SIGNALS AND SYSTEMS

Introduction to Linear Time-Invariant Continuous-Time Systems

Fundamental - signals and systems.

Linearity and Time-Invariance

Linearity

- Superposition and homogeneity
- S[a1x1(t)+a2x2(t)]=a1S[x1(t)]+a2S[x2(t)]=a1y1(t)+a2 y2(t)

Time Invariance

- S[x(t−τ)]=y(t−τ)

Continuous-Time Signals and Systems

Representation of LTI Systems

Impulse Response

The response of an LTI system to a unit impulse function δ(t) is called the **impulse response** h(t).

$$y(t) = (x * h)(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$$

Differential Equations

$$a_n \frac{d^n y(t)}{dt^n} + a_{n-1} \frac{d^{n-1} y(t)}{dt^{n-1}} + \cdots + a_1 \frac{dy(t)}{dt} + a_0 y(t) = b_m \frac{d^m x(t)}{dt^m} + \cdots + b_1 \frac{dx(t)}{dt} + b_0 x(t)$$

Transfer Function

$$H(s) = \frac{Y(s)}{X(s)}$$

Stability

Examples

- Consider a simple LTI system described by the first-order differential equation:

$$\frac{dy(t)}{dt} + y(t) = x(t)$$

- For any arbitrary input x(t), the output is computed as the convolution of

$$y(t) = (x * h)(t)$$

Applications of LTI Continuous-Time Systems

- Control systems
- Signal processing
- Electrical circuits
- Mechanical systems


Thank you