ELEC-E8116 Model-based control systems
/exercises 8

Problem 1. Consider the system

$$\frac{Y(s)}{U(s)} = \frac{s+0.5}{s^2+2s+4} \quad \text{and the criterion to be minimized } J = \int_0^{\infty} (3y^2 + 0.5u^2)\, dt \,.$$

Write a *Matlab m-file* to do the following:

Solve the optimal control law by using the *lqr*-function in Matlab. Calculate the *damping ratio* of the closed loop system. Simulate the system by letting the reference signal be zero (regulator problem) and letting the initial states be non-zero. Then consider the tracking problem. Use a static pre-compensator to set the static gain of the closed-loop system to the value 1. Then simulate the system for a step change in the reference signal.

Problem 2. Consider the multivariable plant

$$G(s) = \frac{1}{(0.2s+1)(s+1)} \begin{bmatrix} 1 & 1 \\ 1+2s & 2 \end{bmatrix}$$

a. Use RGA analysis to evaluate how bad the interconnections between the channels are. Calculate RGA both at zero frequency and the gain crossover frequency. Choose the preferred *pairing* and design *decentralized* PID controllers to control the system. Implement the controller in Matlab/Simulink and plot the responses of the outputs when **a.** a unit step enters the reference of channel 1, **b.** a unit step enters the reference of channel 2 and **c.** unit steps enter at both channels simultaneously. You may use Matlab in implementing the controller and simulating the closed loop, or you can use Simulink if you wish.

b. Design a decoupling controller using the singular value decomposition at zero frequency and choosing the weight matrices W_1 and W_2 accordingly (see Chapter 6 in the lecture slides). Use PID-controllers in the decoupled system. Simulate as in part a.

Hints: Gain crossover of a MIMO system is calculated based on the largest singular value. In tuning the PID controllers you may use the tuning functions in Matlab, see e.g. *pidtune*.