

Reading: FPE, Sections 6.7.3–6.7.6.

Problems:

The two problems in this homework ask you to check and improve two control designs given in class. MATLAB use is allowed but you must explain all steps and justify all answers.

1. For the system

$$G(s) = \frac{10}{\left(\frac{s}{0.2} + 1\right)\left(\frac{s}{0.5} + 1\right)}$$

we want to design a lag controller that provides PM of at least 60° and steady-state tracking of constant references within 10%.

a) For the controller derived in class:

$$KD(s) = 0.4 \frac{s + 0.05}{s + 0.02}$$

compute the PM and steady-state tracking error to verify that the specs are met.

b) Suppose that to get better damping, we increase the PM spec to 70° , while keeping the same steady-state tracking spec as in a). Modify the design to achieve the new specs. Verify that your design indeed works.

2. For the same system as in problem 1, we want to design a lead/lag controller that provides bandwidth of at least 2, PM of at least 60° , and steady-state tracking of constant references within 1%.

a) For the controller derived in class:

$$KD(s) = 4 \frac{\frac{s}{0.8} + 1}{\frac{s}{5} + 1} \cdot \frac{s + 0.05}{s + 0.02}$$

compute the PM, bandwidth, and steady-state tracking error to verify if the specs are met.

b) Suppose that in addition to the above specs, the bandwidth cannot exceed 6. Modify the design to incorporate this new spec, and verify that it indeed works.