometer?

3.What is the difference between speed counter and tachometer?

4.What are the different type of mechanical tachometers?

5. The average speed measurements are given by--------

6. Tachometers are used to measure-------

7. The speed of a sealed compressor units can be measured by---------

8. What are the advantages of stroboscope?

5. CALIBRATION OF PHOTO SPEED SENSOR

AIM:

Calibrate **PHOTO SPEED SENSOR** for the performance using MAGNETIC Speed Sensor.

APPARATUS REQUIRED:

PHOTO & MAGNETIC SPEED SENSORS

Digital SPEED indicators

MOTOR with Controller.

THEORY BEHIND:

The measurement of rotational velocity is more common. For velocity (speed) measurement the most convenient calibrator scheme uses a combination of toothed wheel, a simple magnetic proximity pickup a photo couple sensor and an electronic indicator to measure the speed. The angular rotation is provided by some adjustable speed drive of adequate stability. The toothed wheel mounted with iron rods while passing under magnetic and photo pickup produces an electric pulse. These pulses are fed to signal conditioner unit and displays reading visually. The stability of the rotational drive is easily checked by observing the variation of display reading.

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the Power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

SPEED INDICATORS: To indicate the SPEED.

MOTOR CONTROLLER: To run the motor at various speeds.

SOFTWARE: FACILITATES TO DO THINGS IN COMPUTER FORMAT.

PREPARATION OF EQUIPMENT:

1. Keep the Speed controller knob in minimum position.
2. Connect the instrument to 1ph, 230V AC supply which is having proper earthing.
3. Switch on the Console to activate the panel.

LIMITATIONS

Maximum RPM: 2500rpm

PROCEDURE:

1. Once the equipment is prepared, slowly rotate the Speed controller to set the speed desired in range.
2. Note the Reading on the PHOTO SENSOR PICKUP Indicator
3. Repeat step 1 and step 2 until required within the range.

5. Note down the readings of MAGNETIC PICKUP, simultaneously in every step.
6. Calculate the error and % error.

Note: Clockwise to increase the speed and Anticlockwise to reduce the speed.

TABULATIONS:

Sl. no	Actual Reading, ‘R_a’ mm	Measured Reading, ‘R_m’ mm	Error E = (Ra- Rm)	% Error {(Ra- Rm)/Ra}*100

RESULT: -------------------

Note: Plot a graph between Ra Vs Rm

APPLICATIONS:

1.To measure the electric motors shaft speed.
2.To measure the turbine shaft speed.
3.To measure the engines shaft speed.

VIVA-VOCE QUESTIONS:

1.What is the difference between speed counter and tachoscope?

2.What is the difference between tachoscope and tachometer?

3.What is the difference between speed counter and tachometer?

4.What are the different type of mechanical tachometers?

5.The average speed measurements are given by--------

6.Tachometers are used to measure-------

7.The speed of a sealed compressor units can be measured by---------

8.What are the advantages of stroboscope?

9.What are the different type of electrical tachometer?

10.Tachoscope speed up to----------

6.CALIBRATION OF McLeod GAUGE

AIM:

Calibrate the Vacuum Cell (McLeod Gauge) in comparison with Vacuum Dial Gauge.

APPARATUS REQUIRED :

CYLINDRICAL CELL

Digital Vacuum Gauge

Analog Vacuum Gauge

High-Capacity Vacuum Pump.

THEORY BEHIND:

In everyday usage, vacuum is a volume of space that is essentially empty of matter, such that its gaseous pressure is much less than atmospheric pressure. The word comes from the Latin for “empty”. A perfect vacuum would be one with no particles in it at all, which is impossible to achieve in practice. Physicists often discuss ideal test results that would occur in a perfect vacuum, which they simply call “vacuum” or “free space”, and use the term partial vacuum to refer to real vacuum. The Latin term in vacuum is also used to describe an object as being in what would otherwise be a vacuum.

Vacuum is useful in a variety of processes and devices. Its first widespread use was in the incandescent light bulb to protect the filament from chemical degradation. The chemical inertness produced by a vacuum is also useful for electron beam welding, cold welding, vacuum packing and vacuum frying. Ultra-high vacuum is used in the study of atomically clean substrates, as only a very good vacuum preserves atomic-scale clean surfaces for a reasonably long time (on the order of minutes to days). High to ultra-high vacuum removes the obstruction of air, allowing particle beams to deposit or remove materials without contamination. This is the principle behind chemical vapor deposition, physical vapor deposition, and dry etching which are essential to the fabrication of semi conductors and optical coatings, and to surface science. The reduction of convection provides the thermal insulation of thermos bottles. Deep vacuum lowers the boiling point of liquids and promotes low temperature out gassing which is used in freeze drying, adhesive preparation, distillation, metallurgy, and process purging. The electrical properties of vacuum make electron microscopes and vacuum tubes possible, including cathode ray tubes. The elimination of air friction is useful for flywheel energy storage and ultracentrifuges.

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the Power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

VACUUM ON SWITCH: Provided to activate the system.

VACUUM INDICATORS: To indicate the Vacuum inside the cylinder.

PREPARATION OF EQUIPMENT:

1. Make sure the Vacuum On switch is in off condition.
2. Connect the instrument to 1ph, 230V AC supply which is having proper earthing.

LIMITATIONS

Maximum Vacuum Range: 600mm of Hg or 800mbar

PROCEDURE:

1. Switch on the Console to activate the Panel.
2. Close the Valve on the Cylinder.
3. Start the Vacuum pump and allow attaining maximum vacuum.
4. Note down the Readings on Digital and Analog gauges.
5. Now slowly open the Valve on the cylinder and set to the required Vacuum.
6. Once again note down the Digital and Analog readings.
7. Repeat Steps 5 and 6 until zero.
8. Calculate the error and % error.

TABULATIONS:

Sl. no	Actual Reading, 'R_a' mm	Measured Reading, 'R_m' mm	Error E = (Ra- Rm)	% Error {(Ra- Rm)/Ra}*100

RESULT: --------------------------

Note: Plot a graph between Ra Vs Rm

APPLICATIONS:

1.To clear halls

VIVA-VOCE QUESTIONS:

1.One atmospheric pressure is equivalent to?
2.A barometer is used to measures?
3.A piezometer tube is used to measure?
4.The stagnation(total) pressure at a point is measured by?
5.A U-tube differential manometer is used inverted when pressure difference is ------------
6.A well-type manometer is used in preference to a simple U-tube manometer to obtained-----
7.Which manometer is likely to have the highest sensitivity and accuracy?
8.Mercury is used in barometers because?
9.In a bourdon tube pressure gauge incorrect readings may be encountered due to?
10.Most common material chosen for the fabrication of bellows of a bellows pressure gauge is?
11.A dead weight tester is used for?

7. CALIBRATION OF TEMPERATURE SENSOR

AIM:

Calibrate **TEMPERATURE SENSORS** for the performance using STANDARD water bath.

APPARATUS REQUIRED:

STANDARD WATER BATH with Temperature Controller

Temperature Sensors like RTD, J – Type, K – Type & T – type

Individual Digital Temperature Indicators

THEORY BEHIND:

RESISTANCE TEMPERATURE DETECTOR (RTD)

Resistance thermometers, also called **resistance temperature detectors or resistive thermal devices (RTD)**, are temperature sensors that exploit the predictable change in electrical resistance of some materials with changing temperature. As they are almost invariably made of platinum, they are often called **platinum resistance thermometers (PTR)**. They are slowly replacing the use of thermocouples in many industrial applications below 600ºC, due to higher accuracy and repeatability.

There are many categories like carbon resistors, film and wire wound types are the most widely used.

- ***Carbon resistor***s are widely available and are very inexpensive. They have very reproducible results at low temperatures. They are the most reliable from at extremely low temperatures. They generally do not suffer from significant hysteresis or strain gauge effects.
- ***Film thermometer*** have a layer of platinum on a substrate, the layer may be extremely thin, perhaps one micrometer. Advantages of this type are relatively low cost and fast response. Such devices have improved performance although the different expansion rates of the substrate and platinum give "strain gauge" effects and stability problems.
- ***Wire – wound thermometers*** can have greater accuracy, especially for wide temperature ranges.
- ***Coil element* has** largely replaced wire wound elements in industry. This design has a wire coil which can expand freely over temperature, held in place by some mechanical support which lets the coil keep its shape.

THERMOCOUPLES

The common electrical method of temperature measurement uses the thermocouple, when two dissimilar metal wires are joined at both ends, an emf will exist between the two junctions, if the two junctions are at different temperatures. This phenomenon is called Setback effect. If the temperature of one junction is known then the temperature of the other junction may be easily calculated using the thermoelectric properties of the materials. The known temperature is called reference temperature and is usually the temperature of ice. Potential (emf) is also obtained if a temperature gradient along the metal wires. This is called Thomson effect and is generally neglected in the temperature measuring process. If two materials are connected to an external circuit in such a way that current is drawn, an emf will be produced. This is called as Peltier effect. In temperature measurement, setback emf is of prime concern since it is dependent on junction temperature.

The thermocouple material must be homogeneous. A list of common Thermocouple materials in decreasing order of emf chrome, iron and copper platinum – 10% rhodium, platinum, alumel and constantan (60% copper and 40% nickel). Each material is thermoelectrically positive with respect to the below it and negatives with respect those above.

The material used in the Thermocouple probe is:

1. Iron – Constantan (Type J)
2. Copper – Constantan (Type T)
3. Chromyl – Alumel (Type K)

PANEL DETIALS:

MAINS ON INDICATOR: To indicate the Power given to the system.

CONSOLE ON SWITCH: Provided to activate the system.

TEMPERATURE INDICATORS: To indicate the Temperatures of various sensors.

WATER BATH SETTINGS: To Set the Temperature of Water bath.

SOFTWARE: FACILITATES TO DO THINGS IN COMPUTER FORMAT.

PREPARATION OF EQUIPMENT:

1. Fill the water into the Water Bath to the required level.
2. Make sure the water bath is in off condition.
3. Connect the instrument to 1ph, 230V AC supply which is having proper earthing.

LIMITATIONS

Maximum Temperature: up to 100deg

PROCEDURE:

1. Switch on the Console to activate the Panel and then switch on the water bath.
2. Set the required Temperature of the bath
3. Select the Sensor under study {however other sensors will also be working condition, this is only done to concentrate on particular sensor type}and Note the readings of the selected Sensor indicator for every two degree rise of water bath temperature.
4. Repeat step 2 and step 3 until required within the range.
5. Repeat the above for different sensors.
6. Calculate the error and % error.

TABULATIONS:

Sl. no	Actual Reading, 'R_a' mm	Measured Reading, 'R_m' mm	Error E = (Ra- Rm)	% Error {(Ra- Rm)/Ra}*100

RESULT: --------------------

Note: Plot a graph between Ra Vs Rm

APPLICATIONS:

1.To control of gas flow
2.In electric iron boxes
3.In domestic ovens

VIVA-VOCE QUESTIONS:

1. What are the types of temperature measuring instruments?
2. The lowest temperature limit for mercury-in-glass thermometer is--------
3. Which substance can be used as thermometric substance for temperature measurements Below-40^0C?
4. What should be the shape of an ideal thermometer bulb?
5. Thermocouples are generally used for temperature measurements up to---------
6. Which thermocouple can measure temperature in a comparatively high range?

7. Disappearing filament type optical pyrometer works on the principle of-----------

8. In optical pyrometer absorption filter is used to----------

9. Which thermometer is most suitable for the measurement of surface temperature?

10. Which metal/ non-metal has the highest temperature range?

8.ROTAMETER SETUP

i. **AIM**:

The experiment is conducted to know how to

a. **Calibrate Rotameter** at different flow rate.

ii. **PROCEDURE**:

1. Fill in the sump tank with clean water.
2. Keep the delivery valve closed.
3. Paste the Log sheet from zero marking on the rotameter to its full height and make marking if necessary.
4. Connect the power cable to 1Ph, 220V, 10 Amps with earth connection.
5. Switch on the pump & open the delivery valve.
6. Adjust the flow through the control valve of the pump.
7. Set the height from the log sheet sticked on the rotameter and note the **height in cm** the **rotameter reading in lpm**.
8. Note down the differential head reading in the Manometer. (Expel if any air is the by opening the drain cocks provided with the Manometer.)
9. Operate the Butterfly valve to note down the collecting tank reading against the known time and keep it open when the readings are not taken.
10. Change the flow rate and repeat the experiment.

iii. OBSERVATIONS:

Sl. No	Time for 'R' cm rise in water 'T' sec	Rotameter Reading, 'Q' Lpm	Height measured on Log scale, cm
1			
2			
3			
4			

iv. CALCULATIONS:

1. Theoretical Discharge, Q_{TR}

$$Q_{TR} = \frac{Q}{1000 \, x \, 60} \, m^3/s$$

Where,

Q = Rotameter reading in LPM

2. Actual Discharge, Q_A

$$Q_A = \frac{A \, x \, R}{t \, x \, 100} \, m^3/s$$

Where,

A = Area of collecting tank = 0.125 m^2.

R = Rise in water level of the collecting tank, cm.

t = time for 'R' cm rise of water, sec

100 = Conversion from cm to m.

3. **Co – efficient of discharge, C_D**

$$C_d = \frac{Q_A}{Q_{TH}}$$

Where,

Q_A = Actual Discharge.

Q_{TH} = Theoretical Discharge from Venturi or Rotameter.

v. TABULAR COLUMNS AND GRAPHS:

A. For Rotameter:

Height measured on Log scale, cm	Actual Discharge Q_A m³/sec	Theoretical Discharge Q_{TR} m³/sec	Coefficient of Discharge 'C_D'	Average 'C_D'

B. Graphs

Draw graph of **Actual discharge Vs Height** on Log scale

Draw graph of **Theoretical Discharge Vs Height** on log scale

vi. RESULTS:

For Rotameter:

1. Actual Discharge, Q_A = m³/s
2. Theoretical Discharge, Q_T = m³/s
3. Co – efficient of Discharge, C_d =

4. PRECAUTIONS

1) Do not run the pump dry.
2) Clean the tanks regularly, say for every 15days.
3) Do not run the equipment if the voltage is below 180V.
4) Check all the electrical connections before running.
5) Before starting and after finishing the experiment the main control valve should be in close position.
6) Do not attempt to alter the equipment as this may cause damage to the whole system.

Note: For any further clarifications on how to run the equipment or for up gradation, please contact us.