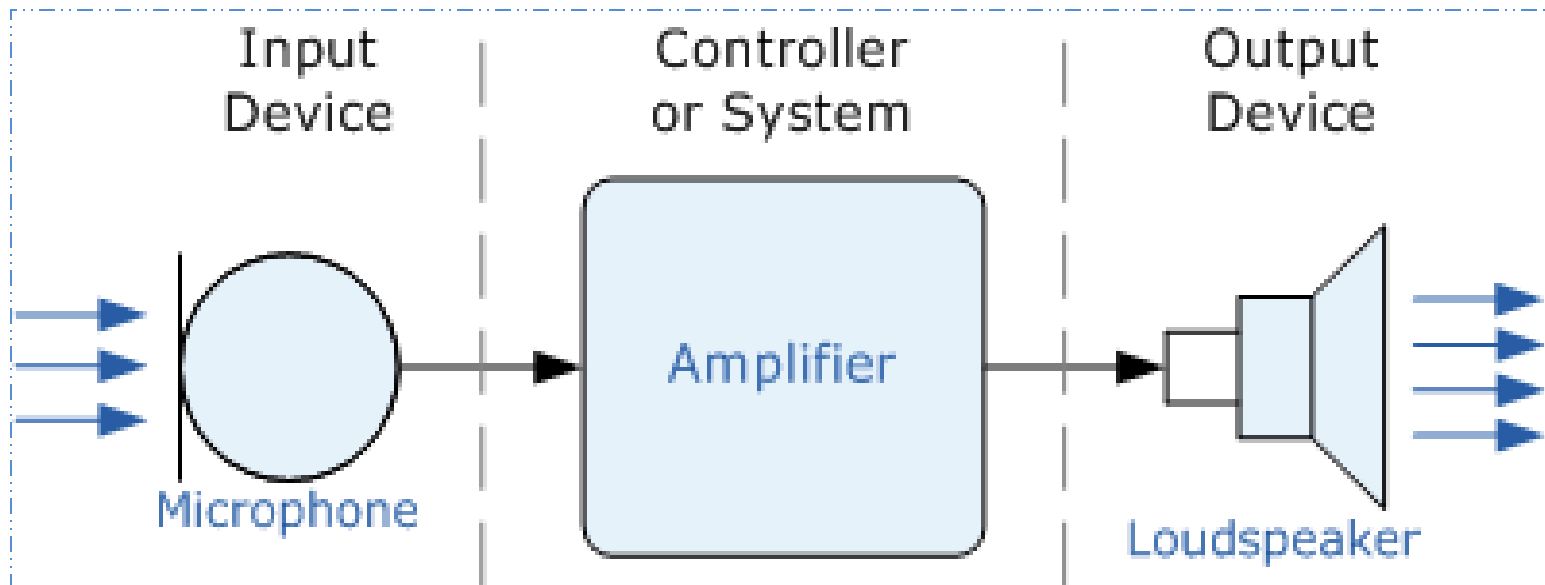
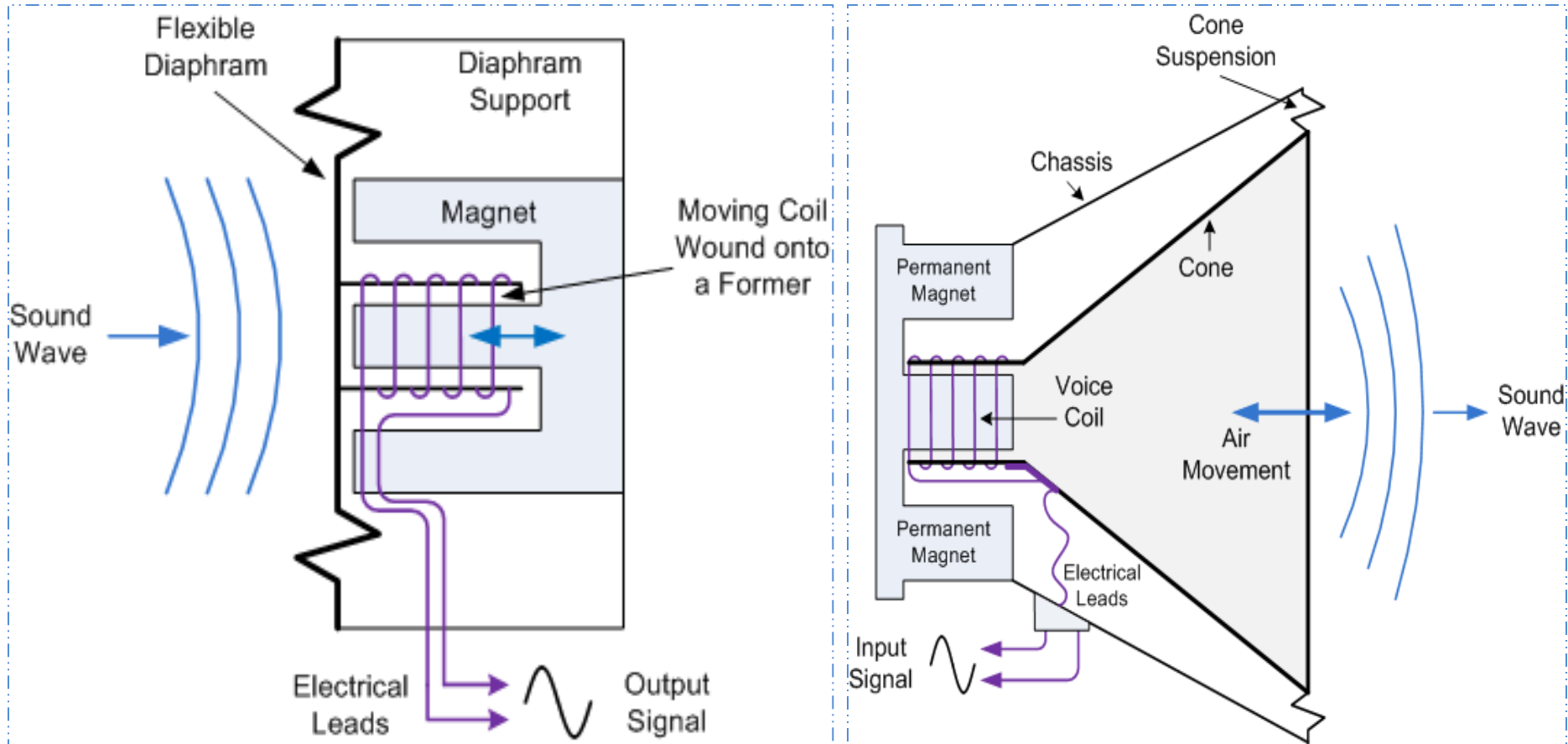


Transducer

- A transducer is a device that converts one type of energy to another.
- The input transducer is called the *sensor*.
- The output transducer is called the *actuator*.



Input and Output Transducers

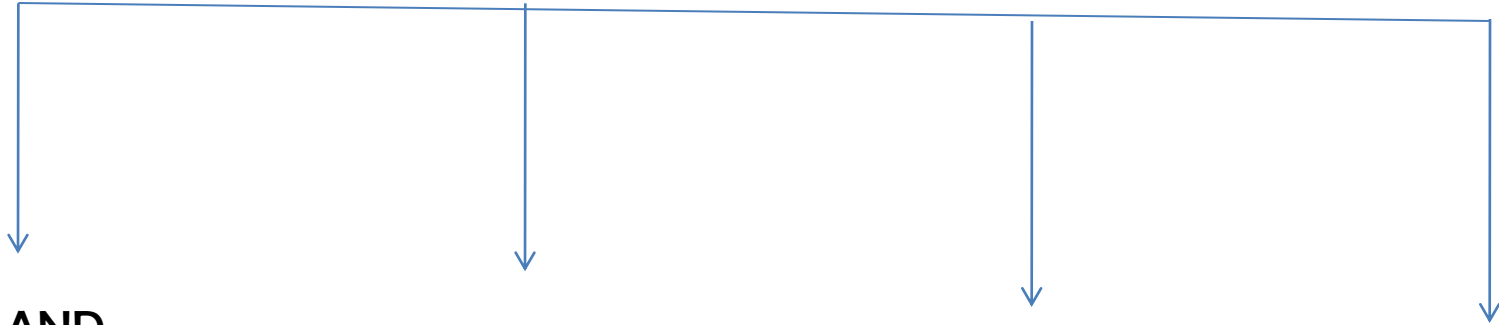


Basic requirements of a transducers

The main function of a transducer is to respond only for the measurement under specified limits for which it is designed.

- RUGGEDNESS (Capability of withstanding overload)
- LINEARITY (input – output characteristics should be linear)
- REPEATABILITY (should reproduce same output signal when the same input signal is applied again and again)
- HIGH OUTPUT SIGNAL QUALITY (quality of output signal should be good)
- HIGH RELIABILITY & STABILITY
- GOOD DYNAMIC RESPONSE (output should be faithful to input when taken as a function of time)
- NO HYSTERESIS (should not give any hysteresis during measurement)
- RESIDUAL DEFORMATION (should be no deformation on removal of load after long period of application)

CLASSIFICATION OF TRANSDUCERS



**PRIMARY AND
SECONDARY
TRANSDUCERS**

**ACTIVE AND PASSIVE
TRANSDUCERS**

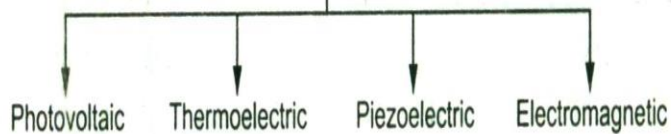
**ANALOG AND
DIGITAL
TRANSDUCERS**

**TRANSDUCERS
AND INVERSE
TRANSDUCERS**

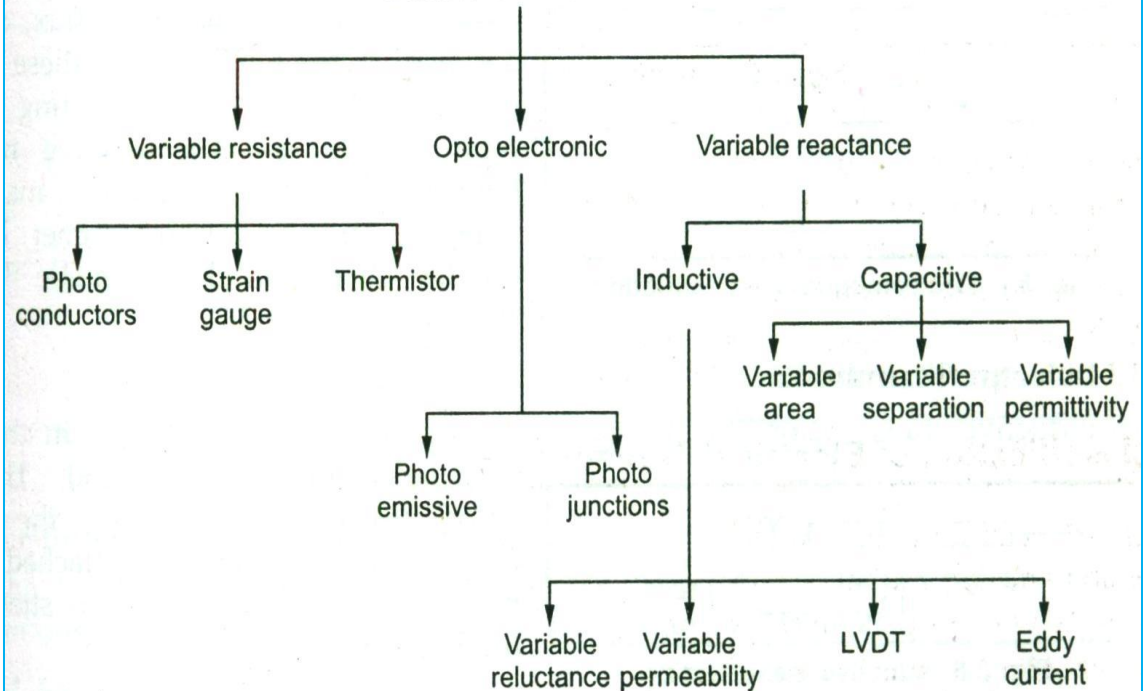
(An inverse transducer is a device which that converts an electrical quantity into a non-electrical quantity)

ACTIVE AND PASSIVE TRANSDUCERS

Active Transducers



Passive Transducers



Active and Passive Transducers

- Active Transducers: The output energy of Active Transducers is supplied entirely or almost entirely by its input signal.
- Passive Transducers: Have an auxiliary source of power. This power source is necessary for the operation of passive transducers.



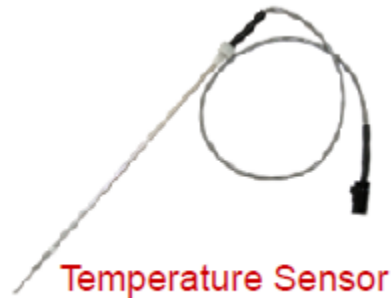
Thermocouple (Active Transducer)



Mic (Passive Transducer)

Primary Sensing Element

- sometimes called pickup, sensor, or transducer.
- It detects the physical variable to be measured, e.g. pressure, temperature, rate of flow, etc. and converts the signal into a more usable form.
- In practice the physical variable is usually transformed into a mechanical or an electrical signal.



Temperature Measurement

The *International Practical Temperature Scale (IPTS)* defines six primary fixed points for reference temperatures in terms of:

- The triple point of equilibrium hydrogen 259.34°C
- The boiling point of oxygen 182.962°C
- The boiling point of water 100.0°C
- The freezing point of zinc 419.58°C
- The freezing point of silver 961.93°C
- The freezing point of gold 1064.43°C

(all at standard atmospheric pressure)

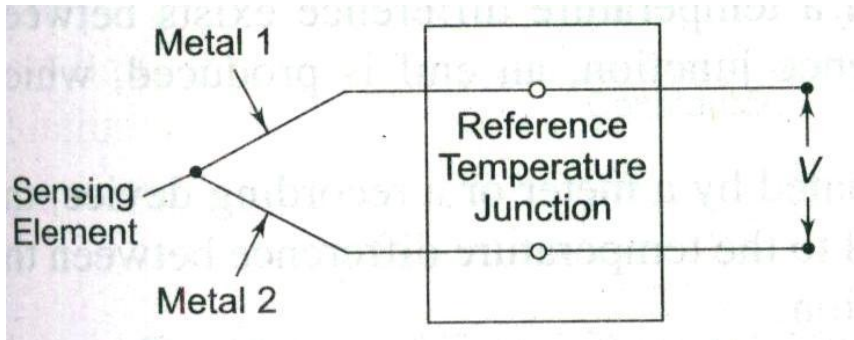
The freezing points of certain other metals are also used as *secondary fixed points* to provide additional reference points during calibration procedures.

Instruments to measure temperature can be divided into separate classes according to the physical principle on which they operate.

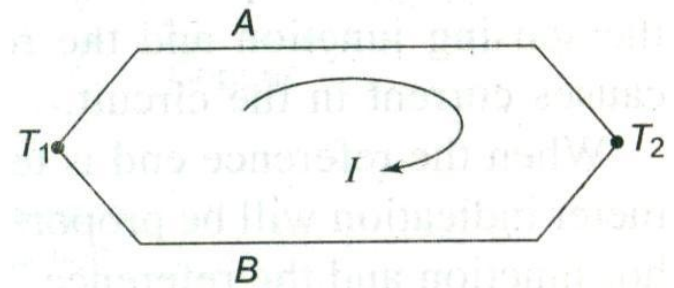
The main principles used are:

- The thermoelectric effect
- Resistance change
- Sensitivity of semiconductor device
- Radiative heat emission
- Thermography
- Thermal expansion
- Resonant frequency change
- Sensitivity of fibre optic devices
- Acoustic thermometry
- Colour change
- Change of state of material.

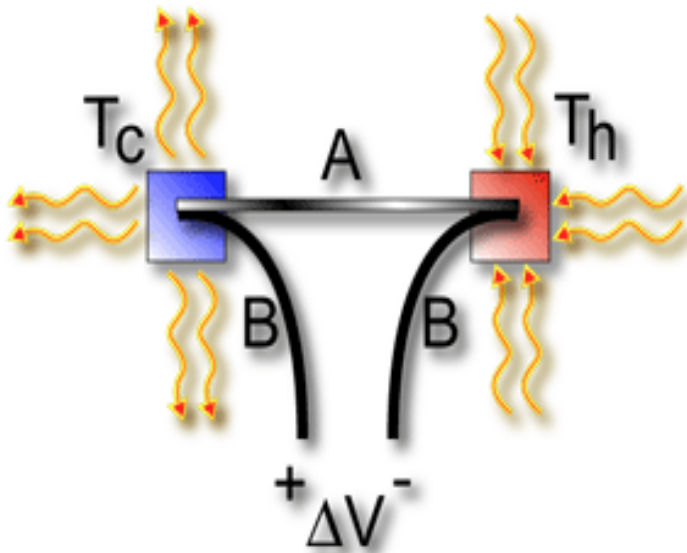
Thermocouple



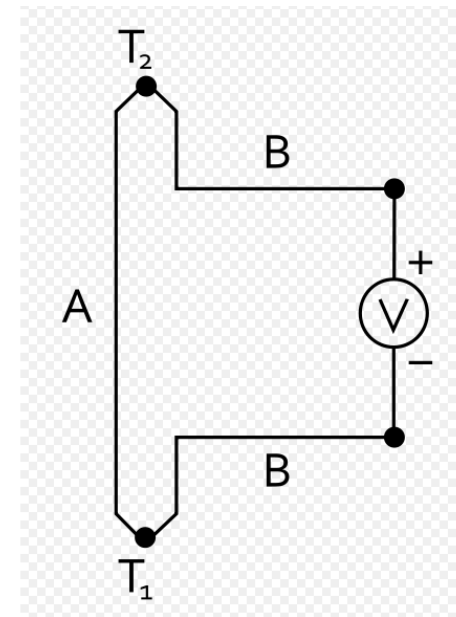
Thermocouple Connection



Current through Two Dissimilar Metals

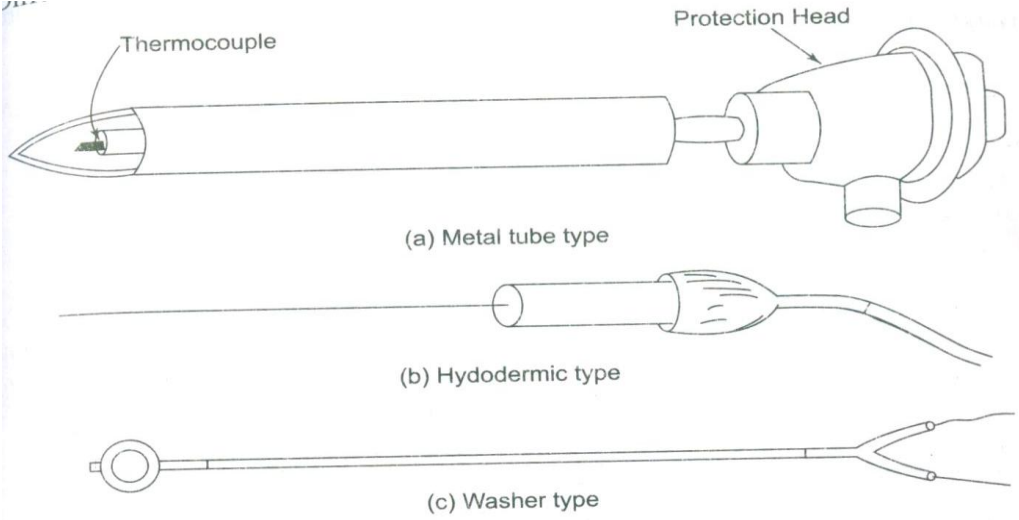
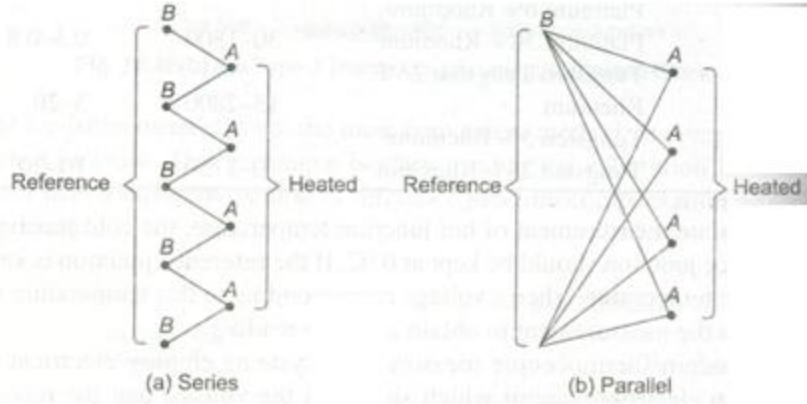
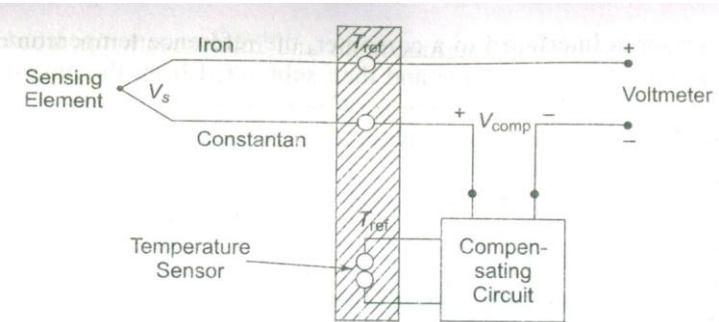


$$V = \alpha(T_h - T_c)$$



Seebeck Effect Circuit

Different Types of Thermocouples

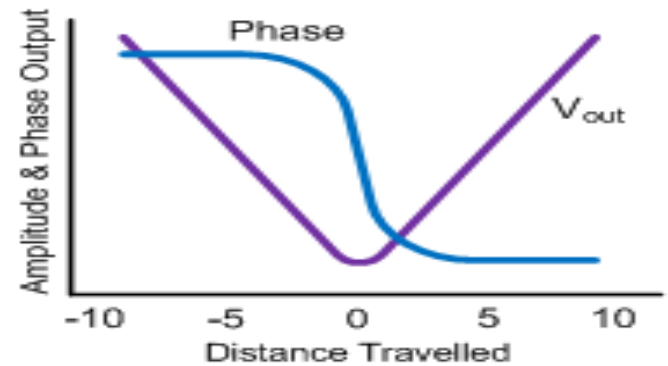
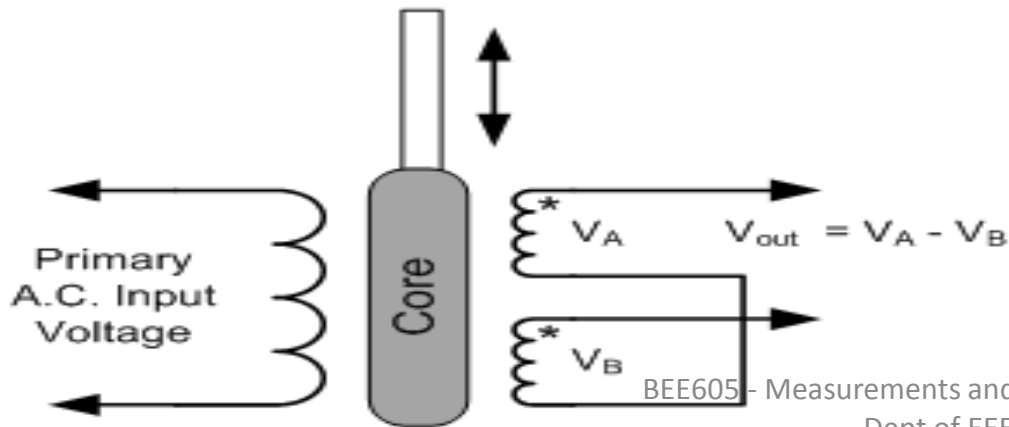
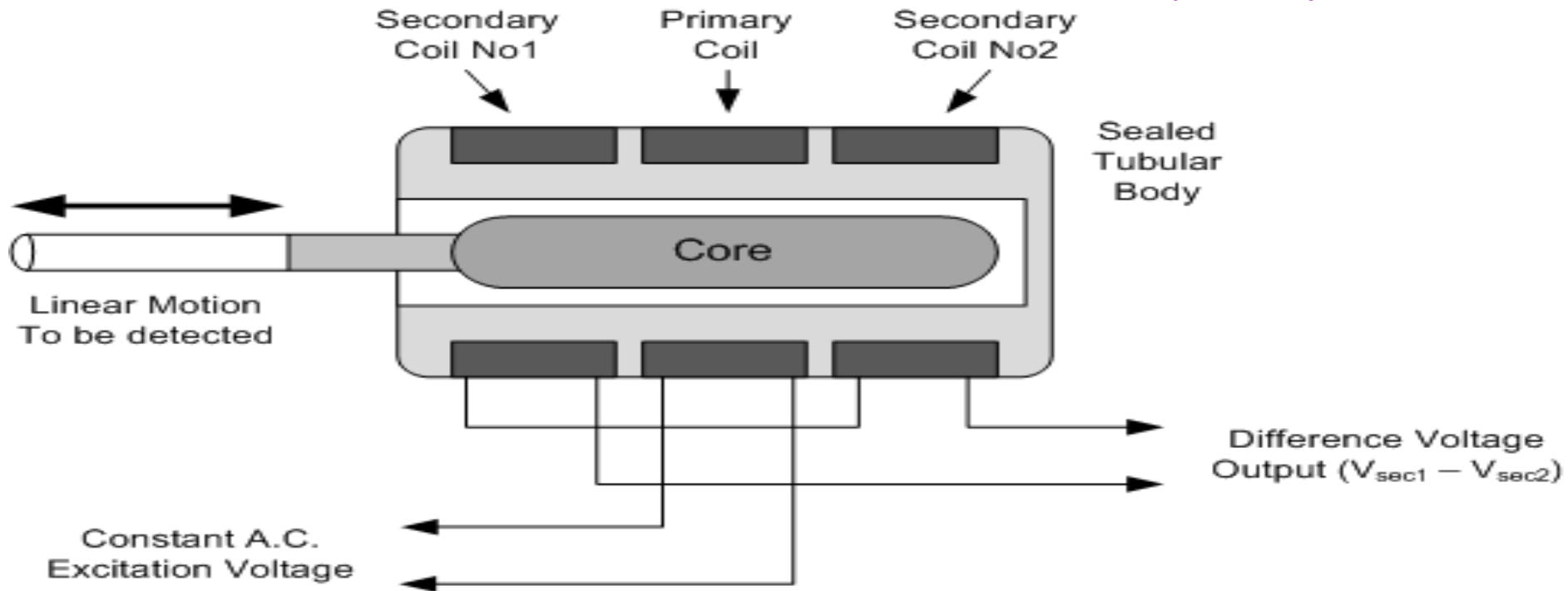


Advantages and Disadvantages of Thermocouples

- ✓ Wide temperature range (-270°C to 2700°C)
- ✓ Rugged Construction
- ✓ Bridge Circuits not required for temperature measurement.
- ✓ Comparatively cheaper in cost
- ✓ Good reproducibility
- ✓ Speed of response is high compared to thermometer systems.
- ✓ Calibration checks can be easily performed
- ✓ Using extension leads and compensating cables, long distance transmission for temperature measurement is possible.
- ✓ Good Accuracy
- ❖ Compensation circuits is essential for accurate measurements
- ❖ They exhibit non-linearity in the emf versus temperature characteristics.
- ❖ Many applications needs signal amplifications.
- ❖ Proper separation of extension leads from thermocouple is required to avoid stray electrical signal pickup.

Linear Variable Differential Transformer

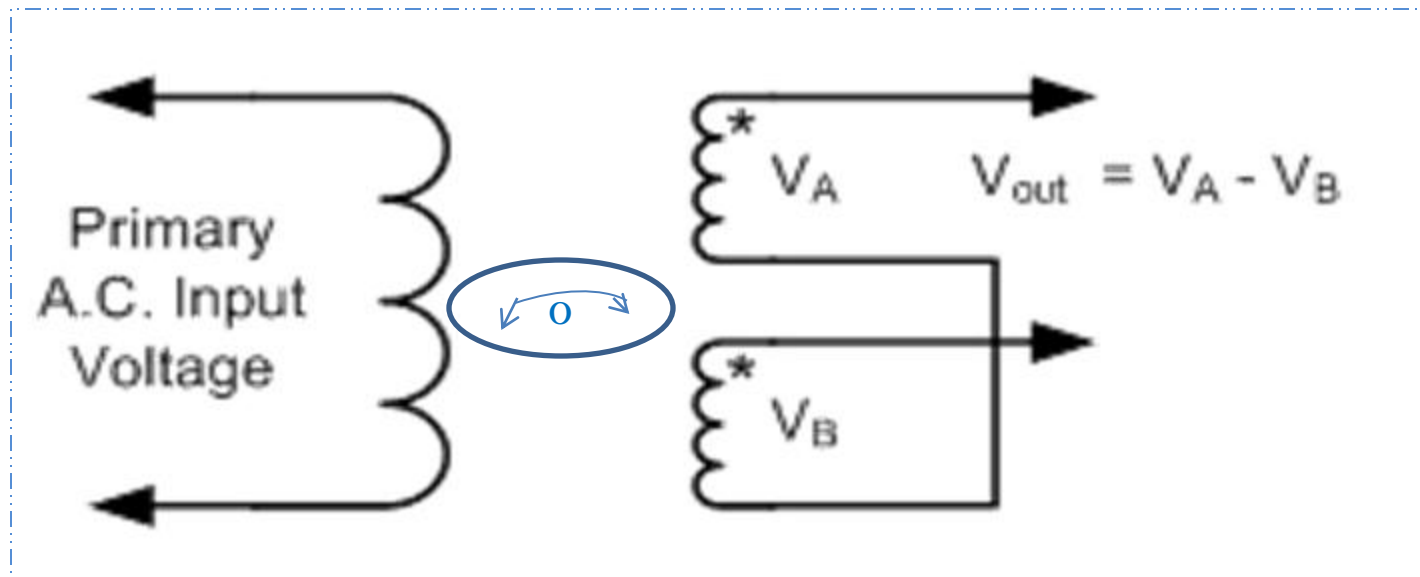
Three Coil mutual inductance device (LVDT)



Rotary Variable Differential Transformer

A **RVDT** is a type of electrical transformer used for measuring Angular Displacement .

The RVDT construction is similar in construction to LVDT, except that a cam-shaped core replaces the core in the LVDT as shown below.



Capacitive Transducers

The principle of these type is that variations in capacitance are used to produce measurement of many physical phenomenon such as dynamic pressure, displacement, force, humidity, etc.

An equation for capacitance is
$$C = \frac{0.088KA(N-1)}{d} \text{ Pico farads}$$

Where $K =$ dielectric constant (for air $K=1$),

$A =$ area of one side of one plate,

$N =$ Number of plates,

$d =$ Separation of plate surfaces (cm)

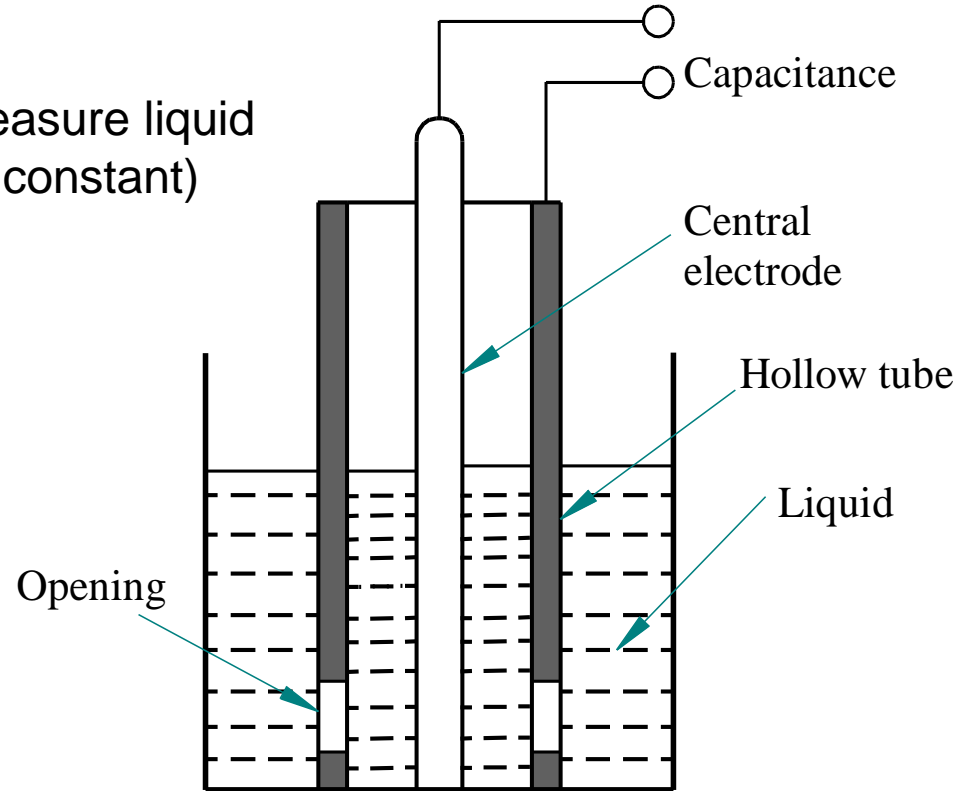
Capacitance is the ability of a body to hold an electrical charge.

Capacitance is also a measure of the amount of electric charge stored for a given electric potential. A common form of charge storage device is a two-plate capacitor. If the charges on the plates are $+Q$ and $-Q$, and V gives the voltage between the plates, then the capacitance is given by $C=(Q/V)$

The SI unit of capacitance is the **farad**; 1 farad = 1 coulomb per volt

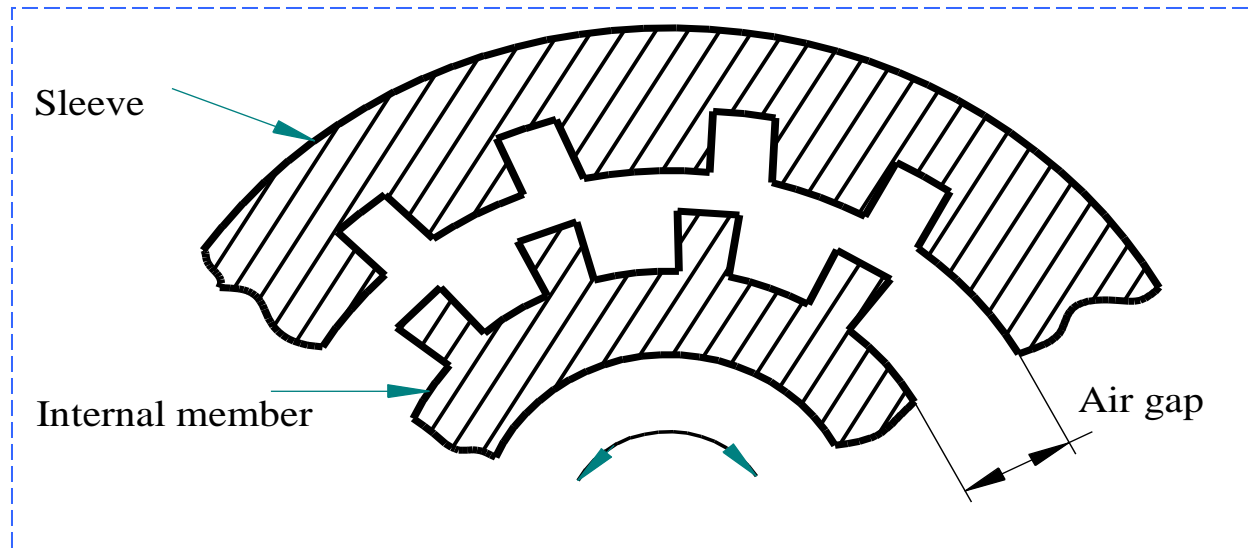
Capacitive Transducer

Capacitance Pickup to measure liquid level (Changing dielectric constant)



The above fig. shows a device used for the measurement of liquid level in a container. The capacitance between the central electrode and the surrounding hollow tube varies with changing dielectric constant brought about by changing liquid level. Thus the capacitance between the electrodes is a direct indication of the liquid level. Variation in dielectric constant can also be utilized for measurements of thickness, density, etc.

Capacitive Transducer (Torque meter)



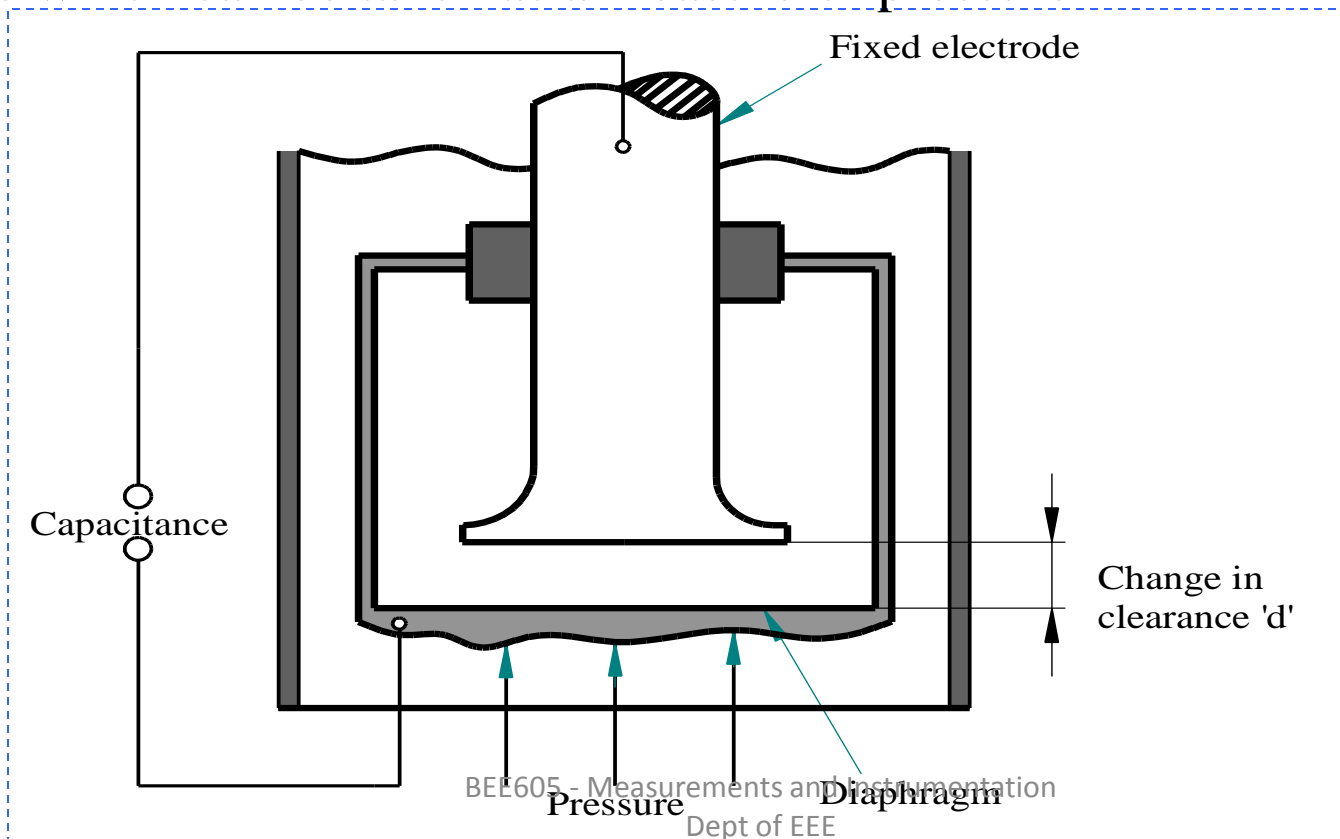
Capacitance changes depending on the change in effective area. This principle is used in the secondary transducing element of a *Torque meter*. This device uses a sleeve with serrations cut axially and a matching internal member with similar serrations as shown in the above fig.

Torque carried by an elastic member causes a shift in the relative positions of the serrations, thereby changing the effective area. The resulting capacitance change may be calibrated to read the torque directly.

Capacitive Transducer

(Capacitive Type Pressure Transducer)

The capacitance varies inversely as the distance between the plates. The fig shows a capacitive type pressure transducer where the pressure applied to the diaphragms changes the distance between the diaphragm & the fixed electrode which can be taken as a measure of pressure.



Advantages of Capacitive Transducers

- (1) Requires extremely small forces to operate and are highly sensitive
- (2) They have good frequency response and hence useful for dynamic measurements.
- (3) High resolution can be obtained.
- (4) They have high input impedance & hence loading effects are minimum.
- (5) These transducers can be used for applications where stray magnetic fields render the inductive transducers useless.

Disadvantages of Capacitive Transducers

- (1) Metallic parts must be properly insulated and the frames must be earthed.
- (2) They show nonlinear behaviour due to edge effects and guard rings must be used to eliminate this effect.
- (3) They are sensitive to temperature affecting their performance.
- (4) The instrumentation circuitry used with these transducers are complex.
- (5) Capacitance of these transducers may change with presence of dust particles & moisture.

Thank You