Laboratory 6: Feedback Loop and Performance

Problem 13:

The following plant is given

$$G(s) = \frac{s-2}{s-4}$$

a. Determine (without computation) which of the following controller transfer functions lead to an instable feedback loop

$$C_1(s) = \frac{s-4}{s+2} \qquad C_2(s) = \frac{s+5}{s-2} \qquad C_3(s) = -1.5$$

b. Verify that the remaining controller transfer function leads to an internally stable feedback loop.

c. Simulate the feedback loop with the plant $G(s)$ and C_1. Give a reference step $r(t) = \sigma(t)$ and measure the output $y(t)$.

d. Simulate the feedback loop with the plant $G(s)$ and C_2. Give an output disturbance step $d(t) = \sigma(t)$ and measure the control input $u(t)$.

e. Simulate the feedback loop with the plant $G(s)$ and C_3. Give a reference step $r(t) = \sigma(t)$ and measure the output $y(t)$.

Problem 14:

Consider the plant transfer function

$$G(s) = \frac{s+4}{(s+7)(s^2+3\,s+3)}$$

Assume that somebody designed a controller $C(s)$ with the transfer function

$$C(s) = K\,\frac{s+7}{(s+1)\,s}$$

a. Assume that $K = 1$. Show that the basic feedback loop with $G(s)$ and $C(s)$ as given above is internally stable.

b. The complementary sensitivity $T(s) = \dfrac{G(s)\,C(s)}{1+G(s)\,C(s)}$ has the following dominant pair of poles for $K = 1$: $s_{1,2} = -0.16 \pm 0.84\,j$. Determine the estimated rise time, peak time and settling time (2%) for the step response of $T(s)$.

c. Which steady-state error do you expect for the feedback loop?

d. Simulate the feedback loop with a reference unit step for $K = 1$. Verify if the rise time, peak time and settling time you computed in **b.** are correct.

e. Compare the steady-state error in **c.** with the steady-state error you find in the simulation in **d.**

f. Now simulate the feedback loop for $K = 10$ and $K = 0.1$. What do you observe?