

EE475 Quiz05

Name: Solution

$$H(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

1. For the under-damped prototype 2nd order system, if one of its poles is given by p ,

a. Then $\omega_n = \frac{|p|}{\cos(\pi - \angle p)}$, $\zeta = \frac{-\operatorname{Re}(p)}{|p|}$, $\frac{|\operatorname{Re}(p)|}{|p|}$

b. And $\sigma = \frac{-\operatorname{Re}(p)}{|\operatorname{Re}(p)|}$, $\omega_d = \frac{|\operatorname{Im}(p)|}{|\operatorname{Re}(p)|}$

2. If ω_n and ζ are given,

a. Then $\sigma = \zeta\omega_n$, $\omega_d = \omega_n\sqrt{1-\zeta^2}$

3. The step response rise time $t_r = \frac{1.8 \sim 2.2}{\omega_n}$, $\frac{2}{\omega_n}$ or anything close

4. The $\pm 1\%$ settling time $t_s = \sim \frac{5}{\sigma}$, $\frac{4.6}{\sigma}$

5. The peak time $t_p = \frac{\pi}{\omega_d}$

6. The percentage overshoot $M_p = e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}} \times 100\%$