Stabilization by feedback

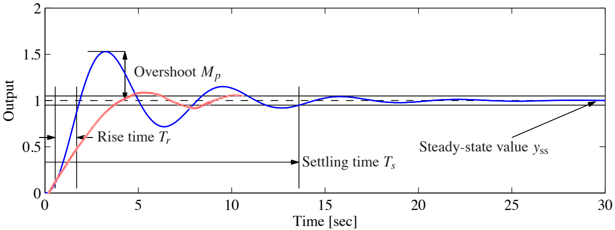


Figure 5.9: Sample step response. The rise time, overshoot, settling time and steady-state value give the key performance properties of the signal.

- Rise time: the amount of time required for the signal to go from 10% to 90% of its final value.
- Overshoot: the percentage of the final value by which the signal initially rises above the final value.

Stabilization by feedback

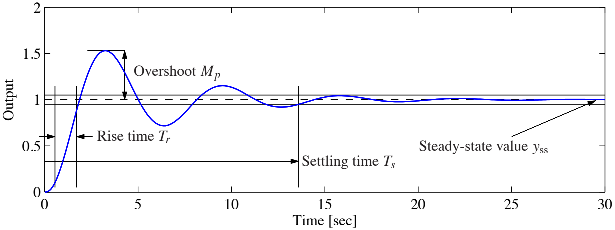


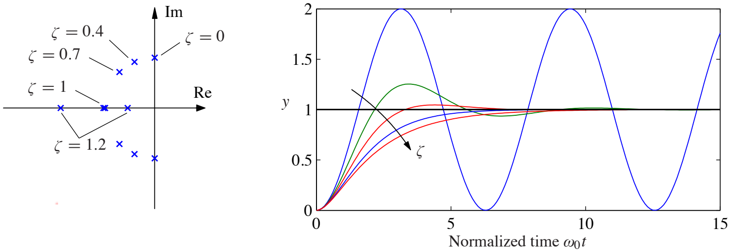
Figure 5.9: Sample step response. The rise time, overshoot, settling time and steady-state value give the key performance properties of the signal.

- Settling time: time required for the signal to stay within 2% of its final value for all future times.
- Steady state value: final level of output, assume convergence.

A second order system with characteristic polynomial

$$s^2 + 2\zeta_0 w_0 s + w_0^2 = 0$$

with eigenvalues $\lambda = -\zeta_0 w_0 \pm \sqrt{w_0^2(\zeta_0^2 - 1)}$.



(a) Eigenvalues (b) Step responses

Figure 6.8: Step response for a second-order system. Normalized step responses h for the system (6.23) for $\zeta = 0, 0.4, 0.7, 1$ and 1.2. As the damping ratio is increased, the rise time of the system gets longer, but there is less overshoot. The horizontal axis is in scaled units $\omega_0 t$; higher values of ω_0 result in a faster response (rise time and settling time).

Example: Feedback control, pole placement

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

Choose a feedback gain K such that the closed loop system is stable and has good control performance (pole placement.)

Summary

- stability criteria of linear time invariant systems.
- reachability, controllability.
- Stablization, goal-reaching, and trajectory tracking.