

## Exercises for Chapter 4

1. Give a list of requirements on a control loop. How should they be formulated quantitatively and how should they be checked? Assume for example that you are going to engage a consultant and have to write specifications for the work.
2. Find the PI controllers that minimize IAE, ISE, and ITAE at step load disturbances at the input to the process

$$P(s) = \frac{1}{(s + 1)^3}$$

Calculate the gang of four for the systems that you obtain, and compare the responses to step changes in the load. Why do we not look at the IE minimization?

3. For the process  $P(s) = 1/(s + 1)$ , find a PI controller which minimizes both the IAE-value during a load disturbance on the process input and the maximum gain of the sensitivity function simultaneously. Discuss the result.
4. The process batch (7.2) on page 227 corresponds to plants common in process industry. Given classical robustness specifications with minimum amplitude margin of 3.5 and minimum phase margin of 41.8 degrees (good robustness), find a PID controller for any one of the 134 batch processes that will provide a maximum gain of the sensitivity function larger than 2.

Note! There will be a small prize for the person that finds the controller resulting in the largest maximum gain value of the sensitivity function (given the specified classical robustness measures).