Instrumentation and data acquisition Spring 2010

Lecture 2: Sensors

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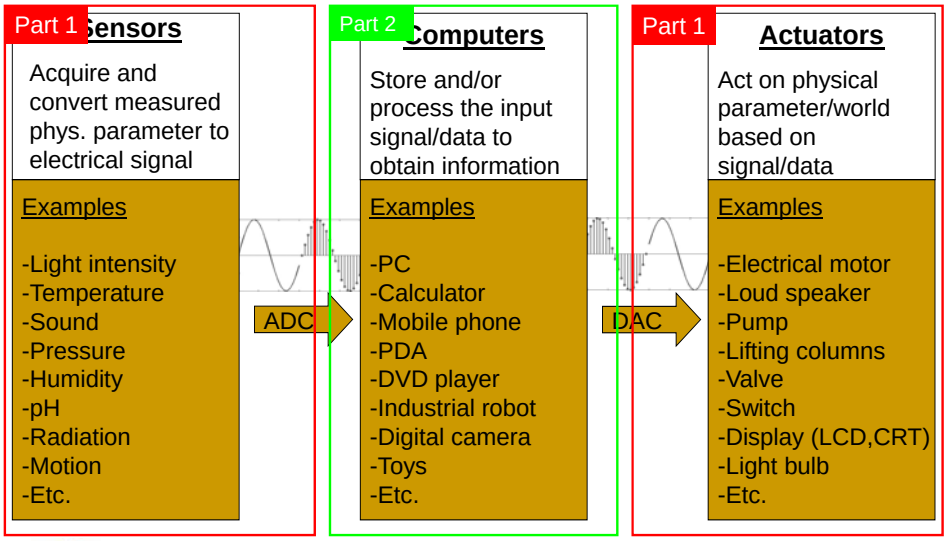
Acquire, process and output data

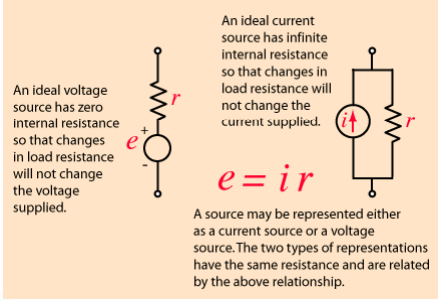


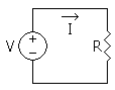
Outline

- Circuit theory
- Strain gauge
- Signals and systems

Voltage and Current Sources

- A voltage source is any device or system that produces an electromotive force between its terminals.
- Real voltage sources can be represented as ideal voltage sources in series with a resistance *r*, the ideal voltage source having zero resistance. Real current sources can be represented as ideal current sources in parallel with a resistance *r*, the ideal current source having infinite resistance.





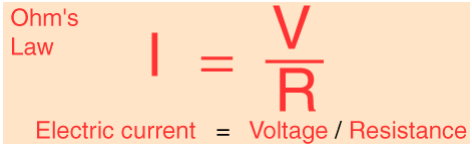
An ideal voltage source, *V*, driving a resistor, *R*, and creating a current *I*

http://hyperphysics.phy-astr.gsu.edu

Reading: The art of electronics

Ohm's Law

- The ratio of voltage to current is called the resistance.

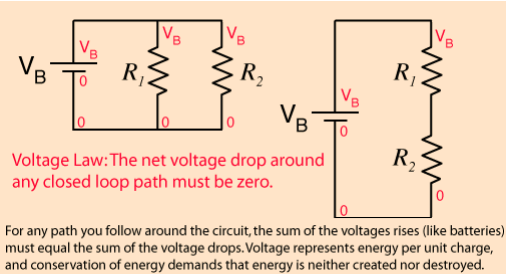


- The electrical resistance of a circuit component or device is defined as the ratio of the voltage applied to the electric current which flows through it.

http://hyperphysics.phy-astr.gsu.edu/Hbase/electric/ohmlaw.html#c1

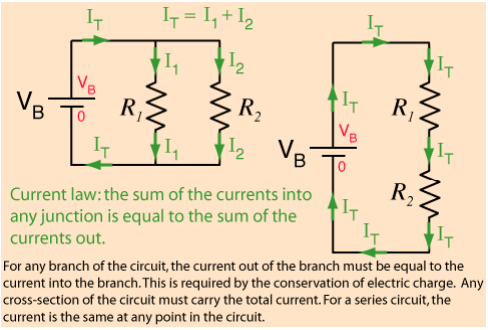
Voltage Law (Kirchhoff's circuit laws)

- The voltage changes around any closed loop must sum to zero.



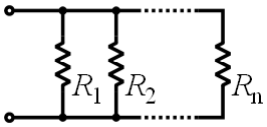
Current Law (Kirchhoff's circuit laws)

- The electric current in amperes that flows into any junction in an electric circuit is equal to the current which flows out.



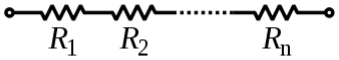
Resistor network

- Parallel resistors



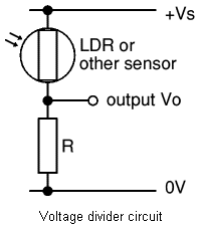
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$

- Series resistors



$$R_{eq} = R_1 + R_2 + \cdots + R_n$$

Using transducer



Voltage divider circuit

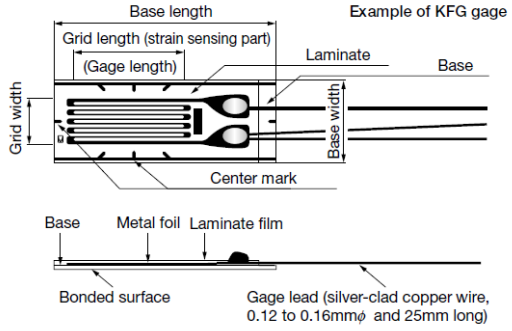
Strain gauges

- A strain gauge is a device used to measure the strain of an object

Structure of Foil Strain Gage

The foil strain gage has metal foil photo-etched in a grid pattern on the electric insulator of the thin resin and gage leads attached, as shown in Fig. 2 below.

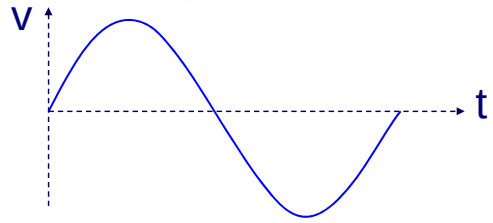
Fig. 2



http://www.kyowa-ei.co.jp/english/products/gages/pdf/howsgw.pdf

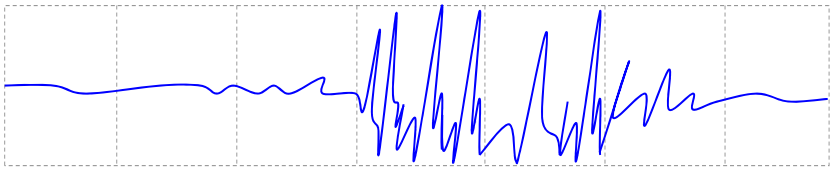
Signal

- What is a signal
- A description of how one parameter is related to another parameter
- Examples
  - The voltage varies with time

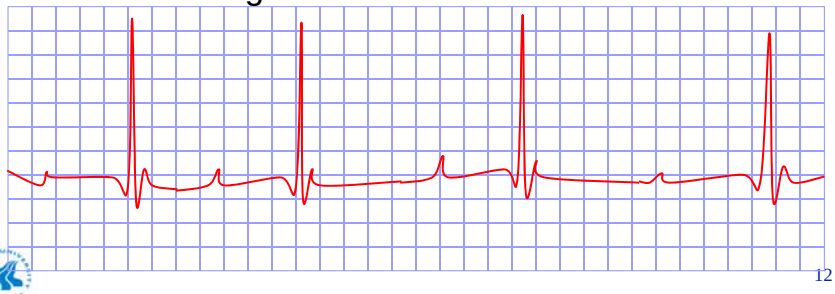


Signal

- The Speech Signal

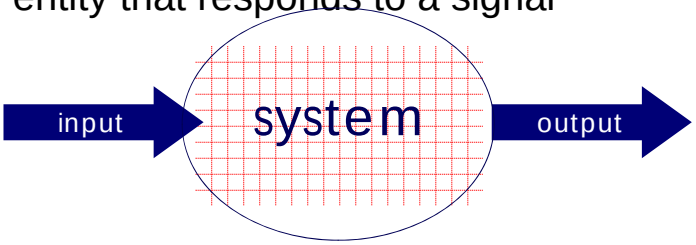


- The ECG Signal

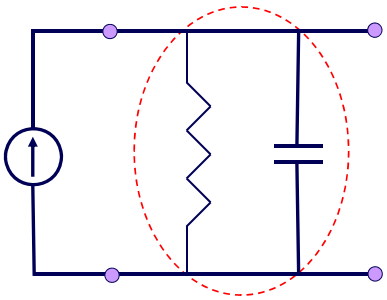


System

- An entity that responds to a signal



- Examples
  - Circuit



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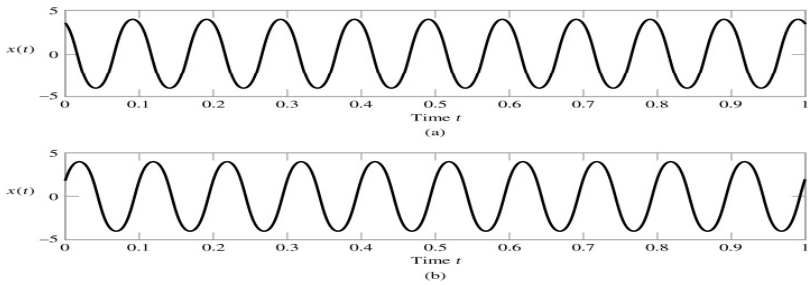
Sinusoidal CT Signals



Oppenheim et al. *Signals and Systems*, Prentice Hall, 1997, p.16

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LTI systems and responses

- Linear time-invariant (LTI) system
- Impulse response (p.96)
- Step response (p.115)
- System function and frequency response (p. 227)
- Frequency-selective filters (p.236)