Course Project

Phase 2

Phase 2 Deadline: January 2, 2021 at 11:59 PM

Phase 2 Discussion: During Lab Exams Week (TBD)

I. Phase 2 Summary:

- Use the transfer function derived in Phase 1 to design a digital PID controller using Simulink, then implement the designed controller on a microcontroller with the actual hardware.
- The closed loop response with the controller in the Simulink should match (as close as possible) the actual hardware response with the controller.
- If the responses do not match then you may need to re-identify your open loop transfer function, e.g., by considering a higher-order transfer function than the one you started from, or by including some neglected effects, e.g., delays, etc.
- In general, you should be operating in the linear range of your system to avoid nonlinear effects.

II. Grading:

Whole course project has 15% from final grade, distributed as follows:

- **Phase 1**: 5%
- **Phase 2**: 6%
- **Presentation and discussion**: 4%
- **Bonus Part**: 4%

III. Phase 2 Requirements:

- Define the specifications of the closed-loop system with the controller. These specifications should depend on your control problem and should differ from one problem to another. The specifications should include:
  - Transient time-domain characteristics: rise time, settling time, and maximum percentage overshoot
  - Steady-state error
  - System stability
- Design your digital PID controller in the Simulink using the open-loop transfer function derived in phase 1. Using a grid search approach in which you test different values of the P, I, and D gains until you satisfy the design criteria.
- After designing the digital controller, you should derive the time-domain state-space equations of your system.
- **Bonus Part:** Implement your digital PID controller on a microcontroller then test them on the actual hardware and collect the closed-loop response of your system.
- **Bonus Part:** Compare the response of the actual hardware with the response in the Simulink. In case of a mismatch, you need to understand where the mismatch comes from (modeling, delays, sampling time, etc.). Iterate your design until the performance of the hardware matches the Simulink performance.
- Document every step clearly. You should have a video for each milestone of the project that will be presented in the discussion.
- Note that missing documentation is not acceptable. Projects without documentation will not be graded.

IV. Course Project Rules

- Write your code so that it can be readable by others. Define your variables clearly (not abbreviated). Use comments as much as you want.
- The figures that you are going to show must be well presented. They must have clear labels, titles, and maybe legends.
- Your answers to the questions in the previous section must be appropriately enumerated.
- Any COPIED reports even one single part will take a **ZERO**.