Exercise Sheet 10: Fundamental Limits

Problem 20:

We investigate the plant

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

that is controlled in the basic feedback loop.

a. Write down time-domain constraints for the output y and the error e in the presence of reference steps and output disturbance steps.

Hint: Study 3 different possible locations for the closed-loop poles.

b. Why is the controller design for this plant particularly difficult?

Hint: Discuss what you expect for the three cases you found above.

Problem 21:

We consider the plant in Problem 20.

a. Perform a pole placement design such that all closed-loop poles are at $s = -10$.

Hint: Use the Sylvester matrix in Lecture 7 and compute the controller parameters in Matlab. Use the pre-filter $F(s) = 6.1312$.

b. Simulate the feedback loop with the controller in **a.** for a reference step and a disturbance step. Compare the result with your expectation in Problem 20 **b.**

c. Perform a pole placement design such that all closed-loop poles are at $s = -2$. Use the pre-filter $F(s) = -0.5797$.

d. Simulate the feedback loop with the controller in **c.** for a reference step and a disturbance step. Compare the result with your expectation in Problem 20 **b.**

e. Perform a pole placement design such that all closed-loop poles are at $s = -0.5$. Use the pre-filter $F(s) = -0.0179$.

f. Simulate the feedback loop with the controller in **e.** for a reference step and a disturbance step. Compare the result with your expectation in Problem 20 **b.**

Problem 22: [optional]

Assume that a complementary sensitivity of $T(s) = \dfrac{1}{(s^2 + 10\,s + 50)(s+20)(s+4)}$ is achieved in the basic feedback loop.

a. Is the controller design suitable if measurement noise with a frequency of more than 100 rad/sec is encountered?

Hint: Look at the poles of $T(s)$.

b. Confirm the result in **a.** by simulating $T(s)$ with input noise.

Hint: Use the simulink model on the webpage and try different values for the frequency of the sinusoidal signal. Also try what happens for frequencies of 10 rad/sec.