Sliding Control Modes.

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Aims of the course.

- To show a domain in the frontier between *“applied mathematics”* and *“engineering”*.

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- *How?* Through a course in control, in particular a course in *Sliding Control Modes*.

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Syllabus

- Lecture 1.
  - What is control?
  - Variable Structure Systems. Sliding Control Modes.
  - Real and ideal sliding modes.
  - The uniqueness problem.
  - Designing controllers.

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- Lecture 1.
  - What is control?
  - Variable Structure Systems. Sliding Control Modes.
  - Real and ideal sliding modes.
  - The uniqueness problem.
  - Designing controllers.
- Lecture 2
  - Definitions. Problems.
  - The equivalent control method.
  - The Ideal Sliding Dynamics.
  - Single Input Single Output Systems (existence).

- Lecture 3
  - Examples: a linear system of relative degree 2, a non-minimum phase nonlinear system of relative degree 1, a time dependent sliding surface.

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- Lecture 4
  - Multi Input Multi Output Systems (existence).
  - A Lyapunov Theorem.
  - An example to be careful.
  - From MIMO to SISO, decoupling inputs and outputs.

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  - Examples: a linear system of relative degree 2, a non-minimum phase nonlinear system of relative degree 1, a time dependent sliding surface.
- Lecture 4
  - Multi Input Multi Output Systems (existence).
  - A Lyapunov Theorem.
  - An example to be careful.
  - From MIMO to SISO, decoupling inputs and outputs.
- Lectures 5 and 6
  - Examples and exercises.

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- System: A device or process having identifiable inputs and outputs.

Control Oriented Notion of System

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- Open vs. closed loop systems.
  In an open loop control system, the input applied to the process under control does not depend on the actual output. In open-loop control there is no error correction.
  The severity of the disturbances determines which systems can operate under open-loop control.
  Regardless of disturbances, the ability to calibrate the system can determine whether or not open-loop control is applicable.

Feedback

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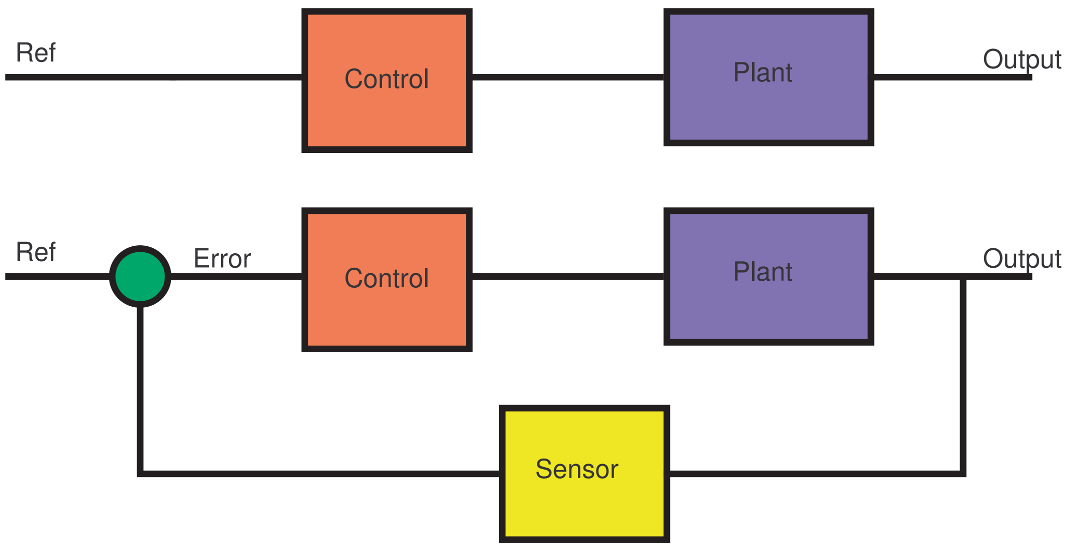
Feedback



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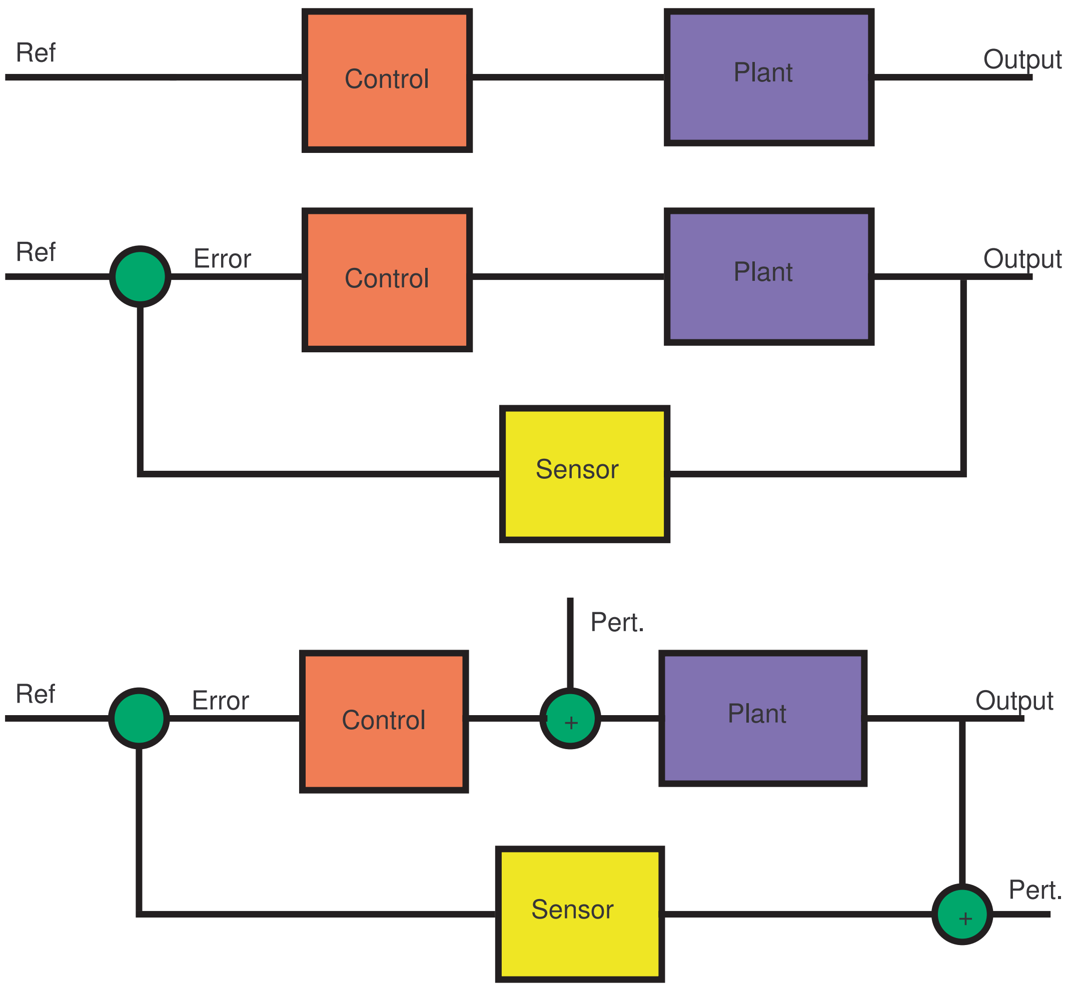

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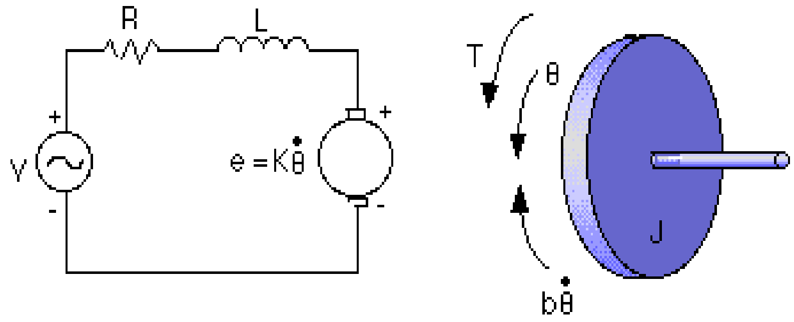
- A DC motor.



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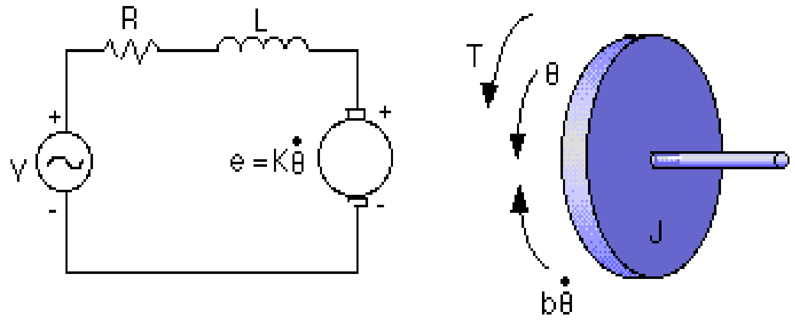

- State-space.

$$\frac{d}{dt}\begin{pmatrix} \dot{\theta} \\ i \end{pmatrix} = \begin{pmatrix} -\frac{b}{J} & \frac{K}{J} \\ -\frac{K}{L} & -\frac{R}{L} \end{pmatrix}\begin{pmatrix} \dot{\theta} \\ i \end{pmatrix} + \begin{pmatrix} 0 \\ \frac{1}{L} \end{pmatrix} v$$

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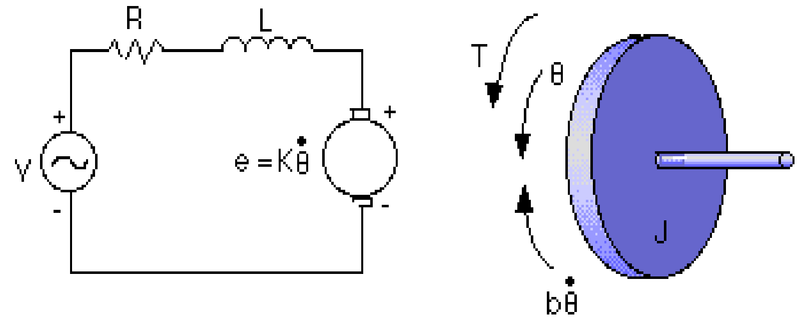

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- Input-Output form.

$$\left.\begin{array}{rcl} s(Js+b)\Theta(s) & = & KI(s)\\ (Ls+R)I(s) & = & V-Ks\Theta(s)\end{array}\right\}\Rightarrow\frac{\dot{\Theta}}{V}=\frac{K}{(Js+b)(Ls+R)+K^2}$$

(Clepsidra, Ctesibio $\sim 300 - 270AC$)