SE 380 Introduction to Feedback Control

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HOMEWORK 4

Due date: November 12, 2023

Note 1: You may use the `Python Control Systems Library` to solve the problems. If you do, in addition to explaining the design process, include also code snippets and figures (such as Bode plots with stability margins and step response with static and dynamic performance highlighted) to support your answers.

Note 2: The skeleton code in the attached Python script `se380_homework4.py` could serve as a starting point to design the controller.

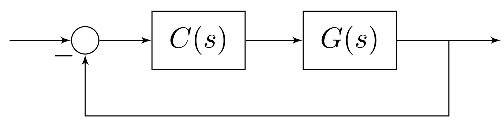

Figure 1: Control system in **1** and **2**

1 Consider the feedback control system in Fig. 1 where

$$G(s) = \frac{5}{(1+s)\left(1+\frac{2\zeta}{\omega_n}s+\frac{s^2}{\omega_n^2}\right)},$$

with $\omega_n = 10$ and $\zeta = 0.1$.

Design a controller $C(s)$ such that the closed-loop system has the following specifications:

- The steady state error in response to a unit step reference is $|e_\infty| \leq 0.05$
- The gain margin $k_m \geq 10\text{dB}$
- The phase margin $\varphi_m \geq 60°$

2 Considering the same feedback control system as in **1**, design a controller $C(s)$ such that the closed-loop system has the following specifications:

- The overshoot is O.S.% = 0%
- The settling time at 1% is $T_s^{1\%} \leq 0.5s$
- The steady state error in response to a unit step reference is $|e_\infty| = 0$