DARBHANGA COLLEGE OF ENGINEERING
DARBHANGA

INSTRUMENTATION AND CONTROL
(SEM-IV:ME)

Course Code- PCC-ME 207

Module 2-Part 1

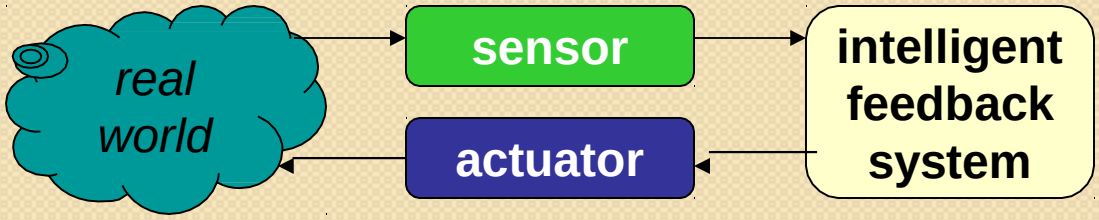
SENSOR AND TRANSDUCERS

INTRODUCTION

- Transducer
  - a device that converts a primary form of energy into a corresponding signal with a different energy form
    - Primary Energy Forms: mechanical, thermal, electromagnetic, optical, chemical, etc.
  - take form of a **sensor** or an **actuator**
- Sensor (e.g., thermometer)
  - a device that detects/measures a signal or stimulus

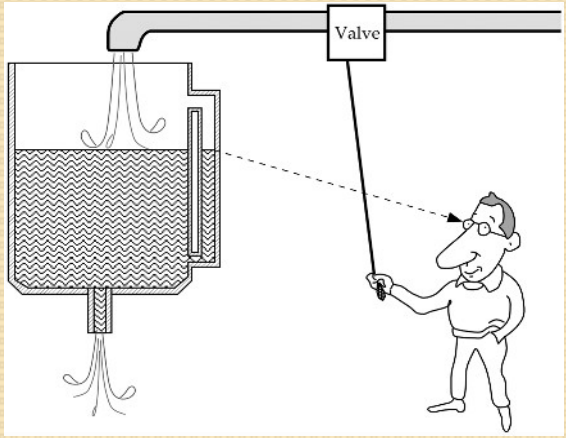
–acquires information from the “real world”

- Actuator (e.g., heater)
  - a device that generates a signal or stimulus



Sensor

- A Device that receives and respond to a signal or stimulus

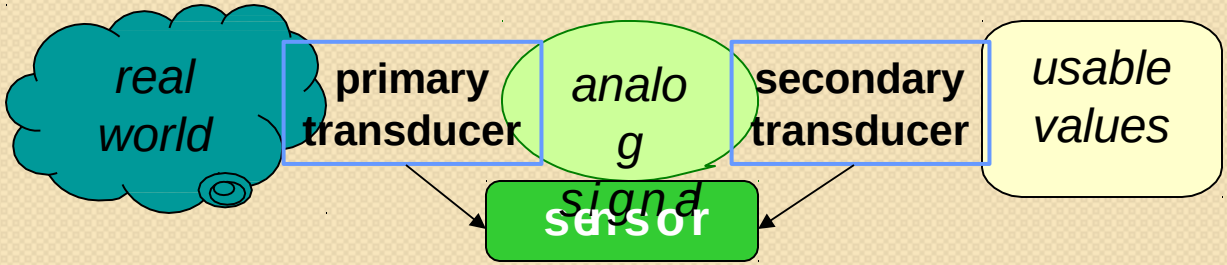


Sensor Systems

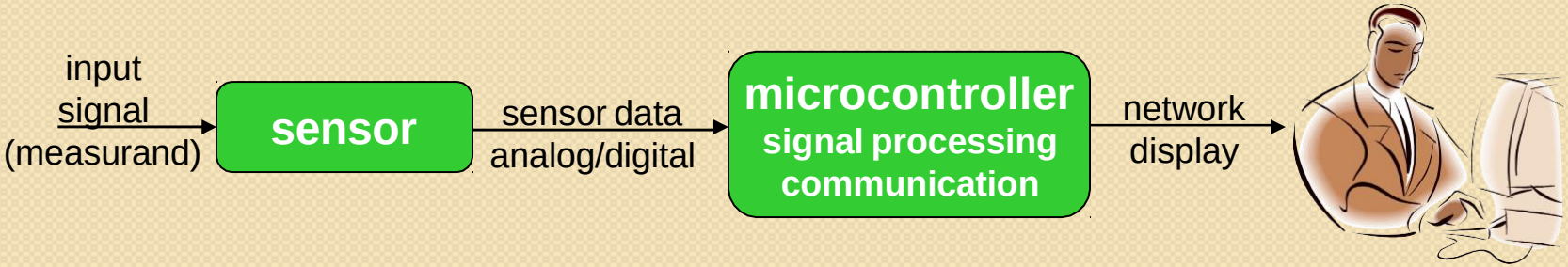
*Typically interested in **electronic sensor***

- convert desired parameter into electrically measurable signal

- General Electronic Sensor
  - primary transducer: changes “real world” parameter into electrical signal
  - secondary transducer: converts electrical signal into analog or digital values



- Typical Electronic Sensor System



Sensor Classification

- **Passive**
  - Doesn’t need any additional energy source
  - Directly generate an electric signal in response to an external stimuli
  - E.g. Thermocouple, photodiode, Piezoelectric sensor
- **Active**
  - Require external power called excitation signal
  - Sensor modify excitation signal to provide output
  - E.g. thermistor, resistive strain gauge

Sensor characteristics

- Span or Full scale input
  - A dynamic range of stimuli which may be converted by a sensor
  - represents the highest possible input value that can be applied to the sensor without causing an unacceptably large inaccuracy
  - g for accelerometer
- Full scale output
  - algebraic difference between the electrical output signals measured with maximum input stimulus and the lowest input stimulus applied
  - E.g. LM35

Sensor characteristics

- Accuracy
  - Accuracy is measured as a highest deviation of a value represented by the sensor from the ideal or true value at its input
  - accuracy limits generally are used in the worst-case analysis to determine the worst possible performance of the system
  - The inaccuracy rating may be represented in a number of forms:
    - Directly in terms of measured value *()*
    - In percent of input span (full scale)
    - In terms of output signal

Sensor characteristics

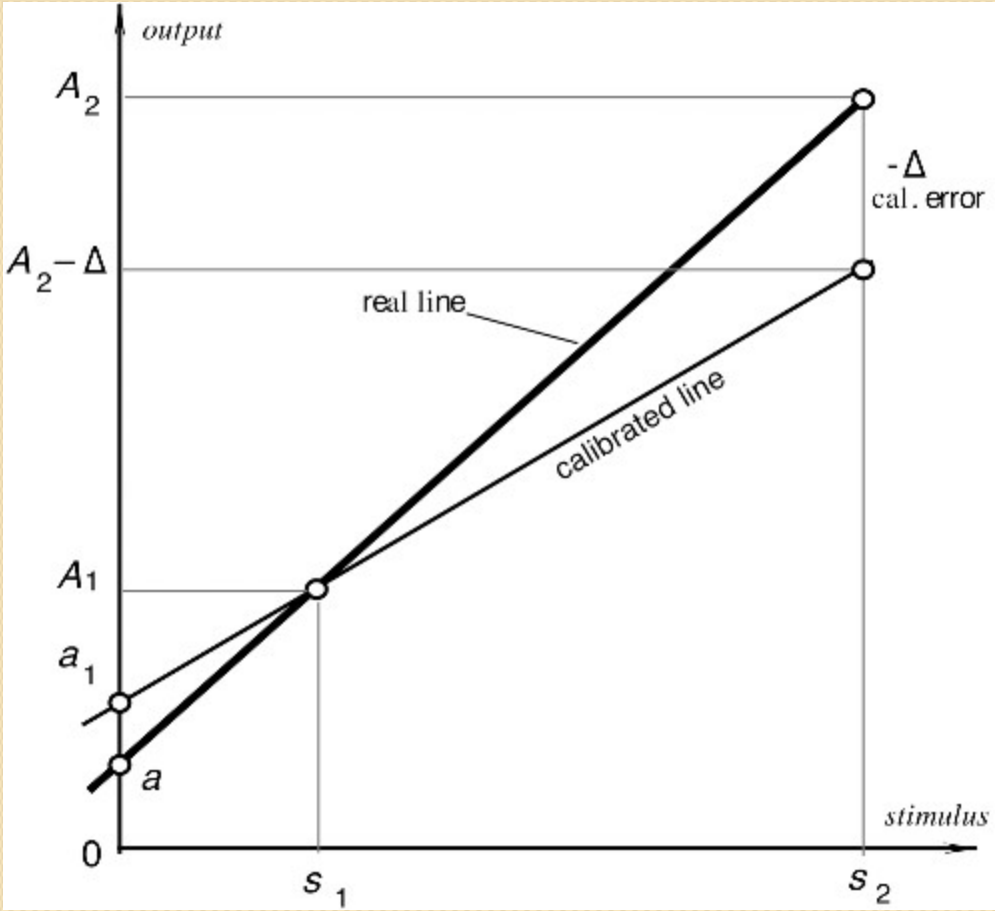
- Calibration
  - determination of specific variables that describe the overall transfer function
    - Overall means of the entire circuit, including the sensor, the interface circuit, and the A/D converter
  - E.g. use of forward biased diode for temperature measurement
    - Transfer function v=a+bt
    - Take measurement at two T's and solve and determine a and b
      - V1=a+bt1 and V2=a+bt2
  - For Non-linear function more than one point can be required depending on the transfer function
  - Another way is to use a piecewise approximation

Sensor characteristics

- Calibration error
  - inaccuracy

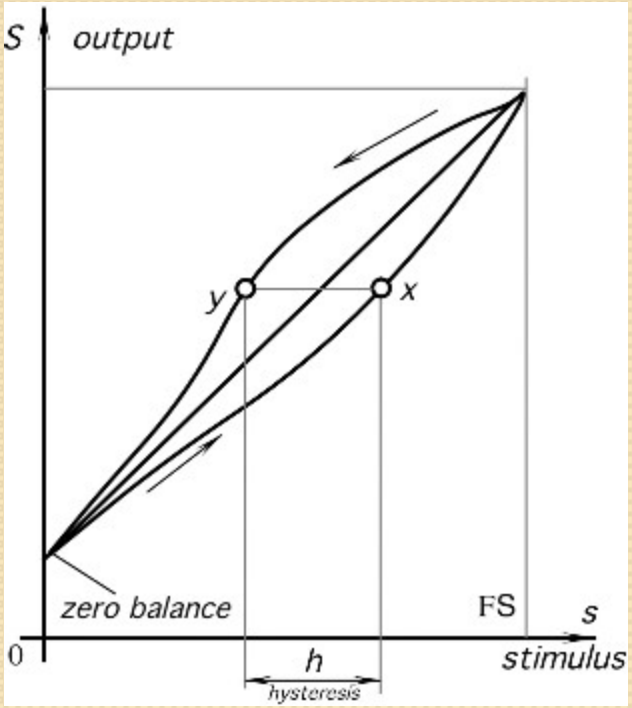
    permitted by a manufacturer when a sensor is calibrated in the factory

    Error is systematic in nature



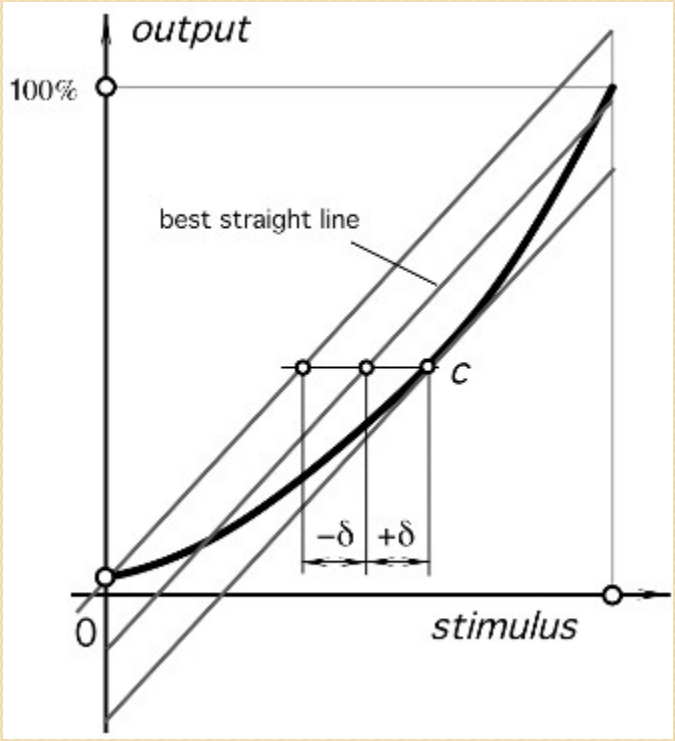
Sensor characteristics

- Hysteresis
  - deviation of the sensor's output at a specified point of the input signal when it is approached from the opposite directions



Sensor characteristics

- Non-linearity error
  - specified for sensors whose transfer function may be approximated by a straight line



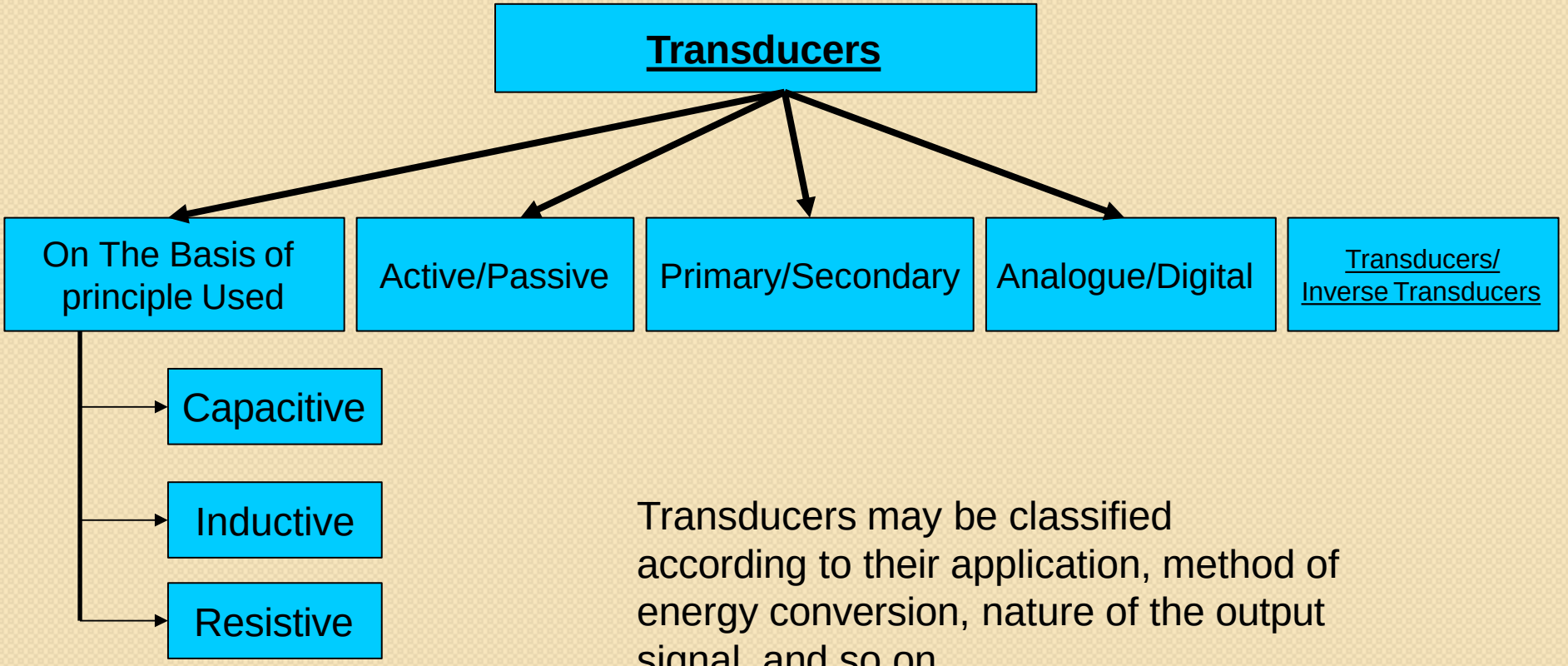
Sensor characteristics

- Repeatability
  - caused by the inability of a sensor to represent the same value under identical conditions
  - It is expressed as the maximum difference between output readings as determined by two calibrating cycles
  - It is usually represented as % of FS

Sensor characteristics

- Resolution
  - the smallest increments of stimulus which can be sensed
- Output impedance
  - The *output impedance Z_{out} is important to know to better interface a sensor with* the electronic circuit
  - For a current generating sensor should have an output impedance as high as possible and the circuit's input impedance should be low
  - For the voltage connection, a sensor is preferable with lower *Z_{out} and the circuit should have Z_{in} as high as practical*

Classification of Transducers



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

Thank you…