Introductory Control Systems
Second Order System Step Response Plots

Peak Time and Percent Overshoot for Case 1 Under-damped, Second Order Systems

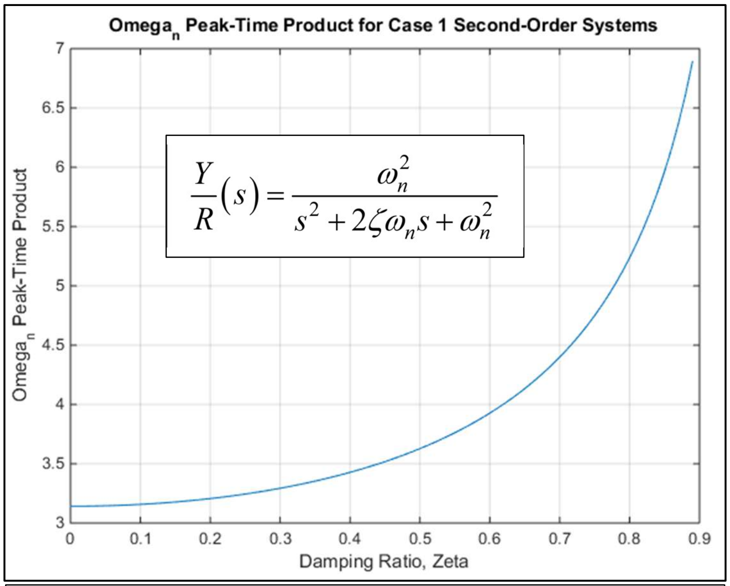

Fig. 1 $\omega_n T_p$ Product vs. Damping Ratio ζ

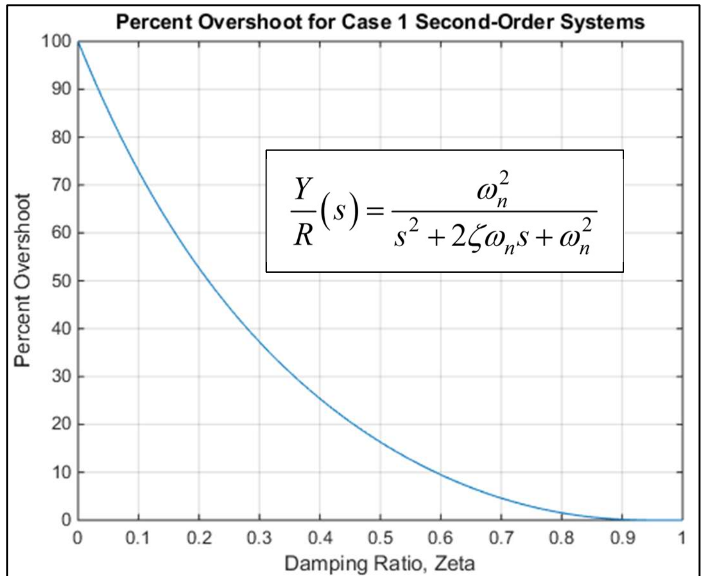

Fig. 2 Percent Overshoot vs. Damping Ratio ζ

Percent Overshoot for Case 2 Under-damped and Critically Damped Second Order Systems

Under-damped:

$$\frac{X}{R}(s)=\frac{(\omega_n^2/a)(s+a)}{s^2+2\zeta\omega_n s+\omega_n^2}$$

$$\beta \triangleq a/\zeta\omega_n$$

Critically damped:

$$\frac{X}{R}(s)=\left(\frac{\alpha^2}{a}\right)\frac{s+a}{(s+\alpha)^2}$$

$$\beta \triangleq a/\alpha$$

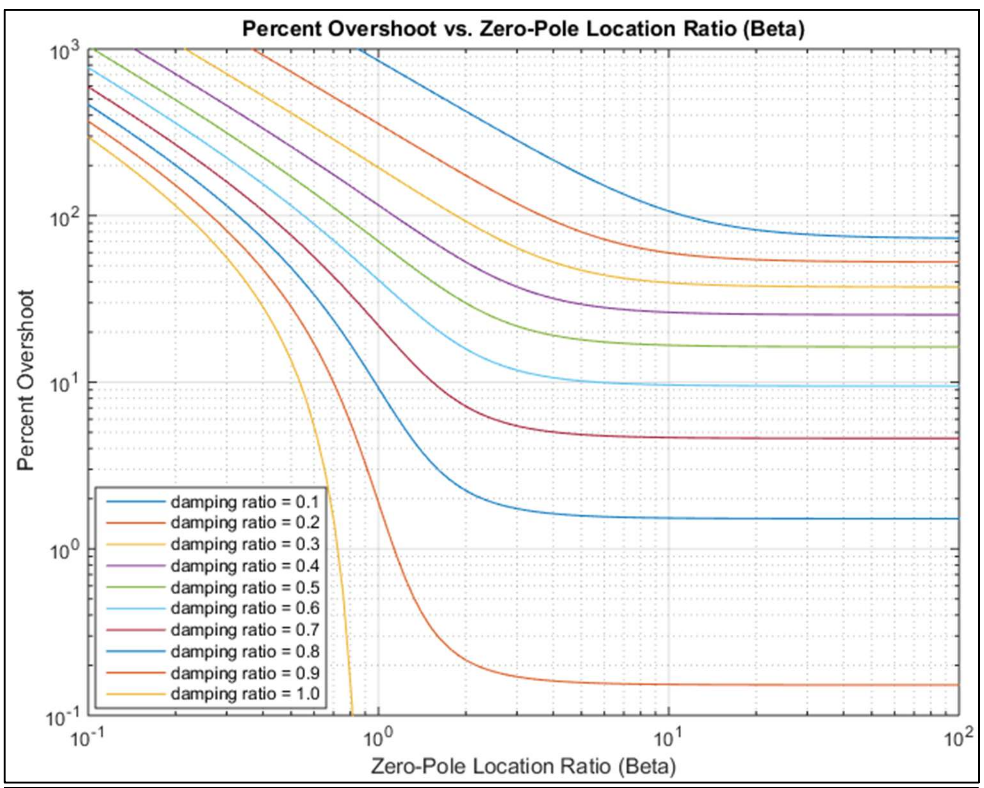

Fig. 3 Percent Overshoot vs. Zero-Pole Location Ratio β