Linear differential equations
Laplace transform
Solving LDEs with the Laplace transform
Properties of state-space representation
Transfer functions
Transient response analysis of first order and second order systems

First order systems
Second order systems

Critically damped system

If the two poles of the system are equal, the system is critically damped and $\zeta = 1$. For a unit-step, $R(s) = \frac{1}{s}$ and we can write:

$$Y(s) = \frac{\omega_n^2}{(s + \omega_n)^2 s}.$$

The inverse Laplace transform gives us:

$$y(t) = 1 - e^{-\omega_n t}(1 + \omega_n t) \text{ for } t \geq 0.$$