stab.exe Exercises for Chapter stab

Exercise stab.saginate

A closed-loop transfer function has denominator

$$s^9 + s^8 + s^7 + 3s^6 + 9s^5 + 4s^4 + 7s^3 + (a - 7)s^2 + s + 3$$

for some $a \in \mathbb{R}$. **Do not** determine necessary and sufficient conditions for stability. Rather, find a **single necessary condition** for stability in terms of a **by inspection**.

Exercise stab.spleniculus

Consider the block diagram of Fig. exe.1. What is the closed-loop transfer function; that is, the transfer function from the command $R(s)$ to the output $Y(s)$? Let the plant G have transfer function

$$G(s) = \frac{10(s - 1)}{(s + 5)(s + 1)}, \tag{1}$$

the feedback transfer function $H(s) = 1$, and the controller C have transfer function

$$C(s) = K \tag{2}$$

where $K \in \mathbb{R}$ is some gain. Determine the range of stable controller gains K.

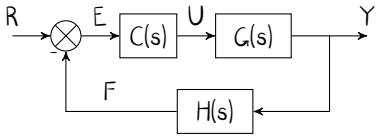

Figure exe.1: a block diagram with a controller $C(s)$.

Transient response performance

Stable system time responses are often described in terms of two intervals, loosely defined as **transient**–the first part during which the effects of initial conditions remain significant–and **steady-state**–the second part during which the response has "settled" near its final value or final amplitude of oscillation.

transient response

steady-state response

In this chapter, we consider performance in terms of the transient response; in the next, we will consider it in terms of the steady-state response–specifically as steady-state error. Transient response characteristics are typically found via two methods:

1. analytically and
    a) **precisely** for first- and second-order systems without zeros and
    b) **approximately** for first- and second-order systems with zeros and higher-order systems that have

dominant poles relatively close to the imaginary complex-plane axis and

2. numerically, in simulation.

The analytical method is especially advantageous for **design**. Design methods we will learn in Chapter rldesign require we "place" the closed-loop poles in the complex plane. The transient response depends very much on this placement, and exactly **how** is something we can better understand from studying first- and second-order system response. We can only simulate systems defined by concrete numbers, so simulation, although powerful, is typically more helpful to fine-tune a controller rather than design it "from scratch."