6 Simulink systems

6.1 Simulink model with PT_1 (first order) transfer function

a) Generate a Simulink model `simulink_systems_ex1.mdl` for the equation

$$y = \frac{\mathtt{V}}{1 + s\,\mathtt{T1}} \cdot u \quad \Leftrightarrow \quad y = \frac{1}{s\,\mathtt{T1}} \cdot (\mathtt{V} \cdot u - y) \tag{1}$$

with input u, output y, $\mathtt{V} = 1$ and $\mathtt{T1} = 0.01$.

In addition to gain, sum etc blocks use integrator blocks as dynamic block **only**.

Save the data for `V` and `T1` in MATLAB initialization file `simulink_systems_ex1.m` to be called before start of the Simulink model.

b) Use a step function from 0 to 1 at 0.1 seconds as input signal u and a simulation time of 0.2 seconds.

c) Use an appropriate scope-block for display of input signal u and output signal y in the same axis.

d) In the same Simulink model now use parallel and in addition to the former programmed function a more simple simulink block and display its output and the above input signal u in the same way as above in a separate scope block.

6.2 Simulink model for integrator function

a) Generate a Simulink model `simulink_systems_ex2.mdl` for the equation

$$y = \frac{1}{s\,\mathtt{Ti}} \cdot u \tag{2}$$

with $\mathtt{Ti} = 0.1$.

Do **not** use an integrator block!

Save the data for `Ti` in MATLAB initialization file `simulink_systems_ex2.m` to be called before start of the Simulink model.

b) Use a step function from 0 to 1 at 0.1 seconds as input signal u and a simulation time of 0.2 seconds.

c) Use *Signal & Scope Manager* (Menue *Tools*) displaying input signal u and output signal y in the same axis.

6.3 Simulink model for state space representation

a) Generate a Simulink model `simulink_systems_ex3.mdl` for the state space representation

$$\begin{aligned} \dot{\mathbf{x}} &= \mathbf{A} \cdot \mathbf{x} + \mathbf{B} \cdot \mathbf{u} \\ \mathbf{y} &= \mathbf{C} \cdot \mathbf{x} + \mathbf{D} \cdot \mathbf{u} \end{aligned} \tag{3}$$

with matrizes

$$\mathbf{A} = -\frac{\mathbf{1}}{\mathtt{Tr}} \quad ; \quad \mathbf{B} = \frac{\mathtt{Vr}}{\mathtt{Tr}} \quad ; \quad \mathbf{C} = \mathbf{1} \quad ; \quad \mathbf{D} = \mathbf{0}$$

with $\mathtt{Vr} = 2$ and $\mathtt{Tr} = 0.005$.

Do **not** use the State-Space-block!

Please be aware that $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$ and $\mathbf{D}$ are matrizes. Hence, gain blocks should not multiply element-by-element!

Save the data for `Vr` and `Tr` in MATLAB initialization file `simulink_systems_ex3.m` to be called before start of the Simulink model.

b) Use a step function from 0 to 1 at 0.1 seconds as input signal u and a simulation time of 0.2 seconds.

c) Use *Signal & Scope Manager* (Menue *Tools*) displaying input signal u and output signal y in the same axis.

d) In the same Simulink model now use parallel and in addition to the former programmed function the State-Space-Block and display its output and the above input signal u in the same way as above in a separate scope of the *Signal & Scope Manager*.

e) Test the Simulink model for the following vaues:

$$\mathbf{A} = \begin{bmatrix} -2Dw & -w^2 \\ 1 & 0 \end{bmatrix}; \quad \mathbf{B} = \begin{bmatrix} w^2 \\ 0 \end{bmatrix}; \quad \mathbf{C} = [\,\mathbf{0}\ \mathbf{1}\,]; \quad \mathbf{D} = \mathbf{0}$$

with $D = 0.75$ and $w = 200$.

6.4 Control loop with Simulink

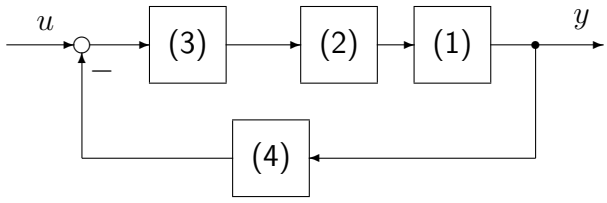

Fig. 1: Feedback control loop

a) Generate a Simulink model `simulink_systems_ex4.mdl` for the control loop shown in fig. 1. The numbers in the blocks refer to the functions defined in the respective Simulink models of exercises 6.1–6.3.

b) Use an appropriate Simulink block for measurement transfer function

$$F_{\mathtt{mess}} = \frac{\mathtt{Vm}}{1 + s\,\mathtt{Tm}} \tag{4}$$

with $\mathtt{Vm} = 1$ and $\mathtt{Tm} = 0.01$.

Save the data for `Vm` and `Tm` in MATLAB initialization file `simulink_systems_ex4.m`. Initialize the system in appropriate manner.

c) Use a step function from 0 to 1 at 0.1 seconds as input signal u and a simulation time of 0.5 seconds.

d) Use *Signal & Scope Manager* (Menue *Tools*) displaying input signal u, measurement output signal from measurement block of equation (4), output signal of state-space-block of equation (3) and output signal y of equation (1)) in four axis.

6.5 Linearization of a Simulink models

For working with the simulink model in MATLAB workspace the simulink model from 6.4 should be linearized from input u to output y.

a) Generate an input and an output block for linearization from input u to output y in Simulink model `simulink_systems_ex4.mdl` .

b) Operate command `linmod` from MATLAB Command Window.

c) Save the linearized Simulink model in variable `sys` and check the result of Simulink simulation by generating the step response of LTI model `sys` with step-command of Control System Toolbox.