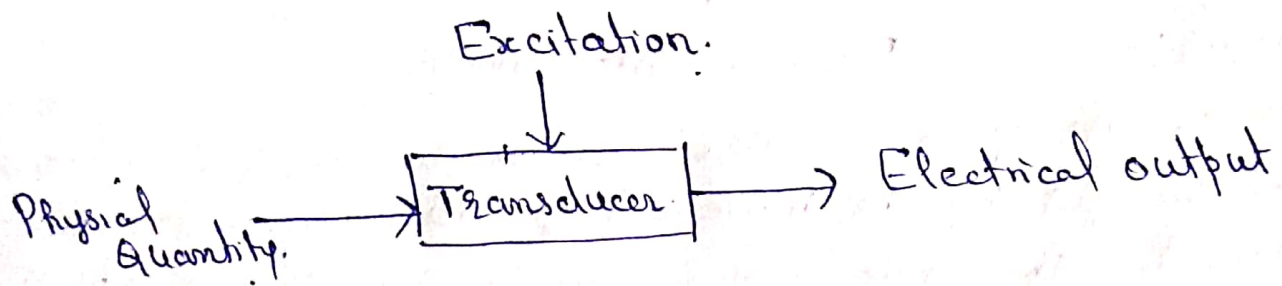


Unit - 5 (INSTRUMENTATION)

①

Transducer:- It is a device which converts the energy from one form into another.

Most of the transducers either convert electrical energy into mechanical, displacement and convert some non-physical quantity, displacement, velocity, temperature etc.



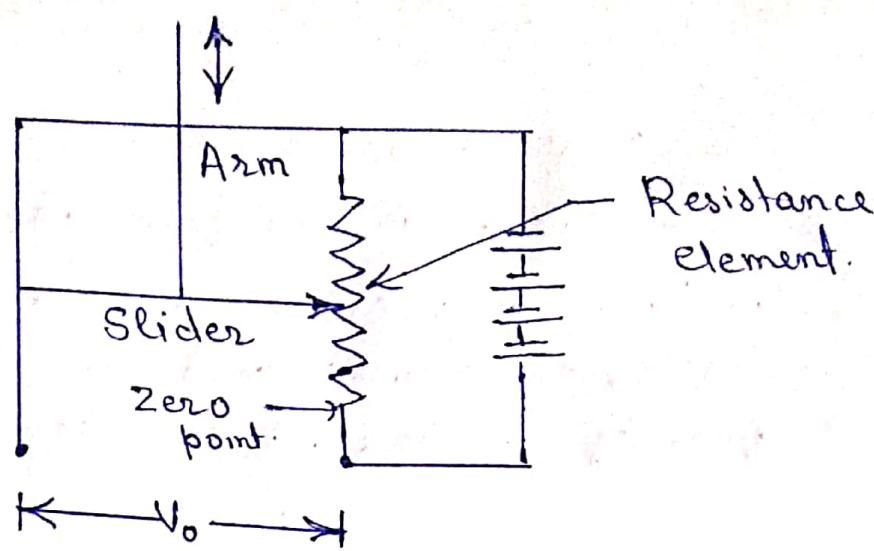
Electromechanical - Transducers:- A device for converting mechanical motion (vibrations) into variation of an electric current or voltage and vice-versa.

These transducers are used as an actuating mechanism in automatic control system.

Measurement of Displacement:- Displacement can be measured by.

1. Resistive potentiometer.
2. Variable Inductance Transducer.
3. Capacitive Transducer.

1. Resistive Potentiometer:- It is a variable resistance transducer which converts linear or angular displacement into change in resistance.



Working:-

Resistive Potentiometer

It consists of a variable resistor whose resistance is changed by the movement of slider over resistance element. The slider moves due to arm movement. The slider moves over the resistance element and thus change the resistance takes place. The direction or amount of displacement indicated by resistance which is increasing or decreasing.

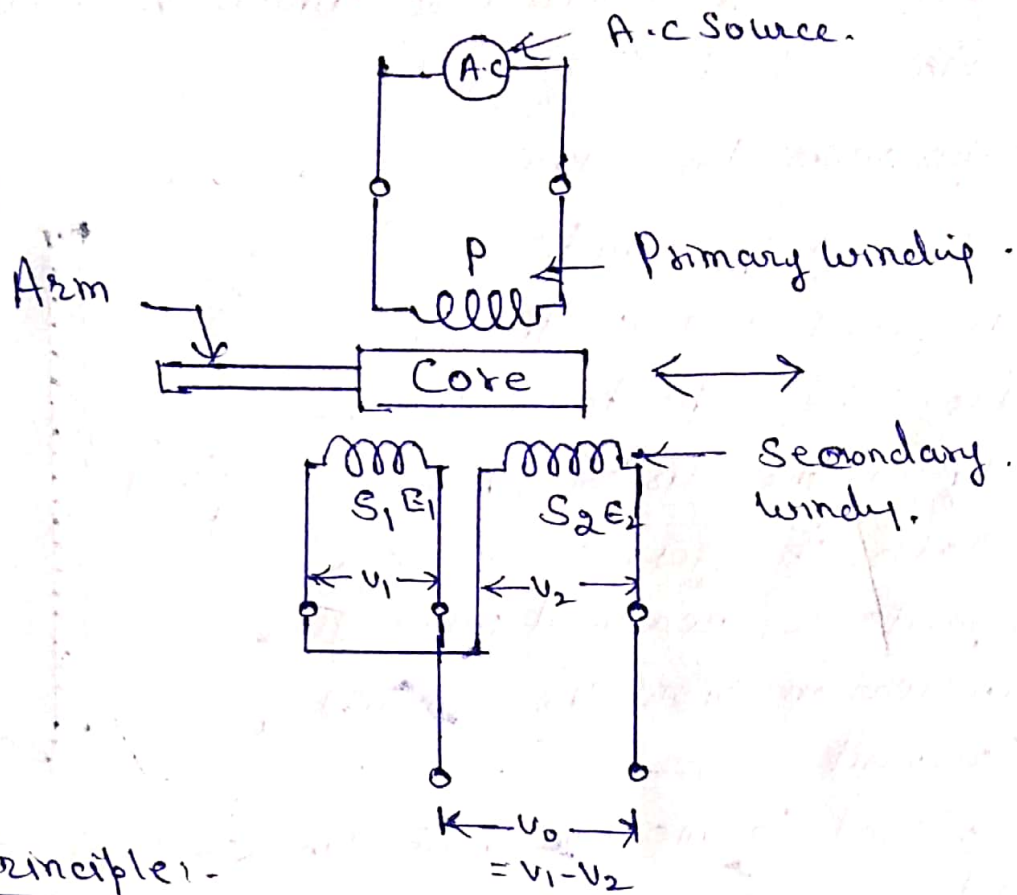
2. Variable Inductance Transducer:- It is of two types.

(i) Active Transducer:- In this voltage is generated due to the relative motion between the conductor and a magnetic field. It is also known as self generating type transducer.

(ii) Passive Transducer:- In this the power required for energy conversion from an external power source. These are also known as externally powered transducers.

Linear Variable differential Transformer (LVDT):-

It is a type of electrical transformer used for measuring linear displacement

Working Principle:-

It is a passive type transformer. They work under the principle of mutual inductance change due to movement of magnetic core.

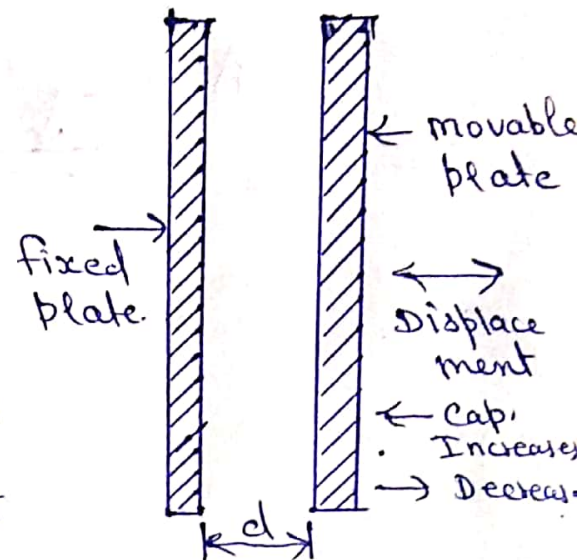
It consists of a primary winding P and two secondary windings. The primary winding is mounted on soft iron core and secondary are placed on either side of the primary on the same magnetic core (S_1, S_2). The two secondary windings have equal no. of turns connected in series but opposite to each other, so that e.m.f. E_1 and E_2 are at phase difference of 180° . The Primary winding is energized by an A.C source

When the Core is in center position called reference position. E_1 and E_2 are equal and opposite in phase. So the output voltage $V_o = 0$ (4)

When the Core shifted by displacement E_1, E_2 differs and net voltage is measured which is proportional to displacement of core.

3. Capacitive Transducer:-

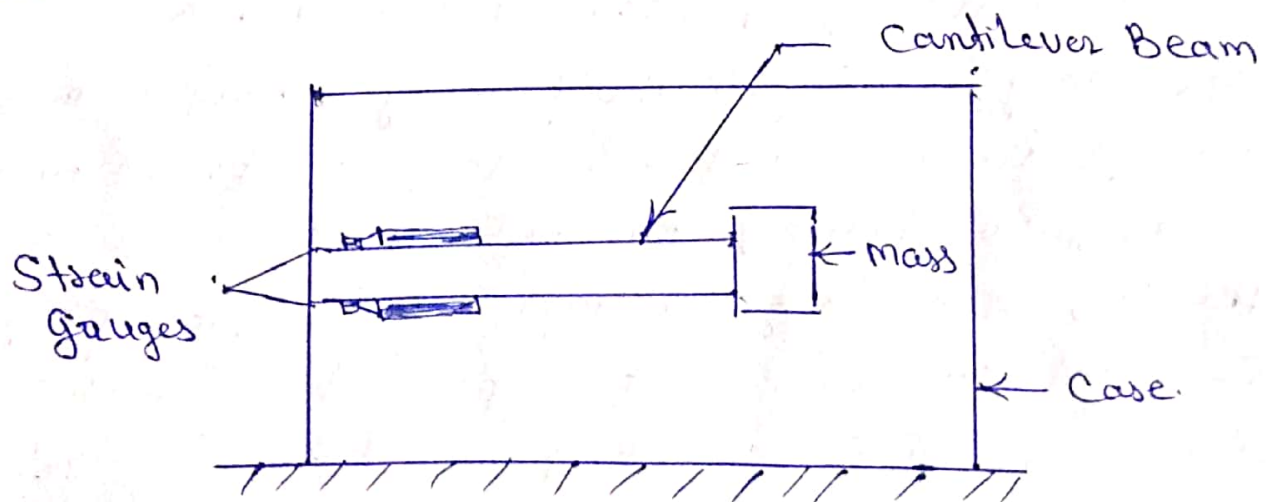
It consists of two plates one is fixed and another is movable. The Capacitance changes inversely as the distance between two plates changes. The change in capacitance measured which gives the indication about the amount of displacement.



It is used to measure both Linear and angular displacement.

Measurement of Vibrations:- It is possible by Accelerometer

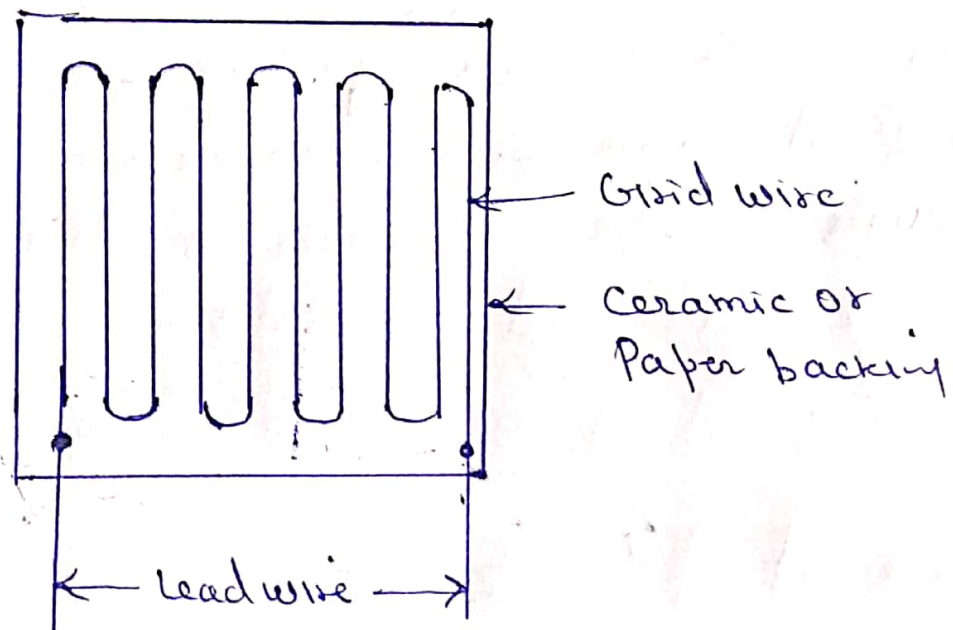
Cantilever Beam Type Accelerometer:-



Working:- It consists of a Case, Cantilever beam, mass and strain gauges. The mass is attached at the end of a cantilever beam. Due to vibrations this mass is subjected to acceleration & a relative displacement of mass with respect of Case is produced and bending of Cantilever beam takes place which are detected by strain gauges.

Measurement of Pressure:- The pressure can be measured with the help of different transducers.

1. Resistance type Pressure Transducer:- The example of this type of transducer is strain gauge



Working:- It works on the principle that when a metal conductor is stretched or compressed the resistance changes due to the fact that both its length and diameter changes. In diagram when the grid 'R' is distorted, resistance 'R' of wire changes.

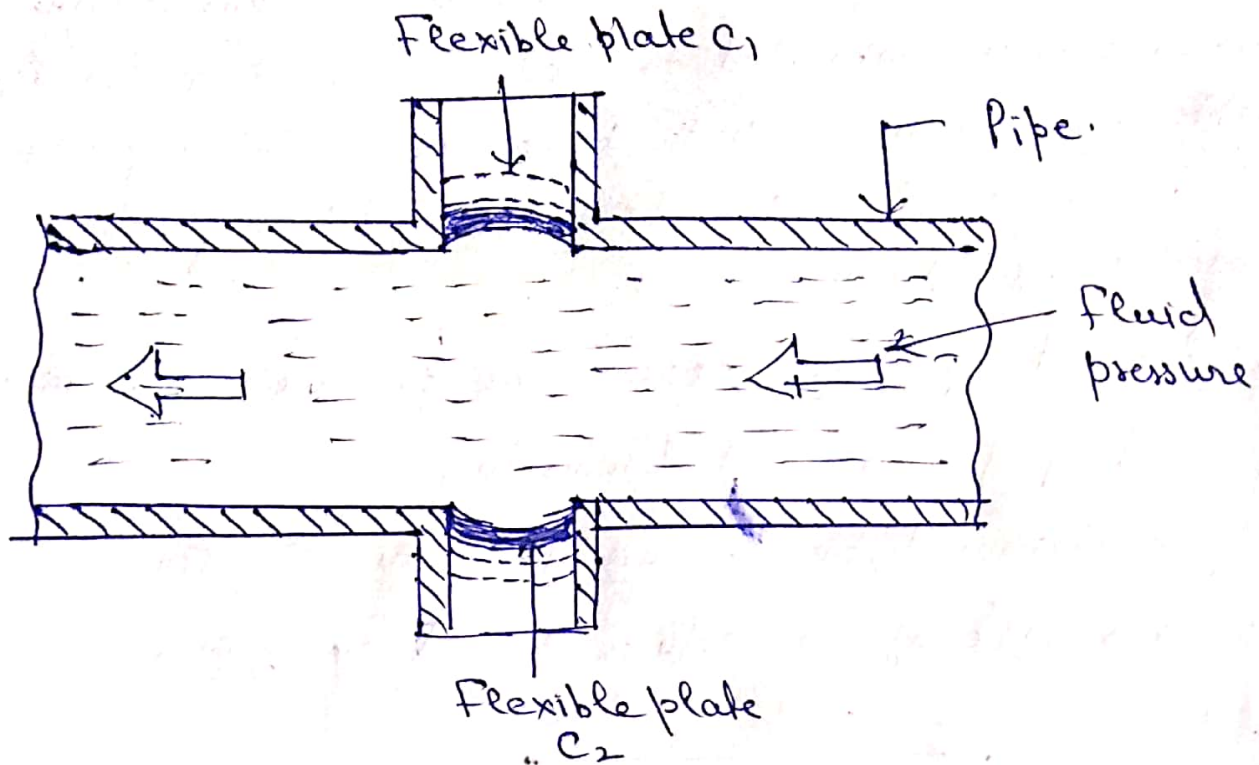
$$R = R \times \frac{L}{A}$$

$R = \text{Constant}$ $A = \text{Cross sectional Area}$
 $L = \text{Length}$

2. Inductance Type Pressure Transducer:-

LVDT (discussed earlier)

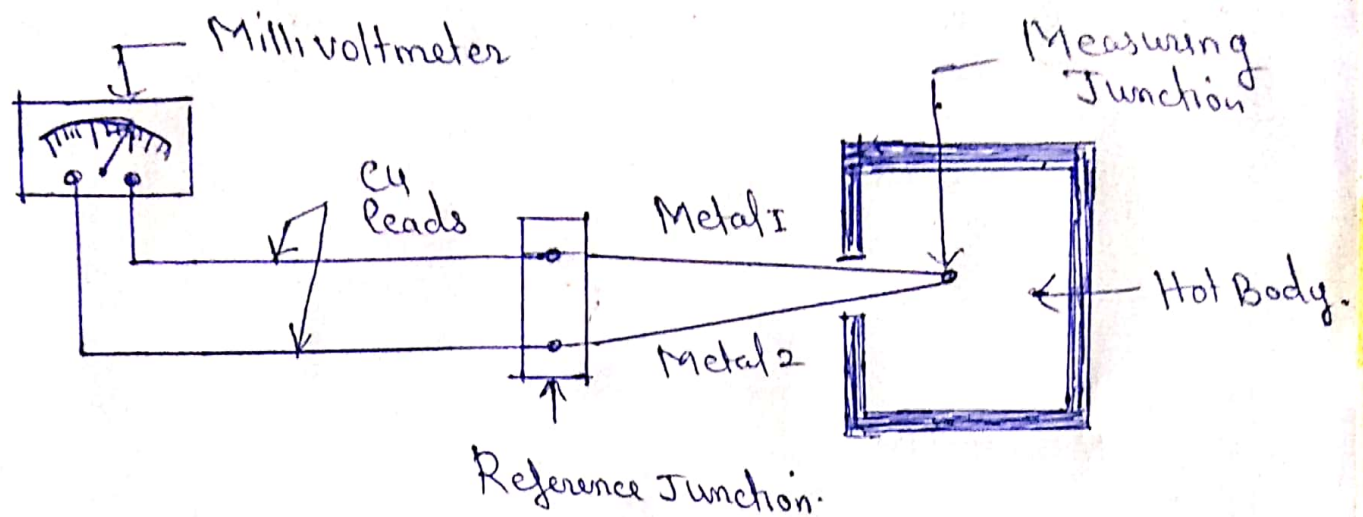
3. Capacitive Type Pressure Transducers:-



Working:- It consists of two flexible plates. The fluid whose pressure to be measured is passed through the pipe. It serves as dielectric. As the pressure is increased the plates move further apart to the extent of variation in pressure.

Measurement of Temperature:-

Thermocouple Thermometer:- It works on the principle that when the dissimilar metal conductors are joined at the ends keeping the junctions at different temperatures a small e.m.f. is produced in the circuit.



Thermocouple

Thermocouple consists of two dissimilar metals which develop e.m.f. when the measuring junction and reference junction are at different temperatures. The ref. junction is maintained at constant temp such as 0°C and the measuring junction is kept in the space whose temp. is to be measured. The diff between hot and cold junction produces e.m.f. which is measured by millivoltmeter.