VE216 RC1

Chapter 1

- Classifications of Signals
- Transformation of Variables
- Singularity Functions
- Systems

Classification of Signals

- continuous & discrete
- even & odd
- periodic & non periodic
- deterministic & random
- energy & power

Classification of Signals

- continuous signal $x(t)$ & discrete signal $x[n]$
    - whether a signal varies continuously with time
- $x(t) \xrightarrow{\text{sampling}} x[n]$

Classification of Signals

- even & odd
  - even signal: $x(t)=x(-t)$; $x[n]=x[-n]$ for all t/n
  - odd signal: $x(t)=-x(-t)$; $x[n]=-x[-n]$ for all t/n

Classification of Signals

- even/odd part of an arbitrary signal
  - $x(t)=x_e(t)+x_o(t)$
  - $x_e(t)=1/2*[x(t)+x(-t)]$
  - $x_o(t)=1/2*[x(t)-x(-t)]$
  - Example: Lecture 1 Slides P 26-29

Classification of Signals

- periodic & non periodic
  - $x(t)=x(t+T)$, $x[n]=x[n+N]$; $T,N>0$
  - fundamental period
- Ex: Assume $x_1(t)=x_1(t+T_1)$, $x_2(t)=x_2(t+T_2)$. Let $x(t)=x_1(t)+x_2(t)$, is $x(t)$ periodic?

Classification of Signals

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Classification of Signals

- energy & power

	x(t)	x[n]
average power during an infinite period: P	$\lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} \| x(t) \|^2 \, dt$	$\lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{+N} \| x[n] \|^2$
total energy during an infinite period: E	$\int_{-\infty}^{\infty} \| x(t) \|^2 \, dt$	$\sum_{n=-\infty}^{+\infty} \| x[n] \|^2$
average power for a periodic signal: P_T	$\frac{1}{T} \int_0^T \|x(t)\|^2 \, dt$	$\frac{1}{N} \sum_{n=0}^{N-1} \|x[n]\|^2$

Classification of Signals

- energy & power
  - energy signal: 0<E<Inf
  - power signal: 0<P<Inf

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Transformation of Variables

- $y(t)=x(at-b)=x[(t-t_0)/w]$
  - first time delay by b; then time scaling by a
  - first time scaling by 1/w; then time delay by t_0
- Exponential signals: Lecture 2 Slides P49

Singularity Functions

Discrete	Continuous
$\delta[n] = \begin{cases} 1, & n = 0 \\ 0, & n \neq 0 \end{cases}$	$\delta\,(\mathrm{t}) = 0,\ \mathrm{t} \neq 0$ $\int_{-\infty}^{\infty} \delta(t)dt = 1$
$u[n] = 0, n < 0,$ $u[n] = 1, n \geq 0.$	$u(t) = 0, t < 0,$ $u(t) = 1, t > 0.$
$\delta\,[n] = u[n] - u[n-1]$	$\delta\,(t) = \frac{du(t)}{dt.}$
$u\,[n] = \sum_{k=0}^{\infty} \delta\,[n-k]$	$u(t) = \int_{-\infty}^{t} \delta\,(\tau)d\tau.$

Singularity Functions

- sampling property of unit impulse

$$x[n]\delta[n - n_o] = x[n_o]\delta[n - n_o]$$

$$x(t)\delta(t - t_o) = x(t_o)\delta(t - t_o)$$

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Systems

- Block Diagram
- Properties of Systems
  - with/without memory
  - causality
  - BIBO stable
  - Time-invariance
  - linearity

Thank you!

Q & A