

What are signals and systems

- Examples of signals:
 - Voltage output of a RLC circuit, stock market, ECG, speech, sequences of bases in a gene, MRI or CT scan
- Examples of systems:
 - RLC circuit, an algorithm for predicting future of stock market, an algorithm for detecting abnormal heart rhythms, speech understanding systems, edge detection algorithm for medical images.
- Continuous vs. Discrete

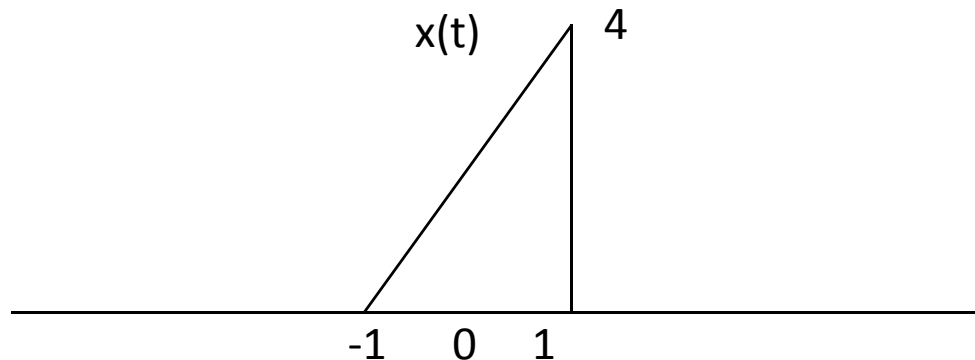
$x(t)$

$x[n], n = \dots -2, -1, 0, 1, 2 \dots$

Transformation of signals

- Signal: $x(t)$
- Scaling: $a * x(t)$
- Time shift: $x(t-t_0)$
- Time reversal: $x(-t)$
- Linear stretch: $x(at)$, $a < 1$
- Linear compression: $x(bt)$, $b < 1$

Examples: $0.5x(t)$, $x(t-3)$, $x(-t)$, $x(t/2)$, $x(2t)$, $x(3-t/2)$



Periodicity

- Continuous:

$$x(t) = x(t+kT), \quad k = 1, 2, \dots \quad T: \text{fundamental period}$$

Any sinuoid is periodic

Ex: $\sin(2\pi t/T)$

- Discrete:

$$x[n] = x[n+kN], \quad N: \text{fundamental period}$$

Not all sinusoid is periodic!

Periodic if $\omega_0/2\pi = m/N$, where m and N are both integers (pg. 26 O & W)

$\omega_0/2\pi$ must be rational number

Ex: $\sin(\omega n)$, $\cos(4\pi n/3)$, $\cos(2n)$

Special signals:

- Sinc: $\text{sinc}(t) = \frac{\sin 2\pi t}{2\pi t}$
- Delta function: $\delta(t) = \begin{cases} \infty & t = 0 \\ 0 & \text{otherwise} \end{cases} \quad \int_{-\infty}^{\infty} f(t)\delta(t)dt = f(0)$
- Unit step (CT): $u(t) = \begin{cases} 1 & t \geq 0 \\ 0 & \text{otherwise} \end{cases}$
- Unit sample: $\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & \text{otherwise} \end{cases}$
- Unit step (DT): $u[n] = \begin{cases} 1 & n \geq 0 \\ 0 & \text{otherwise} \end{cases}$

Note: $\delta[t] = d/dt u[t]$ and $d[n] = u[n] - u[n-1]$
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