Experiment -1

AIM: To measure the speed of a motor by 'Photo Pickup' and Magnetic Pickup methods.

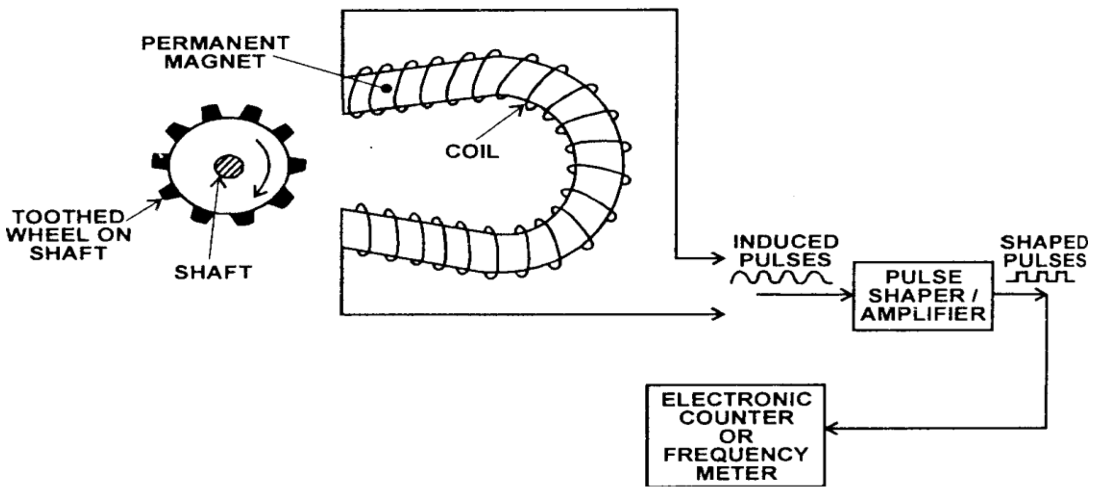
APPARATUS: Tachometer, DPM

THEORY:

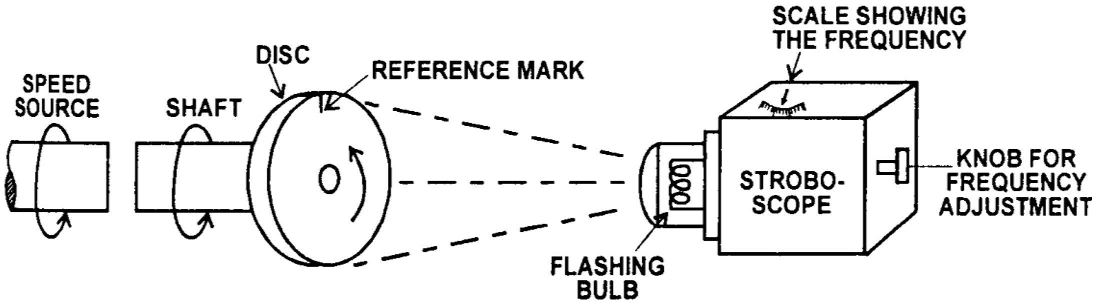
There are two methods for the measurement of speed of a motor shaft with the help of non-contact pickups.

1.Magnetic pickup: In this type of device, a small toothed wheel is to be attached to the shaft whose speed is to be determined. A permanent magnet with a coil wound around around it is placed near the rotating toothed wheel. As the wheel rotates, the magnetic flux linking the magnet and coil changes. As a result, voltage is induced in the coil. The frequency of the pulses depends upon the number of teeth on the wheel.

$$\textbf{Speed of the shaft} = \frac{\text{Pulses per Second}}{\text{Number of teeth on the wheel}}$$



2.Photo electric pickup: This is another method of speed measurement based on photo electric effect. An opaque disc with evenly spaced holes on its periphery is to be attached to the shaft whose speed to be measured. A light source is placed on one side and a light sensitive transducer on the other side of the disc. Both are in alignment with the holes in disc. As the disc rotates the intermittent light falling on the photocell produces voltage pulses whose frequency is a measure of the speed of the shaft. Remaining is same as inductive pickup.



PROCEDURE:

1. Connect the calibration source to the input socket by the cable provided and connect the O/P terminals to the DPM observing polarity.
2. Adjust the pot marked “max” to get 1500 as the meter (DPM). Now the setup is calibrated from 1500rpm, Neglect decimal point.
3. Connect the photo electric and magnetic pickup in proper fashion.
4. Connect the motor terminal cable to the O/P terminals of D.C. supply ensure that dimmer knob is in zero position. Switch on the power supply and control slowly so on changing the speed of motor.
5. Motor speed will be indicated by the DPM for each pickup
6. Compare the DPM reading with digital tachometer reading.

OBSERVATIONS:

S.No	Tachometer (RPM)	Photo pickup (RPM)	Percentage error	Tachometer (RPM)	Magnetic pickup (RPM)	Percentage error

PRECAUTIONS:

1. Always start the motor with zero speed and operate the knob slowly.
2. As soon as the experiment is over disconnect the photo-electric and and magnetic pick-ups.

RESULT:

Experiment-2

AIM: Measurement of temperature using Thermocouple.

APPARATUS REQUIRED: Thermocouple kit, heating arrangement, Ice, Thermometer, H_2O.

THEORY

THERMOCOUPLE

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

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.

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.

OBSERVATION TABLE

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

RESULT - We have measured the temperature using Thermocouple.

EXPERIMENT-3

AIM: Measurement of temperature using Thermistor.

APPARATUS REQUIRED: Thermistor kit, heating arrangement Ice, Thermometer, H_2O.

THEORY

THERMISTOR

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

$$R_T=R_{T1}\exp[\beta(1/T_1-1/T_2)]$$

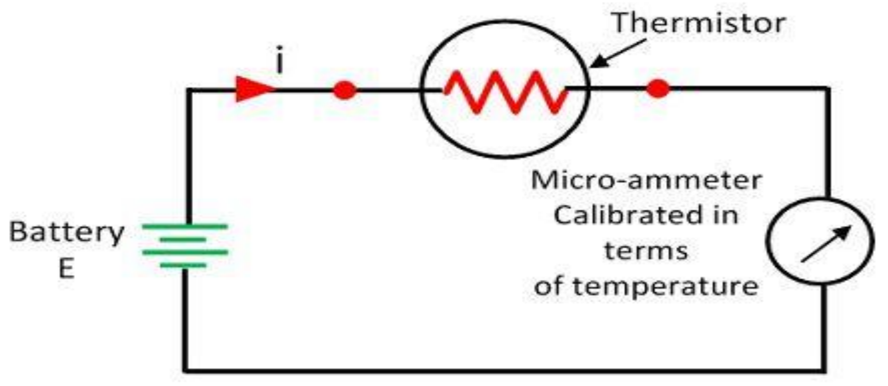
Where R_T=Resistance of the thermistor at absolute temperature T R_{T1}= Resistance of the thermistor at absolute temperature T_1

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^{0}C to +15^{0}C. Its resistance varies from 0.5Ω to 0.75MΩ. 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



Series Circuit For Measurement of Thermistor

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.

PRECAUTIONS:

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

OBSERVATION TABLE

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

RESULT - We have measured the temperature using Thermistor.

EXPERIMENT-4

AIM: To measure the temperature by using resistance temperature detector.

APPARATUS:

Resistance temperature detector (R.T.D), Digital panel meter, Heater and container, Thermometer

THEORY:

The principle of operation of R.T.D. is based as fact that the electrical resistance of many metals increase almost directly with temperature and is reproducible to a high degree of accuracy.

The resistance of the R.T.D. increase as temperature increase. The resistance and temperature linearly related over a wide temperature range. The main parts of R.T.D. is

i. A glass or metal tube which houses a ceramic mandrel on which a platinum resistance wire is wound. The lead wires of the sensing element projected out of the ceramic mandrel. This arrangement becomes the resistance thermometer.

ii. The glass or metal bulb is evacuated or filled with inert gas to protect the resistance wire sensing element.

BASIC PRINCIPLE:

When an electric conductor is subjected to temperature change, the resistance of the conductor changes. Thus, the change in resistance of the electric conductor becomes a measure of the change in temperature when calibrated.

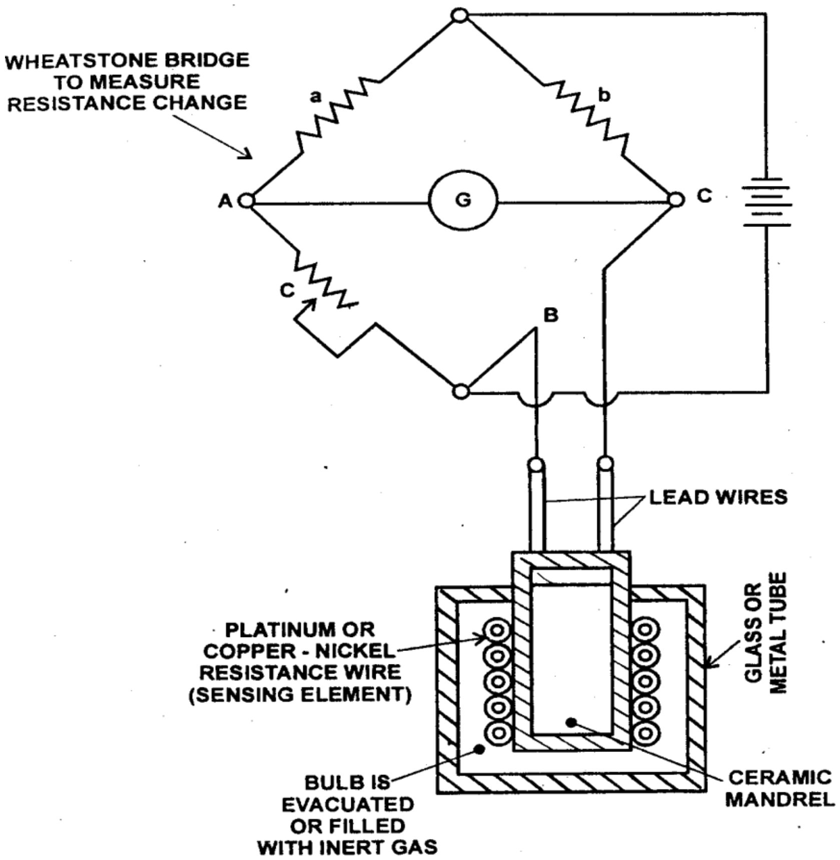


Figure Resistance Thermometer

PROCEDURE:

1. Keep switch SW_2 in position marked "TEMP".

2. Connect a precision resistance of 100 ohms across input terminals

3. Adjust pot marked "MIN"(P_2) to read 0.0 on DPM. This action simulates ice-bath temperature. Since at zero degree centigrade PT 100 exhibits 100 ohms.

4. Now connect a precision resistance of 139 ohms across the input terminals. Adjust MAX pot (P_1) to read 100.0 on DPM. This action simulates boiling point temperature of water i.e.100 degree centigrade.

5. Connect the R.T.D. across the terminals marked input. Note that polarity is immaterial.
6. Connect terminals marked output to DPM input terminals.
7. Note that RTD may be immersed in the boiling water and the resistance of the transducer should be noted down.
8. Note down the readings of the thermometer and RTD.

OBSERVATIONS:

S.No	Thermometer reading (^{o}c)	Temperature on DPM (^{o}c)	Resistance on DPM (ohms)	Percentage Error

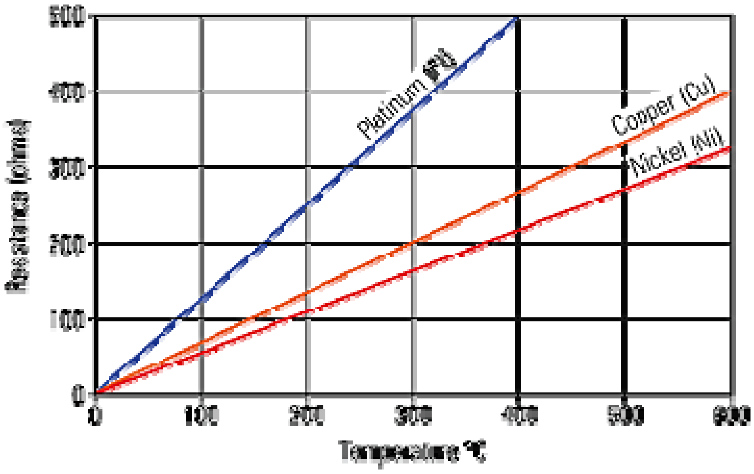
- Please note that RTD exhibits good linearity and good accuracy in comparison with thermocouple
- The time constant of the sensor is large
- Polarity of connections is immaterial as RTD is only a resistance sensor.

PRECAUTIONS:

- ✓ Make the connections properly.
- ✓ Take the readings when they are steady.
- ✓ RTD should not touch the bottom of the vessal.
- ✓ Please handle RTD very carefully as it is very costly. Please ensure that is not dropped on the floor.

GRAPH: Thermometer temperature vs RTD temperature

Thermometer temperature vs RTD Resistance


Platinum (Pt)
Copper (Cu)
Nickel (Ni)
Resistance (ohms)
Temperature °C
0
100
200
300
400
500
600

RESULT:

EXPERIMENT- 5

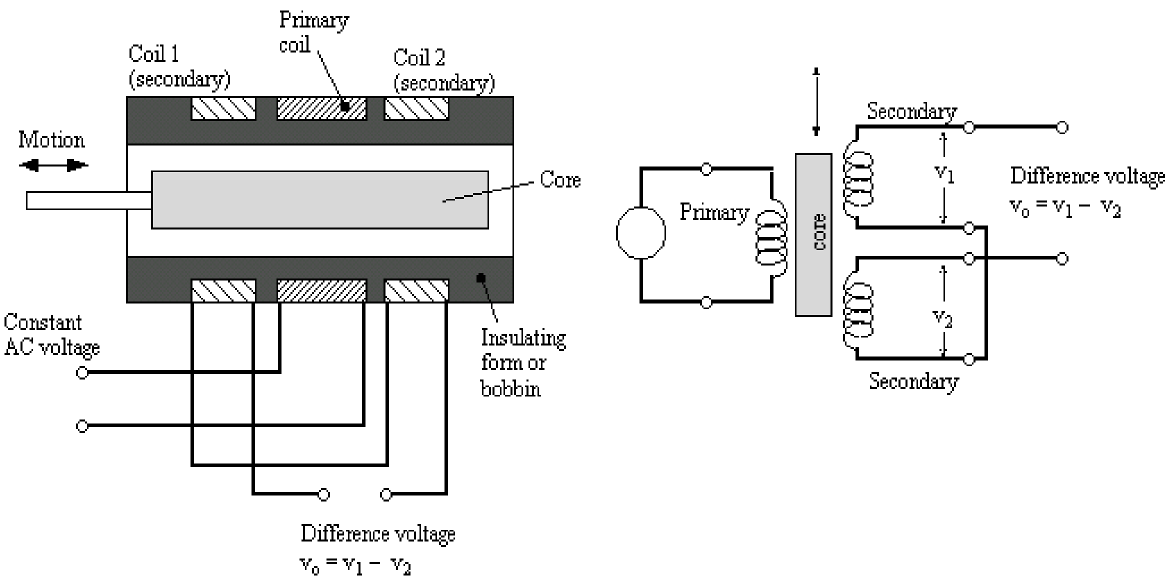
AIM: To measure the linear displacement using Linear Variable Differential Transformer (L.V.D.T.)

APPARATUS:

Digital instrumentation tutor, L.V.D.T.

THEORY:

LVDT converts linear motion into an electrical signal. It is used for measuring displacement. The LVDT consists of a primary winding and two secondary windings, which are wound on cylindrical former. The two secondary windings S_1 & S_2 have equal number of turns. The secondary windings are placed identically on either side of the primary winding. The primary winding is connected to an a.c. source. A movable core is placed inside the cylindrical former.



PRINCIPLE:

As the primary winding is connected to the a.c. source. It is excited and hence a magnetic field is produced. Due to this magnetic field, a voltage is induced in the secondary windings. The differential output is $E_0 = E_{S1}-E_{S2}$ When the core is in the normal (null) position, the magnetic field linking with both the secondary windings S_1 & S_2 are equal. Hence the e.m.f. induced in them are also equal

Therefore null position $E_0 = 0$ ($E_{s1} = E_{s2}$). When the core is moved to the right of the null position, more magnetic field links with the winding S_2 and less with winding S_1. Therefore $E_{s2} > E_{s1}$. The output voltage $E_0 = E_{s2} – E_{s1}$ and is in the phase E_{s2}. When the core is moved to the left of the null position more magnetic field links with the winding S_1 and less with the winding S_2. Therefore $E_{s1} > E_{s2}$. The output voltage of the L.V.D.T. gives a measure of the physical position of the core and it's displacement.

PROCEDURE:

1. Connect the terminals marked "PRIMARY" on the front panel of the instrument to the terminals marked "PRIMARY" on the transducer itself, with the help of flexible wires provided along with. Observe the colour code for the wires provided and the colour of the binding posts.

2. Similarly connect the terminals marked secondary.

3. Keep pot marked "MAX" in most anticlock- wise position.

4. The magnetic core may be displaced and the pointer may be brought to zero position. If the DPM is not indicating zero, use potentiometer marked "MIN" to get a zero on DPM at zero mechanical position. If the core is displaced in both directions, the meter must show indications with appropriate polarity. Now displace the core to 19 mm positions in one of the directions. Adjust the "MAX" pot to get an indication of 19.00 on the DPM under this condition. Now the set up is ready for experimentation. You may again check for zero position also.

5. Now the core can be moved by a known amount in the range ± 19 mm and the DPM readings are taken in the table given below. It may noted that by inter changing the secondary terminals ro the primary, the polarity of the meter indication can be reversed for a given deirection of input displacement.

6. Plot the graph of input displacement and the output indication on the x and y axis respectively.

OBSERVATIONS:

Sl.No.	Input Displacement (mm)	Output Indication (mm)	Difference (mm)	Percentage Error

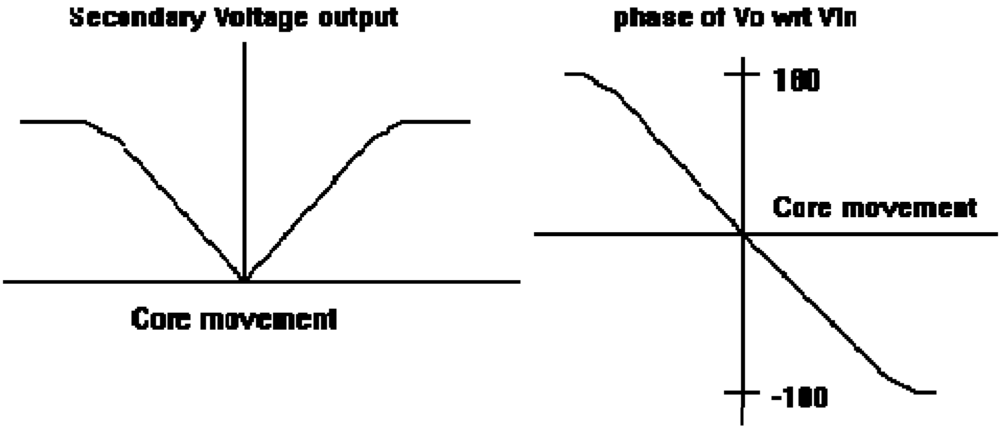
PRECAUTIONS:

1. Move the core with a gentle fashion.
2. While connecting lead wire from panel to transducer make proper connections following colour code. Avoid
3. Avoid starting of the excitations source terminals.
4. Do not try to effect the core movement beyond 20 mm as per the given range.

OBSERVATIONS:

- ✓ Study the linearity of input and output displacements.
- ✓ Note the effects of interchanging the secondary connections on the meter output polarity
- ✓ Note that when the core is mechanically at zero position, a small electrical output is obtained due to imperfections of the transducer

GRAPH: Input Displacement Vs DPM Reading



RESULT:

EXPERIMENT-6

AIM: Measurement of displacement using light dependent resistor.

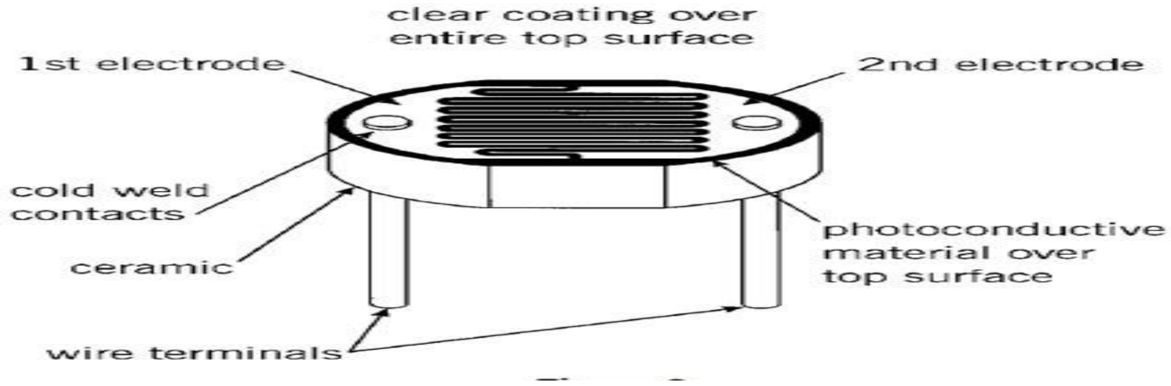
APPARATUS:

Light Dependent Resistor (LDR), DPM

THEORY:

If radiation falls on a semiconductor, its conductivity increases. This is called as photo conductive effect. This effect is the basis of operation of L.D.R. The conductivity of a material is proportional to the concentration of charge carriers present. Radiant energy supplied to the semiconductor causes covalent bonds to be broken & hole and electron pairs in excess of those generated thermally, are created .these increased current carriers decrease the resistance of the material and hence, such a device is called as photo resistor, photoconductor or L.D.R.

The L.D.R, with widest application, is the cadmium sulphide cell. Cd S photoconductors have high dissipation capability, excellent sensitivity in the visible spectrum and low resistance when stimulated by light.



OPERATION:

1. Establish a connection between the lamp and front panel socket for lamp supply
2. Connect the L.D.R to the input terminals on the front panel. Polarity is not important.
3. Connect the output terminals of transducer circuit to D.P.M observing polarity.
4. Adjust the channel on which L.D.R is mounted, so that full scale deflection is obtained on the meter. If required, use potentiometer marked MAX. on the panel.
5. Using the scale mounted on the bottom of ”C” channel, measure the input displacement & the resultant DPM readings.

OBSERVATIONS

Sr.No	Scale reading on the set up	Effective displacement	D.P.M indication	Percentage Error

THE STUDENT MAY NOTE THAT

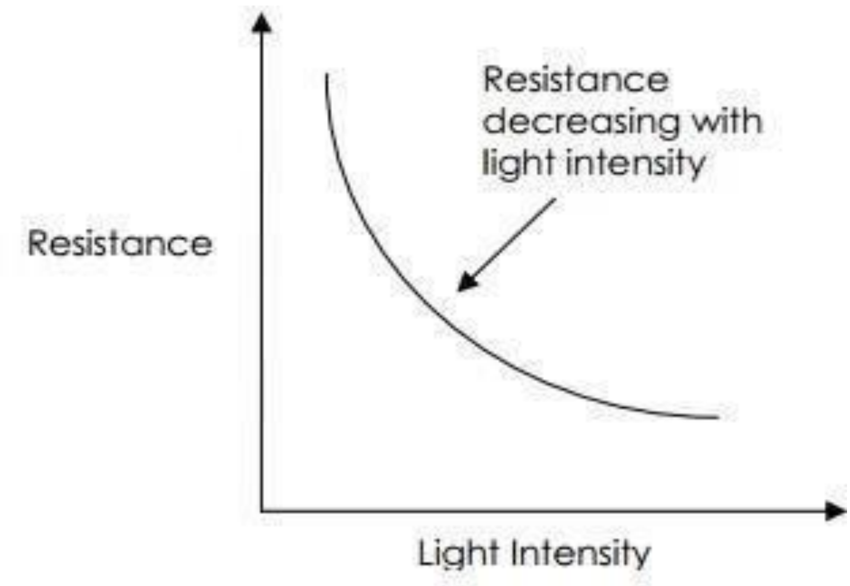
- ✓ The set up can be used to measure displacement over a wide range. However, over a limited range the response is seen to be linear.
- ✓ The L.D.R is sensitive to temperature variation also. Hence at different temperatures, the output-input responses are seen to be slightly changing.

PRECAUTIONS:

- Do not expose the L.D.R to intense light.
- Do not connect the DPM before connecting lamp and L.D.R to the front panel.

GRAPH:

Plot the graph between input Displacement vs DPM Reading



RESULT

EXPERIMENT-7

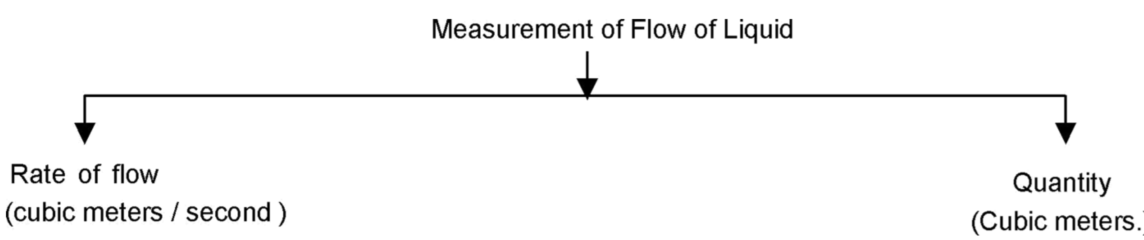
AIM: To measure rate of flow of liquid using Rotameter.

APPARATUS: Rotameter, Fluid source (Pipe line), Outlet pipe, Valve, Container, Rotameter tab with engraved scale, Scale range 0 to 0.05 m3 / min or 50 lit / min, least count of scale – 2 lit / min. Suitable for measuring liquids. Float material – Stainless steel or any non-Corrosive metal, Suitable arrangement for inlet and outlet connections with valves on both the sides.

Proposition 1: Measurement of flow

1. Rate of flow: It is the quantity of liquid flowing per unit time. It is measured in meters per second and then multiplying it by cross sectional area of pipe. It is expressed in cubic meters per second.
2. Quantity: It is the total amount of liquid that flows across a given point in a specified interval of time through the cross sectional area. It is expressed in cubic meters.

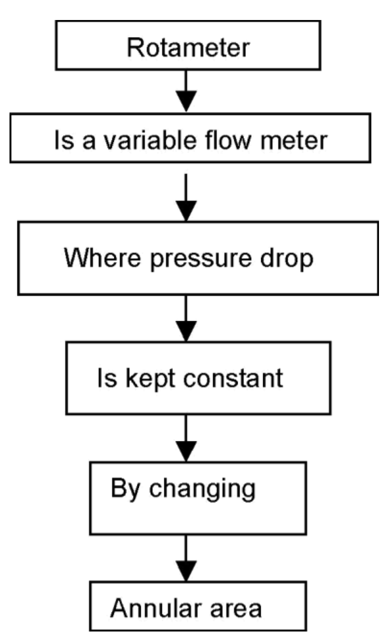
Concept of Structure:



Proposition 2: Rotameter

It is a variable area flow meter where the pressure drop at the inlet and outlet is kept constant, by changing the annular area.

Concept Structure:



DIAGRAM

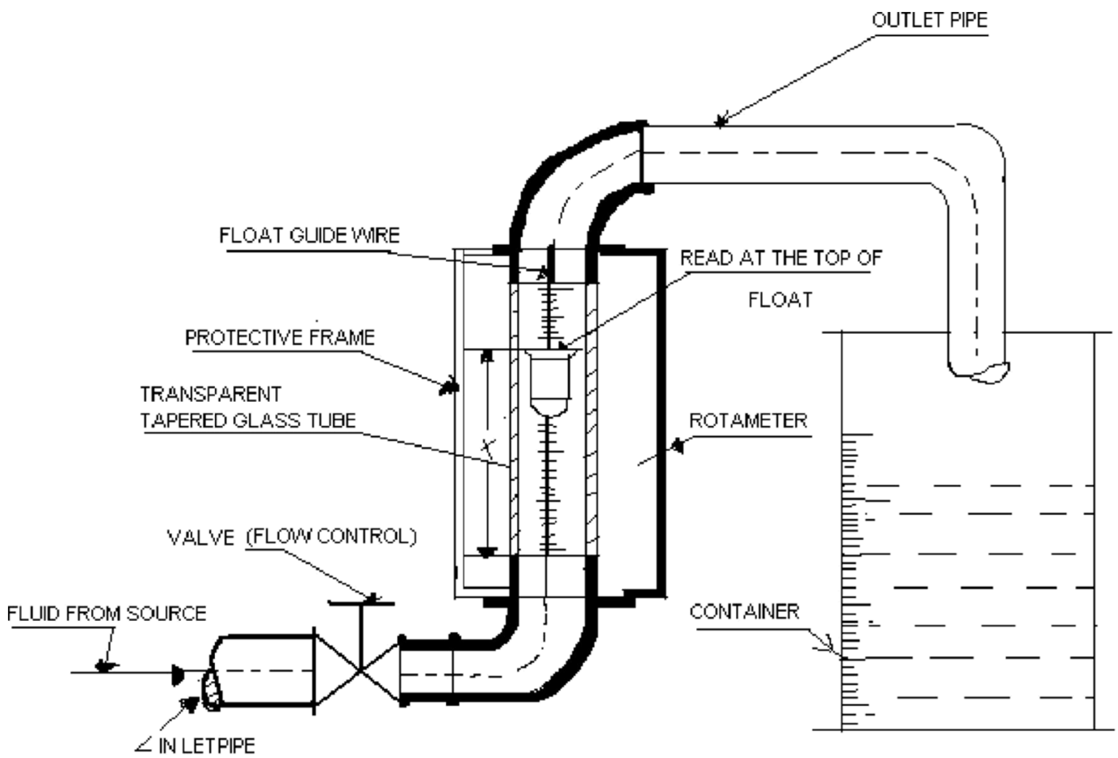


FIG -1 EXPERIMENTAL SETUP FOR FLOW MEASUREMENT USING ROTAMETER

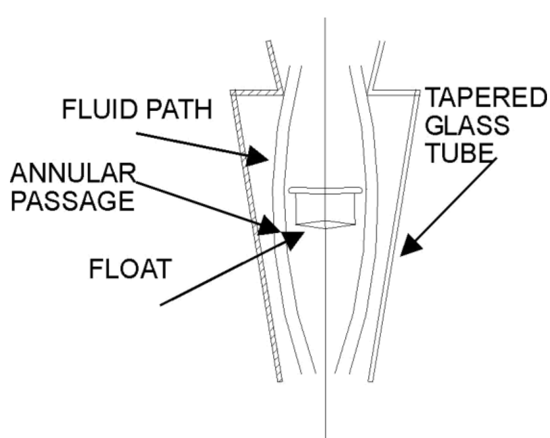


FIG. 2 SHOWING FLOAT LIFT

STEPWISE PROCEDURE:

1. Make the arrangement as shown in the figure. Make sure that the rotameter is in vertical position.
2. Start the flow by operating the tappet or valve slowly.
3. As the float moves upwards, an annular passage is opened between the wall of tapered glass tube and float periphery as shown in figure 2.
4. Now stop the valve adjustment and observe that the float comes to dynamic equilibrium position. This position is reached when the annular passage is sufficient to pass all the fluid.
5. Upward and downward movement of the float depends upon the rate of flow (i.e. each float position corresponds to a particular flow rate.)
6. The float gives readings on a calibrated scale in terms of flow rate (m3/sec or lits/sec) as shown in the figure1.

OBSERVATION TABLE:

Table for rate of flow

Reading No	Flow rate in m^3/sec or lits/sec
1	
2	
3	
4	
5	

CONCLUSION:

(As per result obtained from experiment and skills acquired by the students, teacher shall guide and conclusion to be writte.

Experiment No: 8

Aim: - Study of Weight Measurement is using Strain Gauge.

Apparatus Requirement: -

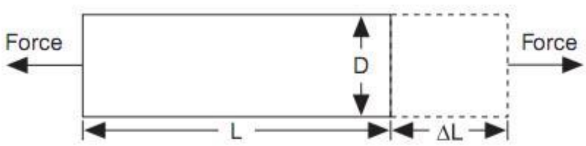
1. Personal computer
2. Lab view 2009 Runtime engine
3. Internet facility (for online experiment)

   For off-line experiment, executable file of the experiment can be downloaded through the download link given on the website.

Theory:

Strain:

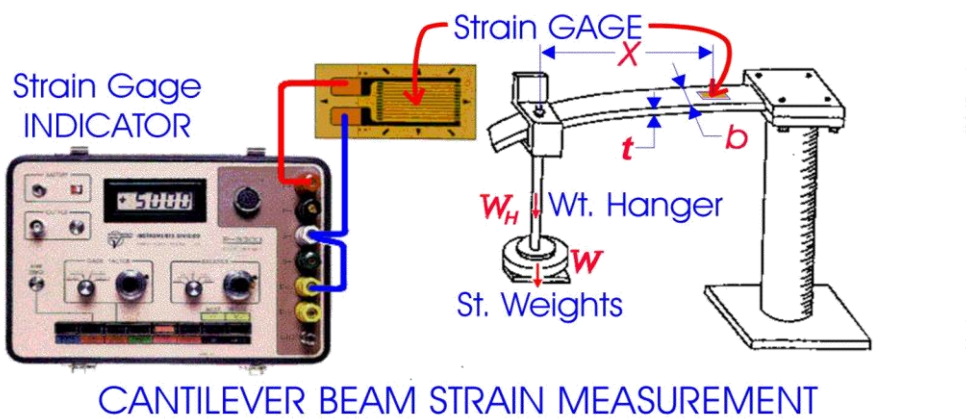
Strain is the amount of deformation of a body due to an applied force. More specifically, strain (ε) is defined as the fractional change in length, as shown in Figure 1 below.



$$\varepsilon = \frac{\Delta L}{L}$$

Figure 1. Definition of Strain

Strain can be positive (tensile) or negative (compressive). Although dimensionless, strain is sometimes expressed in units such as in./in. or mm/mm. In practice, the magnitude of measured strain is very small. Therefore, strain is often expressed as micro strain (με), which is ε × 10–6.



A fundamental parameter of the strain gauge is its sensitivity to strain, expressed quantitatively as the gauge factor (GF). Gauge factor is defined as the ratio of fractional change in electrical resistance to the fractional change in length (strain):

$$GF = \frac{\Delta R / R}{\Delta L / L} = \frac{\Delta R / R}{\varepsilon} \quad (1)$$

or $$GF = 1 + 2v, \quad (2)$$

Where, v is Poisson's Ratio

The Gauge Factor for metallic strain gauges is typically around 2.

Strain

$$\sigma = E \cdot \varepsilon \quad (3)$$

Where,
σ = Strain

E = Young's Modulus

ε = Stress

For a cantilever beam with a point load at its end,

$$M \backslash I = \sigma / y \quad (4)$$

where,

2. is the moment applied, (P*x) where 'x' is the distance between the point of loading and the mid-section at which strain gage is fixed.

P Is power applied in the test specimen, M*g where M is Mass & g is gravitational force.
For a cantilever beam with a point load at its end,

$$M \backslash I = \sigma / y \quad (4)$$

where,

3. is the moment applied, (P*x) where 'x' is the distance between the point of loading and the mid-section at which strain gage is fixed.

P Is power applied in the test specimen, M*g where M is Mass & g is gravitational force.

is the moment of inertia $I = bt^3/12$ about the neutral axis of bending, where *b* = beam width, *t* = beam thickness

7. is the value of stress at a point which is at a distance of

y from the neutral axis and y = t / 2 because the strain gage is fixed to the surface of the beam.

Finally, the formula for strain is:

$$\varepsilon = \frac{6 * P * x}{E * b * t^2}$$

Replace P=M*g in Equation (4) (5)

$$\varepsilon = \frac{6 * m * g * x}{b * t^2 * E}$$

Where,

(6)

E=Young's Modulus

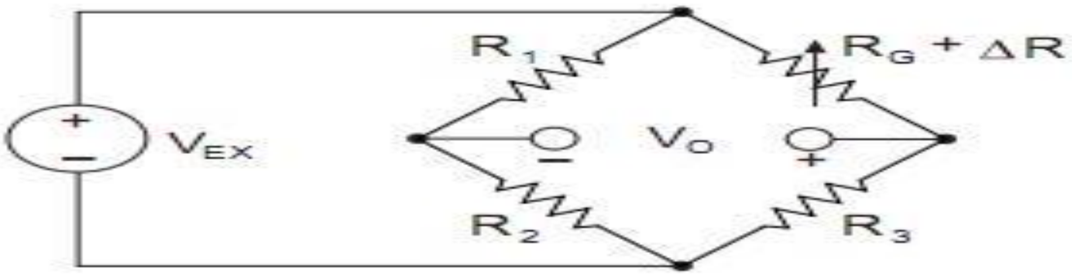
ε= Stress

m = mass or weight

b = beam width

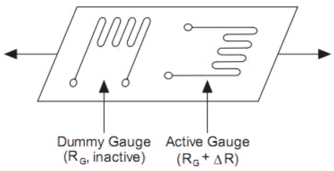
t = beam thickness

x= distance between the point of loading and the mid-section at which strain gage is fixed



$$\frac{V_O}{V_{EX}} = -\frac{GF \bullet \varepsilon}{4}\left(\frac{1}{1 + GF \bullet \frac{\varepsilon}{2}}\right)$$

To measure such small changes in resistance, and compensate for the temperature sensitivity discussed in the previous section, strain gauges are almost always used in a bridge configuration with a voltage or current excitation source. The general Wheatstone bridge, illustrated below, consists of four resistive arms with an excitation voltage, V_{EX}, that is applied across the bridge.



By using two strain gauges in the bridge, the effect of temperature can be avoided. A strain gauge configuration where one gauge is active (RG + ΔR), and a second gauge is placed transverse to the applied strain. Therefore, the strain has little effect on the second gauge, called the dummy gauge. However, any changes in temperature will affect both gauges in the same way. Because the temperature changes are identical in the two gauges, the ratio of their resistance does not change, the voltage VO does not change, and the effects of the temperature change are minimized.

Now we calibrate the weight using equation (5) & equation (7), so get the weight of the hanger (W_H) and convert it into Newtons (SI unit).

$$W_H = \frac{2 * E * b * t^2}{3(V_{EX} + V_o) * GF * g * x} \tag{9}$$

Add the standard weights (W) to the hanger and hang it from the free end of the beam. So the total Force on the strain gauge is

$$P = W + W_H \tag{10}$$

The Percentage error of Weight is Actual Weight & Measured Weight.

Percentage Error (%) = (Measured Weight- Actual Weight)*100

Appendix:-

Gauge factor, Young's Modulus & Poisson's Ratio for some Common Materials

Material	Gauge Factor	Young's modulus	Poisson's Ratio
Aluminium	1.668	69(GPa)	0.334
Copper	1.71	123	0.355
Steel	1.53	204	0.265
Magnesium	1.70	109	0.35
Bronzes	1.68	123	0.34