ME2046 – Spring 2025 – University of Pittsburgh

Digital Control Systems – Course Project

The course project will consist of three deliverables:

Deliverable	Due Date	Percentage of Project Grade
Project Proposal	~~3/20/2025~~ 3/27/2025	10%
Project Update	4/10/2025	40%
Final Project Report	4/24/2025	50%

The goal of the project is to exercise the concepts and skills that you have learned in class on a realistic problem, with the practical concerns that may entail. If you have a plant to apply a feedback control system to and/or have a practical problem in mind from your research, you can use that in your proposal. You could also do a little research to find a system you are interested in studying to control. You may consult with Prof. Bajaj about a project suggestion (He will post a couple options as well).

Proposal:

For the proposal, you should describe the system of interest, including a block diagram of the control system, and how the digital control system is implemented, and answer questions including:

- Where does information come from—what sensors or measurements are used?
- Where in the system does sampling occur? Are there ZOH anywhere?
- Are there previous control solutions for this system? Please provide a couple citations.
- What does a reasonably good model of the system look like? (Continuous time differential/delay equations are okay for this)
- What are the realistic capabilities of the processing system (this could simply describe the processing system)? If there is not a processing system present or selected, part of your project should be to discuss what the capabilities need to be for success (e.g. what sampling rates do you need?) so please outline what such questions you will need to answer.
- In response to your proposal, Dr. Bajaj will propose a couple potential control approaches based on course material, and perhaps a "stretch goal" that may be interesting for you to pursue.

The proposal should be up to two pages, 11 pt font, single spaces, but with text and images only taking up 1.5 pages maximum. You may use the rest of the space for references. You should include a figure of a block diagram or alternatively give the governing equations. Cite references appropriately (e.g. if you take a model, image, block diagram, equation, etc. let me know where it came from).

Project Update:

For Project Update 1, you will have begun writing your report. You will be expected to submit a report in the paper template format that will include a description of the system, the system representation in continuous and discrete time domains, linearization if the model is nonlinear to begin with, and analysis of stability, controllability, and observability for the open loop system (in discrete time). You should include block diagrams, and, if applicable, free body diagrams, circuit diagrams, schematics (whatever is required to derive the system model). The representation may be state-space or z-domain, whatever is appropriate for the system. I will provide a rubric for the Update when the proposal is due.

By the time of Project Update 1, you should have a Simulink model of your plant, preferably with at least a simple, stabilizing controller, showing that it is at the very least, stable (no concern about performance

yet). You should study and present the effect of sampling period on stability with your system. You should also include in your discussion anything that you receive in comments for the Proposal.

Final Project:

By this time, you will have had more experience with control algorithms from the course. You will be expected to implement at least 2 methods of control design from the course on your system and compare and contrast the effects of important parameters relevant to digital control. The designed controllers should be checked for stability, etc. as we will discuss for the different design methods.

You will prove out your algorithms and confirm your analysis using your Simulink algorithm. Finally, you will be asked to write pseudocode that could be passed off to your embedded firmware engineer in order to implement a controller in a timed loop.

A more detailed rubric and discussion for what is needed in final report will be provided at the time of the Project Update, and you should also include in your discussion anything that you receive in comments for the Project Update.