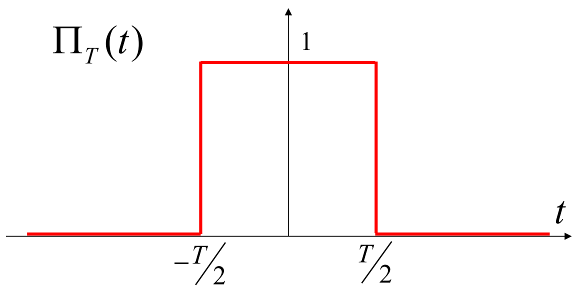

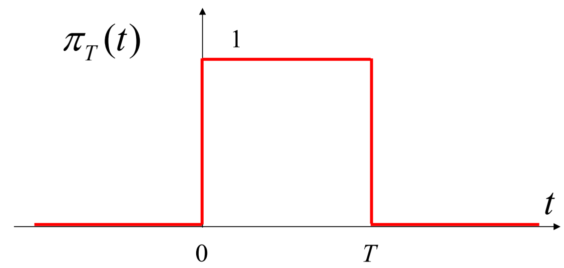

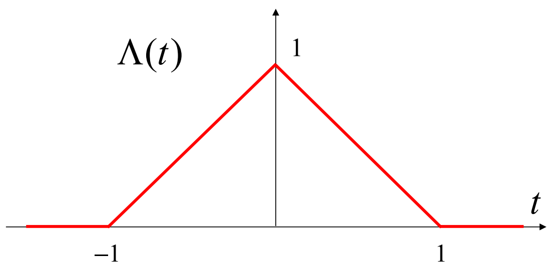

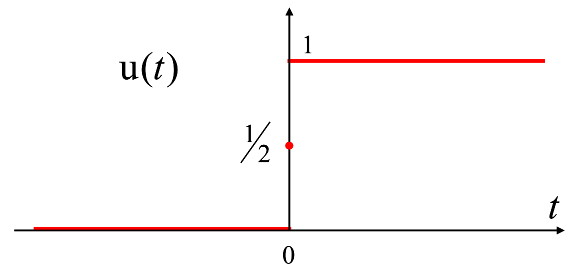

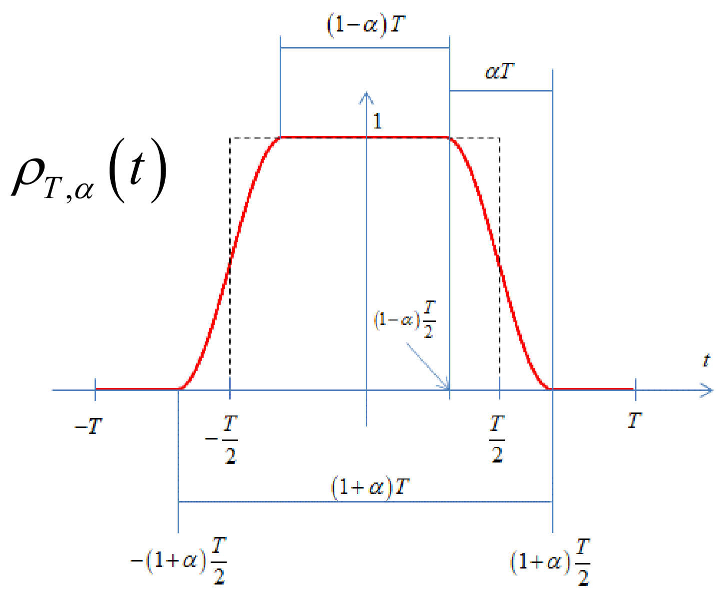

$$\mathrm{Sinc}\left(\frac{t}{T}\right)=\frac{\sin\left(\pi\frac{t}{T}\right)}{\pi\frac{t}{T}}$$

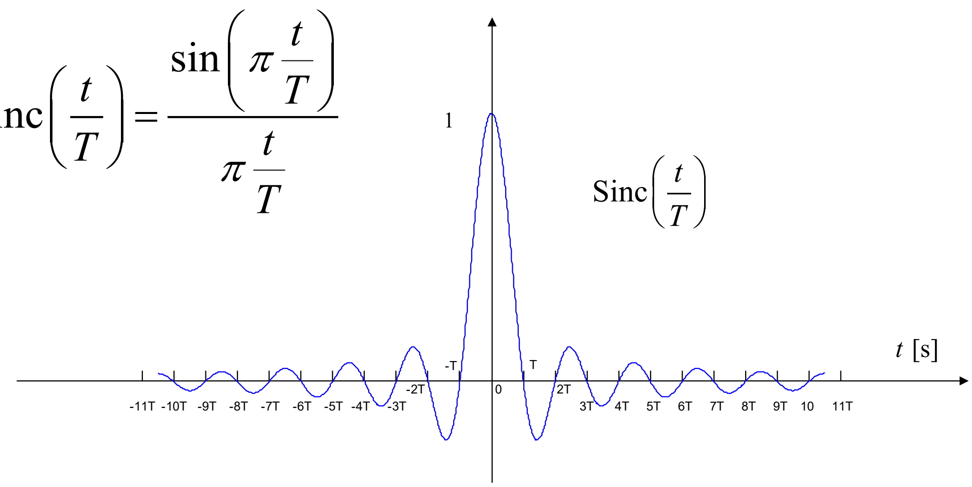

Table of Fourier transforms

$s(t)$	$S(f)$
$\Pi_T(t)$	$\dfrac{\sin(\pi f T)}{\pi f} = T\ \mathrm{Sinc}(fT)$
$\Lambda_T(t)$	$\dfrac{1}{T}\left[\dfrac{\sin(\pi f T)}{\pi f}\right]^2 = T\ \mathrm{Sinc}^2(fT)$
$e^{-t^2/2\sigma^2}$	$\sqrt{2\pi\sigma^2}\, e^{-2\pi^2 f^2\sigma^2}$
$e^{-\alpha t}u(t) \quad \alpha > 0$	$\dfrac{1}{\alpha + j2\pi f}$
$te^{-\alpha t}u(t) \quad \alpha > 0$	$\dfrac{1}{(\alpha + j2\pi f)^2}$
$\dfrac{t^n}{n!}e^{-\alpha t}u(t) \quad \alpha > 0$	$\dfrac{1}{(\alpha + j2\pi f)^{n+1}}$
$e^{-\alpha\|t\|} \quad \alpha > 0$	$\dfrac{2\alpha}{\alpha^2 + 4\pi^2 f^2}$
$\rho_{T,\alpha}(t)$	$T\ \mathrm{Sinc}(fT)\dfrac{\cos(\pi\alpha fT)}{1-(2\alpha fT)^2}$
$u(t)$	$\dfrac{\delta(f)}{2} + \dfrac{1}{2j\pi f}$
$tx(t)$	$\dfrac{j}{2\pi}\dfrac{d}{df}X(f)$
$\sum_{n=-\infty}^{\infty}\delta(t-nT_0)$	$f_0\sum_{n=-\infty}^{\infty}\delta(f-nf_0) \quad , \quad f_0 = 1/T_0$

Table of z-transforms

$x[n]$	$X(z)$
$a^n u[n]$	$\dfrac{z}{z-a}$, ROC: $\lvert z\rvert > \lvert a\rvert$
$-a^n u[-n-1]$	$\dfrac{z}{z-a}$, ROC: $\lvert z\rvert < \lvert a\rvert$
$na^n u[n]$	$\dfrac{az}{(z-a)^2}$, ROC: $\lvert z\rvert > \lvert a\rvert$
$n^2 a^n u[n]$	$\dfrac{az(z+a)}{(z-a)^3}$, ROC: $\lvert z\rvert > \lvert a\rvert$
$r_N[n]$	$\dfrac{1-z^{-N}}{1-z^{-1}} = 1 + z^{-1} + \cdots + z^{-(N-2)} + z^{-(N-1)}$
$nx[n]$	$-z \dfrac{d}{dz} X(z)$
$x[0]$	$\lim_{z\to\infty} X(z)$
$\lim_{n\to\infty} x[n]$	$\lim_{z\to 1}[X(z) - z^{-1}X(z)]$

$u[n] = 1$ for $n \geq 0, u[n] = 0$ for $n < 0$

$r_N[n] = 1$ for $n = 0, \dots, N-1$, $\quad r_N[n] = 0$ ***elsewhere***

$\text{sign}[n] = 0$ for $n = 0$, $\text{sign}[n] = 1$ for $n > 0$, $\text{sign}[n] = -1$ for $n < 0$

Basic trigonometric formulas

$$\cos\left(\alpha-\frac{\pi}{2}\right)=\sin(\alpha) \qquad \sin\left(\alpha+\frac{\pi}{2}\right)=\cos(\alpha)$$

$$\sin(\alpha+\beta)=\sin(\alpha)\cos(\beta)+\cos(\alpha)\sin(\beta) \qquad \cos(\alpha+\beta)=\cos(\alpha)\cos(\beta)-\sin(\alpha)\sin(\beta)$$

$$\cos^2(\alpha)=\frac{1}{2}+\frac{1}{2}\cos(2\alpha) \qquad \sin^2(\alpha)=\frac{1}{2}-\frac{1}{2}\cos(2\alpha)$$

$$\cos(\alpha)\cos(\beta)=\frac{1}{2}\cos(\alpha+\beta)+\frac{1}{2}\cos(\alpha-\beta)$$

$$\sin(\alpha)\cos(\beta)=\frac{1}{2}\sin(\alpha+\beta)+\frac{1}{2}\sin(\alpha-\beta)$$

$$\sin(\alpha)\sin(\beta)=\frac{1}{2}\cos(\alpha-\beta)-\frac{1}{2}\cos(\alpha+\beta)$$

Series and integrals:

$$\sum_{k=0}^{N-1} r^k=\frac{1-r^N}{1-r} \qquad \int\frac{1}{a^2+x^2}dx=\frac{1}{a}\tan^{-1}\frac{x}{a}$$

Some change of integration variable rules:

$$\int_{t_0}^{t_1} s\left(\alpha\cdot[t-t_d]\right)dt=\begin{cases}\dfrac{1}{|\alpha|}\displaystyle\int_{\alpha\cdot[t_0-t_d]}^{\alpha\cdot[t_1-t_d]} s(t)\,dt & \alpha>0\\ \dfrac{1}{|\alpha|}\displaystyle\int_{\alpha\cdot[t_1-t_d]}^{\alpha\cdot[t_0-t_d]} s(t)\,dt & \alpha<0\end{cases} \qquad \int_{t_0}^{t_1} s\left(\alpha\cdot[t-t_d]\right)g(t)\,dt=\begin{cases}\dfrac{1}{|\alpha|}\displaystyle\int_{\alpha\cdot[t_0-t_d]}^{\alpha\cdot[t_1-t_d]} s(t)\,g\left(\tfrac{\tau}{\alpha}+t_d\right)dt & \alpha>0\\ \dfrac{1}{|\alpha|}\displaystyle\int_{\alpha\cdot[t_1-t_d]}^{\alpha\cdot[t_0-t_d]} s(t)\,g\left(\tfrac{\tau}{\alpha}+t_d\right)dt & \alpha<0\end{cases}$$

Train of Dirac's Deltas generation formula:

$$\frac{1}{a}\sum_{n=-\infty}^{\infty} e^{\pm j\frac{2\pi}{a}nx}=\sum_{k=-\infty}^{\infty}\delta(x-n\cdot a) \qquad x\in\mathbb{R}$$

The delta-generating integral:

$$\int_{-\infty}^{\infty} e^{\pm j2\pi f t}df=\delta(t)=\delta(-t)$$

The Fourier basis for L_I^2

$$\Phi=\left\{\hat{\varphi}_n(t)\right\}_{n=-\infty}^{+\infty}=\left\{\frac{1}{\sqrt{T}}e^{j\frac{2\pi\cdot t}{T}n}\right\}_{n=-\infty}^{+\infty} \quad , \quad t\in[t_0,\ t_1],\ T\triangleq t_1-t_0$$

The autocorrelation and cross-correlation functions for finite-energy signals

$$R_x(\tau) \triangleq \left(x(t), x(t-\tau)\right) = \int_{-\infty}^{+\infty} x(t)x^*(t-\tau)dt$$

$$R_{xy}(\tau) \triangleq \left(x(t), y(t-\tau)\right) = \int_{-\infty}^{+\infty} x(t)y^*(t-\tau)dt$$

The Expectation operator

$$E_\xi\{g(\xi)\} \triangleq \int_{-\infty}^{+\infty} g(x) f_\xi(x)dx$$

where $g(\cdot)$ is any function, ξ is a random variable and $f_\xi(x)$ id the pdf of ξ

The fundamental formula of joint pdfs

$$f_{\xi,\eta}(x,y) = f_{\xi|\eta}(x\,|\,y) f_\eta(y) = f_{\eta|\xi}(y\,|\,x) f_\xi(x)$$

The joint Expectation operator

$$E_{\xi\eta}\{g(\xi,\eta)\} \triangleq \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} g(x,y) f_{\xi\eta}(x,y)dxdy$$

Gaussian pdf and its integral:

$$f_\xi(x) = \frac{1}{\sqrt{2\pi\sigma_\xi^2}} e^{-\frac{(x-\mu_\xi)^2}{2\sigma_\xi^2}}, \qquad \int f_\xi(x)dx = \frac{1}{2} + \frac{1}{2}\mathrm{erf}\left(\frac{(x-\mu_\xi)}{\sqrt{2\sigma_\xi^2}}\right) + C$$

The Joint Gaussian pdf

$$f_{\xi_1\xi_2\ldots\xi_N}(x_1, x_2, \ldots, x_N) = f_{\boldsymbol{\xi}}(\mathbf{x}) = \frac{1}{(2\pi)^{N/2}\sqrt{\det\{\boldsymbol{\Sigma}\}}} \cdot \exp\left\{-\frac{1}{2}(\mathbf{x}-\boldsymbol{\mu})^{\mathrm{T}} \cdot \boldsymbol{\Sigma}^{-1} \cdot (\mathbf{x}-\boldsymbol{\mu})\right\}$$

$$\boldsymbol{\xi} = \begin{bmatrix} \xi_1 \\ \xi_2 \\ \vdots \\ \xi_N \end{bmatrix} \quad \mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_N \end{bmatrix} \quad \boldsymbol{\mu} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_N \end{bmatrix} \quad \boldsymbol{\Sigma} = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \sigma_{1N} \\ \sigma_{21} & \sigma_2^2 & & \\ \vdots & & \ddots & \\ \sigma_{N1} & & & \sigma_N^2 \end{bmatrix}$$