Fundamentals of Electrical Engineering

Digital Signals and Systems

- Fundamental signals
- Basic systems

RICE

Discrete-Time Signals

Complex exponential: $s(n) = e^{j2\pi fn}$

$$e^{j2\pi(f+\ell)n} = e^{j2\pi fn}e^{j2\pi\ell n} = e^{j2\pi fn}$$

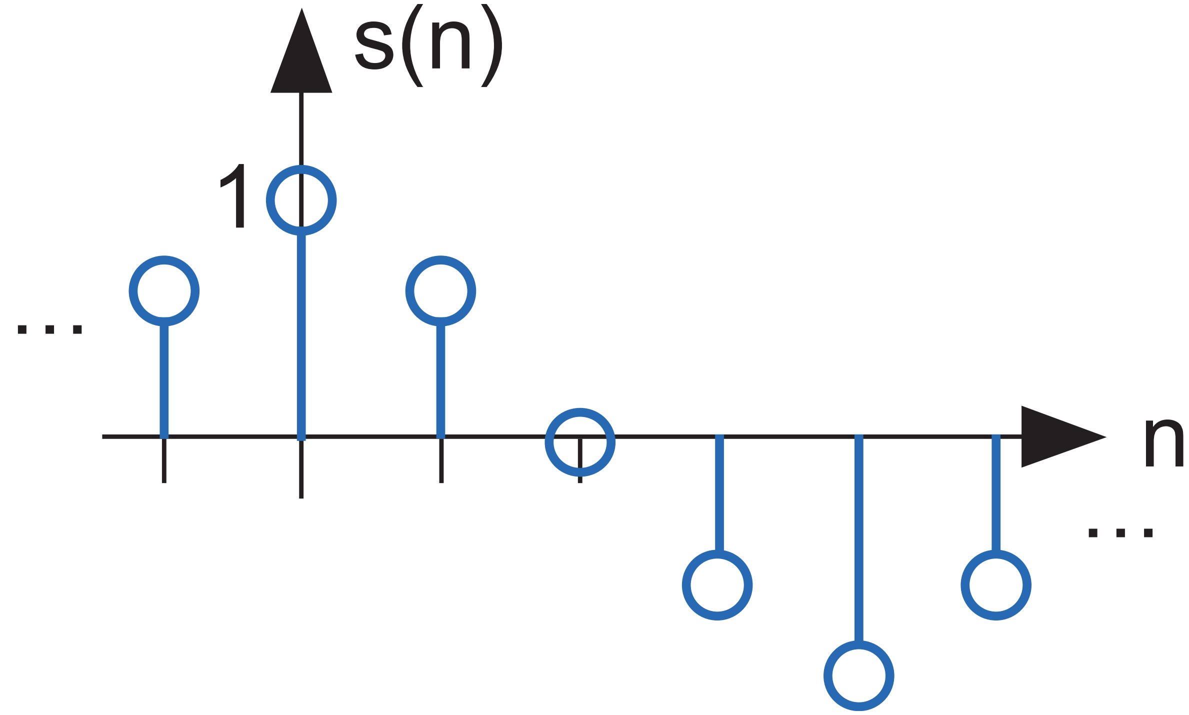
$$e^{j2\pi(1-f)n} = e^{j2\pi n} \cdot e^{j2\pi(-f)n} = e^{j2\pi(-f)n}$$

$$e^{j2\pi fn}\Big|_{f=0} = 1$$

$$e^{j2\pi fn}\Big|_{f=.5} = (-1)^n$$

Discrete-Time Signals

Sinusoid: $$s(n) = A\cos(2\pi f n + \phi)$$

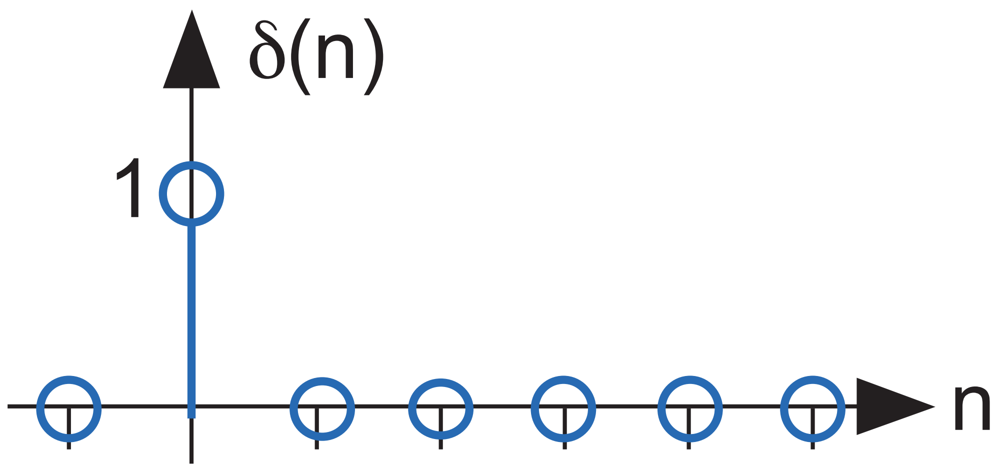


$$f \in \left(-\frac{1}{2}, +\frac{1}{2}\right]$$

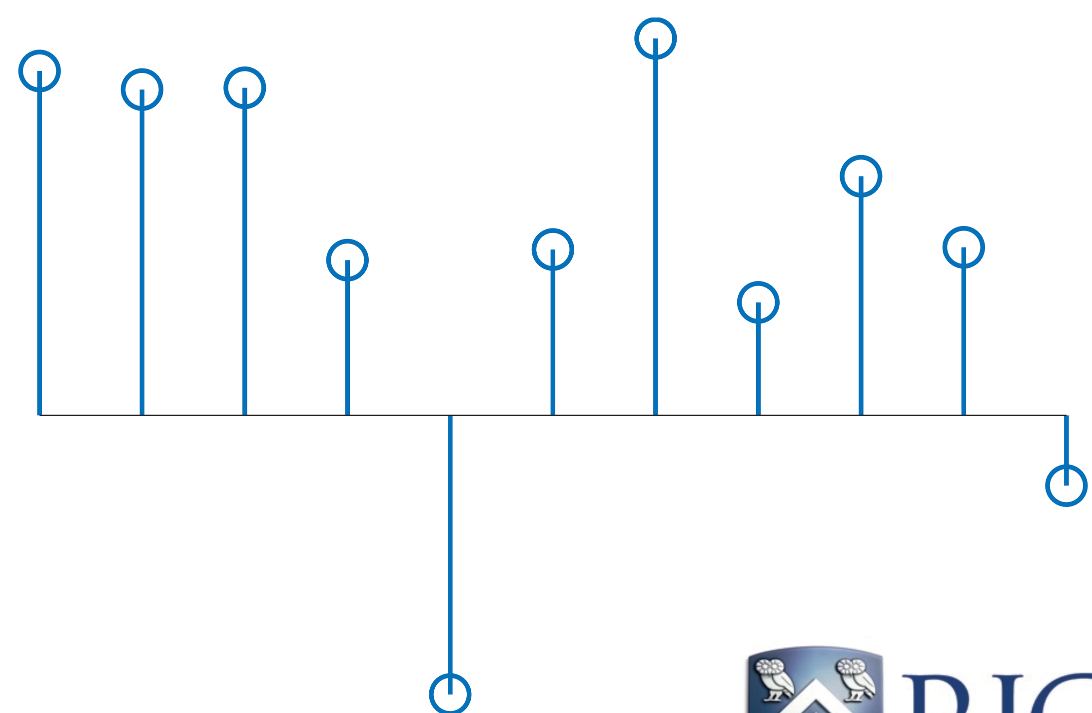
Basic Signals

Unit step: $$\mathrm{u}(n) = \begin{cases} 1 & n \geq 0 \\ 0 & n < 0 \end{cases}$$

Unit sample: $$\delta(n) = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$



$$\boxed{s(n) = \sum_{m=-\infty}^{\infty} s(m)\delta(n-m)}$$



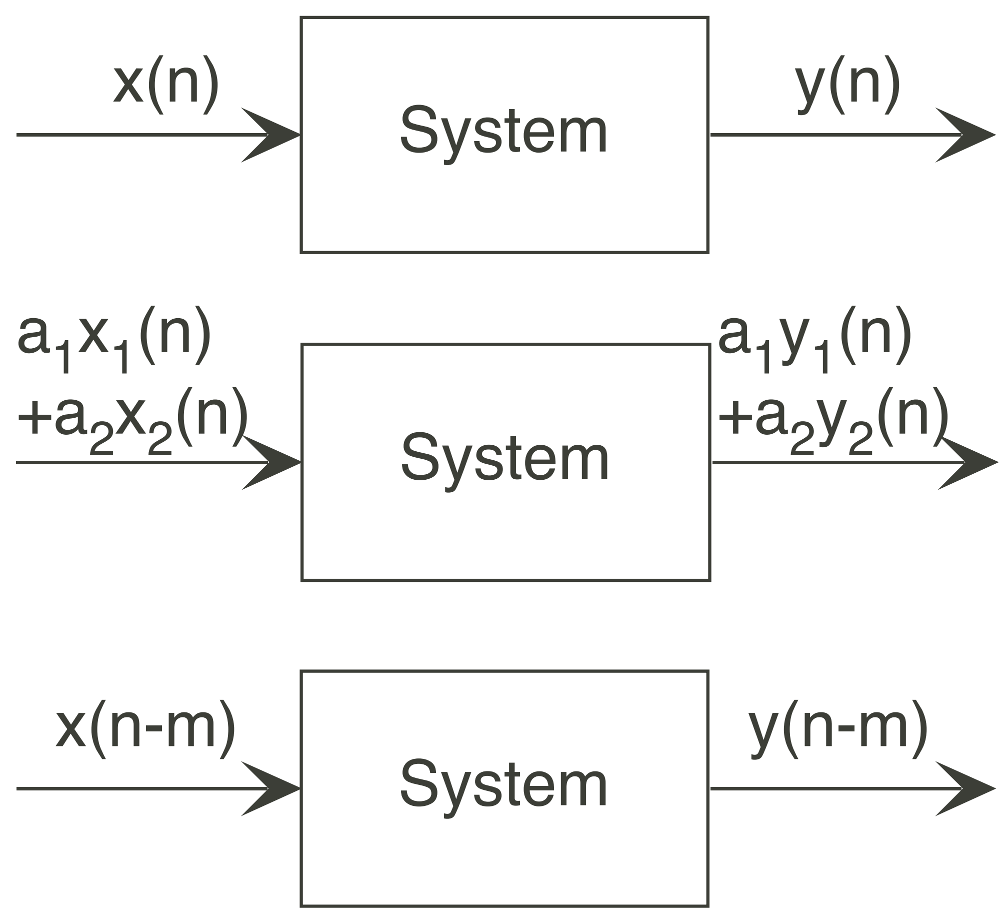
RICE

Discrete-Time Systems

Amplifier: $y(n) = G * x(n)$

"Time" delay: $y(n) = x(n - n_0),\ n_0$ integer

Linear, shift-invariant systems:



Digital Signals and Systems

- Signals are functions of the integers
- Frequency is dimensionless and defined uniquely over unit-length intervals, commonly $[0,1)$ or $(-\frac{1}{2}, \frac{1}{2}]$.
- Linear signal and system theory similar for analog and digital signals