

Lecture 3 (Physiological transducers)

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# **SIMULATED ELECTRONICS OF BIOLOGICAL SYSTEMS**

# TRANSDUCERS

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- ✗ Devices that convert one form of energy into another (usually electric).
- ✗ Factors affecting transducers choice.
- ✗ Transducers classifications.
  - + Active/passive
  - + Principle used
  - + Measured physiological variable

# TRANSDUCERS PERFORMANCE CHARACTERIST.

## ✖ Static

- + Accuracy—Precision---Resolution---Drift---Linearity
- + Threshold---Noise---Saturation---Conformance

## ✖ Dynamic

- + Zero-order system
- + First-order system
- + Second-order system.

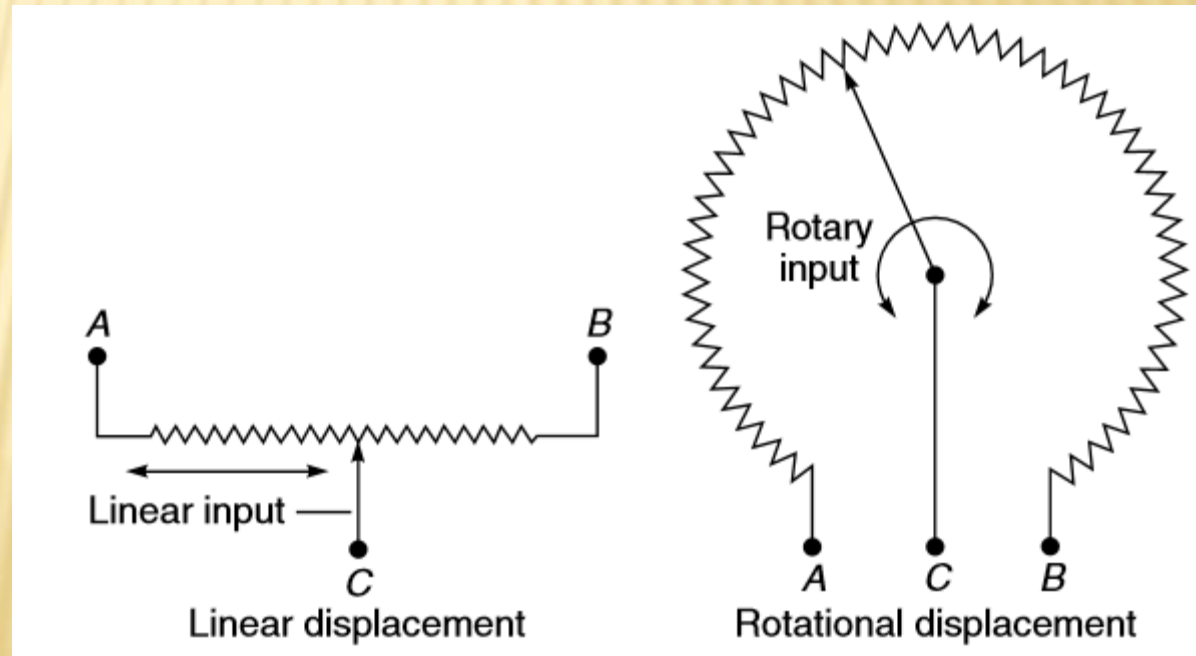
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# **DISPLACEMENT/POSITION/MOTION**



# POTENTIOMETRIC TRANSDUCERS

- ✖ Position/displacement/ motion
- ✖ Direct/ indirect measurements
- ✖ linear/angular displacement



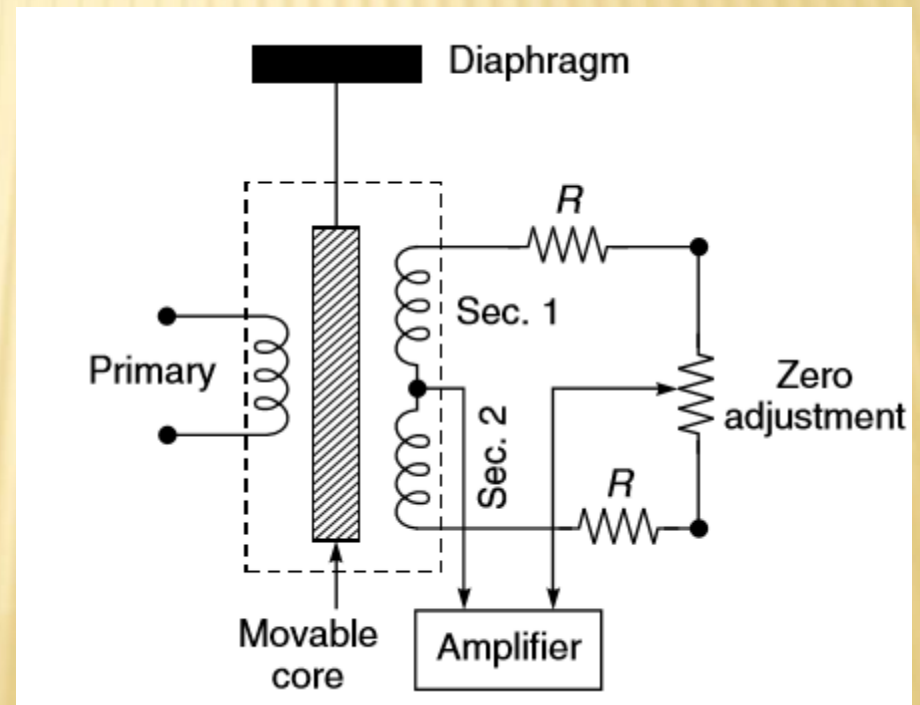
# VARIABLE CAPACITANCE/INDUCTANCE

- ✗ Hyperbolic displacement/capacitance relation and linear relation.
- ✗ How to incorporate it in a circuit.
- ✗ Advantages/Disadvantages
- ✗ How to relate inductance and displacement
- ✗ Variable reluctance transducer.
- ✗ Relation of displacement/inductance is non linear.

# LINEAR VARIABLE DIFFERENTIAL TRANS.(LVDT)

- ✗ Differential transformers are designed where the central primary coil is connected to a sinewave, the two other secondary coils create outputs that are equal in magnitude and opposite in phase.

✗



# PRESSURE TRANSDUCERS

- ✖ Pressure transducers are flexible diaphragm which gets deformed by the action of pressure exerted on it.
- ✖ Absolute/Gauge pressure.
- ✖ Types
  - + Capacitance manometer
  - + Differential transformer
  - + Strain gauge
- ✖ LVDT pressure transducer consists of: a plastic dome– stainless steel diaphragm—core assembly with plastic body containing LVDT coil.
- ✖ Strain gauge pressure transducers is based upon changes in wire resistance produced due to small mechanical displacements.
- ✖ Gauge Factor  $g = (\Delta R/R)/(\Delta L/L)$  determine the sensitivity of the strain gauge.



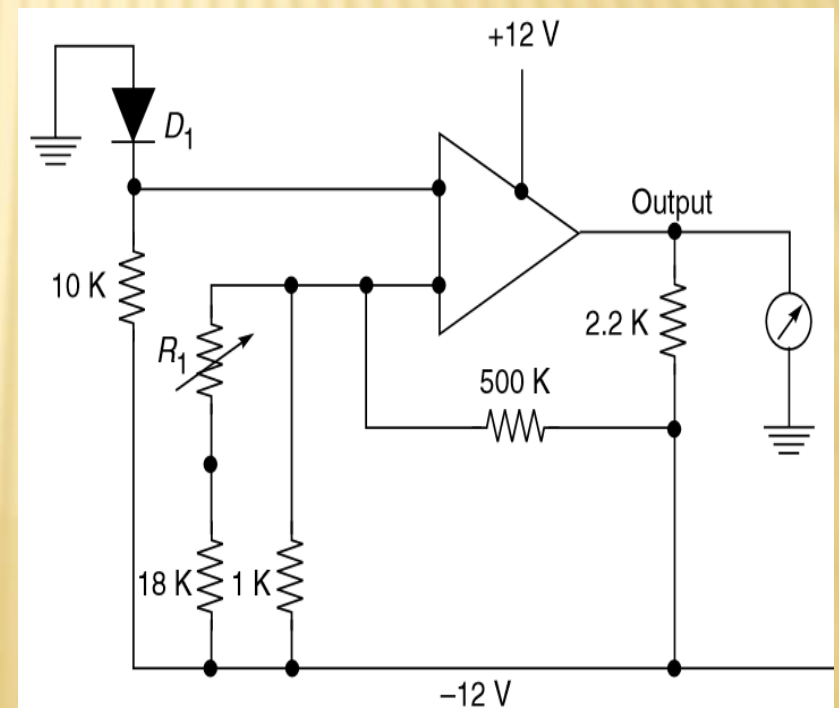
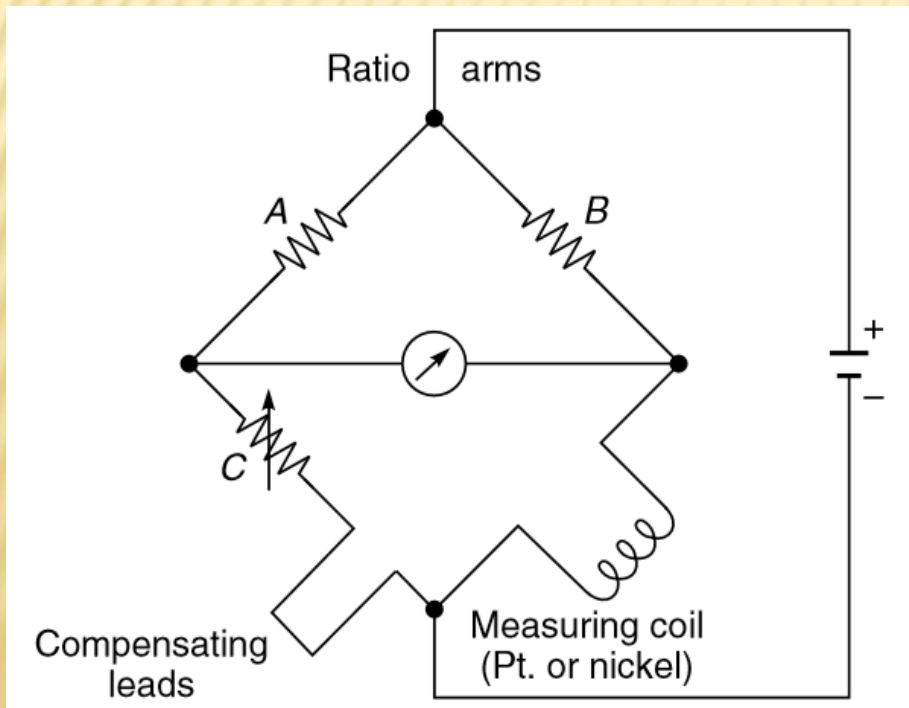
# TEMPERATURE TRANSDUCERS

- ✗ Resistance thermometers measure absolute temperature while thermocouples generally measure relative temperature.
- ✗ Thermocouples definition (measuring/ reference junction).  
The theory of operation.
- ✗ The electrical resistance thermometer
  - + Theory the resistance of a metallic conductor at any temperature is given by  $R_t = R_0(1 + \alpha t)$
  - + Wheatstone bridge (definition and schematic)
  - + An AC bridge is recommended to neglect any electrochemical or polarization effects
  - + The dummy or compensating leads.
- ✗ Silicon diode
  - + The voltage drop across a forward bias silicon diode varies with temperature.
  - + Disadvantages (require a stable calibrated source).
  - + Advantages can be the small integrated circuit with the transducers.

# TEMPERATURE SENSORS

## ✖ Chemical thermometry

- + Theory
- + Advantages (better contact-less cross contamination)
- + Disadvantages (small resolution – slow response – modify skin temperature)



# PHOTOELECTRIC AND OPTICAL FIBERS

## ✖ Photoelectric transducers

- + Theory
- + Types (photovoltaic (no external source)-photoemissive (require external source))
- + Disadvantages (fail to respond immediately-need time to warm up)

## ✖ Optical fiber sensors

- + Advantages & types
- + Photometric sensors for amplitude and frequency measurements

