GOVT CO-ED POLYTECHNIC

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LAB MANUAL

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CONTENTS

Experiment No: 1

AIM: Calibration of capacitive transducer for angular displacement measurement.

Theory:

Capacitance is well known to be a function of effective area of the conductors, separation between them, and the dielectric strength of the material in the separation. Capacitive transducers convert the physical quantity to be measured in to a change of capacitance which is processed by them ensuring 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. The over lapping area between two stator and rotor plates of the capacitor goes on changing gas the shaft capacitor is rotated. The arrangement is used to demonstrate the measurement of angular displacement.

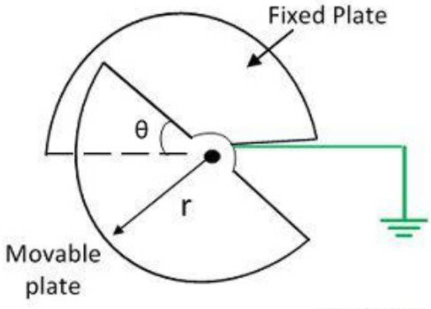

Fig. 1.1 : Setup of capacitive transducer for angular displacement measurement.

The capacitive transducer works on the principle of change in capacitance due to change in overlapping area of plates can be used for angular displacement measurement. The capacitance of a parallel plate capacitor which is given by

$C = \epsilon . A/d$

where C = Capacitance of a capacitor in Farads

$\epsilon = \epsilon_r \epsilon_o$

ϵ = Permittivity of the dielectric medium (F/m)

A= Area of plates or electrodes. (m^2)

ϵ_r = Relative permittivity (dielectric constant)

ϵ_o= Permittivity of free space ($8.54*10^{-12}$ F/m)

d = Distance between two plates (m)

The change in overlapping area of rotating parallel plates is considered for measuring angular displacement.

Procedure:

1. Connect the capacitive pick-up to the input socket o the front panel of the instrument.
2. Allow the instrument in On position for 10 minutes for initial warm-up
3. Move the moving plate to Zero position.
4. Adjust the ZERO potentiometer so that the display reads'000'
5. Now turn the shaft of the capacitive pick-up to full clockwise position gently till the scale reading is 1700. Adjust the meter reading to 1700 by operating the CAL POT.
6. Turn the shaft of the capacitive pick-up full clockwise position in a gentle manner in step of 5 to 100 for angular sensor and note down the reading in the tabular column till 1700
7. A known displacement is given to the parallel plate and note down the readings corresponding to input angular displacement and indicated angular displacement on the digital meter in the following observation table.
8. Plot the input and output readings on the x and y axis of a graph.
9. Repeatability can be calculated by repeating the experiment 3 to 4 times and tabulating the readings both for ascending and descending of angular displacement.

Observation Table:

S. No.	Angular displacement protractor reading (R_a in Degrees)	Measured Displacement reading (R_m)0 (degrees)	Error (Rm–Ra) (degrees)

Precautions:

- All connections should be neat and clean.
- Digital indicator reading has to be noted accurately.
- Readings on the Protractor is noted without parallax error.
- To check the power source, it should be 230V, 50 Hz. to avoid over voltage hazards.

Result:

Thus, the calibration of capacitive transducer for angular displacement measurement, has been performed successfully.

viva Questions:

1. On what parameters the capacitance depends.
2. What is principle used in this experiment.
3. What is measurand?
4. What is the range of the instrument.
5. What is error and correction

Experiment No: 2

AIM: Study and calibration of LVDT transducer for linear displacement measurement.

Theory:

LVDT consists of a cylindrical former where it is surrounded by a one primary winding in the center of the former and two secondary windings at the sides. The number of turns in both the secondary windings are equal, but they are opposite to each other, ie., if the left secondary windings is in the clockwise direction, the right secondary windings will be in the anti-clockwise direction, hence the net output voltages will be the difference in voltages between the two secondary coil. The two secondary coil is represented as S1 and S2. Esteem iron core is placed in the center of the cylindrical former which can move in to and fro motion as shown in the figure.

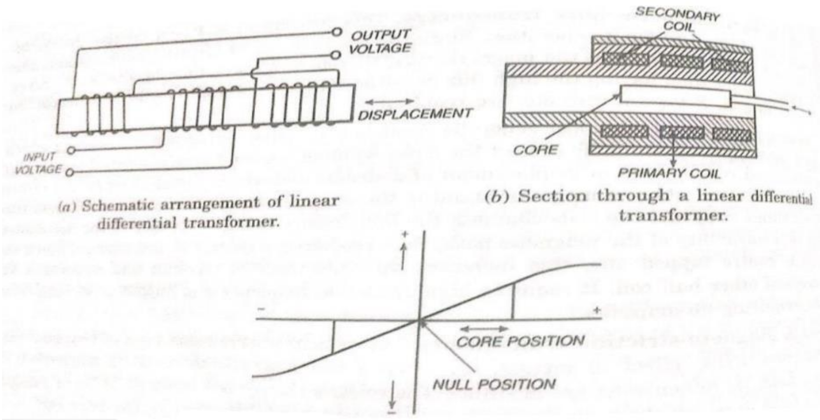

Fig. 2.1 : Setup of LVDT transducer for linear displacement measurement.

Procedure:

1. Connect the power cable to 230V, 50Hz to mains and switch on the instrument.
2. Make the display to read zero(000) by using zero knob.
3. Connect the LVDT cable pins to the instrument with proper color code.
4. Make the display to read zero by rotating the micrometer . This is called null balancing. Note down the micrometer reading.
5. Give the displacement of 5mm by rotating the micrometer from the null position either clockwise or anticlockwise.
6. Then display will be read 5.00mm. if not adjust the display by using Cal-knob. Now the instrument is calibrated.
7. Again rotate the micrometer to null position and from the retake down the reading in steps of 1m. that is on both the sides.
8. Plot the graph micrometer reading v/s display reading (Actual v/s Measured reading).

Observations:

Range of Micrometer. : ----------
Least count of Micrometer. : ----------
Linearity Range of LVDT. : ----------
Least count of LVDT. : ----------
Initial reading of Indicator (null position): Micro meter reading at null position.

Precautions:

- All connections should be neat and clean.
- Initial Zero setting may be done properly
- move the core gently.
- Micrometer should be maintained properly.
- LVDT core and micrometer are mounted on instant fixture with curve and ensure that the core and micrometer spindle lies in the same axis.
- Digital indicator reading has to be noted accurately.
- To check the power source, it should be 230V, 50 Hz. to avoid over voltage hazards.
- To get best performance, you have to put the instrument at dust proof and humidity free environment.
- Do not try to open the instrument or repair it.

Result:

Thus, the calibration of LVDT transducer for linear displacement measurement has been performed successfully.

Viva Questions:

1. when core is at centre position, the emf produced is -----
2. What is the Range, mention the value of range for LVDT that is used.
3. Difference between Span and Range
4. Least count of LVDT
5. What is the relation error and correction?
6. Name transducers used for measurement of displacement.

Experiment No: 3

AIM: Study of resistance temperature detector for temperature measurement.

Theory:

Resistance thermometers, also called **resistance temperature detectors (RTD)**, are temperature sensors that exploit the predictable changeinelectricalresistanceofsomematerialswithchangingtemperature. The resistance of RTD increases as the temperature increases. The RTD is linearly related over a wide temperature range. As they are almost in variably made of platinum, they are often called **platinum resistance thermometers.** There are many categories like carbon resistors, film and wire wound types are the most widely used. Platinum is widely used for sensor fabrication since it is the most stable of all the metals, is the least sensitive to contamination, and is capable of operating over a very wide range of temperature. The dynamic response of on RTD depends almost entirely on construction details. In this experiment PT-100 is considered as RTD sensor.

The principle of operation of RTD: is that the resistance of the conductor varies with the variation in temperature The amount of change occurred in the resistance can be given by $R = Ro(1+ \alpha_1 T + \alpha_2 T_2 +\alpha_3 T_3+\ldots\ldots. + \alpha_n T_n)$

Where Ro is the resistance at zero temperature

And α_1, α_2 ,α_3 ………. α_n are constants

Considering one term only, the equation becomes $R = R_o (1+ \alpha t)$

α = temperature coefficient of resistance.

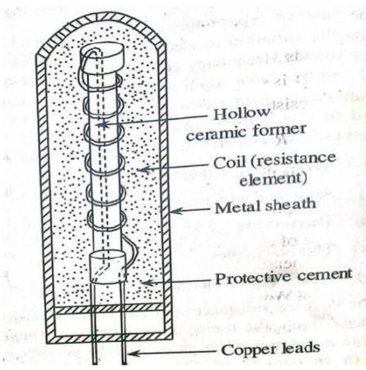

Fig. 3.1 : Schematic showing resistance temperature detector.

Experimental procedure:

1. To connect the RTD sensor (PT-100) to pin connector.

2. Switch 'ON' the system the power indicator. The RED LED on the front panel will glow.

3. Immerse the transducer in the ice-bath, wait for 2-3 minutes so that the temperature equilibrium takes place and adjust the 0.00 reading on the display by adjusting Zero Pot.

4. Keep the RTD into the boiling water and adjust the display reading to 10

5. Make 0by adjusting through Span Pot 1000 C..

6. Switch off the heater supply and allow the water and immersed RTD to cool down, and observe the bath temperature. With thermometer For every 50 C drop in water temperature, note down the thermometer reading and the display temperature and note in observation table.

7. Calculate the Error, correction, % absolute % error and draw the graphs.

8. Keep the RTD in air in room temperature. The indicator will display room temperature.

Sl.no	Temp. of Water by thermometer T_a ^oC	Temp. of Water by RTD, T_m ^oC	Error = $(T_m–T_a)$ ^oC	Correction= $(T_a–T_m)$ ^oC	Absolute %Error= $[(T_m - T_a)/ T_m]*100$
1					
2					
3					
4					
5					
6					

Precautions:

- All connections should be neat and clean.
- Thermometer should be maintained properly.
- Digital indicator reading has to be noted accurately.
- Readings on the thermometer is noted without parallax error.
- To check the power source, it should be 230V, 50 Hz. to avoid over voltage hazards.

Result:

Thus, the study of resistance temperature detector has been conducted successfully.

Viva Questions:

1. What is calibration?

2. What is relation between temp & resistance?

3. What is positive temperature coefficient (PTC)?

Experiment No: 4

AIM: Calibration of thermistor for temperature measurement.

Theory:

A Thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. Thermistors are semiconductors of certain materials that are extremely sensitive to temperature. The material is made by sintering oxides of such materials as Manganese, Nickel, Cobalt, Copper, Iron etc. Physical forms may be beads, discs, washers and rods. The temperature co-efficient of resistivity of metallic oxide semiconductors is –ve. The resistance of a thermistor decreases as the temperature increases. Moreover, the temperature resistance relationships of thermistors are exponential. Most important point in favour of thermistor is their extremely high sensitivity to temperature changes. The highest temperature up to which thermistors can be used is limited up to 2000 C. **Small Horizontal Axis Wind Turbine Cross-sectional View**

The temperature-resistance function for a thermistor is given by

R = Ro ek
K = β (1/T - 1/To) Ro
R = the resistance at any temperature T in 0 K
Ro = the resistance at reference temp To *in 0 K*
E = the base of Naperian logarithms. ,
β = a constant
The constant β generally has a value between 3400 and 3900 depending on thermistor formulation.

Thermistor can be classified in to two types, depending on the sign of k. If k is positive, the resistance increases with increasing temperature ,and the device is called a positive temperature co-efficient (PTC) Thermistor .If k is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature co-efficient(NTC)thermistor.Resistorsthatarenotthermistoraredesigned to have a 'k' as close to zero as possible, so that the resistance remains nearly constant over a wide temperature range.

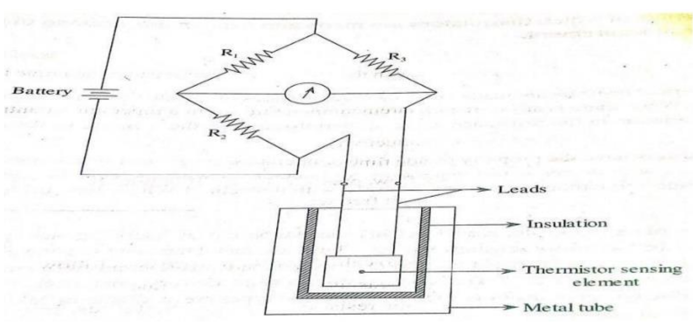

Fig. 4.1 : Schematic showing thermistor based temperature sensing.

Procedure:

1. Check connection made and Switch 'ON' the instrument by rocker switch at the front panel. The display glows to indicate the instrument is ON.

2. Allow the instrument in ON Position for 10 minutes for initial warm-up.

3. Pour around 3/4th full of water to the kettle and place sensors and thermometer inside the kettle. Note down the initial water temperature from the thermometer.

4. Select the sensor on which the experiment to be conducted through selection switch on the front panel. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature.

5. Switch on the kept and wait till the water boils note down the reading inn the thermometer and set final set potentiometer till the display reads boiling water temperature.

6. Remove the sensor from the boiling water immerse it the cold water. Set the cold water temperature using initial set potentiometer.

7. Repeat the process till the display reads exact boiling water and cold water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle.

8. Experiment can be repeated for all the three sensors. Temperature in the thermometer and the indicator readings in steps of 100 C can be tabulated.

Observation Table

Sl..no.	Temp. of Water by Thermometer$_a$ ^oC	Temp. of Water by Thermistor, T_m ^oC	Error = $(T_m - T_a)$ ^oC	Correction= $(T_a - T_m)$ ^oC	Absolute %Error= $[(T_m - T_a)/T_m]*100$
1					
2					
2					
3					
4					
5					

Result:

Thus, the study & calibration of thermistor for temperature measurement, has been conducted successfully.

Viva Questions:

1. What are sources of error.?
2. Name different forms of thermistor.
3. Name the materials used for thermistor
4. What mean by negative temperature coefficient?

Experiment No: 5

AIM: Study & calibration of thermocouple for temperature measurement.

Theory:

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 Seebeck effect. If the temperature of one junction is known then the temperature of the other junction may be easily calculated using the thermo electric 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, seeback 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%copperand 40%nickel). Each material is thermo electrically positive with respect to the below it and negatives with respect those above.

The material used in thermo couple probe is:

1. Iron–Constantan (TypeJ) (-300F to 1580F)
2. Copper–Constantan (TypeT) (-3000 F to 6000 F)
3. Chromyl–Alumel (TypeK).

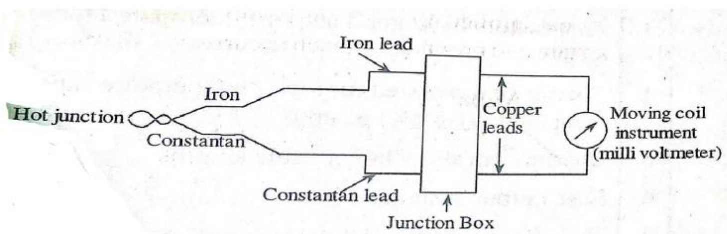

Fig. 5.1 : Schematic showing thermocouple based temperature sensing.

Procedure:

1. Check connection made and Switch ON the instrument by rocker switch at the front panel. The display glows to indicate the instrument is ON.
2. Allow the instrument in 'ON' position for 10 minutes for initial warm-up.
3. Pore around 3/4th full of water to the heater kettle and place sensors and thermometer inside the kettle. Note down the Initial water temperature from the thermometer.

4. Select the sensor on which the experiment to be conducted through selection switch on the front panel. Adjust the Initial set Potentiometer in the front panel till the display reads initial water temperature.
5. Switch on the kept and wait till the water boils note down the reading inn the thermometer and set Final set potentiometer till the display reads boiling water temperature.
6. Remove the sensor from the boiling water immerse it I the cold water. Set the cold water temperature using initial set potentiometer.
7. Repeat the process till the display reads exact boiling water and cold water temperature. Change the water in the kettle with and re heat the water. Now the display starts showing exact temperature raise in the kettle.
8. Experiment can be repeated for all the three sensors. Temperature in the thermometer and the indicator readings in steps of 100 C can be tabulated.

Observation Table:

Sl.no	Temp. of Water by Thermometer T_a ^oC	Temp.of Water by thermocouple, T_m ^oC	Error = $(T_m - T_a)$ ^oC	Correction = $(T_a - T_m)$ ^oC	Absolute %Error = $[(T_m - T_a)/ T_m]*100$
1					
2					
3					
4					
5					
6					

Result:

Thus, the study & calibration of thermocouple for temperature measurement, has been conducted successfully.

Viva Questions:

1) What is law of Intermediate metals?
2) Name the thermocouple materials.
3) What is calibration?
4) How the thermocouples are used for temperature measurement and what is the range of thermocouples?
5) What is error, correction, % error

Experiment No: 6

AIM: Study & calibration of pressure gauges.

Theory:

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 (mm of mercury or mater of water). A typical pressure gauge will measure the difference in pressure between two pressure. Thus, a pressure gauge is connected to the hydraulic line and the gauge itself stands in atmospheric pressure. The gauge reading will be the difference between the air pressure and the atmospheric pressure and is called gauge pressure. The absolute pressure (the actual pressure within the airline) is the sum of the gauge pressure and atmospheric pressure. Pressure transducer is basically an electro-mechanical device, especially manufactured and designed or wide range application in pressure measurement. The pressure transducer comprises of diaphragm and an input of a 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 measure disallowed to deflect the diaphragm (sensing member), which is a single block material and forms an integral part of the pressure transducer. It is 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 provided 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.

Pressure cells are divisors that convert pressure into electrical signal through a measurement of either displacement strain or piezoelectric response. Diaphragm type pressure transducers with strain gauges as sensor is used here for measurement of pressure.

Fig. 6.1 : Schematic showing pressure gauge based load pressure testing.

Procedure:

1. Connect the pressure cell to the pressure indicator with given cable.

2. Connect the instrument to mains, i.e.230V.Power supply and switch on the instrument.

3. Adjust the zero pot of the indicator to indicate zero.

4. Close the release valve of pressure gauge tester and apply the 5/10kg dead weight on flange.

5. Slowly rotate the screw rod in clockwise direction with the help of handle until flange lift up (so that pressure is developed up to applied load). Now observe the digital reading. If it is not showing zero then make it zero by rotating ZERO knob. Now instrument is said to be calibrated.

6. Apply the load(upto10Kgs)on the flange and give pressure by rotating the screw rod.

7. Note down the readings of dial gauge and pressure indicator, simultaneously in every step.

8. Calculate the error if any and absolute% error.

Observation Table:

Sl.No	Pressure in gauge, P_c kg/ cm^2	Pressure in Digital indicator, P_g kg/ cm^2	Error $P_g–P_c$ kg/ cm^2	Correction $P_c–P_g$ kg/ cm^2	Absolute %Error $[(P_g - P_c)/ P_g]$ *100
1					
2					
3					
4					

Result:

Thus, the study & calibration of pressure gauge has been conducted successfully.

Viva Questions:

1. what is mean by resolution, threshold

2. what is accuracy?

3. what is range of pressure gauge?

4. What is the span of the instrument?

5. What is observational error?