

Introductory Control Systems

First-Order System Step Response

- The general form of a transfer function for a first-order system is $G(s) = \frac{K}{s + a}$.
- The **time constant** associated with this system is $\tau = 1/a$. The time constant tells how quickly the system responds. For example, if $a = 1$, then the system responds on the order of $\tau = 1$ second; however, if $a = 100$, then the system responds on the order of $\tau = 0.01$ seconds. So, systems that **respond quickly** have **large** values of a , and systems that **respond slowly** have **small** values of a .
- The **2% settling time** for a first order system is approximately $T_s = 4\tau = 4/a$. This represents the amount of time required for the system to reach and stay within 2% of the final value.
- The plot below shows the **step response** for three different systems with a values of 0.5, 1, and 5. Setting $K = a$ allows each system to attain a final value of 1, but note that the larger the value of a , the more quickly the system reaches the 98% value.
- Using the formula above, the 2% settling times for the three systems are estimated to be 4/5, 4, and 8 seconds, respectively. In the MATLAB plot below, the red, green, and blue dots represent MATLAB's estimates of these times.

