Exercise 6

1. Problem 10.1 in the course book
2. † Problem 10.3 in the course book
3. Problem 10.4 in the course book
4. Problem 10.9 in the course book
5. † Consider a system P and a controller K

$$P(s) = \frac{1}{75s+1}\begin{bmatrix} -87.8 & 1.4 \\ -108.2 & -1.4 \end{bmatrix}, \quad K(s) = \frac{75s+1}{s}\begin{bmatrix} -0.0015 & 0 \\ 0 & -0.075 \end{bmatrix}$$

and a diagonal uncertainty $\Delta = \text{diag}\{\delta_1, \delta_2\}$.

- With the help of Robust Control Toolbox, calculate $\mu_\Delta(T) = \min_D \|DTD^{-1}\|$ (Why?) and $\|T\|$ at the frequency $\omega_0 = 0.2$ for $T = KP(I+KP)^{-1}$. Estimate the conservatism.
- Compare maximal singular values of $T(j\omega_0)$ and $D_{\min}T(j\omega_0)D_{\min}^{-1}$.
- Assume the multiplicative uncertainty model

$$P_\Delta = P(I + W\Delta), \quad W(s) = \frac{s+0.2}{0.5s+1}, \ \|\Delta\|_\infty < 1$$

and the performance criterion to be

$$\|W_p(I + P_\Delta K)^{-1}\|_\infty \leq 1, \quad W_p(s) = \frac{s+0.1}{2s}.$$

(a) Test stability robustness ignoring the structure of Δ.
(b) Test stability robustness taking into account the structure of Δ.
(c) Test nominal performance.
(d) Test robust performance taking into account the structure of Δ.