**Advanced control**
**TI0090**

# Homework I: Modelling of a dynamic system

The objective of this homework is to model and simulate a dynamical system that will be used as virtual plant for the controllers to be developed during the course. For this exercise set, choose either System 1 (S1), System 2 (S2) or System 3 (S3), below[1].

S1: Three-tank system.

S2: Inverted pendulum.

S3: Hot and cold water mixing tank.

Regardless of your choice, you must:

1. Describe the system of your choice and obtain a mathematical model for it. Derive the differential equations describing the system dynamics. Discuss and justify the assumptions/simplifications you adopt. Build the model in a simulation environment of your choice using the numerical values provided in the class material. Define the states, the inputs and the outputs of the system.

2. Linearise the mathematical model obtained in the first task and represent it as a state-space. Use Taylor series for the approximation. Simulate the linearised model and compare it with the one you obtained in the first task (using some input signal, e.g., a sin wave). Plot the comparison results.

3. Transform the state space model into the transfer function that describes the input-output system. Plot the step response of the system. The step has an amplitude of 1. Use the figure and identify, if possible, (i) the steady state value; (ii) the overshoot in % of the final value; (iii) the rise time; (iv) the settling time.

4. Analyse the stability of the system by studying the poles position of the linearised model (in open loop configuration). Compute and plot the pole-zero map. Identify the open-loop system poles and zeros. Discuss their effect on the process response and the important information you get from the poles-zeros map.

[1]Details and assumptions on each system have been given and discussed in class. They can be retrieved from the slide's lecture (TI0090-L1).

## Guidelines

Regardless of your choice of dynamical system (S1, S2 or S3), you must generate a report consisting of the following:

- A clear and exhaustive description of the models and their derivation, the associated plot/tables of the simulation results and your comments.
- The code you used to perform the simulations. Regardless of your choice programming, your code must be executable/functioning. The code (and the relevant functions, if needed) can be either pasted in the report (for instance, as an appendix) or packaged together with the report as a zip file.

The report must be submitted by **April 15, 2018**. Note that **delays will be penalized** (<24h: 20% penalty; <48h: 40% penalty; etc.).