EEE 5109 Digital Signal Processing.

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Today's Lecture

1. Operations on discrete time signals

Scaling, addition, subtraction, multiplication

- $\alpha x[n]$
- $x_3[n] = x_1[n] \pm x_2[n]$
- $x_3[n] = x_1[n]x_2[n]$

Examples

- $-2u[n]$
- $\delta[n] + r[n]$
- $\frac{1}{2}^n u[n]$

Delay

- We can form a signal $y[n]$ as a delayed version of $x[n]$ with

$$y[n] = x[n - n_d]$$

  where n_d is an integer
- Sketch $\delta[n-3]$, $u[n+2]$

Time reversal

- We can form a signal $y[n]$ as a time reversed version of $x[n]$ with
$$y[n] = x[-n]$$
- Sketch $\delta[-n]$, $u[-n]$

Examples in Notebook

Examples

- $u[n] - u[n - n_d]$
- $u[-n - 5]$

General expression for discrete signals

- Consider the signal

$$x[n] = \begin{cases} 2 & n = -1 \\ -3 & n = 0 \\ 1 & n = 3 \\ 0 & \text{otherwise} \end{cases}$$

- $x[n] = 2\delta[n+1] - 3\delta[n] + \delta[n-3]$
- In general

$$x[n] = \sum_{k=-\infty}^{k=\infty} x[k]\delta[n-k]$$

Linear systems

- Linear systems satisfy two properties namely
  1. Superposition: if the input sequence $x_1[n]$ produces the output sequence $y_1[n]$ and input $x_2[n]$ produces output $y_2[n]$. Then the output of the system in response to input $x_1[n] + x_2[n]$ is $y_1[n] + y_2[n]$.
  2. Homogeneity: If input $x[n]$ produces output $y[n]$, then input $ax[n]$ where $a \in \mathbf{C}$ produces output $ay[n]$.

Examples

- Consider an accumulator system whose response $y[n]$ to an input $x[n]$ is given by

$$y[n] = \sum_{k=-\infty}^{n} x[k]$$

Derive and sketch the output of the accumulator to

1. $u[n]$, the unit step
2. $r[n]$, the unit ramp