# EMI LAB
SEM V (ECE)
EXPERIMENT NO.: 1

AIM:-   Measurement of displacement using LVDT.

APPARATUS REQUIRED: - LVDT kit, multimeter, connecting wires.

BRIEF THEORY: -
The differential transformer is a passive inductive transformer also known as Linear Variable Differential Transformer (LVDT). LVDT has a soft iron core which slides within the hollow transformer & therefore affects magnetic coupling between the primary and two secondaries. The displacement to be measured is applied at its arm attached to soft iron core. When core is in normal position (null), equal voltages are induced in the two secondaries. The frequency of ac applied to the primary winding ranges from 50Hz to 20KHz.
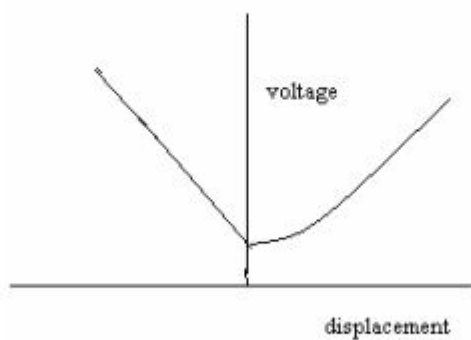
CIRCUIT DIAGRAM:
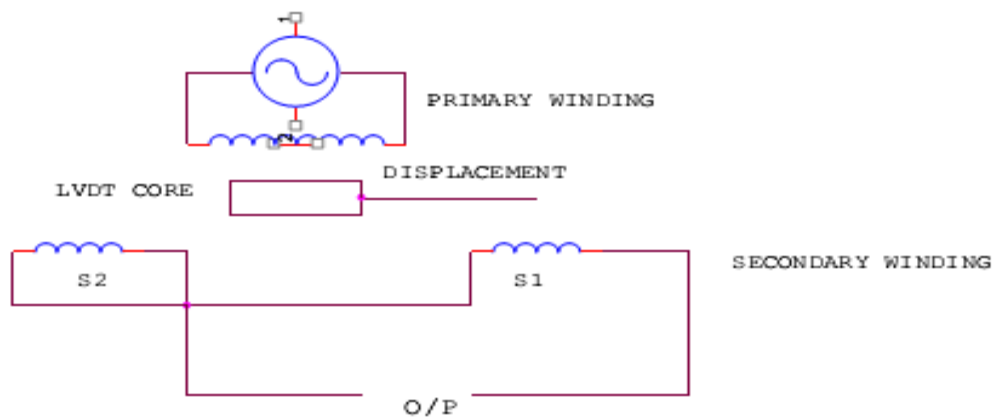
PROCEDURE: -

1. Connect the circuit according to circuit diagram.
2. Switch on the power supply.
3. The core is initially brought to null position.
4. First turn the nut in clockwise direction to move core inwards i.e. left of null position & take respective voltage readings on the voltmeter.
5. Now turn nut in anticlockwise direction to move the core towards right of null point & again take respective voltage reading from voltmeter.
6. Plot the graph from the observations taken.

OBSERVATIONS TABLE:

S.No	Displacement Micrometer (mm)	Displacement Reading (mm)	Analog o/p
1.			

GRAPH:

RESULT: - Graph between voltage and displacement is plotted.

DISCUSSION: it worked as linear variable differential transformer

PRECAUTIONS: -

1. Handle all equipments with care.
2. Make connections according to the circuit diagram.
3. Take the readings carefully.
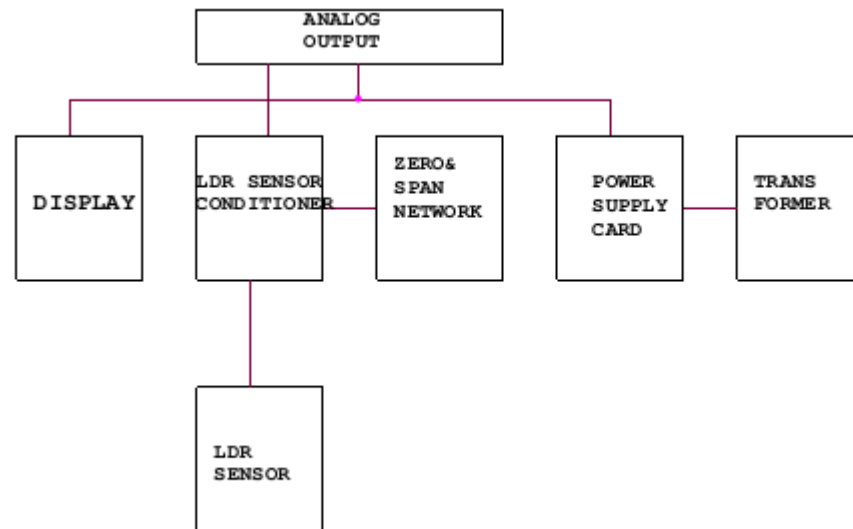4. The connections should be tight.

EXPERIMENT NO.: 2

AIM:- Measurement of distance using LDR

APPARATUS REQUIRED: - LDR kit, multimeter, connecting wires.

BRIEF THEORY: -
If radiation falls upon a semiconductor, its conductivity increases. The photoconductive effect is explained as follows: Radiant energy supplied to the semiconductor ionizes covalent bond i.e. these bonds are broken & electron-hole pair in excess of those generated thermally is created. The increase current carrier decrease resistance of material and hence such a device is called a photo resistor. For a light intensity change of 100f the resistance of a commercial photoconductor may change by several KO.

CIRCUIT DIAGRAM:

PROCEDURE: -

1. Connect the circuit as shown & note that the connection must be proper and tight.
2. Switch on the lamp & adjust the lamp such that light falls on LDR.
3. Move the direction of lamp and note variation in 'R'. Make sure the movement should be slow.

OBSERVATION TABLE:-

S.No	Lux Meter (lux)	Display Reading (mv)
1.		
2.		

PRECAUTIONS: -
1. Handle all equipments with care

2. Make connections according to the circuit diagram

3. Take the readings carefully

4. The connections should be tight.

RESULT: - The resistance of LDR decreases with increase in intensity

DISCUSSION:- The variations of resistance with intensity is studied.

QUIZ / ANSWERS: -

Q1 What is LDR?
A1 Light Dependent Resistor

.

Q2 What is the working principle of LDR?
A2 Resistance of LDR changes with the application of light
Q3 Why the resistance of LDR decreases with the fall of light?
A3 Because the covalent bonds are broken by the application of light & current carriers are increased.
Q4 On which effect the LDR works?
A4 Photoconductive effect
Q5 What are the uses of LDR?
A5 Used in street light, for measuring intensity of light
Q6 Which type of transducer is LDR?
A6 Resistive type
Q7 Give an example of resistive type of transducer
A7 Potentiometer
Q8 LDR is an active type of transducer or passive type?
A8 Passive type
Q9 What is a transducer?
A9 Transducer converts one form of energy into another form of energy.
Q10 Give an example of active type of transducer.
A10 Thermocouple

EXPERIMENT NO.: 3

AIM: - Measurement of temperature using RTD.

**APPARATUS REQUIRED: -** RTD kit, heating arrangement, Ice, Thermometer, H_2O

BRIEF THEORY: -
This type of transducer is used for temperature measurement. Here the basic concept used is that electrical resistance of different metal changes in accordance with the temperature i.e. for temperature measurement. Principle used is that the resistance of a conductor changes in proportion with the change in temperature. The unknown temperature is determined in terms of electrical resistance of the conductor, which senses the temperature. The change in resistance of this device is precisely determined either by bridge circuit or by ohmmeter.   Resistance of a conductor changes with change in temperature. This property is used for the measurement of temperature and each transducer is called Resistive Thermometer and falls in the category of electrical resistive transducer. The variation of resistance 'R' with temperature 'T' can be presented as:

Generally the metals used are Platinum. This is used because of following features:
1. Platinum provides good stability and accuracy.
2. It can operate on wide range of temperature.
3. It has good linearity over wide temperature range.
4. Less errors during operation.

CIRCUIT DIAGRAM:
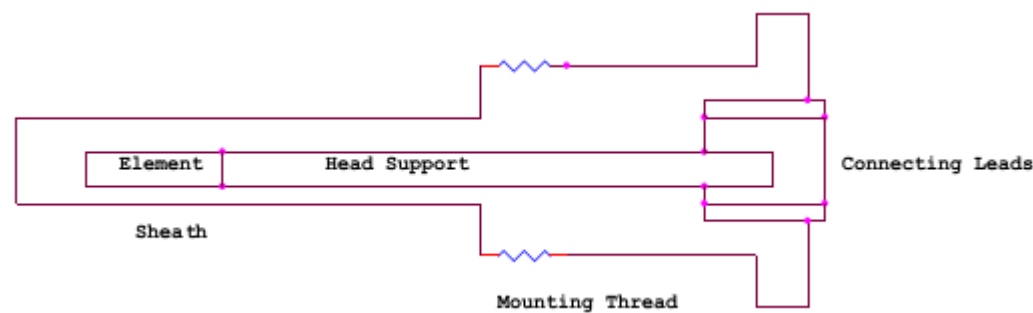
PROCEDURE: -

1. Connect the input power supply to main power.
2. Switch on the power supply, the red LED will glow.
3. **Connect the RTD source/sensor at a pin connector & 100 ^{0}C temperature is calibrated.**

OBSERVATION TABLE:

S.No	Temperature	Display Reading (mv)
1.	Temp with Ice point	
2.	Temp with Boiling Point	

SAMPLE CALULATION:

$$R = R_0\,(1 + \alpha_1 T + \alpha_2 T^2 + \ldots)$$
Where $R_0 \rightarrow$ resistance at 0^0C
$\alpha_1, \alpha_2 \rightarrow$ constant

We have measured the temperature with RTD and verified that the boiling point of water is 100C

DISCUSSION :-The boiling point of water is studied

PRECAUTIONS: -

9. Handle all equipments with care.
10. Make connections according to the circuit diagram.
11. Take the readings carefully.
12. The connections should be tight.

QUIZ / ANSWERS: -

Q1 What do you mean by RTD?
A1 Resistance Temperature Detector
Q2 Which material is generally used in the construction of RTD?
A2 Platinum
Q3 What are the uses of RTD?
A3 Temperature measurement of solid, fluid and gases
Q4 Explain the advantages of RTD?
A4 Good accuracy and linearity
Q5 Give the disadvantages of RTD?
A5 External source of power is needed for measurement of temperature
Q6 What is the temperature range of Platinum?
A6 -260^0 C to 110^0 C
Q7 This is active type of transducer or of passive type?
A7 Passive
Q8.The resistance temperature co efficient of RTD.
A8 +ve .
Q9 Which type of transducer is this?
A9 Resistive
Q10 What do we use for very-very high temperature?
A10 Pyrometer

AIM:- Measurement of temperature using thermocouple.

APPARATUS REQUIRED: - Thermocouple kit, Heating arrangement, Ice, Thermometer, H_2O.

BRIEF THEORY: -
This transducer is widely used in industrial applications for temperature measurement. Thermocouple is active transducer because there is no need of voltage source and transducer bridge circuitry. The working principle of thermocouple is explained below: - When two dissimilar metals A & B are joined together to form a closed circuit and the junctions J_1 and J_2 are kept at two different temperatures T_1 and T_2 then an e.m.f. is generated resulting flow of current in the loop or circuit. The two junctions in the loop are reference or cold junction which is generally kept at $0\ ^0C$ and the other is hot junction at which the temperature is to be measured. The e.m.f. generated is proportional to the difference of temperatures, the materials used for thermocouple. This phenomenon is called as Seeback effect. Thermocouple is having a lot of advantages like low cost, mechanically rigid and strong, high range etc. But the main disadvantage is that it requires a compensation arrangement.

CIRCUIT DIAGRAM:

IRON LEAD   a

c   COPPER LEAD

b   CONSTANTUN LEAD

d

PROCEDURE: -

1. Connect the main power cord at I/P main socket.
2. Switch ON the power supply
3. Connect the thermocouple sensor at the pin connector.
4. Keep the thermocouple in boiling water & adjust the display ranging 100 by the adjustment span knob.

OBSERVATION TABLE:

S.No	Temperature	Display Reading (mv)
1.	Temp with Ice point	
2.	Temp with Boiling Point	

AIM:- Measurement of   weight using strain gauge.

APPARATUS REQUIRED: - Strain cantilever kit, multimeter, connecting wires.

BRIEF THEORY: -
Strain is defined as compression per unit area. The primary quantities like resistance, capacitance are measured with the strain gauge element, where force applied to any elastic material,   results in strain.
R=   L/ A
Where R= resistance (O)
= Resistivity (O-m)
L= Length of wire (m)
A= Uniform cross- sectional area of wire (m ^{2})

If a metal wire or conductor is stretched or compressed its resistance changes because of change in length, change in resistivity and change in cross sectional area. This effect is called piezoresistive effect. The cantilever used in the primary elastic transducer of force measuring system, where a known mass is attached to cantilever, the unbalanced voltage, can be calibrated in terms of either force or weight.

CIRCUIT DIAGRAM:
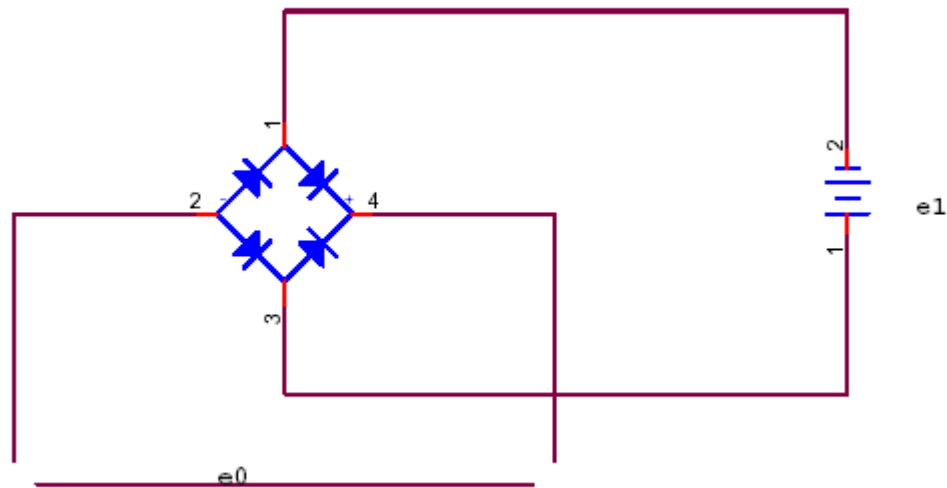
PROCEDURE: -

1. Connect the strain cantilever at the experimental kit.
2. Switch ON the power supply.
3. Give some time to stabilize the instrument.
4. Balance the strain cantilever bridge by corresponding zero, then turn trim port.
5. Set the gain of strain cantilever by SPAN, then turn trim port.
6. Now apply weight at the cantilever beam and take readings.

OBSERVATION TABLE:

S.No	Weight	Display Reading	Analog o/p (volt)	Signal (mv)

SAMPLE CALCULATION:

R= ρL/ A

Where R= resistance (Ω)

ρ = Resistivity (Ω-m)

L= Length of wire (m)

A= Uniform cross- sectional area of wire (m^2)

RESULT: - Weight can be measured by using strain gauge

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DISCUSSION:- Piezoresistive effect is studied with the help of strain gauge **.**

PRECAUTIONS: -

17. Handle all equipments with care.
18. Make connections according to the circuit diagram.
19. Take the readings carefully.
20. The connections should be tight.

QUIZ / ANSWERS : -

Q1 What is the working principle of strain gauge?

A1 Piezoresistive effect

Q2 Which type of transducer is strain gauge?

A2 Resistive

Q3 What are the advantages of strain gauges?

A3 High gauge factor and excellent hysteresis characteristics

Q4 What are the uses of strain gauges?

A4 Measurement of force & pressure, displacement, acceleration etc

Q5 What do we call the combination of gauges?

A5 Rossettes

Q6 Is it active type of transducer or of passive type?

A6 passive

Q7 How would you classify strain gauge?

A7 Bonded wire, Bonded metal, Semiconductor type etc

Q8 What is strain?

A8 Strain is defined as compression per unit area.

Q9 What is gauge factor?

A9 Gauge factor is defined as the ration of per unit change in resistance to per unit change in length.

Q10What is Poisson's ratio?

A10 Poisson's ratio, ν = -(ΔD/D)/(ΔL/L)

<p style="text-align:center;">**EXPERIMENT NO.: 6**</p>

AIM:- Measurement of temperature using thermistor

APPARATUS REQUIRED: - Thermistor kit, Heating arrangement, Ice, Thermometer, H_2O.

BRIEF THEORY: -
Thermistors are also called thermal resistors. For thermistor the absolute temperature-resistance relationship is given by

$$R_T = RT_1 \exp[\beta(1/T_1 - 1/T_2)]$$

Where R_T = Resistance of the thermistor at absolute temperature T
R_{T1} = Resistance of the thermistor at absolute temperature T_1
β = Constant
T_1 and T_2 = Absolute temperatures
Thermistors are made up of semiconductor materials. As temperature changes the resistance of materials also changes. The temperature range for thermistor is $-60\ ^0C$ to $+15^0 C$. Its resistance varies from 0.5O to 0.75MO. Thermistor is placed in contact with the media whose temperature is to be measured. As the temperature of the media changes, the resistance of the thermistor gets changed. This change of resistance can be measured by connecting the thermistor in any one arm of the Wheat stone bridge.

CIRCUIT DIAGRAM:
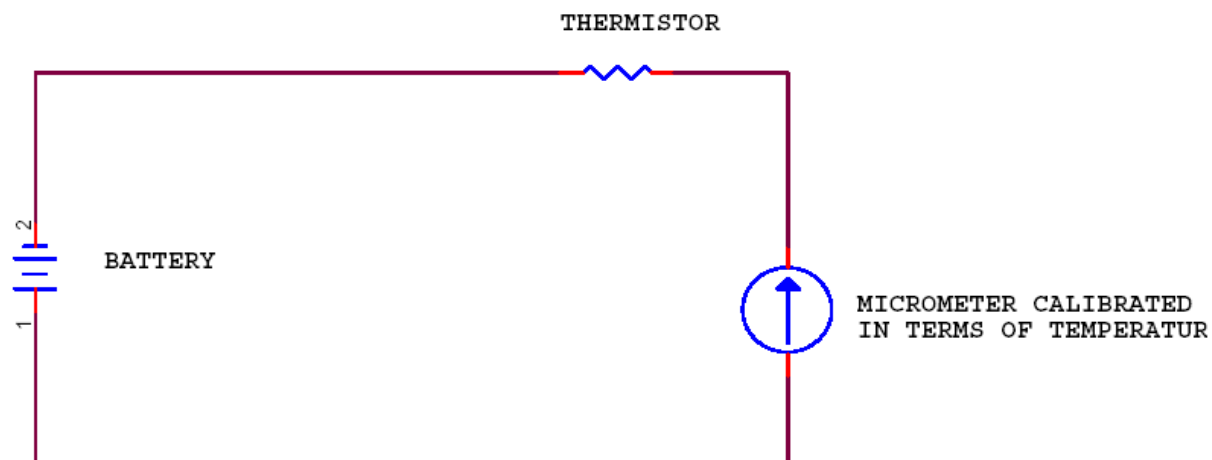
PROCEDURE: -

1. Connect the main power cord at I/P main socket.
2. Switch ON the power supply
3. Connect the thermistor sensor at the pin connector.
4. Keep the thermistor in boiling water & adjust the display ranging 100 by the adjustment span knob.

<u>**OBSERVATION TABLE:**</u>

S.No	Temperature Sensor	Display Reading (mm)

RESULT: - We have measured temperature using Thermistor.

DISCUSSION:- Change in temperature will give corresponding change in resistance

PRECAUTIONS: -

21. Handle all equipments with care.
22. Make connections according to the circuit diagram.
23. Take the readings carefully.
24. The connections should be tight.

QUIZ / ANSWERS: -

Q1 What are the advantages of thermistors?
A1 Small size, Compact, Good stability
Q2 What are the limitations of thermistors?
A2 Non-linear, low temperature range, require bridge arrangement
Q3 Which material is used in their construction?
A3 Semiconductor
Q4 What are the various configurations of thermistors?
A4 Bead, Probe, Disc and Rod
Q5 What is the temperature range of thermistor?
A5 -60^0 C to $+15^0$ C
Q6 What do you mean by positive temperature coefficient?
A6 If the value of resistance increases with increase in temperature, then we call that +ve temperature coefficient .
Q7 What are the uses of thermistor?
A7 Temperature measurement of solid, liquid and gases
Q8 Is it of active type or passive type?
A8 Passive
Q9 Which type of transducer is this?
A9 Resistive
Q10 How the temperature and resistance are related in case of thermistor ?
A10 $R_T = RT_1 \exp[\beta(1/T_1 - 1/T_2)]$

AIM:- Measurement of distance using capacitive pick up.

THEORY: -
The term Capacitor is defined as two metal plates separated by some distance 'd' and dielectric media is placed between the two metal plates. When a voltage or potential or potential difference is applied to the metal plates, equal and opposite charge gets developed on the metal plates. Capacitive transducers can be used for the measurement of displacement, vibrations, pressure, sound, level etc. Capacitive transducer works on the principle of capacitance of parallel plate capacitor, which is given by:

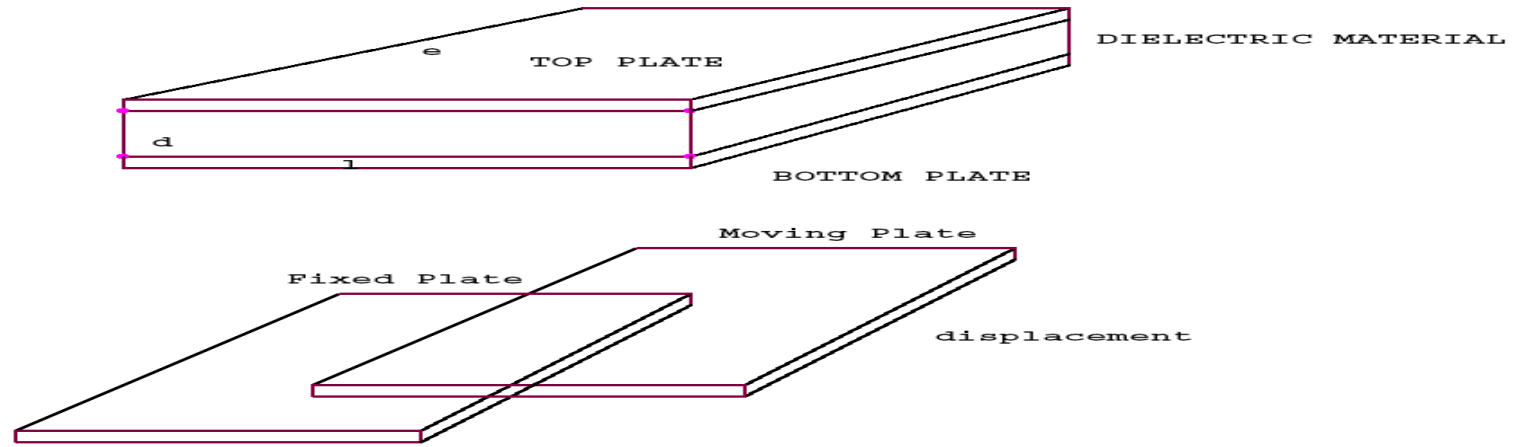Capacitance, C= $\epsilon_0 \epsilon_r$ A/d Farad

Where A= area of plates (m^2)
d= distance between two plates (m)
ϵ_0 = permittivity of free space or vacuum (8.854*10^{-12} F/m)
ϵ_r = relative permittivity

From the above equation it is observed that capacitance can be changed by changing the area, changing the distance between two plates or by changing the dielectric constant.

CIRCUIT DIAGRAM:

PROCEDURE:-
1.Connect circuit according to circuit diagram.
2.Switch on the power supply.
3.Plot graph on the basis of observations taken.

SAMPLE CALCULATION:
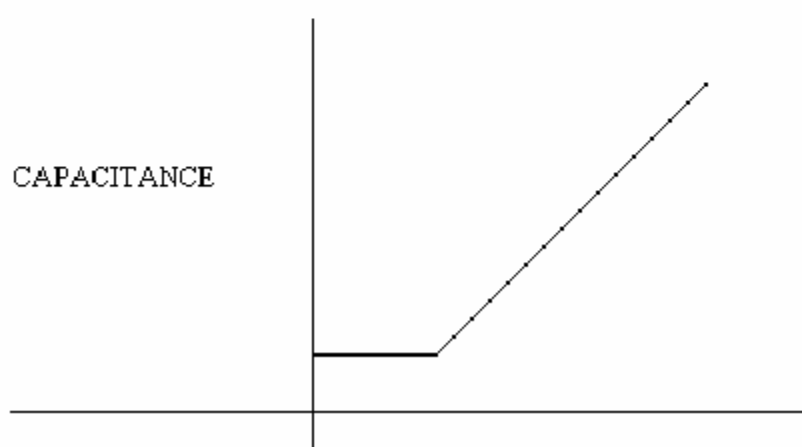
Capacitance, C= $\epsilon_0 \epsilon_r$ A/d Farad
Where A= area of plates (m^2)
      d= distance between two plates (m)
      ϵ_0 = permittivity of free space or vacuum (8.854*10^{-12} F/m)
      ϵ_r = relative permittivity

GRAPH:

RESULT: - We have studied the capacitive transducer.

DISCUSSION:- Change in capacitance will give an electrical output signal.

PRECAUTIONS:-
1.Handle all the equipments with care.
2.Make connections according to circuit diagram.
3.Connections should be tight.

QUIZ / ANSWERS: -

Q1 What is the formula for calculating capacitance?
A1 C= A/d
Q2 How the capacitance can be changed?
A2 a) Change in overlapping area of plates
b) Change in distance between the plates
c) Change in dielectric materia
Q3 What are the uses of capacitive transducers?
A3 Measurement of displacement, vibrations, pressure, level etc.
Q4 What is the working principle of capacitive transducer?
A4 Change in capacitance
Q5 What is the accuracy of capacitive transducers?
A5 0.005%
Q6 Write any one advantage of capacitive transducer.
A6 They have high input impedance so loading effect is minimum.
Q7 Write any one disadvantage of capacitive transducer.
A7 Require good isolation
Q8 Capacitive transducers are active or passive?
A8 Passive
Q9 Do we connect ammeter in series or parallel?
A9 Series
Q10 The resistance of ideal voltmeter should be how much?
A10 Infinite

AIM:- Measurement of distance using inductive pick up.

APPARATUS REQUIRED: - Variable inductive transducer kit, multimeter, connecting wires.

BRIEF THEORY: -

The variable inductive transducer work on the same principle as of LVDT. A transducer if variable type consists of coil of ferromagnetic core. The displacement to be measured is applied to ferromagnetic target. This target does not have any physical contact with the core on which it is mounted. The core and target are separated by air gap as shown. The displacement of the target allows change in inductive output voltage due to change in reluctance due to air gap.

CIRCUIT DIAGRAM:-
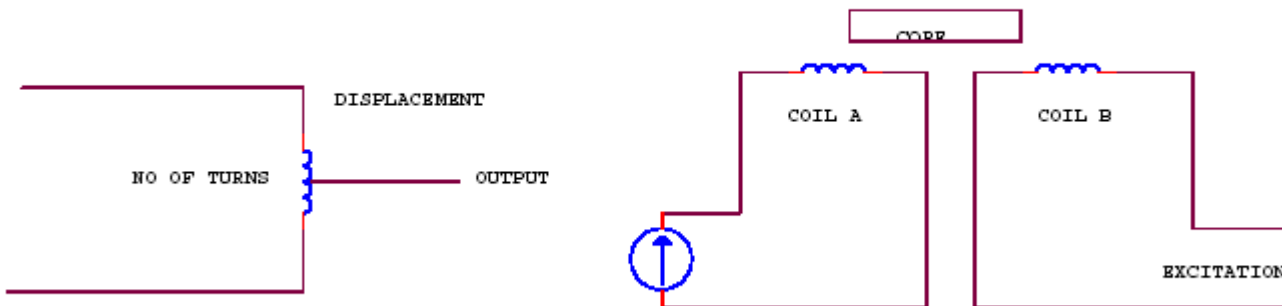
PROCEDURE: -

1. Connect the multimeter into the kit and make sure that all the connections are tight.
2. Set variable inductance knob on zero position and see there should not be any error.
3. Now rotate the knob from zero, there is variation in multimeter. Note the readings carefully.
4. Repeat step 3 for five times.
5. Make a graph between displacement and output voltage carefully

OBSERVATION TABLE:-

S.No	Displacement	Displacement Reading	Analog o/p
1.			
2.			

RESULT: - Resultant graph will be plotted between voltage & displacement.

DISCUSSION:- Variation of voltage w.r.t. displacement is studied.

PRECAUTIONS: -

25. Handle all equipments with care.
26. Make connections according to the circuit diagram.
27. Take the readings carefully.
28. The connections should be tight.

QUIZ / ANSWERS : -

Q1 What is the working principle of Inductive transducer?
A1 Same as LVDT
Q2 The core of inductive transducer is made up of which material?
A2 Ferromagnetic material
Q3 What are the uses of inductive transducer?
A3 Distance measurement
Q4 Which type of transducer is this?
A4 Inductive type
Q5 Inductive transducer is active or passive?
A5 Passive
Q6 How the change in inductance occurs in an inductive transducer?
A6   a) Change in self inductance
 b) Change in mutual inductance
Q7 The core of RVDT is of which shape?
A7 Cam shaped
Q8 What do you mean by error?
A8 Deflection of measured value from the true value is called error.
Q9 What is accuracy?
A9 Accuracy is a degree of exactness to the true value.
Q10 What is the difference between sensor and transducer?
A10 The sensor is a part of transducer, which senses or responds to a physical quantity while transducer is a device, which is used for measurement of physical quantity by electrical means.

<div align="center">**EXPERIMENT NO.: 9**</div>

AIM: - Measurement of pressure using piezoelectric pick up.

BRIEF THEORY: -
This transducer works on the principle of piezoelectric effect, which is explained below. When a mechanical force is applied to piezoelectric material the dimensions of these material gets changed resulting the generation of electric charge or electric potential across the surface of crystal. In the reverse manner, if electric charge or electric potential is applied across the surface of crystal, it results the change in dimension of crystal due to deformation. This principle is used in piezoelectric transducers for the measurement of pressure, force and acceleration i.e. mechanical input and electrical output. The piezoelectric materials are classified as follows:

1) Natural: Quartz crystal, Rochelle salt
2) Synthetic group: Lithium sulphate, barium titanate etc.

Polymer films can be used as piezoelectric materials. For piezoelectric effect the crystal should have natural asymmetrical charge distribution. Because of this asymmetric charge distribution, the lattice deformation takes place. If the asymmetric charge distribution is not available in some materials e.g. ferroelectric ceramics then such materials gets polarized artificially by applying strong electric field. This electric field produces asymmetry in the lattice.

CIRCUIT DIAGRAM:
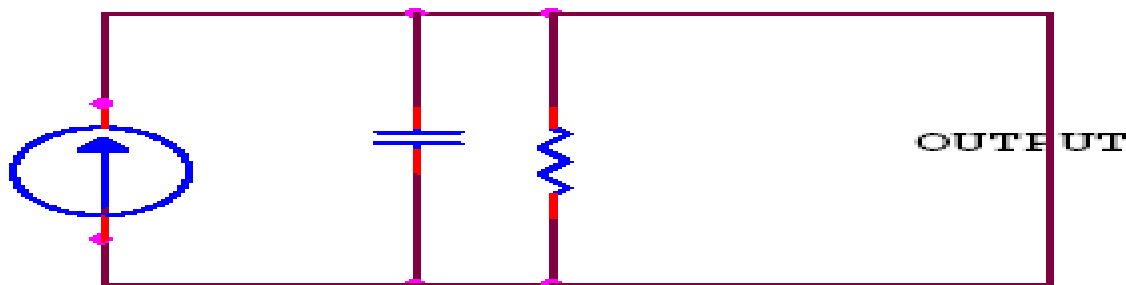
PROCEDURE:-
1.Connect the circuit according to circuit diagram.
2.Switch on the power supply.
3.plot graph according to readings taken.

RESULT: - We have studied the piezoelectric transducer.

DISCUSSION :- Piezoelectric effect is studied

PRECAUTIONS:-
1.Connect the circuit according to circuit diagram.
2.All the connections should be tight.

QUIZ / ANSWERS: -

Q1 What is the working principle of piezoelectric transducer?
A1 Piezoelectric effect

Q2 How can we classify the piezoelectric transducers?
A2 These can be classified into two types:
    a) Natural group
    b) Synthetic group

Q3 What do we call the elements that exhibit piezoelectric effect?
A3 Electro resistive elements

Q4 Are the piezoelectric materials direction sensitive or not?
A4 yes

Q5 Give the example of natural type of piezoelectric materials.
A5 Quartz, Rochelle salt

Q6 What is Piezoelectric effect?
A6 When a mechanical force is applied to piezoelectric material, the dimensions of that material gets changed resulting the generation of electric charge across the surface of crystal or vive versa.

Q7 What are the uses of piezoelectric transducers?
A7 Measurement of pressure, acceleration and force

Q8 Explain the features of piezoelectric transducers.
A8 more stability, maximum output

Q9 Are these active type of transducers or of passive type?
A9 Active

Q10 Give the example of synthetic type of piezoelectric material.
A10 Lithium sulphate, Barium titanate

AIM:- Measurement of speed of D.C motor by photoelectric pick up.

APPARATUS REQUIRED: - DC motor, CRO, photoelectric pick up, connecting wires.

BRIEF THEORY: -
       In this method, on the shaft of DC motor, a disc with opaque and transparent segments is mounted above the disc. A photoconductor of high sensitivity is placed & a source of light is placed below the disc. Output is connected to CRO. When the motor rotates, the disc connected to its shaft rotates. This disrupts the path of light coming below the finite time interval that depends upon rotation speed & photoconductor responds for interruption. On CRO, we get a square wave.
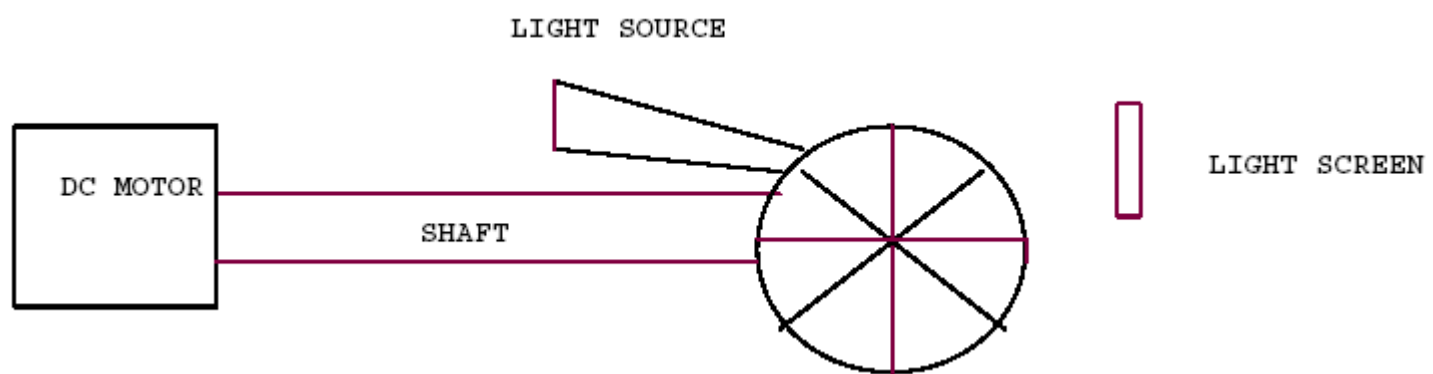
Speed of DC motor = (frequency * diameter of disc)/ No of segments

Where
D= 56.5 mm
S= 60

CIRCUIT DIAGRAM:

PROCEDURE: -

1. Connect the circuit according to the diagram &   switch ON the power supply.
2. Adjust the speed of DC motor by the knob & wait until the motor attains maximum speed at corresponding knob position.
3. Measure the frequency from output wave on CRO.
4. Find the speed of DC motor by the given formula.

OBSERVATION TABLE:-

S.No	RPM Sensor	Display Reading
1.		
2.		

SAMPLE CALCULATION:

Speed of DC motor = (frequency * diameter of disc)/ No of segments

Where
D= 56.5 mm
S= 60

RESULT: - The speed of DC motor is calculated by the photoelectric pick up.

DISCUSSION:- The photoelectric effect is studied

PRECAUTIONS: -

29. Handle all equipments with care.
30. Make connections according to the circuit diagram.
31. Take the readings carefully.
32. The connections should be tight.

QUIZ / ANSWERS: -

Q1 What is the formula for speed calculation?
A1 (frequency*diameter of disc)/ number of segments
Q2 What is photoelectric transducer?
A2 This converts light energy into electrical energy.
Q3 What are the uses of photoelectric transducer?
A3 Speed measurement, counters.
Q4 What is optocoupler?
A4 It is the combination of light source and light sensor.
Q5 What is photoelectric effect?
A5 The generation of electrons due to influence of light.
Q6 Give an example of photo transducer.
A6 Photo diode
Q7 What are the applications of photo diode?

A7 used in optical communication as a detector, object counter, switching circuits etc.

Q8 What do you mean by photoconduction?

A8 Photoconductive means in which the resistance of a material changes in accordance with the illumination.

Q9 What is the difference between analog and digital transducers?

A9 Analog transducers convert continuous quantity into continuous output while digital transducers convert the input quantity into digital output.

Q10 What do we use to measure resistance?

A10 Ohmmeter