Systems and Simulations—Lecture 3a

Transfer-Function Approach to Modelling Dynamic Systems

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Fall 2014

Impulse Response and Convolution

- Impulse response of a system, $g(t)$.
- Output as convolution of input and impulse response, $x(t) * g(t)$.
- Examples: cases of infinte and finite durations.
- Laplace transform of convolution.

Transfer Function and Impulse Response

- Input-output relationship
- Linear time-invariant systems
- Property of system itself. But, does not capture physical nature.
- Used to provide system output for any input.
- Ratio between Laplace transform of output to Laplace transform of input.
- Differential equation and transform.
- Example

Block Diagram

- A common engineering approach for visualizing systems.
- Nonunique
- Closed loop system example

Partial-fraction expansion—MATLAB

- Transfer function represented by two arrays.
- For $F(s) = \frac{b_n s^n + b_{n-1} s^{n-1} + \cdots + b_0}{a_n s^n + b_{n-1} s^{n-1} + \cdots + a_0}$, define

$$num = [b_n \; b_{n-1} \; \cdots \; b_0],$$

$$den = [a_m \; a_{m-1} \; \cdots \; a_0].$$

- Example.
- Use command: `[r,p,k]=residue(num,den)`.
- Example.

Transient-response—MATLAB

- Command sys=tf(num,den)
- Command step(sys)
- Command impulse(sys)
- Command lsim(sys,u,t)