ELEC-C8201 Control and Automation / Homework problems 1

Homework Assignment published on 17. 1. 2024. Solutions must be submitted in **pdf-form** in MyCourses-portal (ELEC-C8201 -> Homework) at latest on Friday 2. 2. 2024 at 18:00.

- Solutions must be submitted in **pdf-form** (not Word, no Latex files etc.). The whole solution must be written in **one document** and set in **one file**, including calculations, program codes, figures etc.
- The solution file must have enough information, so that it becomes clear, how you have solved the problem. For example, the MATLAB program codes, and Simulink diagrams must be included in the solution document. If you want to use handwriting (and then change the document to pdf) you can do it, provided that the document can be read without difficulty. It is good to practice writing informative and good reports. When you have solved the homework problem, writing a good report must happen relatively fast. (This is not the last occasion in your study and work career, when you write reports).
- It is allowed to discuss and do the problems in groups. However, everybody must prepare and deliver his/her report individually. Copying directly somebody else's solution is not considered group work and is prohibited.

The above information concerns all six homework assignments given during the course.

Problem. Consider a process with the following state equations:

$$\dot{x}_1(t) = -x_1(t) + u(t)$$
$$\dot{x}_2(t) = x_1(t) - 2x_2(t)$$
$$y(t) = x_2(t)$$

The initial states at time zero are zero.

1. Write the state-space equations in standard matrix form.
2. Use MATLAB (not Simulink) to simulate the process:
   a) Plot the response, considering a step input from 0 to 1 at time instant 0.
   b) Plot the response, considering a unit impulse input.
3. Construct a Simulink model of the process by using integrators (not the State Space block of Simulink). Simulate the unit step response and save it in a MATLAB variable.
4. Now use the Simulink's State Space block to realize the model. You can do that in the same diagram as in above part. Plot in the same figure the step responses obtained in part **2**, **3** and **4**, to show that they are identical.

- Hints: Suitable MATLAB commands might be: *ss, step, impulse, plot, axis.*
- MATLAB: *help x*, to get information about a command *x*.

A good idea in general is to write the solution always as a MATLAB m-code, where the models and parameter values are set in the beginning. They are then always the same after running the code

and directly available in Simulink. Later it is good practice to have parameters in Simulink in a symbolic form. Changing the parameter value is straightforward by editing and running the MATLAB m-code.

When constructing the Simulink diagram note that if the input to the integrator block $\frac{1}{s}$ is x_2 and the output is x_1, then $\dot{x}_1(t) = x_2(t)$.

In Simulink the *Scope* makes an easy way to plot results. But in the above homework problem the result must be stored in MATLAB output variable to be used for plotting other results in the same figure. Simulink library: *To Workspace*.