

**Table 9.1:** Transfer functions for some common linear time-invariant systems.

| Type               | System   | Transfer Function                              |
|--------------------|--|--|
| Integrator         | $\dot{y} = u$  | $\frac{1}{s}$                                  |
| Differentiator     | $y = \dot{u}$  | $s$  |
| First-order system | $\dot{y} + ay = u$                                   | $\frac{1}{s + a}$                              |
| Double integrator  | $\ddot{y} = u$                                       | $\frac{1}{s^2}$                                |
| Damped oscillator  | $\ddot{y} + 2\zeta\omega_0\dot{y} + \omega_0^2y = u$ | $\frac{1}{s^2 + 2\zeta\omega_0s + \omega_0^2}$ |
| State space system | $\dot{x} = Ax + Bu, y = Cx + Du$                     | $C(sI - A)^{-1}B + D$                          |
| PID controller     | $y = k_p u + k_d \dot{u} + k_i \int u$               | $k_p + k_d s + \frac{k_i}{s}$                  |
| Time delay         | $y(t) = u(t - \tau)$                                 | $e^{-\tau s}$                                  |