ECE 602: LUMPED LINEAR SYSTEMS

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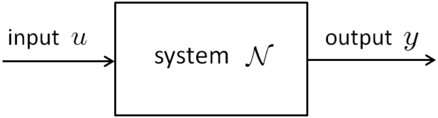
Systems and Input/Output Signals

Systems



Block diagram of a system

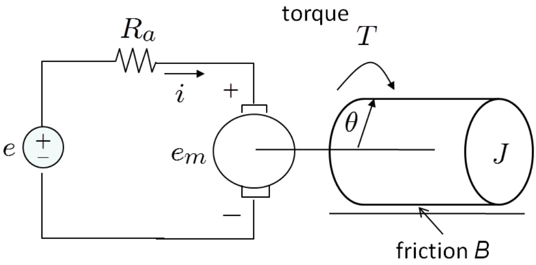
- Systems are mathematical models of physical objects/processes
- Systems are represented by mappings from input signal u to output signal y:

$$y = \mathcal{N}(u)$$

  - $\mathcal{N}$ may be given by ODEs, PDEs, SDEs, difference equations, algorithms...

Example of Systems

- Electrical systems
- Mechanical systems
- Transportation systems
- Energy/power systems
- Biological systems
- Ecological systems
- Social networks
- Stock market



An electro-mechanical system

Signals

Signals are (real) vector-valued functions defined on a time index $\mathcal{I}$:

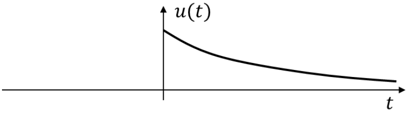
$$u : \mathcal{I} \to \mathbb{R}^n$$

- Continuous-time signals if $\mathcal{I} = \mathbb{R} = (-\infty, \infty)$:

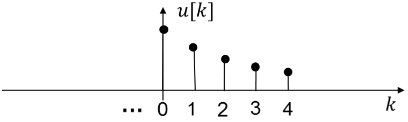
$$u(t), \ -\infty < t < \infty$$

- Discrete-time signals if $\mathcal{I} = \mathbb{Z} = \{\dots, -1, 0, 1, \dots\}$:

$$u[k], \ k = \dots, -1, 0, 1, \dots$$



A continuous-time signal



A discrete-time signal

- Causal signals if $\mathcal{I} = [0, \infty)$ or $\mathcal{I} = \{0, 1, \dots\}$

Admissible Input Signals

Admissible input signal set $\mathcal{U}$: set of allowable input signals to system $\mathcal{N}$

Assumptions

1. Linear combinations of admissible input signals are still admissible
2. Time delays (right shift) of admissible input signals are still admissible

Examples:

- $\mathcal{U}$ is the set of all mappings u from $\mathcal{I} = \mathbb{R}$ to $\mathbb{R}^n$
- $\mathcal{U}$ is the set of all mappings u from $\mathcal{I} = \mathbb{R}$ to $\mathbb{R}$ whose Laplace transforms exist