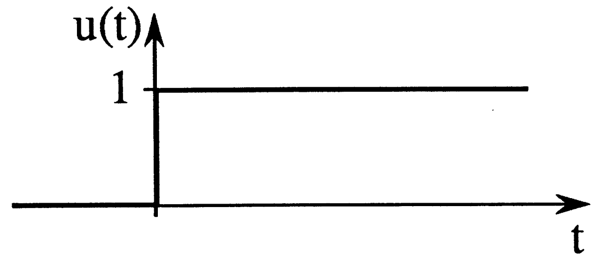
1.1.4 SPECIAL SIGNALS

1. Unit step

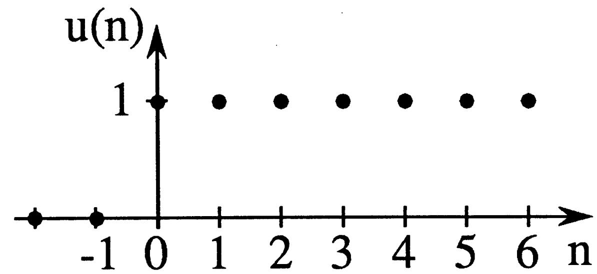
a. CT

$$u(t) = \begin{cases} 1, & t > 0 \\ 0, & t < 0 \end{cases}$$



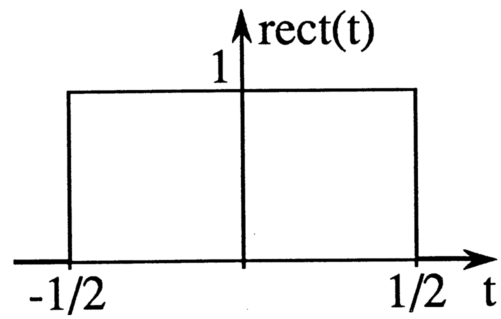
b. DT

$$u(n) = \begin{cases} 1, & n \geq 0 \\ 0, & \text{else} \end{cases}$$



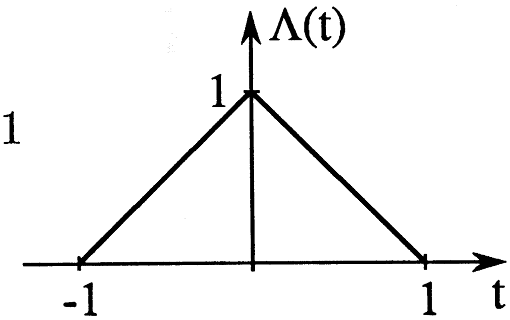
2. Rectangle

$$\text{rect}(t) = \begin{cases} 1, & |\,t\,| < 1/2 \\ 0, & |\,t\,| > 1/2 \end{cases}$$



3. Triangle

$$\Lambda\ (t) = \begin{cases} 1 - |\,t\,|\ , & |\,t\,| \leq 1 \\ 0\ , & \text{else} \end{cases}$$

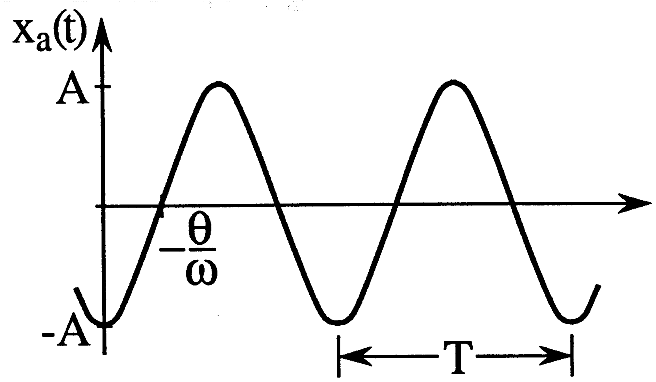


4. Sinusoids

a. CT

$$x_a(t) = A \sin(\omega_a t + \theta)$$

amplitude (A), frequency (ω_a), phase (θ)



analog frequency

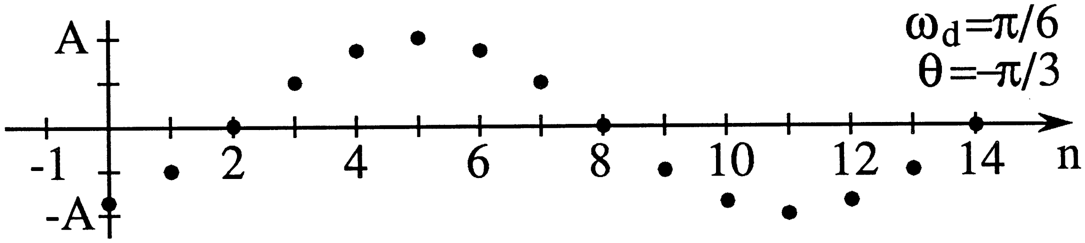
$$\omega_a \left(\frac{\text{radians}}{\text{sec.}}\right) = 2\pi\, f_a \left(\frac{\text{cycles}}{\text{sec.}}\right)$$

period

$$T\left(\frac{\text{sec.}}{\text{cycle}}\right) = \frac{1}{f_a}$$

b. DT

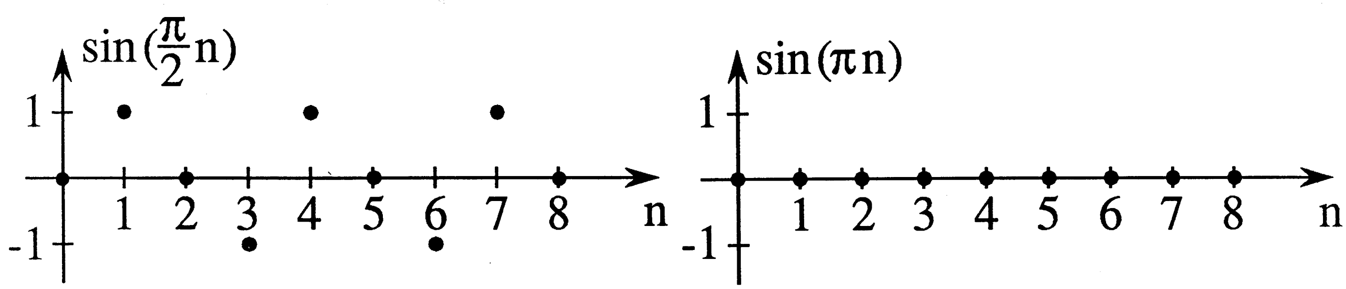
$x_d(n) = A \sin(\omega_d n + \theta)$



digital frequency

$$\omega_d \left(\frac{\text{radians}}{\text{sample}}\right) = 2\pi\mu\left(\frac{\text{cycles}}{\text{sample}}\right)$$

i. Depending on ω, $x_d(n)$ may not look much like a sinusoid.



ii. Digital frequencies $\omega_1 = \omega_0$ and $\omega_2 = \omega_0 + 2\pi k$ are equivalent.

$$x_2(n) = A \sin [\omega_2 n + \theta]$$

$$= A \sin [(\omega_0 + 2\pi k)n + \theta]$$

$$= x_1(n), \qquad \text{for all } n$$

iii. $x_d(n)$ will be periodic if and only if $\omega_d = 2\pi(p/q)$ where p and q are integers. In this case, the period is q.

4. Sinc

$$\text{sinc}(t) = \frac{\sin(\pi t)}{(\pi t)}$$