Laplace Transform Properties

1. **Linearity:** $\mathcal{L}\{af(t)\} = aF(s)$
2. **Superposition:** $\mathcal{L}\{f_1(t) + f_2(t)\} = F_1(s) + F_2(s)$
3. **Modulation:** $\mathcal{L}\{e^{-at}f(t)\} = F(s + a)$
4. **Time-Shifting:** $\mathcal{L}\{f(t - \tau)u(t - \tau)\} = e^{-s\tau}F(s)$
5. **Scaling:** $\mathcal{L}\{f(at)\} = \frac{1}{a}F\left(\frac{s}{a}\right)$
6. **Real Differentiation:** $\mathcal{L}\left\{\frac{d}{dt}f(t)\right\} = sF(s) - f(0)$
7. **Real Integration:** $\mathcal{L}\left\{\int_0^t f(t)dt\right\} = \frac{1}{s}F(s)$
8. **Complex Differentiation:** $\mathcal{L}\{tf(t)\} = -\frac{d}{ds}F(s)$
9. **Complex Integration:** $\mathcal{L}\left\{\frac{f(t)}{t}\right\} = \int_s^\infty F(s)ds$
10. **Convolution:** $\mathcal{L}\{f(t) * g(t)\} = F(s) \cdot G(s)$

Common Laplace Transform Pairs

f(t)	F(s)
$\delta(t)$	1
$u(t)$	$\frac{1}{s}$
$tu(t)$	$\frac{1}{s^2}$
$e^{-at}u(t)$	$\frac{1}{s + a}$
$te^{-at}u(t)$	$\frac{1}{(s + a)^2}$
$\cos(wt)u(t)$	$\frac{s}{s^2 + w^2}$
$\sin(wt)u(t)$	$\frac{w}{s^2 + w^2}$
$e^{-at}\cos(wt)u(t)$	$\frac{s + a}{(s + a)^2 + w^2}$
$e^{-at}\sin(wt)u(t)$	$\frac{w}{(s + a)^2 + w^2}$
$2B\,e^{-at}\cos(wt+\theta)u(t)$	$\frac{\overline{B}}{s + a - jw} + \frac{\overline{B}^*}{s + a + jw}$, where $\overline{B} = B\angle\theta$