Industrial Controls Systems and Automation

Class Location/Time: 219 Riggs Hall – MWF 1:25 PM – 2:15 PM. If instructor is absent for 15 minutes after the start of class, it can be considered cancelled for the day.

Instructor: Dr. Apoorva Kapadia
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Office: 307 Fluor Daniel EIB
Phone: 864-656-3946
Office Hours: Mondays, Tuesdays, Wednesdays, and Thursdays 10:30 AM – 12 PM or by appointment in person or by email. Feel free to stop by or ask about a more convenient time if my office hours do not work for you. Additionally, there might be days when I will have to cancel Office Hours – I will do my best to ensure it is not before exams or due homework and provide sufficient notice.

Teaching Assistant/Grader (if applicable): TBD

Course Description

Introduction to control systems specifically related to industrial applications, and manufacturing and production systems. Topics include continuous variable control and the PID paradigm, the Z-transform, digital control, model-predictive control, direct adaptive control, discrete logic control, ladder logic and PLC implementation, and equipment interfacing and industrial networking protocols. **Prerequisite:** ECE 4090 with a C or better

Course Objectives

The goals for this course are to provide the student with an understanding of applied industrial and process control methodologies and a framework for programming controllers in the manufacturing environment. The students will: 1) Learn how to apply mathematics to the analysis of control systems using methods beyond classical linear control, 2) Learn how to adapt control theory for discrete-time systems, and 3) Learn how to create ladder logic algorithms for control needs and implement them on a PLC.

Required Materials

You will need a scientific calculator for this class. Some problems on the HW or the test, however, may not involve numbers.

Textbook: *Industrial Controls and Manufacturing*, Kamen, Academic Press (useful but not mandatory)
Computer: Windows or Linux computer required for SoftPLC programming

Topical Outline

1. **The Process Control Problem (1 week)**
   a. Motivation
   b. The Two-Tank Problem
   c. Continuous Variable Control
2. **Control of Continuous Variable Processes (1.5 weeks)**
   a. PID Control
   b. Effect of Disturbances
   c. Input Delay
3. **Introduction to Digital Control (0.5 weeks)**
   a. The Z-Transform
4. **Model Predictive Control (2 weeks)**
5. **Direct Adaptive Control (1.5 weeks)**
6. **Neural Network Controllers (1 week)**
7. **Discrete Logic Control (1.5 weeks)**
8. **Ladder Logic (1.5 weeks)**
9. **PLC Implementation – programming and testing on Linux PC or Arduino (3 weeks)**
10. **Equipment Interfacing and Industrial Network Protocols (0.5 weeks)**
11. **Tests (1 week)**

Grading

Final grades will be determined by averaging the homework, exams, and the final exam based on the distribution below.

Regular Homework	20%
PLC Programming	20%
1 Midterm Exam	30%
Final Project	30%
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Course Grade	100%

90% – 100%	A
80% – < 90%	B
70% – < 80%	C
60% – < 70%	D
0% – < 60%	F

Additional Policies

Logistics

To keep up with course announcements, you need to check the Canvas site on a regular basis. All the material you need for the course is on the Canvas site. The site contains the lecture notes, homework assignments and due dates, homework answers, upcoming test dates, practice tests, test answers, and much more. Any exams cancelled due to power outages, inclement weather or similar conditions will be held at the next class meeting unless explicitly stated by me on Canvas. Any assignments due at the time of the class cancellation will be rescheduled for the next class meeting day and will be stated on Canvas.

Homework
Homework assignments will be posted on the Canvas site. The homework assignments should all be scanned and submitted as a PDF by 5:00 PM on the day it is due. Answers for every homework assignment will be posted after the due date. Working the homework problems is essential to the learning of the material in this course; *Late homework will not be accepted.*

Exam Attendance
There will be 1 closed book midterm exam. You will be allowed to have one **handwritten sheet of paper** for the exam on which you may write anything you wish – the Laplace and Z Transform pairs will be provided. You will need to be present for the exam – if it is not possible, prior permission is to be sought from the instructor. In the event of illness, the instructor must be informed as soon as possible, preferably prior to the exam time. *Exam date will be announced in class.*

Questions
Questions in class are strongly encouraged. The worst thing I can do is move too slowly and bore you. The second worst thing I can do is move too quickly and confuse you. If either of these occurs, it is your responsibility to speak up. You are paying for an education, and if the material is not presented clearly with confusion being eliminated shortly after it sets in, you are not getting what you contracted for. On the other hand, if I never confuse you I am being unduly conservative, and hence, not conscientious. There is a fine balance here, with you as students and me as instructor each having very definite responsibilities for keeping open all channels of communication. It is extremely difficult to teach a course without some sort of real time feedback.

General
We might not have time in class to go over homework and exam solutions. The answers will be place on Canvas and if there are still questions after you have read them, you can ask for explanations in class or during office hours. Note in particular that you should not skip class immediately after the exam assuming that we will go over the exam and hence cover no new material.