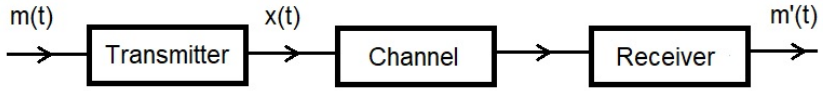
Communication Theory

Communication system operates on input message signals according to its characteristics.

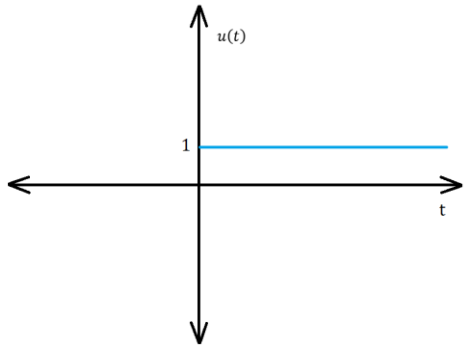
- Message signal m(t) originates from an information source in the form of voice, image, video, data etc. These signals are generated using transducers and are mostly baseband.
- Transmitter includes signal processing such as low-pass filtering to convert message into a band-limited signal and modulating (amplitude, frequency, phase etc.) it for transmission.
- Channel is a transmission media such as fiberoptic, copper, twisted pair, wireless etc.
- Receiver involves de-modulation and signal extraction.



Basic signals

Unit Step Signal

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



Properties

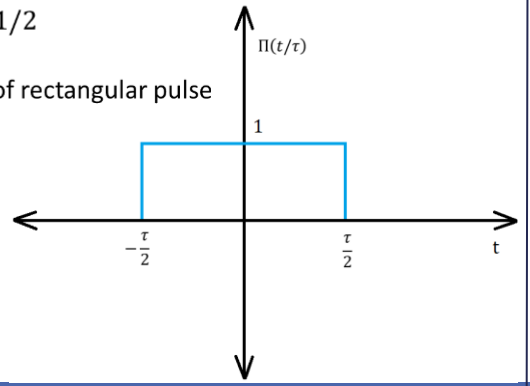
$u(t - t_0)$

$u(at) = u(t)$

Rectangle Pulse

$$\Pi(t/\tau) = \begin{cases} 1 & |\frac{t}{\tau}| < 1/2 \\ 0 & |\frac{t}{\tau}| > 1/2 \end{cases}$$

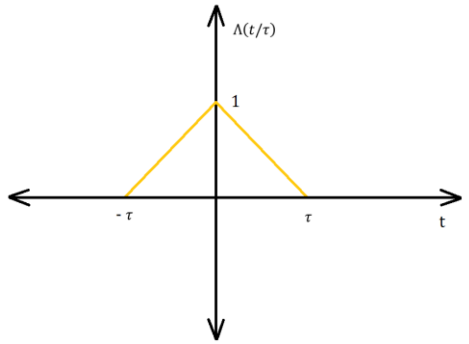
τ is the total time period of rectangular pulse



Triangular Pulse

$$\Lambda(t/\tau) = \begin{cases} 1 - \left|\frac{t}{\tau}\right| & |\frac{t}{\tau}| < 1 \\ 0 & \left|\frac{t}{\tau}\right| > 1 \end{cases}$$

2τ is the total time period of triangular pulse

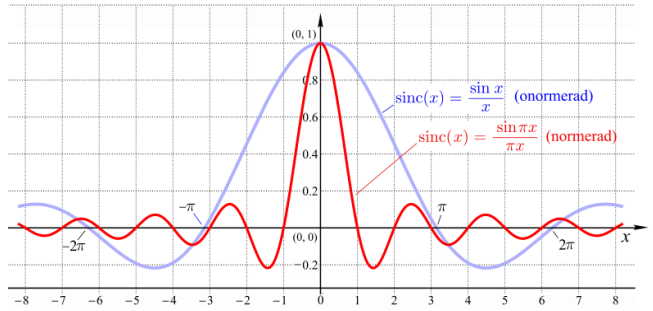


Sinc Signal

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

$sinc(at) = 0 \qquad at = \pm 1, \pm 2, \pm 3 \ldots$

$sinc(at) = 1 \qquad at = 0$



Above given function is a normalized function.

Sampling function is an unnormalized function $f_{sampling}(at) = \frac{\sin(at)}{at}$

Unit Impulse Signal

$$\delta(t) = \begin{cases} 1 & t = 0 \\ 0 & t \neq 0 \end{cases}$$

Properties

$$\int_{-\infty}^{\infty} \delta(t)\, dt = 1$$

$$\delta(t - t_0) = \begin{cases} 1 & t = t_0 \\ 0 & t \neq t_0 \end{cases}$$

$f(t)\delta(t) = f(0)$

$f(t)\delta(t - t_0) = f(t_0)$

$\delta(kt) = \frac{1}{|k|}\delta(t)$