02.4 stab.exe Exercises for Chapter 02 stab

Exercise 02.1 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 02.2 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.

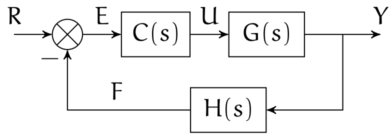

Figure exe.1: a block diagram with a controller $C(s)$.

03 trans

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. 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 06 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."