DARBHANGA COLLEGE OF ENGINEERING
DARBHANGA

INSTRUMENTATION AND CONTROL (SEM-IV:ME)

Course Code- PCC-ME 207

Lecture 2

SENSOR AND TRANSDUCERS

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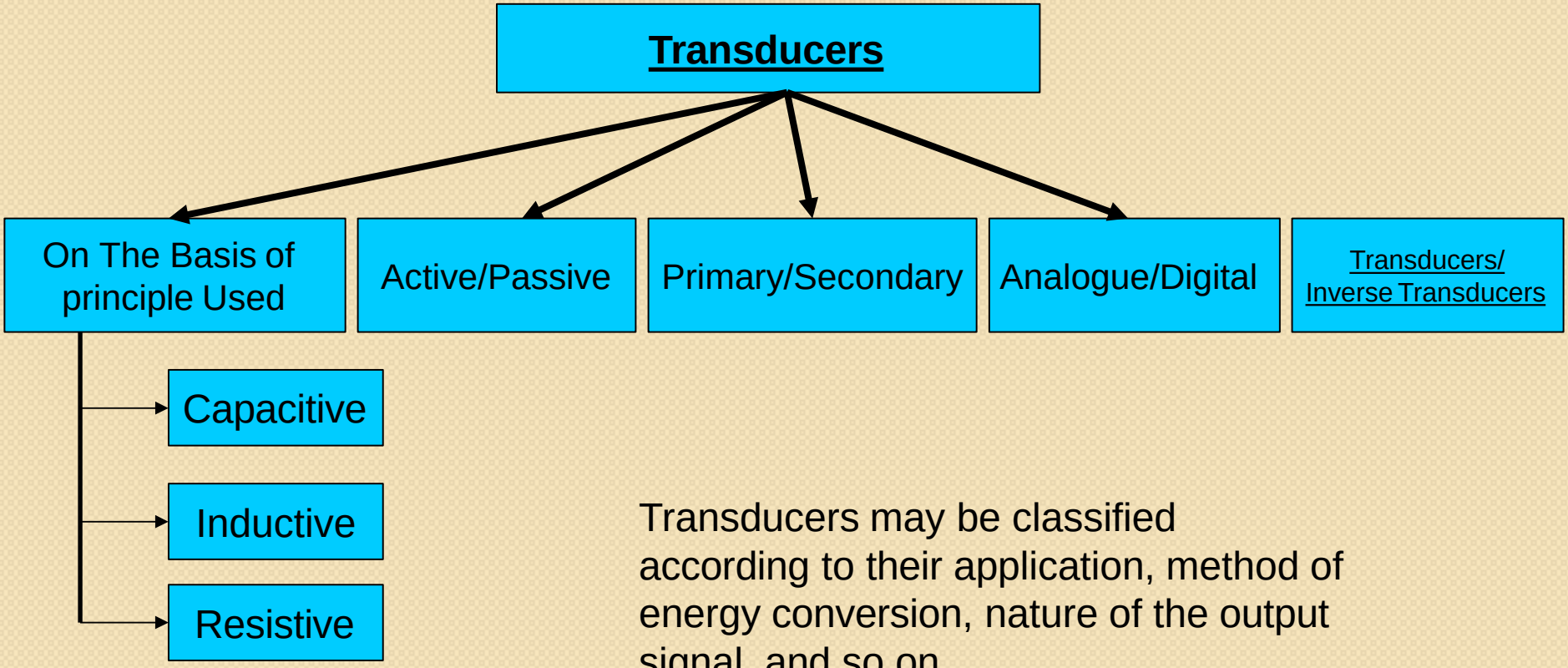
Classification of Transducers



Transducers may be classified according to their application, method of energy conversion, nature of the output signal, and so on.

Selecting a Transducer

- What is the physical quantity to be measured?
- Which transducer principle can best be used to measure this quantity?
- What accuracy is required for this measurement?
  - Fundamental transducer parameters
  - Physical conditions
  - Environmental conditions
  - Compatibility of the associated equipment
- Reducing the total measurement error :
  - Using in-place system calibration with corrections performed in the data reduction
  - Artificially controlling the environment to minimize possible errors

Transducer, Sensor, and Actuator

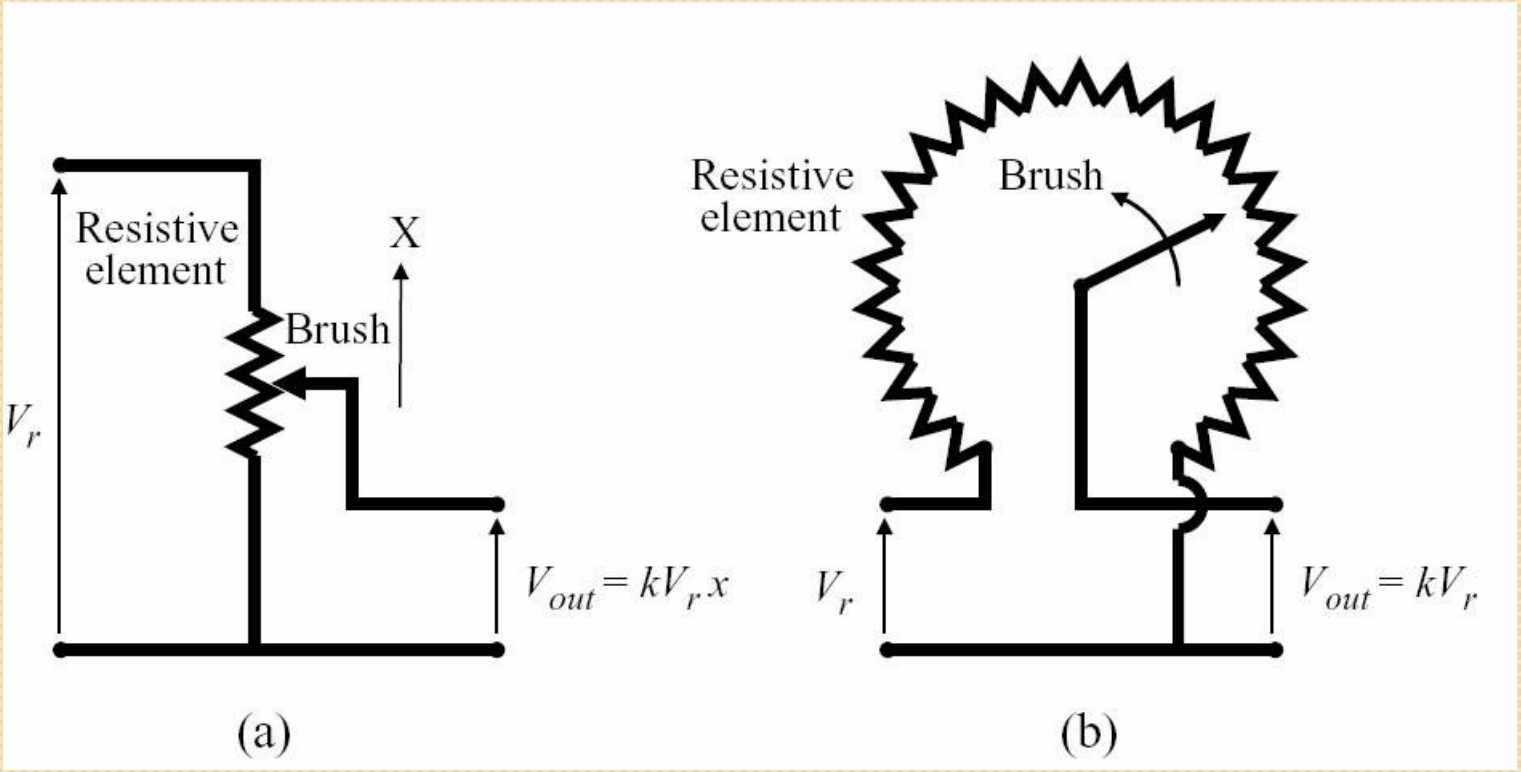
- Transducer:
  - a device that converts energy from one form to another
- Sensor:
  - converts a physical parameter to an electrical output (a type of transducer, e.g. a microphone)
- Actuator:
- converts an electrical signal to a physical output (opposite of a sensor, e.g. a speaker)

1.DISPLACEMENT,POSITION & PROXIMITY

- Displacement sensors are concerned with the measurement of the amount by which some object has been moved.
- Position sensors are concerned with the determination of the position of some object in relation to some reference point.
- Proximity sensors are a form of position sensor and are used to determine when an object has moved to within some particular critical distance of the sensor. They are essentially devices which give on/off outputs.

1.1 Potentiometer Sensor

- **Potentiometer** is one of the common sensors for position measurements.
- It relates the change in position (linear or rotary) into the change in resistance, as shown in Figure a and b



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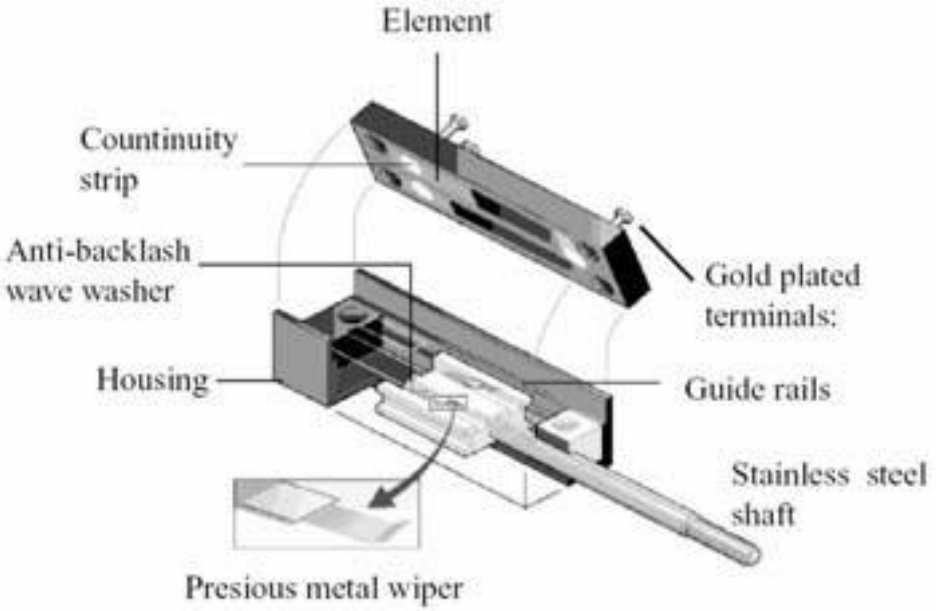
- The resistance change is then converted to a proportional voltage change in the electrical circuit of the sensor.
- Hence, the relationship between the measured physical variable, translational displacement *X* or rotary displacement θ,

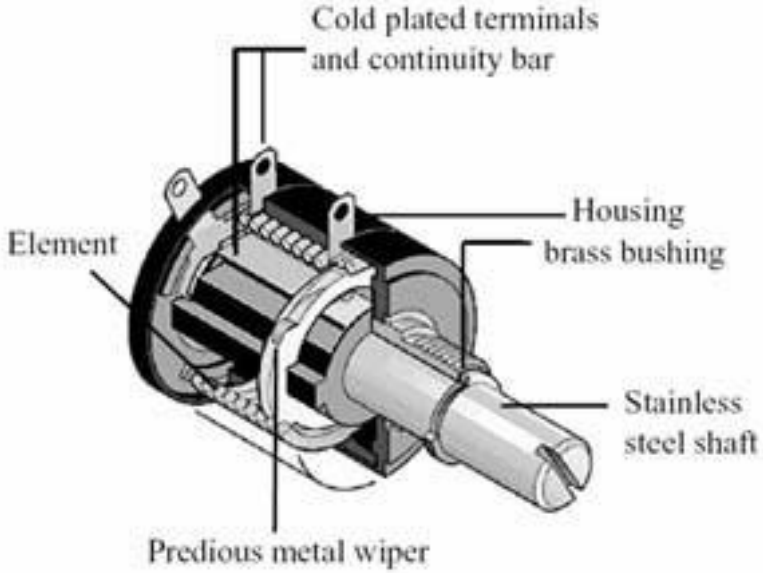
$$V_{out} = (k \cdot V_r) \cdot x \quad \text{or} \quad V_{out} = (k \cdot V_r) \cdot \theta$$

potentiometer is

where the sensitivity, ($k * V_r$) , of the potentiometer is a function of the winding resistance and physical shape of the winding.

Potentiometer Picture

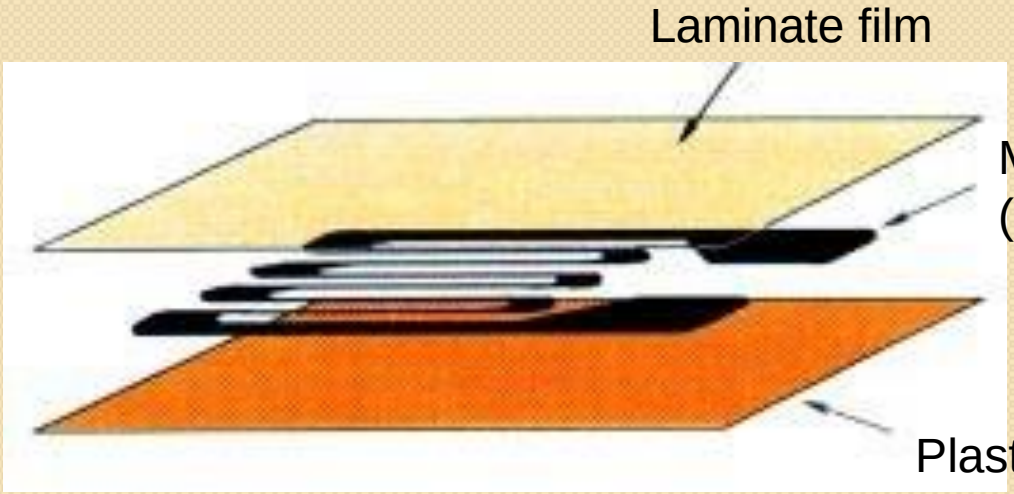




1.2 Strain Gauge

- Strain gauge: it is an electrical conductor whose resistance changes as it is strained.
- Structure of Strain Gauges

There are many types of strain gauges. Among them, a universal strain gage has a structure such that a grid-shaped sensing element of thin metallic resistive foil (3 to 6μm thick) is put on a base of thin plastic film (15 to 16μm thick) and is laminated with a thin film.



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- Principle of Strain Gages
- The strain gage is tightly bonded to a measuring object so that the sensing element (metallic resistive foil) may elongate or contract according to the strain borne by the measuring object.
- When bearing mechanical elongation or contraction, most metals undergo a change in electric resistance.
- The strain gage applies this principle to strain measurement through the resistance change. Generally, the sensing element of the strain gage is made of a copper-nickel alloy foil.
- The alloy foil has a rate of resist-ance change proportional to strain with a certain constant.

Let's express the principle as follows:

$$\frac{\Delta R}{R} = K.\varepsilon$$

where, R: Original resistance of strain gage, Ω (ohm)
ΔR: Elongation- or contraction-initiated resistance change, Ω (ohm)
K: Proportional constant (called gage factor)
ε: Strain

Thank you