Automatic Control – laboratory assignment

COUPLED TANKS

Model

The goal is to obtain approximate mathematical model of the laboratory model to be able to design a controller in the next step.

Assignments (the assessment is only recommended, not fixed):

1. Make sure that your model communicates with Simulink
2. Find out the mathematical model of the system. The equations are given in the appropriate Simulation assignment (the model in the laboratory K26 is described in Coupled tanks with gear pump simulation assignment). Write down state equations describing the system.
3. Linearize the model in some appropriate operating point. Keep in mind, that valves are inputs to the system. [10%]
4. Identify all possible static nonlinearities such as saturation, deadband, … etc. [5%]
5. Propose and carry out experiments to find out parameters of the given nonlinear model. Keep the configuration of the valves unchanged. [20%]
6. Create the nonlinear (with all static nonlinearities) and linearized model in Simulink. [5%]
7. Compare the responses of the original, nonlinear and linearized models. Use reasonable signals. Evaluate the performance of the models. Include also the input signal to the figures. [10%]

You do not need to identify all the parameters, sometimes, it is even impossible. Instead of that, you may identify appropriately substituted parameters. Submit the report in PDF and the Simulink models in one .mdl or .slx files.

Control of the model

The controlled variable is the water level in the second tank h_2. Design a controller for the linearized model, if the controller works try it on the laboratory model. Compare responses of nonlinear, linear and laboratory model with each designed controller and discuss ability of the controller to suppress an error signal. Respect the limits of the laboratory model during the design of the controllers.

For each designed controller compare all responses of the closed loop (reference tracking, input disturbance rejection and controller effort).

Assignments:

1. Design and evaluate three different types of dynamic output feedback compensators for control of the water level h_2 $[m]$ (P, PI, PID, lead, lag, lead-lag etc.). Design each controller with a different method. At least one of the proposed controllers has to achieve zero steady state error and at least one should completely reject the step of disturbance. Try to design the controllers such that the settling time is as short as possible and that the overshoot is maximally 20% of the reference signal. [30%]
2. Design a state feedback controller with zero steady state error with overshoot not exceeding 20%. [20%]