4 MATLAB: Control System Toolbox II

4.1 Analysing LTI-Models

4.1.1 Model dynamics

Check the following parameters for the LTI-models created in exercise 3.1:

a) Type of LTI-model

b) DC gain value

c) natural frequencies and damping

d) Poles and zeros

e) Gain margin, Phasen margin, delay margin, stability

4.1.2 Time responses

Show the following time responses for the LTI-models creates in exercise 4.1.1 and the discrete-time LTI-models created in exercise 3.2 a) (Sampling time 0.01 sec):

a) Initial response

b) Impulse response

c) Step response

d) Zero-Pole-Map

4.1.3 Frequency responses

Show the following frequency responses for the LTI-models creates in exercise 4.1.1 and the discrete-time LTI-models created in exercise 3.2 a) (Sampling time 0.01 sec):

a) Bode diagram

b) Bode margin plot

4.2 Compensator systems

(Re-)Create the LTI-models `plant`, `forward`, `g = - forward * mess`, `sys` and `sys2` created in exercise 3.3.

4.2.1 Analyzing model properties

Check the following parameters for these LTI-models:

a) DC gain value

b) natural frequencies and damping

c) Poles and zeros

d) Gain margin, Phasen margin, delay margin, stability

e) Step response

f) Zero-Pole-Map

g) Bode margin plot

4.2.2 Applying different input signals

a) Define a periodic pulse input signal `u1` with a time period of 1 sec.

b) Simulate LTI–models `sys` and `sys2` with `lsim` and input signal `u1`.

c) Define a sinusoidal input signal `u2` with a time period of 1 sec.

d) Simulate LTI–models `sys` and `sys2` with `lsim` and input signal `u2`.

4.2.3 SISO-Design-Tool

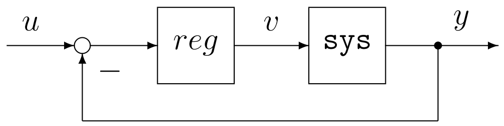
a) Open the SISO design tool.

b) Import the above LTI-models creating the feedback control loop at the respective functions in the SISO design tools.

c) Vary compensator coefficients and compensator structure.

4.2.4 Variation of compensator time constant

Close all figures and models and clear the workspace!



$$\texttt{sys} \;=\; \frac{1}{1 + 0.1 \cdot s}$$

Fig. 1: Feedback control loop for first order plant

The following questions are related to the feedback control loop shown in Fig. 1.

a) **Create TF-LTI-models :** Create the TF-LTI-models `sys` of the plant.

b) **Create P-Compensator (Proportional):** The plant should be compensated by a P-Compensator (proportional compensator) reg with compensator gain 2. Create the LTI-model of the P-Compensator `regP`.

c) **Transfer function of closed feedback loop:** Create transfer function `regsysP` of the closed feedback loop

$$\texttt{regsysP} \;=\; \frac{y}{u} \;=\; \frac{\texttt{sys} \cdot reg}{1 + \texttt{sys} \cdot reg} \tag{1}$$

d) **Step response P-compensated plant:** Show the step responses of the plant and the P-compensated plant (`sys`, `regsysP`) together in a single plot (description as legend).

e) **Create PI-Compensator (Proportional-Integral):** From step response of the P-compensated system it could be found that the DC gain value is different to one.

Hence, the plant should be compensated by a PI-Compensator (proportional integral compensator) reg with compensator gain 2. Create the LTI-model of the P-Compensator `regP` with the following transfer function:

$$\texttt{regPI} \;=\; V_R \cdot \left(1 + \frac{1}{s \cdot T_R}\right) \qquad \text{mit} \quad V_R = 2 \;\; \text{und} \;\; T_R = 0.01 \tag{2}$$

f) **Transfer function of closed feedback loop** Create transfer function `regsysPI` of the closed feedback loop.

g) **Step response PI-compensated plant:** Show the step responses of the plant, the P-compensated and the PI-compensated plant (`sys`, `regsysP`, `regsysPI`) together in a single plot (description as legend).

h) **Variation of compensator time constant T_R:** Vary the compensator time constant T_R of the PI-compensator with the values 0.01 sec, 0.1 sec and 0.2 sec and show the dampings and poles of the respective compensated systems for the different values of T_R.

Plot the step responses of the plant and the PI-compensated plant (`sys`, `regsysPI`) with the different time constants together in a single plot.