

BME101 Introduction to Biomedical Engineering



Biomedical Instrumentation and Biomedical Signals

Özlem BİRGÜL

**Ankara University
Department of Biomedical Engineering**

Outline



- Biomedical Sensors
- Medical Instrumentation
- Bioelectricity
- Signal Processing
- *Medical Imaging*

Biomedical Sensors

What is a transducer?

an electronic device that converts energy from one form to another

What is a sensor?

a device that detects and responds to some type of input from the physical environment

What is an actuator?

a transducer that accepts energy and produces the kinetic energy of movement (action)

Static Sensor Characteristics

- range / span
- accuracy
- precision
- repeatability
- sensitivity
- resolution
- linearity
- hysteresis

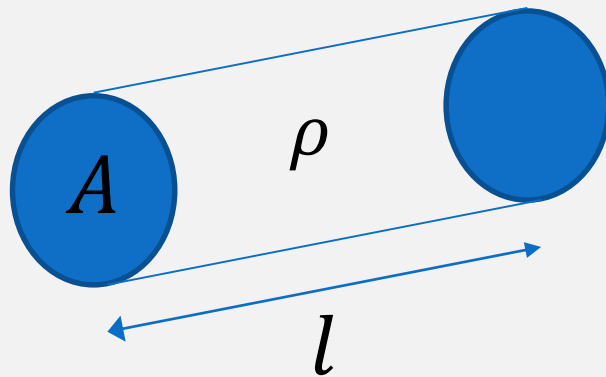
Types of Sensors

- Resistive Sensors
- Capacitive Sensors
- Inductive Sensors
- Piezoelectric Sensors
- Biological Sensors
- Optic Sensors
- ...

Resistive Sensors

resistance:

$$R = \rho \frac{l}{A}$$



- temperature sensitivity
- strain sensitivity
- moisture sensitivity

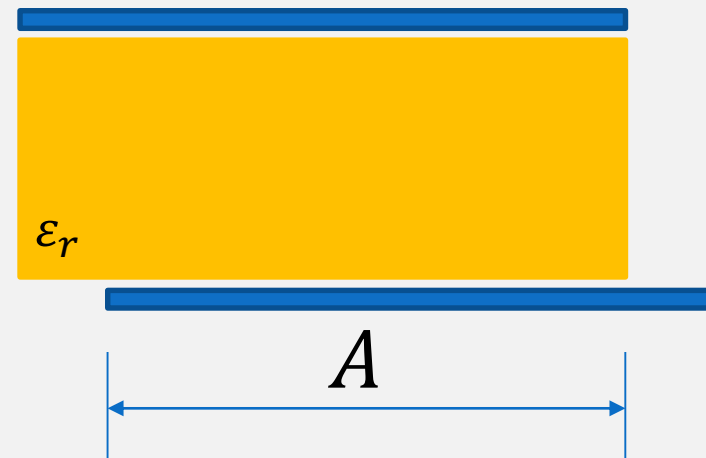
Capacitive Sensors

capacitance:

$$C = \epsilon_r \epsilon_0 \frac{A}{d}$$



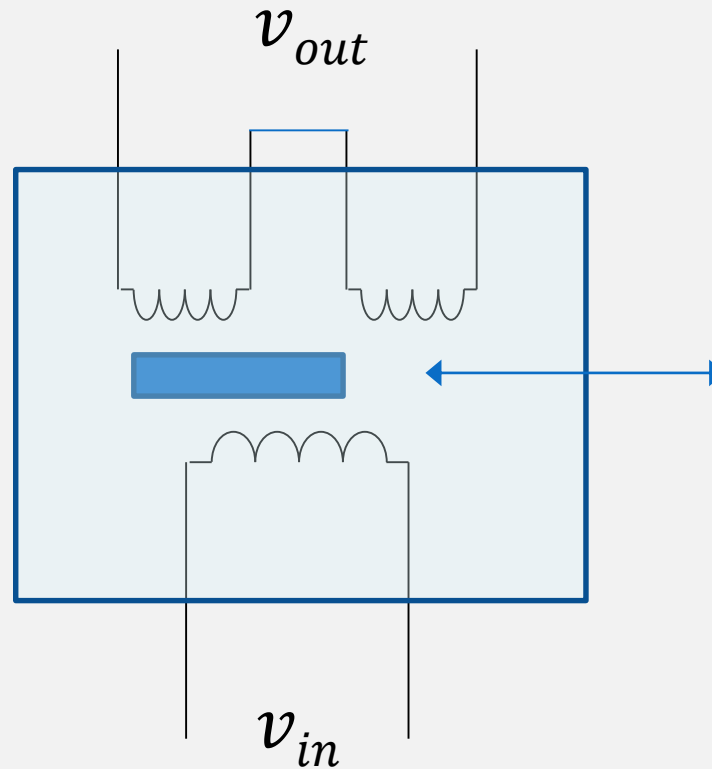
Cylindrical capacitor



Parallel plate capacitor

Inductive Sensors

$$v(t) = L \frac{di}{dt}$$



Electrodes

- a type of sensor

surface electrodes

needle electrodes

Bioelectricity

- Cell membrane
- Equivalent circuit model of the cell membrane
- Action potentials
- Propagation of action potentials

Bioelectric Signals

- ECG (electrocardiogram)
- EEG (electroencephalogram)
- EMG (electromyogram)

Signal Processing

- Low amplitude
- Sensitive to noise
- Generally low frequency
- Amplification
- Filtering
- Time-domain analysis
- Frequency domain analysis

Related Courses in the Program

	Fall Semester	Spring Semester
Year 2	BME 201 Circuit Analysis BME 211 Electrical Circuits Lab.	BME 202 Electronics BME 212 Electronics Laboratory
Year 3	BME 311 Biomedical Instrumentation I BME 301 Signals and Systems	BME 312 Biomedical Instrumentation II BME 302 Medical Imaging BME 304 Electromagnetics (elec.) <i>BME 322 System Dynamics and Control</i> <i>EEE 316 Information System Architecture</i> <i>EEE 322 Communication Theory</i>
Year 4	BME 401 Physiological Control Systems (elec.) BME 403 Bioelectricity and Biomagnetics (elec.) <i>EEE 405 Numerical Computing and Symbolic Programming</i> <i>EEE 423 Digital Signal Processing</i>	BME 402 Biosignal and Medical Image Processing (elec.) <i>EEE 412 Introduction to Estimation</i>

Medical Imaging (next course)

- Computerized Tomography
- Ultrasound Imaging
- Magnetic Resonance Imaging
- Nuclear Imaging

- Imaging optical properties
- Imaging electrical properties
- ...