TOOL: The following list of identities allows one to generate complicated Laplace transforms from basic Laplace transforms. Proofs follow from the definition of the Laplace transform:

$$\mathcal{L}\left[v(t)\right] \equiv V(s) \equiv \int_{0^-}^{\infty} v(t)e^{-st}dt$$

Other terms used are $\delta(t)$, which is the impulse (or delta) function, and $u(t)$, which is the unit step function.

$$\delta(t) \equiv \begin{cases} 0 & t \neq 0 \\ \infty & t = 0 \end{cases} \quad \text{with} \quad \int_{-\infty}^{\infty} \delta(t)dt = 1, \qquad u(t) \equiv \begin{cases} 0 & t < 0 \\ 1 & t \geq 0 \end{cases}$$

LIST:

Name	*t-domain*	*s-domain*	*Condition*
definition	$v(t)$	$V(s)$	
linearity	$av_1(t) + bv_2(t)$	$aV_1(s) + bV_2(s)$	
delay	$v(t-a)u(t-a)$	$e^{-as}V(s)$	$a \geq 0$
multiply by t	$tv(t)$	$-\frac{d}{ds}V(s)$	
multiply by e^{-at}	$e^{-at}v(t)$	$V(s)\Big\vert_{s+a \text{ replaces } s}$	$a \geq 0$
divide by t	$\frac{v(t)}{t}$	$\int_s^{\infty} V(\underline{s})d\underline{s}$	
derivative	$\frac{d}{dt}v(t)$	$sV(s) - v(t = 0^-)$	
nth derivative	$\frac{d^n}{dt^n}v(t)$	$s^n V(s) - s^{n-1}v(t)\Big\vert_{t=0^-} - s^{n-2}\frac{d}{dt}v(t)\Big\vert_{t=0^-} \cdots - s^0 \frac{d^{n-1}}{dt^{n-1}}v(t)\Big\vert_{t=0^-}$	
integral	$\int_{0^-}^{t} v(t)dt$	$\frac{V(s)}{s}$	
time scaling	$v(at)$	$\frac{1}{a}V(s)\Big\vert_{\frac{s}{a} \text{ replaces } s}$	$a \geq 0$

REF: [1] James A. Nilsson, Susan A. Riedel, *Electric Circuits,* 8th Ed., Upper Saddle River, NJ: Prentice Hall, 2007.