Choosing FSFB Pole Locations

The poles of the FSFB closed-loop design are generally chosen based on the desired transient response to a specified input, e.g. settling time for unit step input disturbance, or to non-zero initial conditions.

Performance Characteristics

Peak Time

$$T_p = \frac{\pi}{\omega_d}$$

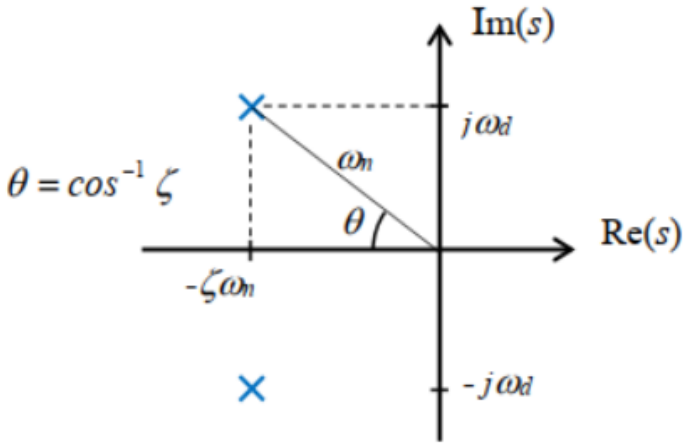
2% Settling Time

$$T_s \sim \frac{4}{\zeta \omega_n}$$

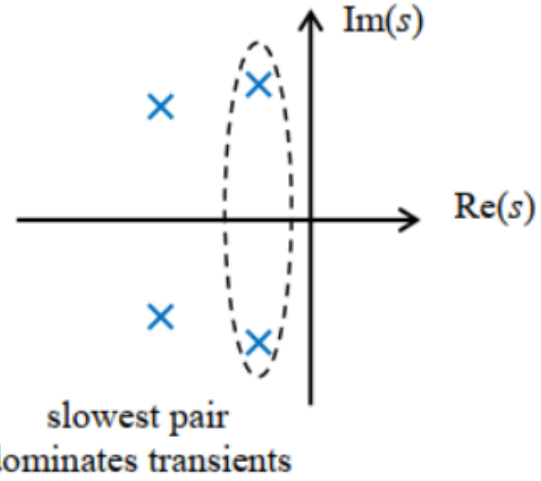
Overshoot

$$\%OS = e^{\frac{(\zeta\pi)}{\sqrt{1-\zeta^2}}} \cdot 100\%$$

For underdamped *second-order* systems:



For *higher-order* systems:



Placing poles further into the LHP will increase the speed of response but will require a larger control effort to do so

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Solving equations of the form

$$\dot{\underline{x}} = \begin{bmatrix} 1 & 0 \\ 0 & -2 \end{bmatrix} \underline{x} + \begin{bmatrix} 3 & - \\ 1 & 1 \end{bmatrix} \underline{u}$$

With desired poles of CL system at

$$\lambda_i^D = \{-2, -3\}$$

Find the gain matrix K in $\underline{u} = -K\underline{x}$

1. Check if controllable - Not needed, but good in practice
2. Calculate $A - BK$ where K is a 2x2 Matrix in this case

3. Use pole placement equation $\det(\lambda I - (A - BK)) = (\lambda - \lambda_1^D)(\lambda - \lambda_2^D)\dots(\lambda - \lambda_n^D)$ from State Regulation and solve by equating coefficients