Basic Electrical Engineering-303106102

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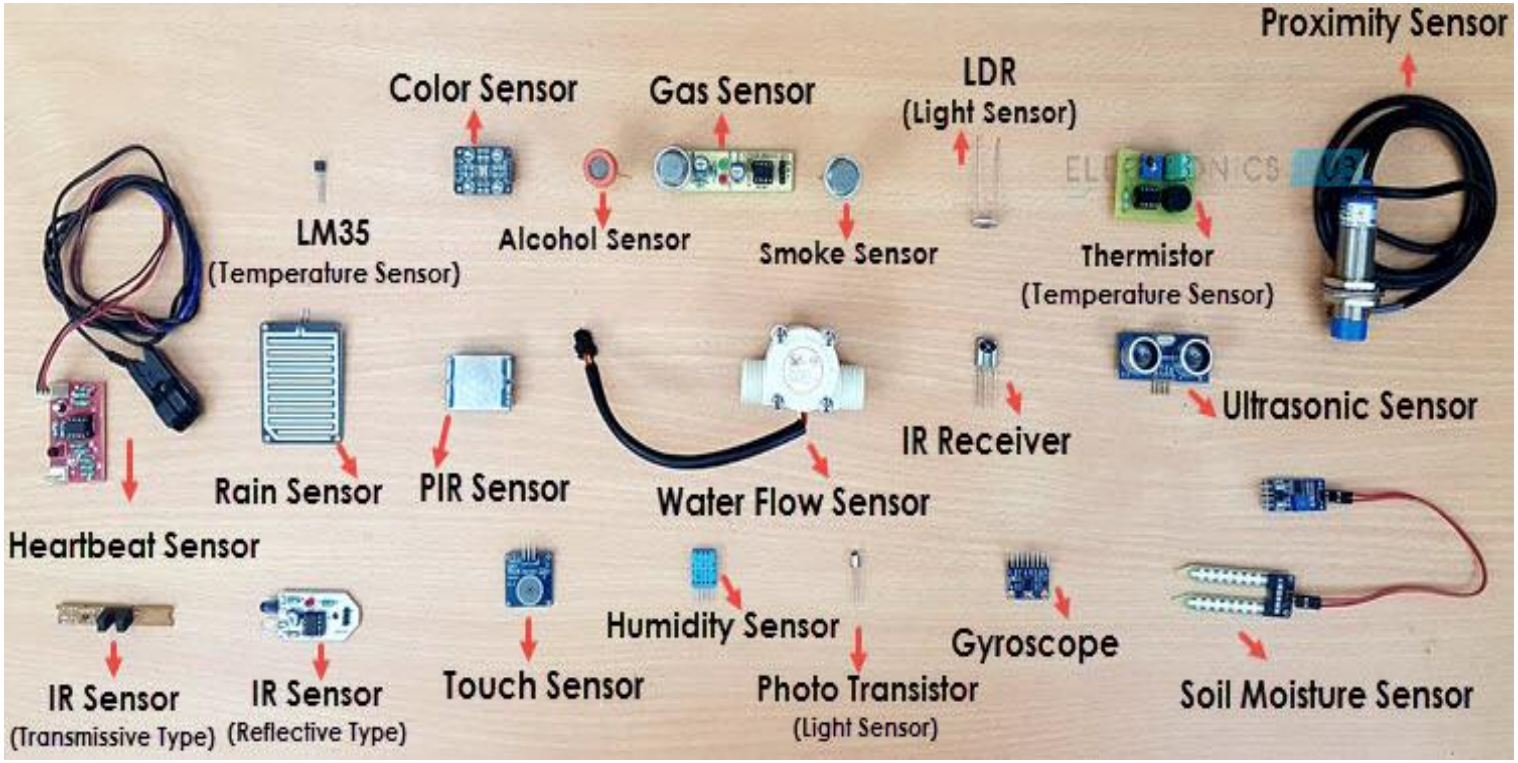
DIGITAL LEARNING CONTENT

CHAPTER-5

Sensors & Trasnducers

Introduction to Sensors & Transducers

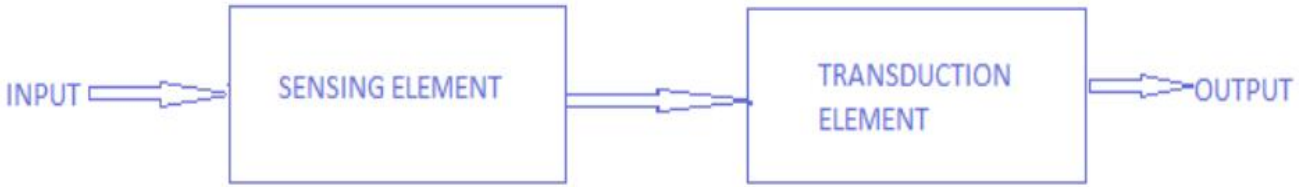
- **Sensors:** A sensor is a device that detects and responds to some type of input from the physical environment. The input can be light, heat, motion, moisture, pressure, or any number of other environmental phenomena
- The output is generally a signal that is converted to a human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.
- **Example:** LDR


Proximity Sensor
Color Sensor
Gas Sensor
LDR
(Light Sensor)
LM35
(Temperature Sensor)
Alcohol Sensor
Smoke Sensor
Thermistor
(Temperature Sensor)
Ultrasonic Sensor
IR Receiver
Rain Sensor
PIR Sensor
Water Flow Sensor
Heartbeat Sensor
IR Sensor
(Transmissive Type)
IR Sensor
(Reflective Type)
Touch Sensor
Humidity Sensor
Photo Transistor
(Light Sensor)
Gyroscope
Soil Moisture Sensor

Introduction to Sensors & Transducers

- **Transducers:** A transducer is defined as a device that receives energy from one system and transmits it to another, often in a different form.
- The input quantity for most instrumentation systems is nonelectrical. In order to use electrical methods and techniques for measurement, the nonelectrical quantity is converted into a proportional electrical signal by a device called a "transducer".

Introduction to Sensors & Transducers



www.InstrumentationToday.com

INPUT - Resistance, Capacitance, Inductance, Stress, Strain, Heat

OUTPUT - Force, Displacement, Pressure, Sound, Magnetic Flux, Voltage, Current

- Actually, an electrical transducer consists of two parts that are very closely related to each other. These two parts are the sensing or detecting element and the transduction element.

Comparesion: Sensors Vs. Transducers

Sr. No	Sensors	Transducers
1	A sensor is a device which converts the physical parameter of a quantity into corresponding electrical output.	A transducer is a device that transforms energy from one form to another, such as speed into electrical signal.
2	A sensor does not have any other component except itself.	The components of a transducer are – input device (sensor), processing device (signal conditioning), and output device.
3	All the sensors are not transducers.	A sensor is the part of all the transducers.

Cont.

Sr. No	Sensors	Transducers
4	A sensor is less complicated in its construction and processing	Transducer is a relatively more complex device because it involves the transformation of energy from one form to another
5	it only measures the change in the physical quantity and cannot give input to the system on its own.	Transducer generally provides feedback to the system through the output device after processing.
6	Common examples of sensors are temperature sensors, photo sensors, proximity sensors, etc.	Examples of transducers are: strain gauge, microphones, loudspeakers, piezoelectric elements, etc

Application of Sensors

Automotive: Antilock Braking System (ABS) Sensors connected to the wheel, measure the speed of the wheel and braking pressure and keep sending them to ABS controlling When the driver applies the sudden brake, the ABS system, with breaking pressure and speed data received from the sensors, releases the braking pressure to avoid skidding/locking of wheels. It is one of the critical safety aspects of vehicles.

Application of Sensors

Manufacturing: Predictive maintenance of the machinery, Assembly equipment using the data collected from sensors in the machines. Optimal utilization of Machines by continuously monitoring the performances and effectively rejigging the operations with the data collected from sensors. Fine-tuning the Quality systems and enhancing the quality standards using the data collected from sensors. Design notifications and alerts in case of a deterioration of quality and process standards. Agility in reacting to market demands

Application of Sensors

Aviation:

- Sensors deployed in the aviation industry measure the data during the navigation of aircraft, monitoring various systems, and controlling instruments. These data are utilized for inefficient flight operations, improved aircraft performance, and design improvements.
- Some of the instrumentation sensors are tachometers, gauges to measure engine pressure and oil& and fuel quantity, Altimeters, airspeed meters, etc. Sensors help measure the testing of the ground conditions, vibration, and environmental factors and provide useful inputs to the pilot to manage the general operation and emergency conditions.

Application of Sensors

Medical & Healthcare

- Blood pressure monitoring (self).
- Continuous glucose monitoring by Individuals.
- Automatic measurement of the vitals of the patient and sending it to the patient's doctor.
- More home care facilities and ambulatory treatments
- Decentralized laboratories.
- Robotics in Operation Theater.

Application of Transducers

Ultrasonic Transducer

- This transducer can be used to measure the distance of the sound based on reflection. This measurement is based on a suitable method compared to the straight methods which use different measuring scales.
- The areas which are hard to find, such as pressure areas, and very high temperatures, using conventional methods the measurement of the distance is not a simple task. So, this transducer-based measuring system can be used in this kind of zone.

Application of Transducers

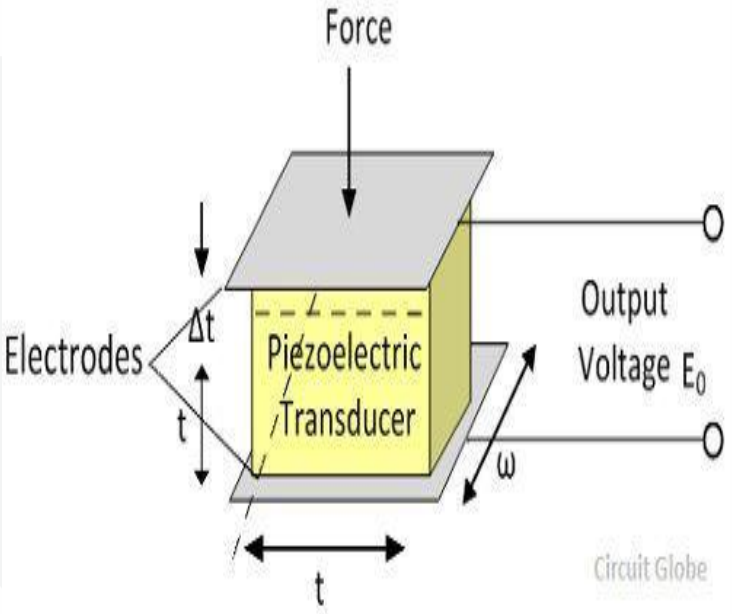
Temperature Transducer

A temperature transducer is used to measure the temperature of the air such that to control the temperature of several control systems like air-conditioning, heating, ventilation, and so on.

Application of Transducers

Piezoelectric Transducer

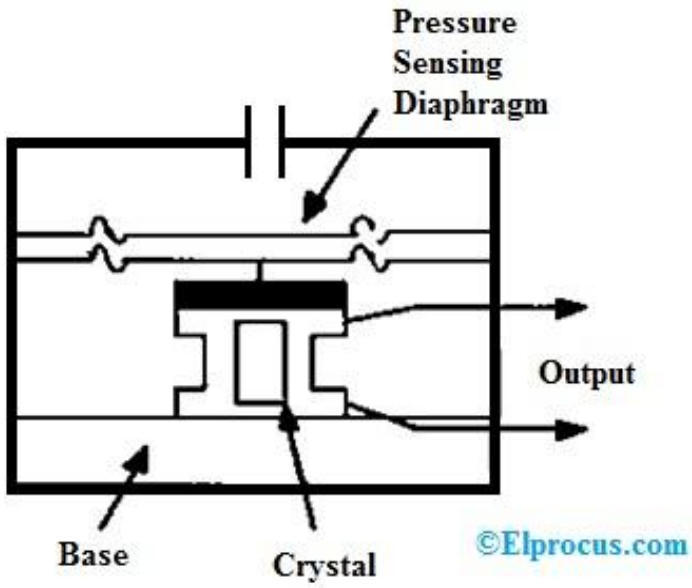
Piezoelectric transducers are a type of electroacoustic transducer that convert the electrical charges produced by some forms of solid materials into energy. The word "piezoelectric" literally means electricity caused by pressure



Application of Transducers

Pressure Transducer

- The applications of pressure transducers mainly involve altitude sensing, pressure sensing, level or depth sensing, flow sensing, and leak testing.
- These transducers can be used for generating electrical power under the speed breakers on the highways or roads where the force of the vehicles can be converted into electrical energy.



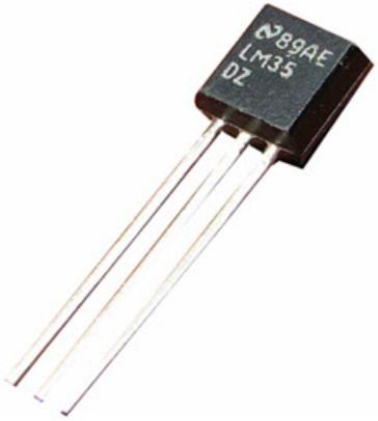
Common application of Transducers

1. Strain gauge
2. Hall Effect
3. Force
4. Torque
5. Power
6. Position
7. Displacements
8. Humidity
9. Temperature
10. Pressure

Types of Electronic Sensors

Temperature Sensor

- A Temperature Sensor, as the name suggests, senses the temperature i.e., it measures the changes in the temperature.
- There are different types of Temperature Sensors like Temperature Sensor ICs (like LM35, DS18B20), Thermistors, Thermocouples, RTD (Resistive Temperature Devices), etc.



LM35 - Temperature Sensor IC

10KΩ NTC Thermistor

Types of Electronic Sensors

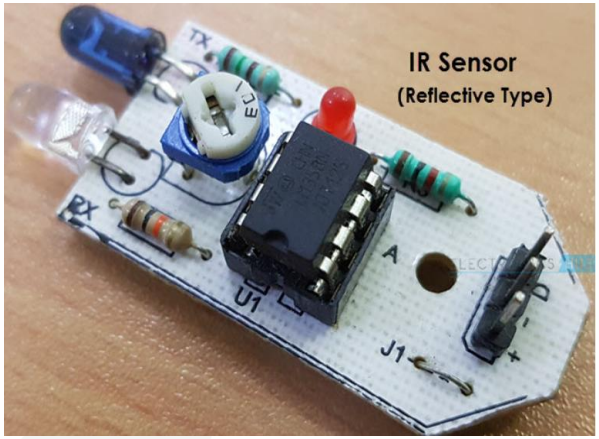
Proximity Sensors

- A Proximity Sensor is a non-contact type sensor that detects the presence of an object.
- Proximity Sensors can be implemented using different techniques like Optical (like Infrared or Laser), Sound (Ultrasonic), Magnetic (Hall Effect), Capacitive, etc.
- Applications of Proximity Sensors are Mobile Phones, Car Parking

Types of Electronic Sensors

Infrared Sensor

- IR Sensors or Infrared Sensors are light-based sensors that are used in various applications like Proximity and Object Detection.
- There are two types of Infrared or IR Sensors: Transmissive Type and Reflective Type.
- In Transmissive Type IR Sensor, the IR Transmitter (usually an IR LED) and the IR Detector (usually a Photo Diode) are positioned facing each other so that when an object passes between them, the sensor detects the object.



Types of Electronic Sensors

Ultrasonic Sensor

- An Ultrasonic Sensor is a non-contact type device that can be used to measure distance as well as velocity of an object.
- An Ultrasonic Sensor works based on the properties of the sound waves with frequency greater than that of the human audible range.

Ultrasonic Sensor

Types of Electronic Sensors

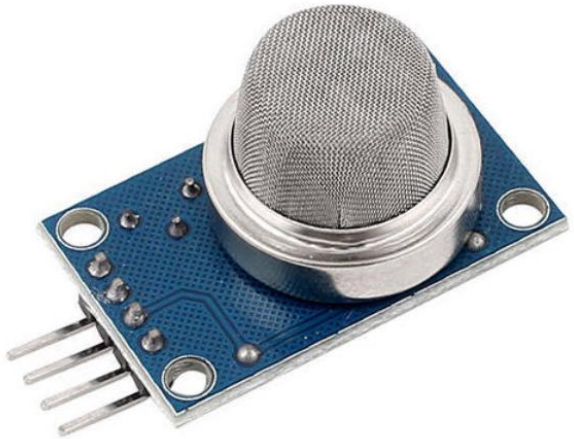
Light Sensor

- A simple Light Sensor available today is the Light Dependent Resistor or LDR.
- The property of LDR is that its resistance is inversely proportional to the intensity of the ambient light i.e., when the intensity of light increases, its resistance decreases and vice-versa.

Types of Electronic Sensors

Smoke and Gas Sensors

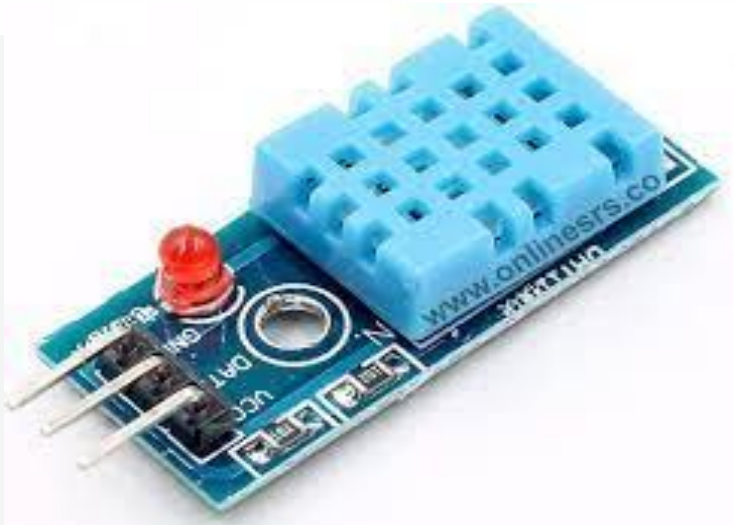
- Almost all offices and industries are equipped with several smoke detectors, which detect any smoke (due to fire) and sound an alarm.
- Gas Sensors are more common in laboratories, large-scale kitchens, and industries. They can detect different gases like LPG, Propane, Butane, Methane (CH4), etc.



Types of Electronic Sensors

Humidity Sensor

- All humidity sensors measure relative humidity (a ratio of water content in the air to the maximum potential of air to hold water).
- Since relative humidity is dependent on the temperature of the air, almost all Humidity Sensors can also measure Temperature.



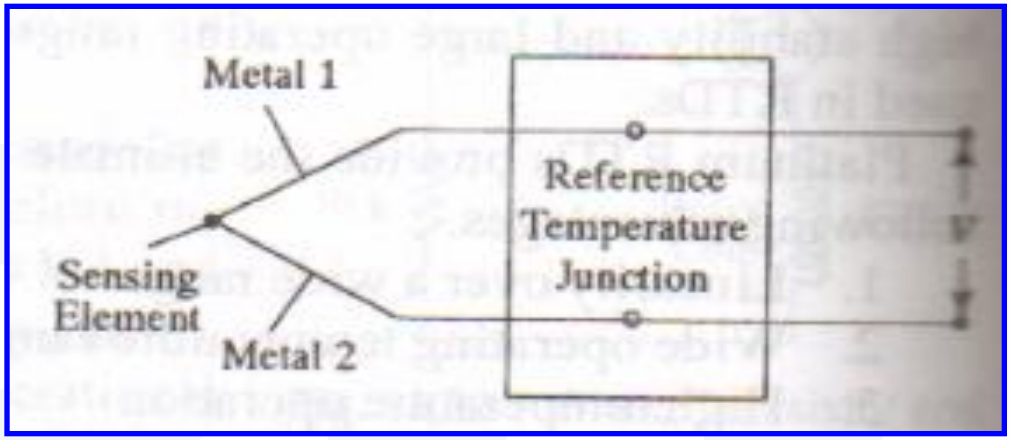
Types of Transducers

Types of Transducers based on Quantity to be Measured

- Temperature transducers (e.g., a thermocouple)
- Pressure transducers (e.g., a diaphragm)
- Displacement transducers (e.g., LVDT)
- Oscillator transducer
- Flow transducers
- Inductive Transducer

Temperature Transducers

Thermocouple

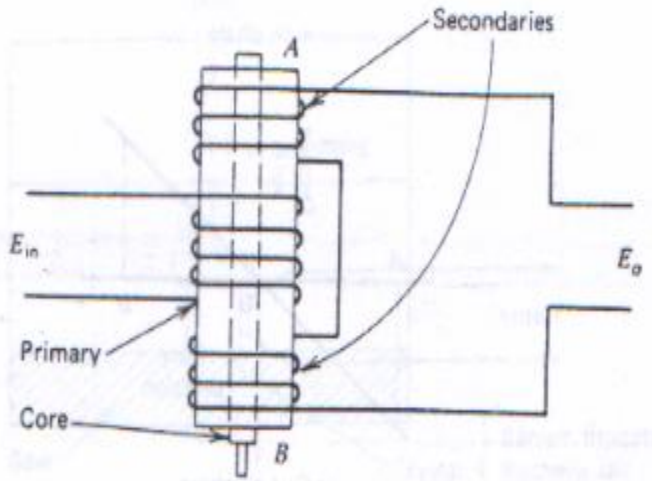


- It consists of two wires of different metals are joined together at one end, a temperature difference between this end and the other end of the wires produces a voltage between the wires.
- The magnitude of this voltage depends on the materials used for the wires and the amount of temperature difference between the joined ends and the other ends.

Inductive Transducers

LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (LVDT)

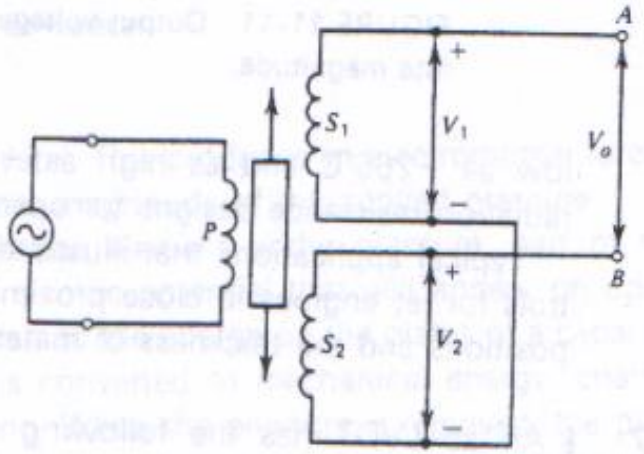
It consists basically of a primary winding and two secondary windings, wound over a hollow tube and positioned so the primary winding is between two secondaries. In figure shows the construction of the LVDT.



Inductive Transducers

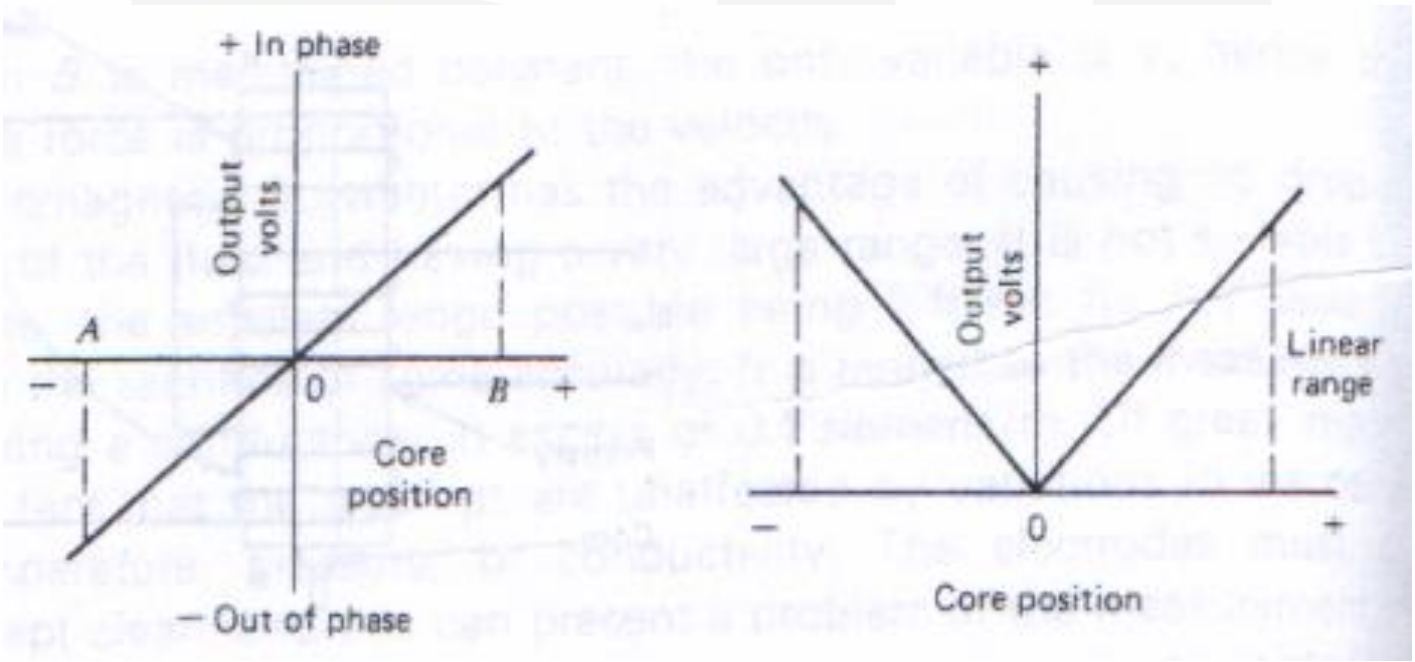
LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (LVDT)

An iron core slides within the tube and therefore affects the magnet coupling between the primary and the two secondaries. When the core is in the center, voltage induced in the two secondaries is equal. When the core is moved in one direction from center, the voltage induced in one winding is increased and that in the other is decreased. Movement in the opposite direction reverses this effect



Inductive Transducers

LINEAR VARIABLE DIFFERENTIAL TRANSFORMER (LVDT)



Types of Transducers

Types of Transducers based on the Principle of Operation

- Photovoltaic (e.g., a solar cell)
- Piezoelectric transducer
- Chemical
- Mutual induction
- Electromagnetic
- Hall effect
- Photoconductors

Types of Transducers

Active and Passive Transducers:

Active or self-generating type transducer:

Do not require external power; produce an analog voltage or current when stimulated by some physical form of energy.

Examples:

Thermocouples, Photovoltaic cell, tacho generators, Piezoelectric crystals

Passive transducer:

Requires an external power, and the output measures some variation (resistance or capacitance).

Examples:

Slide-wire resistor, Resistance strain gauge, Differential transformer

Types of Transducers

Analog and Digital Transducers:

Analog Transducers:

These transducers convert the input quantity into an analog output which is a continuous function of time.

Examples:

Strain Gauge, LVDT, Thermocouple, Thermistor

Digital transducer:

These transducers convert the input quantity into an electrical output which is in the form of pulses.

Examples:

Glass Scale can be read optically by means of a light source, an optical system and photocells.

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