Lab 4: Report Marking Criteria

• The reports for Lab 4 and Lab 5 will be combined into one major report worth 15% of the total grade for this subject. Please submit the report on Canvas. Only one submission is required per group.

• You may work in a group of maximum three members. Your group must be the same for Labs 4 and 5. All group members must attend the same lab session.

• Address the questions in the order as they appear in this document, and in your reports, clearly indicate the section that you are answering.

• Finally, please ensure that the content included in your report is your own intellectual property. Any occurrence of significant plagiarism may result in loss of partial/full credit.

The Lab 4 will contribute a maximum of **[110 marks]** in your combined Lab 4+5 report.

For the entire report:

1. Present results and diagrams clearly with explanations. Plots require a legend, title, x-axis and y-axis labels.

2. Have you adjusted all of your simulation parameters to the values as instructed?

3. Presentation quality of the Lab 4 report **[10 marks]**

4. Please answer the questions in the order suggested below.

1A: Read the temperature sensor

1. Explain the purpose of this task. In the context of the control system, what is its significance/how will it be used? **[1 mark]**

1B: Send an input to the Arduino

1. Explain the purpose of this task. In the context of the control system, what is its significance/how will it be used? **[1 mark]**

2. A saturation block was supposed to be added. Why should we add this block? What was your choice for the saturation limits, and why? **[1 mark]**

1C: Estimate the Plant

1. Include your Simulink diagrams, MATLAB scripts and plots **[10 marks]**

2. Explain some advantages and some disadvantages of an empirical model compared to a physics-based model. **[2 marks]**

3. Explain the formula/process you used to calculate τ. Use the variables T_1 and T_0 in your answer. **[2 marks]**

1D: Open-Loop Simulation

1. Include your Simulink diagrams, MATLAB scripts and plots **[5 marks]**

2. Compare the amplitude and the times between the open-loop simulation with the open-loop experiment. Identify major similarities or dissimilarities (if any) **[2 marks]**

2A: PI Controller Simulation on Simulink

1. Show the derivation for your calculated PI parameters **[5 marks].**

2. What ω_n was chosen? What were the calculated PI parameters? **[1 mark].**

3. Include your Simulink diagrams, MATLAB scripts and plots **[10 marks].**

4. Show that the performance criteria has been achieved, in simulation **[2 marks].**

5. For the PI controller structure that you selected, simulate the other PI controller structure that was not investigated and compare/discuss the advantages/disadvantages compared to the structure that was selected for this lab. Use simulation results and theory. **[10 marks]**

6. For the simulation that was NOT implemented in hardware, confirm that the system can reject an OUTPUT step disturbance of -5°C and is robust in the presence of measurement noise using: *Sources: Random Number with mean = 0 and variance = 0.5.* The disturbance can occur at a time of your choice, as long as it clearly supports your argument. **[5 marks].**

2B: PI Controller on Arduino

1. Include your Simulink diagrams, MATLAB scripts and plots **[20 marks].**

2. Identify if/when the control signal was limited by the saturation block either in simulation or in the experiment. **[1 mark]**

3. Explain potential source(s) of noise for this experiment? **[2 marks]**

4. Explain the similarities of this lab experiment with a real-world equipment/appliance. **[3 marks]**

5. For your chosen real-world equipment/appliance, explain:

    a. The consequences/impracticalities of excessive overshoot. **[2 marks]**

    b. The consequences/impracticalities of a long rise time. **[2 marks]**

    c. An example of an output disturbance. How would you model this disturbance in a simulation? Why? **[5 marks]**

6. Compare the simulation with the experimental results. Explain key similarities and differences (if any). **[5 marks]**

7. For your experiment or other students' experiments, what could be some sources of differences between the simulation results and the experiment? **[3 marks].**