Common Laplace Transform Pairs

Time Domain Function		Laplace Domain Function
Name	Definition*	
Unit Impulse	$\delta(t)$	1
Unit Step	$\gamma(t)$ †	$\frac{1}{s}$
Unit Ramp	t	$\frac{1}{s^2}$
Parabola	t^2	$\frac{2}{s^3}$
Exponential	e^{-at}	$\frac{1}{s+a}$
Asymptotic Exponential	$\frac{1}{a}(1-e^{-at})$	$\frac{1}{s(s+a)}$
Dual Exponential	$\frac{1}{b-a}\left(e^{-at}-e^{-bt}\right)$	$\frac{1}{(s+a)(s+b)}$
Asymptotic Dual Exponential	$\frac{1}{ab}\left[1+\frac{1}{a-b}\left(be^{-at}-ae^{-bt}\right)\right]$	$\frac{1}{s(s+a)(s+b)}$
Time multiplied Exponential	te^{-at}	$\frac{1}{(s+a)^2}$
Sine	$\sin(\omega_0 t)$	$\frac{\omega_0}{s^2+\omega_0^2}$
Cosine	$\cos(\omega_0 t)$	$\frac{s}{s^2+\omega_0^2}$
Decaying Sine	$e^{-at}\sin(\omega_d t)$	$\frac{\omega_d}{(s+a)^2+\omega_d^2}$
Decaying Cosine	$e^{-at}\cos(\omega_d t)$	$\frac{s+a}{(s+a)^2+\omega_d^2}$
Generic Oscillatory Decay	$e^{-at}\left[B\cos(\omega_d t)+\frac{C-aB}{\omega_d}\sin(\omega_d t)\right]$	$\frac{Bs+C}{(s+a)^2+\omega_d^2}$
Prototype Second Order Lowpass, underdamped	$\frac{\omega_0}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_0 t}\sin\left(\omega_0\sqrt{1-\zeta^2}\,t\right)$	$\frac{\omega_0^2}{s^2+2\zeta\omega_0 s+\omega_0^2}$
Prototype Second Order Lowpass, underdamped - Step Response	$1-\frac{1}{\sqrt{1-\zeta^2}}e^{-\zeta\omega_0 t}\sin\left(\omega_0\sqrt{1-\zeta^2}\,t+\phi\right)$ $\phi=\tan^{-1}\left(\frac{\sqrt{1-\zeta^2}}{\zeta}\right)$	$\frac{\omega_0^2}{s(s^2+2\zeta\omega_0 s+\omega_0^2)}$

*All time domain functions are implicitly=0 for t<0 (i.e. they are multiplied by unit step, $\gamma(t)$).
†u(t) is more commonly used for the step, but is also used for other things. $\gamma(t)$ is chosen to avoid confusion (and because in the Laplace domain it looks a little like a step function, $\Gamma(s)$).

Common Laplace Transform Properties

Name	Illustration
Definition of Transform	$\mathrm{f}(\mathrm{t}) \xleftrightarrow{\mathrm{L}} \mathrm{F}(\mathrm{s})$ $\mathrm{F}(\mathrm{s}) = \int_{0^-}^{\infty} \mathrm{f}(\mathrm{t}) \mathrm{e}^{-\mathrm{st}} \mathrm{dt}$
Linearity	$Af_1(t) + Bf_2(t) \xleftrightarrow{L} AF_1(s) + BF_2(s)$
First Derivative	$\frac{df(t)}{dt} \xleftrightarrow{L} sF(s) - f(0^-)$
Second Derivative	$\frac{d^2 f(t)}{dt^2} \xleftrightarrow{L} s^2 F(s) - sf(0^-) - \dot{f}(0^-)$
n^{th} Derivative	$\frac{d^n f(t)}{dt^n} \xleftrightarrow{L} s^n F(s) - \sum_{i=1}^{n} s^{n-i} f^{(i-1)}(0^-)$
Integral	$\int_0^t f(\lambda) d\lambda \xleftrightarrow{L} \frac{1}{s} F(s)$
Time Multiplication	$tf(t) \xleftrightarrow{L} -\frac{dF(s)}{ds}$
Time Delay	$\mathrm{f}(\mathrm{t}-\mathrm{a})\gamma(\mathrm{t}-\mathrm{a}) \xleftrightarrow{\mathrm{L}} \mathrm{e}^{-\mathrm{as}}\mathrm{F}(\mathrm{s})$ γ(t) is unit step
Complex Shift	$f(t)e^{-at} \xleftrightarrow{L} F(s+a)$
Scaling	$f\left(\frac{t}{a}\right) \xleftrightarrow{L} aF(as)$
Convolution Property	$f_1(t) * f_2(t) \xleftrightarrow{L} F_1(s) F_2(s)$
Initial Value (Only if F(s) is strictly proper; order of numerator < order of denominator).	$\lim_{t \to 0^+} f(t) = \lim_{s \to \infty} sF(s)$
Final Value (if final value exists; e.g., decaying exponentials or constants)	$\lim_{t \to \infty} f(t) = \lim_{s \to 0} sF(s)$