

TABLE 2-1 Laplace Transform Pairs

| | $f(t)$ | $F(s)$ |
|----|--|---------------------------------|
| 1 | Unit impulse $\delta(t)$ | 1 |
| 2 | Unit step $1(t)$ | $\frac{1}{s}$ |
| 3 | t | $\frac{1}{s^2}$ |
| 4 | $\frac{t^{n-1}}{(n-1)!} \quad (n = 1, 2, 3, \dots)$ | $\frac{1}{s^n}$ |
| 5 | $t^n \quad (n = 1, 2, 3, \dots)$ | $\frac{n!}{s^{n+1}}$ |
| 6 | e^{-at} | $\frac{1}{s+a}$ |
| 7 | te^{-at} | $\frac{1}{(s+a)^2}$ |
| 8 | $\frac{1}{(n-1)!} t^{n-1} e^{-at} \quad (n = 1, 2, 3, \dots)$ | $\frac{1}{(s+a)^n}$ |
| 9 | $t^n e^{-at} \quad (n = 1, 2, 3, \dots)$ | $\frac{n!}{(s+a)^{n+1}}$ |
| 10 | $\sin \omega t$ | $\frac{\omega}{s^2 + \omega^2}$ |
| 11 | $\cos \omega t$ | $\frac{s}{s^2 + \omega^2}$ |
| 12 | $\sinh \omega t$ | $\frac{\omega}{s^2 - \omega^2}$ |
| 13 | $\cosh \omega t$ | $\frac{s}{s^2 - \omega^2}$ |
| 14 | $\frac{1}{a}(1 - e^{-at})$ | $\frac{1}{s(s+a)}$ |
| 15 | $\frac{1}{b-a}(e^{-at} - e^{-bt})$ | $\frac{1}{(s+a)(s+b)}$ |
| 16 | $\frac{1}{b-a}(be^{-bt} - ae^{-at})$ | $\frac{s}{(s+a)(s+b)}$ |
| 17 | $\frac{1}{ab} \left[1 + \frac{1}{a-b}(be^{-at} - ae^{-bt}) \right]$ | $\frac{1}{s(s+a)(s+b)}$ |

TABLE 2-1 (continued)

| | $f(t)$ | $F(s)$ |
|----|---|---|
| 18 | $\frac{1}{a^2}(1 - e^{-at} - ate^{-at})$ | $\frac{1}{s(s+a)^2}$ |
| 19 | $\frac{1}{a^2}(at - 1 + e^{-at})$ | $\frac{1}{s^2(s+a)}$ |
| 20 | $e^{-at} \sin \omega t$ | $\frac{\omega}{(s+a)^2 + \omega^2}$ |
| 21 | $e^{-at} \cos \omega t$ | $\frac{s+a}{(s+a)^2 + \omega^2}$ |
| 22 | $\frac{\omega_n}{\sqrt{1-\zeta^2}} e^{-\zeta\omega_n t} \sin \omega_n \sqrt{1-\zeta^2} t$ | $\frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$ |
| 23 | $-\frac{1}{\sqrt{1-\zeta^2}} e^{-\zeta\omega_n t} \sin(\omega_n \sqrt{1-\zeta^2} t - \phi)$ $\phi = \tan^{-1} \frac{\sqrt{1-\zeta^2}}{\zeta}$ | $\frac{s}{s^2 + 2\zeta\omega_n s + \omega_n^2}$ |
| 24 | $1 - \frac{1}{\sqrt{1-\zeta^2}} e^{-\zeta\omega_n t} \sin(\omega_n \sqrt{1-\zeta^2} t + \phi)$ $\phi = \tan^{-1} \frac{\sqrt{1-\zeta^2}}{\zeta}$ | $\frac{\omega_n^2}{s(s^2 + 2\zeta\omega_n s + \omega_n^2)}$ |
| 25 | $1 - \cos \omega t$ | $\frac{\omega^2}{s(s^2 + \omega^2)}$ |
| 26 | $\omega t - \sin \omega t$ | $\frac{\omega^3}{s^2(s^2 + \omega^2)}$ |
| 27 | $\sin \omega t - \omega t \cos \omega t$ | $\frac{2\omega^3}{(s^2 + \omega^2)^2}$ |
| 28 | $\frac{1}{2\omega} t \sin \omega t$ | $\frac{s}{(s^2 + \omega^2)^2}$ |
| 29 | $t \cos \omega t$ | $\frac{s^2 - \omega^2}{(s^2 + \omega^2)^2}$ |
| 30 | $\frac{1}{\omega_2^2 - \omega_1^2} (\cos \omega_1 t - \cos \omega_2 t) \quad (\omega_1^2 \neq \omega_2^2)$ | $\frac{s}{(s^2 + \omega_1^2)(s^2 + \omega_2^2)}$ |
| 31 | $\frac{1}{2\omega} (\sin \omega t + \omega t \cos \omega t)$ | $\frac{s^2}{(s^2 + \omega^2)^2}$ |