# ME 360 Control Systems
# Dominant (or Insignificant) Poles

- The ***slowest poles*** of a system (those closest to the imaginary axis in the s-plane) give rise to the longest lasting terms in the transient response of the system.
- If a pole or set of poles are ***very slow compared to others*** in the transfer function, then they may ***dominate*** the transient response.
- If we plot the transient response of the system without accounting for the transient response of the fastest poles, we may find little difference from the transient response of the original system.

<u>Example: A Third Order System</u>

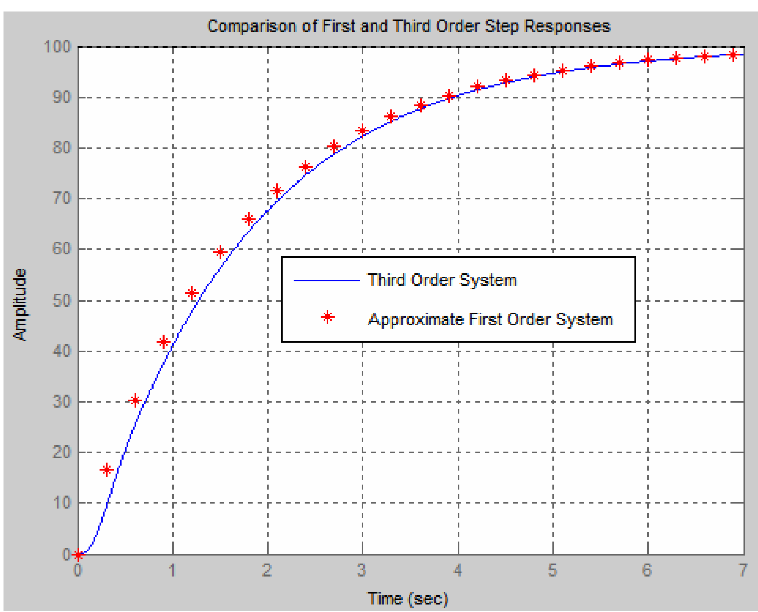
Consider a third order system that has ***one real and two complex conjugate poles***.

$$\boxed{T(s) = \frac{K}{(s+p)(s^2 + 2\zeta\omega_n s + \omega_n^2)}}$$

In general, these systems exhibit both first and second order responses. However, they may exhibit dominant first or second order behavior.

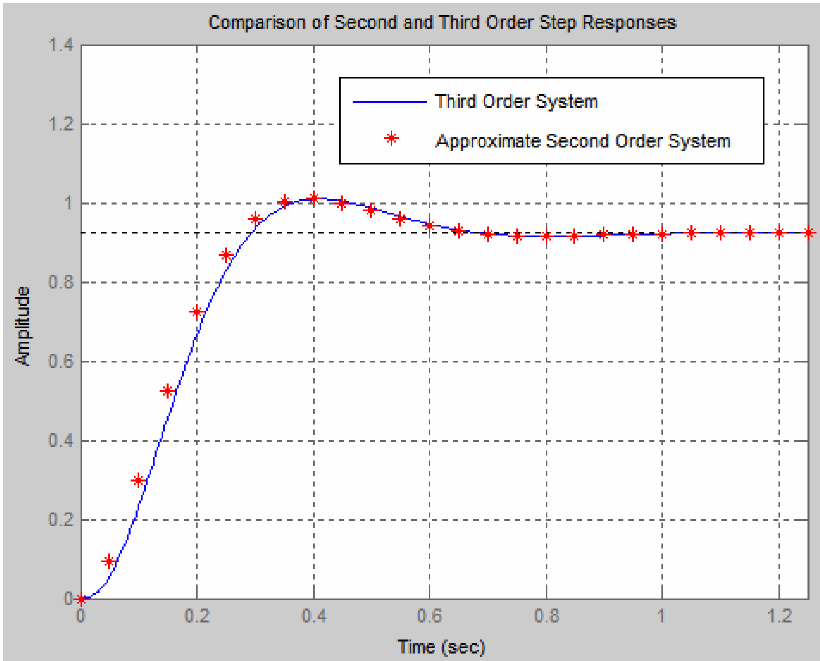
### Dominant First Order Behavior

If $\boxed{\zeta\omega_n \geq 10p}$, then the system exhibits ***dominant first order*** behavior. The ***approximate lower order transfer function*** is $\boxed{T(s) \approx \frac{K/\omega_n^2}{(s+p)}}$. The plot below shows results using $K = 6000$, $\zeta = 0.6$, $\omega_n = 10$, and $p = 0.6$.



## Dominant Second Order Behavior

If $\boxed{p \geq 10\zeta\omega_n}$, then the system exhibits ***dominant second order*** behavior. The ***approximate lower order transfer function*** is $\boxed{T(s) \approx \dfrac{K/p}{(s^2 + 2\zeta\omega_n s + \omega_n^2)}}$. The plot below shows results using $K = 6000$, $\zeta = 0.6$, $\omega_n = 10$, and $p = 65$.




**Note:** In each case we ***"drop" the s-dependence*** of the ***insignificant*** pole, but keep the constant part to maintain the correct steady-state response.

First-Order Dominant
$\zeta\omega_n \geq 10p$

Second-Order Dominant
$p \geq 10\zeta\omega_n$