Laplace Transform Table and Properties

$$F(s) = \int_0^\infty f(t)e^{-st}\,dt$$

Property/Rule	Mathematical Expression
Linearity	$\mathcal{L}\{af(t) + bg(t)\} = aF(s) + bG(s)$
Shifting in Time (t-translation)	$\mathcal{L}\{u(t-a)f(t-a)\} = e^{-as}F(s)$
s-shift (Frequency Shift)	$\mathcal{L}\{e^{at}f(t)\} = F(s-a)$
Differentiation (First Derivative)	$\mathcal{L}\{f'(t)\} = sF(s) - f(0^-)$
Differentiation (Second Derivative)	$\mathcal{L}\{f''(t)\} = s^2F(s) - sf(0^-) - f'(0^-)$
Differentiation (nth Derivative)	$\mathcal{L}\{f^{(n)}(t)\} = s^nF(s) - s^{n-1}f(0^-) - \cdots - f^{(n-1)}(0^-)$
t-Multiplication	$\mathcal{L}\{tf(t)\} = -F'(s)$
t-Multiplication (nth power)	$\mathcal{L}\{t^nf(t)\} = (-1)^nF^{(n)}(s)$
Integration of f(t)	$\mathcal{L}\left\{\int_0^t f(\tau)\,d\tau\right\} = \frac{F(s)}{s}$
Convolution	$\mathcal{L}\{(f*g)(t)\} = F(s)G(s)$, where $(f*g)(t) = \int_0^t f(\tau)g(t-\tau)\,d\tau$
Integration with $\frac{f(t)}{t}$	$\mathcal{L}\left\{\frac{f(t)}{t}\right\} = \int_s^\infty F(\sigma)\,d\sigma$

Function $f(t)$	**Transform** $F(s)$	**ROC**
1	$\frac{1}{s}$	$\Re(s) > 0$
e^{at}	$\frac{1}{s-a}$	$\Re(s) > \Re(a)$
t	$\frac{1}{s^2}$	$\Re(s) > 0$
t^n	$\frac{n!}{s^{n+1}}$	$\Re(s) > 0$
$\cos(\omega t)$	$\frac{s}{s^2+\omega^2}$	$\Re(s) > 0$
$\sin(\omega t)$	$\frac{\omega}{s^2+\omega^2}$	$\Re(s) > 0$
$e^{at}\cos(\omega t)$	$\frac{s-a}{(s-a)^2+\omega^2}$	$\Re(s) > \Re(a)$
$e^{at}\sin(\omega t)$	$\frac{\omega}{(s-a)^2+\omega^2}$	$\Re(s) > \Re(a)$
$\delta(t)$	1	All s
$\delta(t-a)$	e^{-as}	All s
$\cosh(kt)$	$\frac{s}{s^2-k^2}$	$\Re(s) > \|k\|$
$\sinh(kt)$	$\frac{k}{s^2-k^2}$	$\Re(s) > \|k\|$
$\frac{1}{2\omega^3}(\sin(\omega t) - \omega t\cos(\omega t))$	$\frac{1}{(s^2+\omega^2)^2}$	$\Re(s) > 0$
$\frac{t}{2\omega}\sin(\omega t)$	$\frac{s}{(s^2+\omega^2)^2}$	$\Re(s) > 0$
$\frac{1}{2\omega}(\sin(\omega t) + \omega t\cos(\omega t))$	$\frac{s^2}{(s^2+\omega^2)^2}$	$\Re(s) > 0$
$u(t-a)$	$\frac{e^{-as}}{s}$	$\Re(s) > 0$
t^ne^{at}	$\frac{n!}{(s-a)^{n+1}}$	$\Re(s) > \Re(a)$
$\frac{1}{\sqrt{\pi t}}$	$\frac{1}{\sqrt{s}}$	$\Re(s) > 0$
t^a	$\frac{\Gamma(a+1)}{s^{a+1}}$	$\Re(s) > 0$
$\cos(\omega t) - \omega t\sin(\omega t)$	$\frac{s^2-\omega^2}{(s^2+\omega^2)^2}$	$\Re(s) > 0$