Laplace Transform Definition:

$$\mathcal{L}\left\{f(t)\right\} = \int_0^\infty e^{-st} f(t)\,dt$$

Unit Step Definition:

$$\mathcal{U}(t-a) = \begin{cases} 0, & 0 \le t < a \\ 1, & t \ge a \end{cases}$$

$f(t)$	$F(s)$
1	$\frac{1}{s}$
t^n	$\frac{n!}{s^{n+1}}$
$t^{-\frac{1}{2}}$	$\sqrt{\frac{\pi}{s}}$
$t^{\frac{1}{2}}$	$\frac{\sqrt{\pi}}{2s^{\frac{3}{2}}}$
$\sin(kt)$	$\frac{k}{s^2+k^2}$
$\cos(kt)$	$\frac{s}{s^2+k^2}$
$\sin^2(kt)$	$\frac{2k^2}{s(s^2+4k^2)}$
$\cos^2(kt)$	$\frac{s^2+2k^2}{s(s^2+4k^2)}$
$e^{\alpha t}$	$\frac{1}{s-a}$
$\sinh(kt)$	$\frac{k}{s^2-k^2}$
$\cosh(kt)$	$\frac{s}{s^2-k^2}$
$\sinh^2(kt)$	$\frac{2k^2}{s(s^2-4k^2)}$
$\cosh^2(kt)$	$\frac{s^2-2k^2}{s(s^2-4k^2)}$
$t\sin(kt)$	$\frac{2ks}{(s^2+k^2)^2}$
$t\cos(kt)$	$\frac{s^2-k^2}{(s^2+k^2)^2}$
$\sin(kt)+kt\cos(kt)$	$\frac{2ks^2}{(s^2+k^2)^2}$
$\sin(kt)-kt\cos(kt)$	$\frac{2k^3}{(s^2+k^2)^2}$
$\delta(t-t_0)$	e^{-st_0}

$f(t)$	$F(s)$
$t\sinh(kt)$	$\frac{2ks}{(s^2-k^2)^2}$
$t\cosh(kt)$	$\frac{s^2+k^2}{(s^2-k^2)^2}$
$\frac{e^{at}-e^{bt}}{a-b}$	$\frac{1}{(s-a)(s-b)}$
$\frac{ae^{at}-be^{bt}}{a-b}$	$\frac{s}{(s-a)(s-b)}$
$1-\cos(kt)$	$\frac{k^2}{s(s^2+k^2)}$
$kt-\sin(kt)$	$\frac{k^3}{s^2(s^2+k^2)}$
$\frac{a\sin(bt)-b\sin(at)}{ab(a^2-b^2)}$	$\frac{1}{(s^2+a^2)(s^2+b^2)}$
$\frac{\cos(bt)-\cos(at)}{a^2-b^2}$	$\frac{s}{(s^2+a^2)(s^2+b^2)}$
$\sin(kt)\sinh(kt)$	$\frac{2k^2s}{s^4+4k^4}$
$\sin(kt)\cosh(kt)$	$\frac{k(s^2+2k^2)}{s^4+4k^4}$
$\cos(kt)\sinh(kt)$	$\frac{k(s^2-2k^2)}{s^4+4k^4}$
$\cos(kt)\cosh(kt)$	$\frac{s^3}{s^4+4k^4}$
$\frac{e^{bt}-e^{at}}{t}$	$\ln\left(\frac{s-a}{s-b}\right)$
$e^{at}f(t)$	$F(s-a)$
$\mathcal{U}(t-a)$	$\frac{e^{-as}}{s}$
$f(t-a)\mathcal{U}(t-a)$	$e^{-as}F(s)$
$f*g=\int_0^t f(\tau)g(t-\tau)\,d\tau$	$F(s)G(s)$
$g(t)\mathcal{U}(t-a)$	$e^{-as}\mathcal{L}\left\{g(t+a)\right\}$

Laplace Derivative Formulas:

$$t^n f(t) = (-1)^n \frac{d^n}{ds^n}[F(s)]$$

$$\mathcal{L}\left\{f^{(n)}(t)\right\} = s^n F(s) - s^{n-1} f(0) - s^{n-2} f'(0)$$

$$|\mathbf{A} - \lambda_n \mathbf{I}|\mathbf{K} = 0$$

If a k value is not explicitly zero, assume it is equal to one

$$k_1 = f(x, y)$$
$$k_2 = f\left(x + \frac{h}{2}, y + \frac{h \cdot k_1}{2}\right)$$
$$k_3 = f\left(x + \frac{h}{2}, y + \frac{h \cdot k_2}{2}\right)$$
$$k_4 = f(x + h, y + h \cdot k_3)$$
$$RK4 = y + h\left(\frac{k_1}{6} + \frac{k_2}{3} + \frac{k_3}{3} + \frac{k_4}{6}\right)$$

For truncation errors:

$$O(h^n) = y^{(n)}(c)\frac{h^n}{n!}$$

$O(h^4)$ for global truncation on $RK4$

$O(h^5)$ for local truncation on $RK4$

Orthogonal if:

$$(\phi_m, \phi_n) = \int_a^b \phi_m(x)\phi_n(x)\, dx = 0$$

$$||\phi_n(x)||^2 = \int_a^b \phi_n^2(x)\, dx$$

$$||\phi_n(x)|| = \sqrt{\int_a^b \phi_n^2(x)\, dx}$$

$$c_n = \frac{\int_a^b f(x) w(x) \phi_n(x)\, dx}{||\phi_n(x)||^2}$$

$$||\phi_n(x)||^2 = \int_a^b w(x)\phi_n^2(x)\, dx$$

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left(a_n \cos\left(\frac{n\pi}{p}x\right) + b_n \sin\left(\frac{n\pi}{p}x\right)\right)$$
$$a_0 = \frac{1}{p}\int_{-p}^{p} f(x)\, dx$$
$$a_n = \frac{1}{p}\int_{-p}^{p} f(x)\cos\left(\frac{n\pi}{p}x\right)\, dx$$
$$b_n = \frac{1}{p}\int_{-p}^{p} f(x)\sin\left(\frac{n\pi}{p}x\right)\, dx$$

$$\int_a^b f(t)\delta(t - t_0)\, dt = f(t_0)$$

$$\delta(t - t_0) = \begin{cases} 0, & 0 \le t < t_0 - a \\ \frac{1}{2a}, & t_0 - a \le t < t_0 + a \\ 0, & t \ge t_0 + a \end{cases}$$