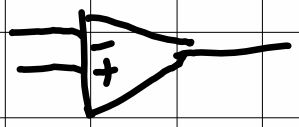
ME 133 lecture 16 3/1/2022

Last time:



op-amps

- Inverting Amp.
- non-inverting Amp.
- Buffer
- Integrators
- differentiator
- Comparator
- Sample & hold
- Instrumentation amplifier

Today:

- Sensors Overview
- Actuators Overview
- ADCs

What is a sensor?

* element in a mechatronic system that detects the magnitude of a physical quantity & changes it into a signal that can be processed

→ sometimes called transducer

→ energy converter

Position $\dot{s}$ Speed

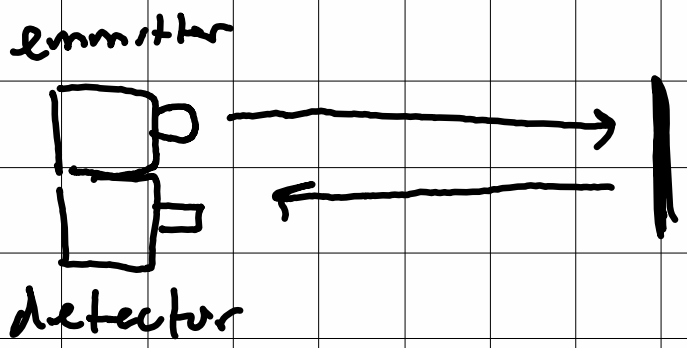
(maybe)

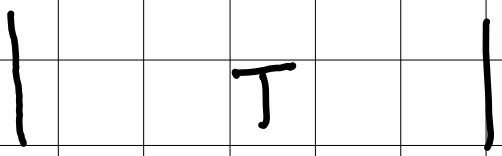
* most common measurement

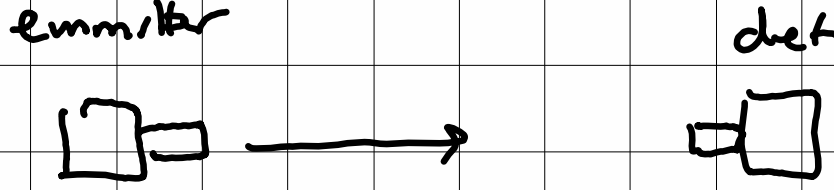
→ rotary position sensors

Proximity Sensors $\dot{s}$ Switches

* photoemitter - detector pair

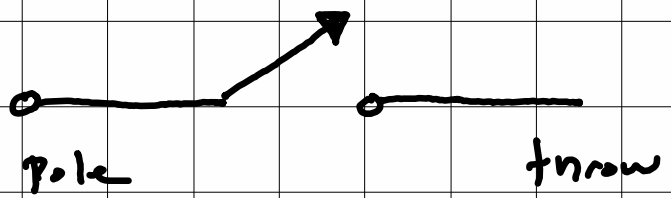




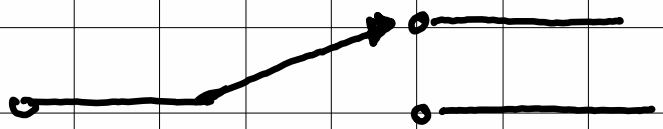


Switches

→ Characterized by # of poles
& by # of throws

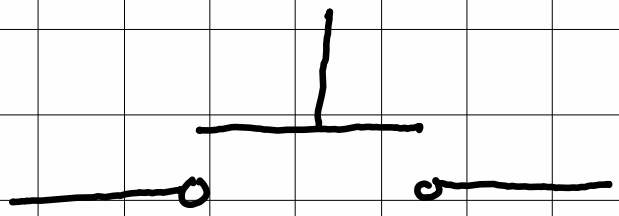


SPST



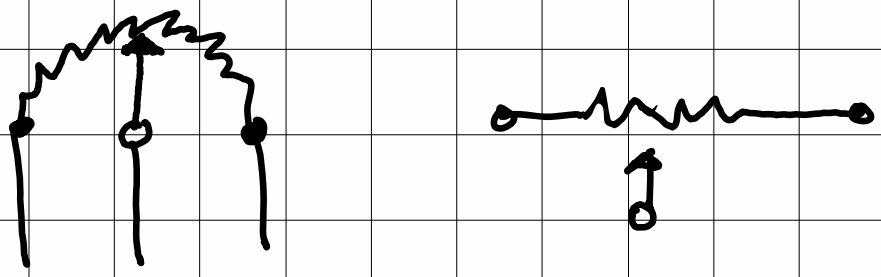
SPDT

- Normally open — NO
  Normally closed — NC



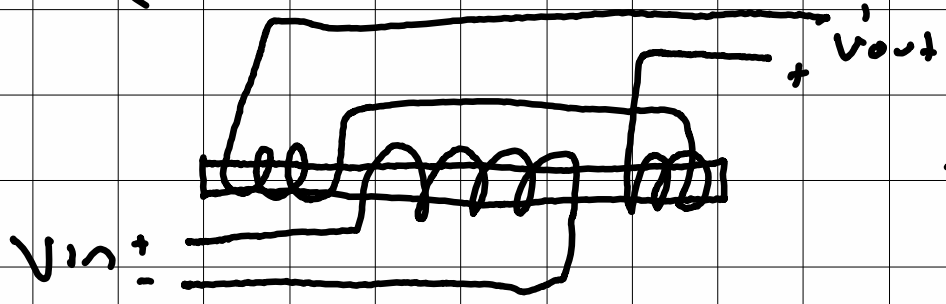
Potentiometers (Pots)

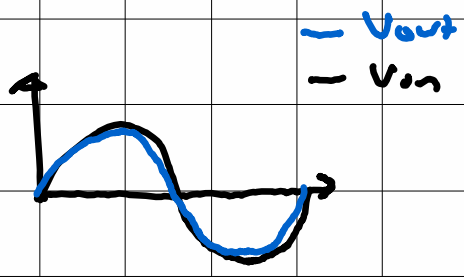
* Variable resistor

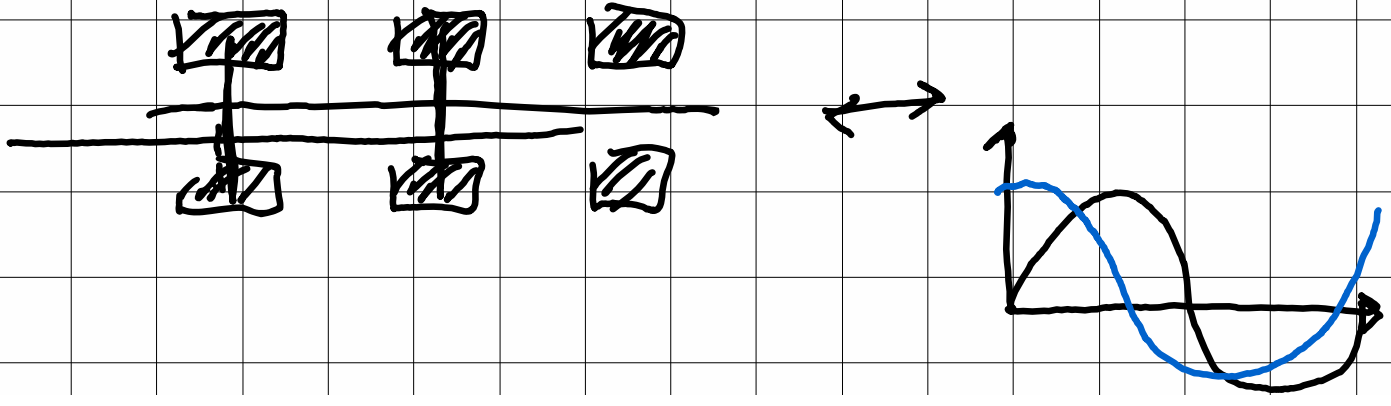


Linear Variable Differential Transducer

(LVDT) → linear displacement



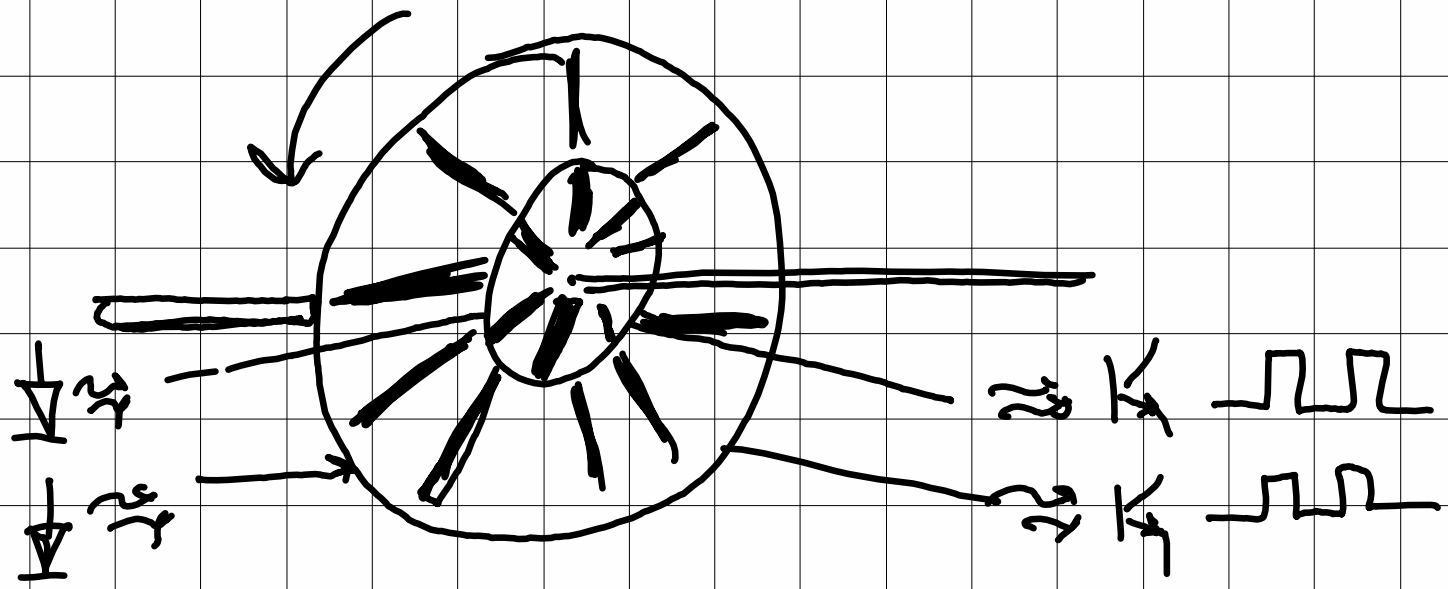




Digital Encoder

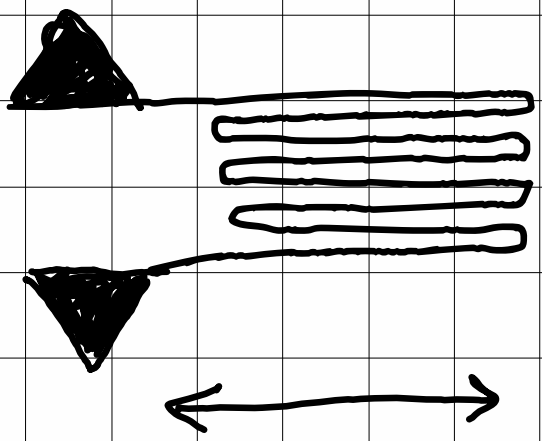
* converts motion into a series of digital pulses

* count pulses to get positions

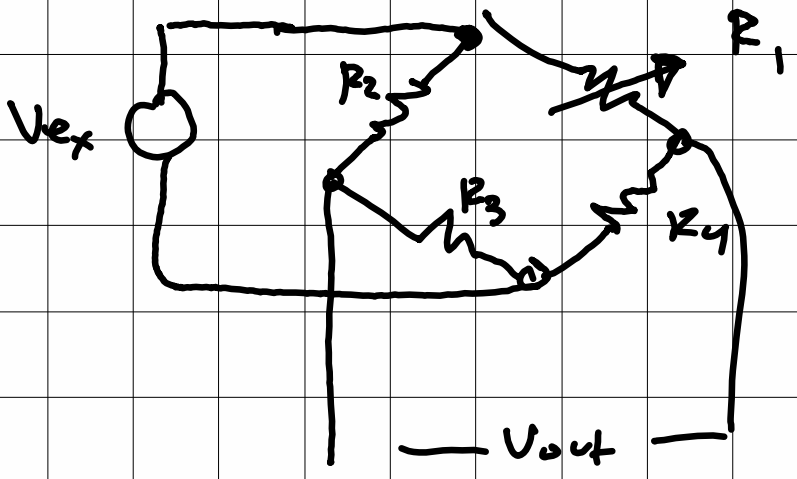


Stress & Strain

* Strain gage is a thin foil conductor which can change length depending on loading → change in resistance

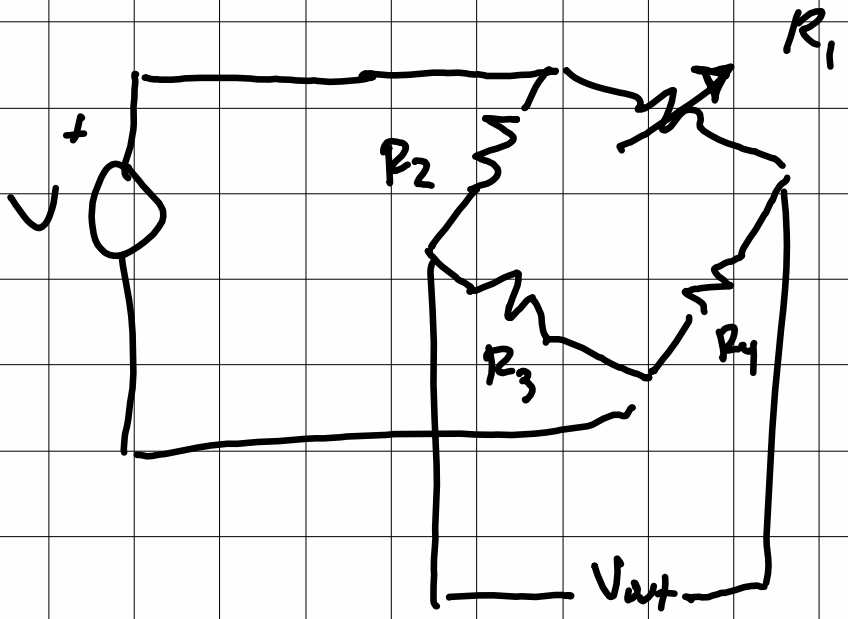


Wheatstone Bridge

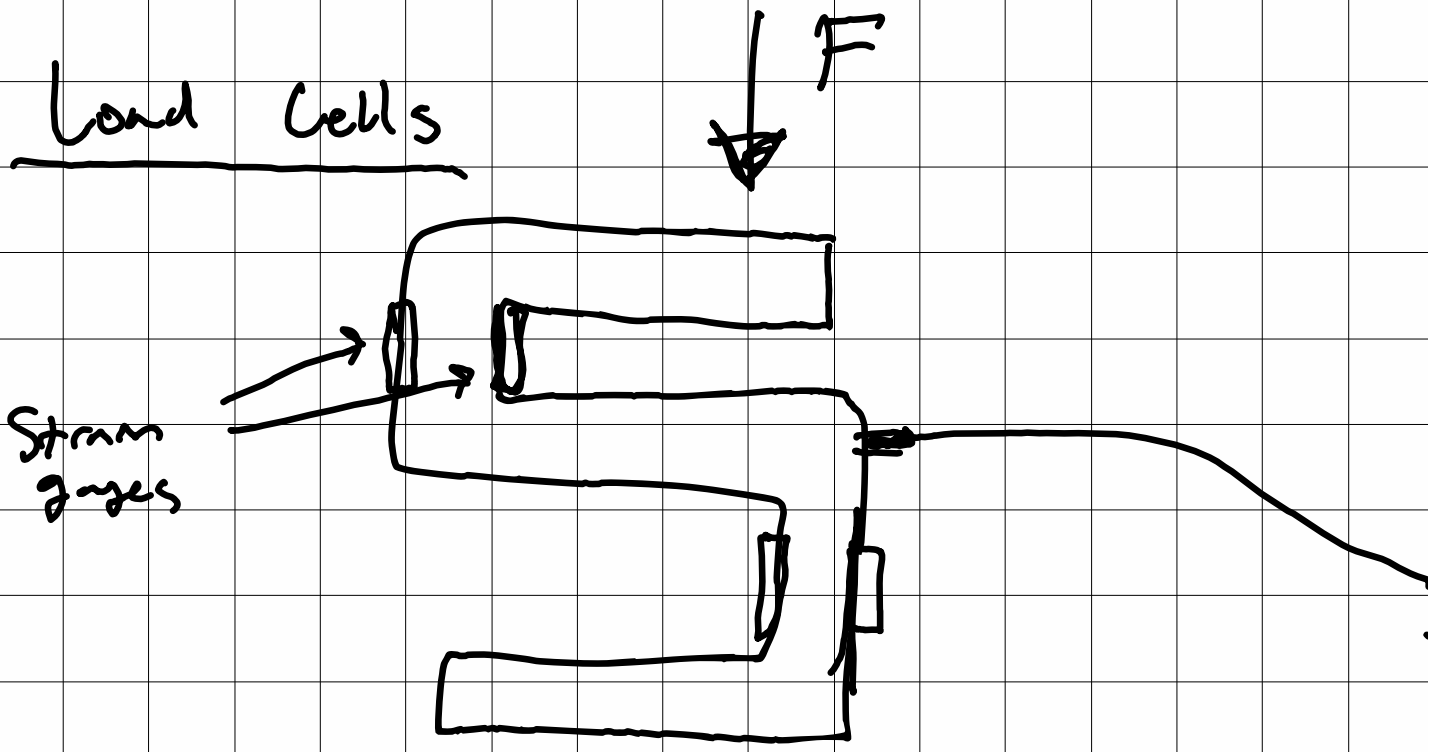


$$V_{out} = V_{ex}\left(\frac{R_1}{R_1+R_4} - \frac{R_2}{R_2+R_3}\right)$$

$$V_{out} = V_{ex}\left(\frac{R_1}{R_1 + R_4} - \frac{R_2}{R_3 + R_2}\right)$$



Load Cells

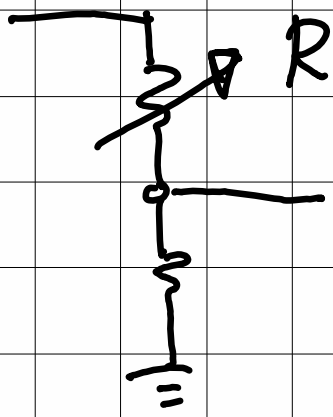


Temperature

- thermistor
- thermometer
- thermocouple

- resistance temperature device

$$R = R_0 \left[1 + \alpha (T - T_0) \right]$$

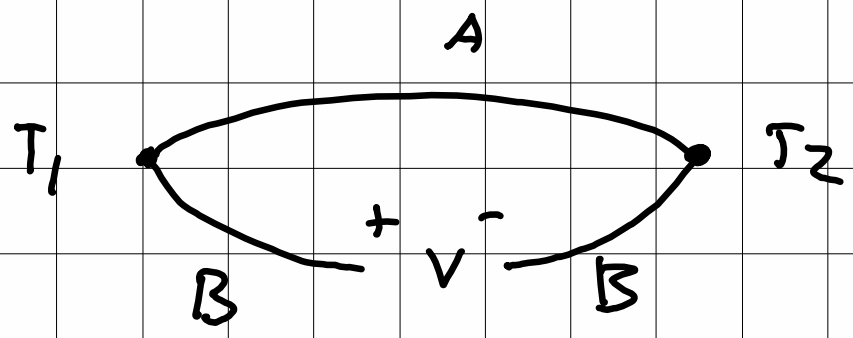


Voltage divider

- thermistor

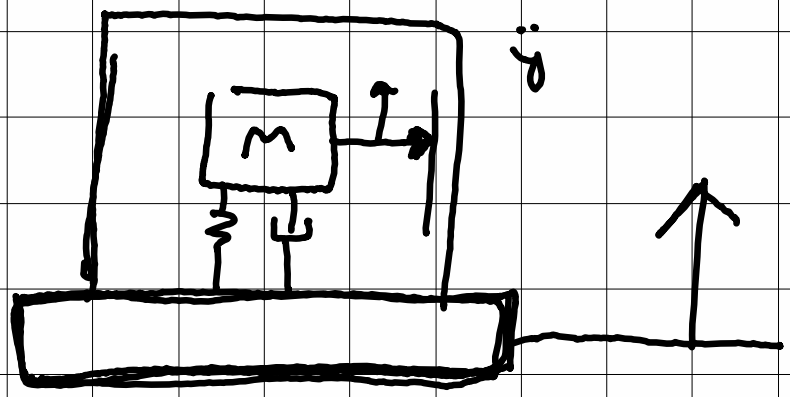
$$R = R_0 e^{\left(\beta \left[\frac{1}{T} - \frac{1}{T_0} \right]\right)}$$

• Thermocouple



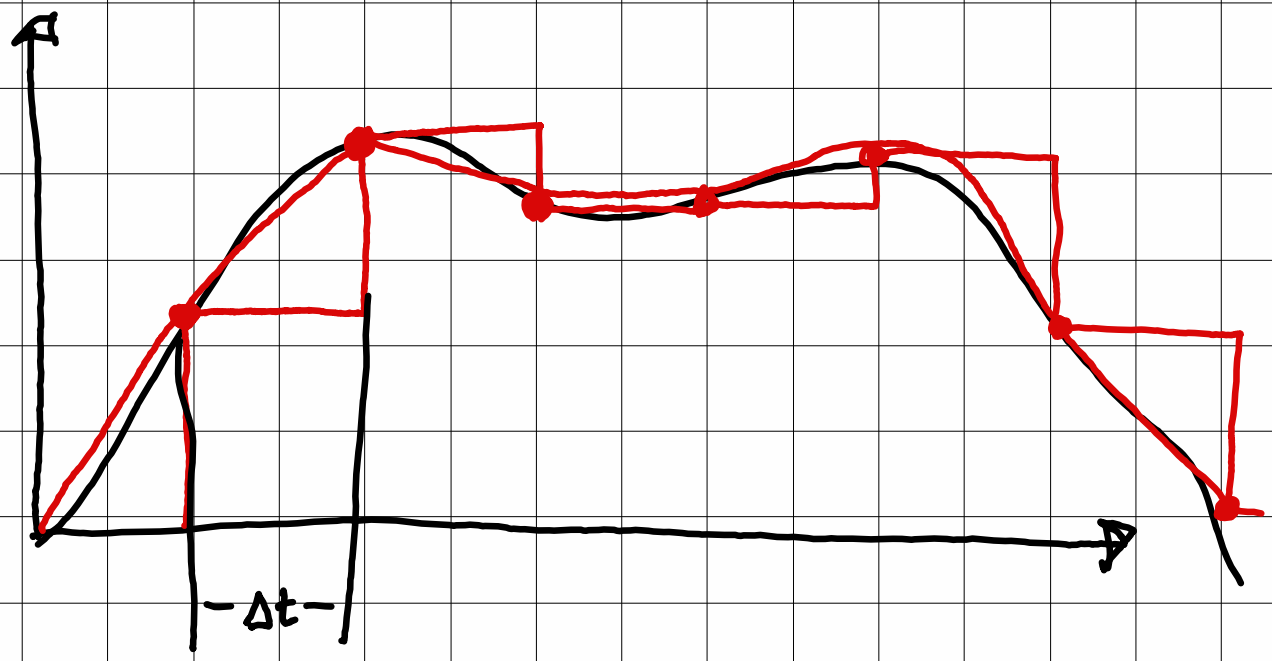
$$V = \alpha (T_1 - T_2)$$

• Vibration & Acceleration



MEMS : micro electro mechanical devices

DATA Acquisition



Shannon's Sampling theorem

$$f_s \geq 2 \cdot f_{max}$$

f_s: sampling freq.

f_{max}: maximum resolvable frequency.