ECHE 589P Discrete Time Process Dynamics and Control

Spring 2011

Tth 12:30-1:45 Swearingen 2A24

Instructor: Ed Gatzke
Office: Swearingen 3C05
Phone: (803) 777-1159
Email: gatzke@sc.edu
Office hours: Monday, 11:00-12:00, Wednesday, 11:00-12:00

Description –

Advanced concepts in applied process control methods. Topics include Programmable Logic Control (PLC), discrete-time modeling and control, model identification, process measurement and instrumentation, basic state estimation methods, model-based control, and hybrid dynamic systems.

Prerequisites – Differential equations MATH 242 is required for this class.

Objectives / Learning Outcomes –

1. Students will gain the ability to model the transient behavior of multivariable dynamic systems.
2. Students will gain the ability to synthesize advanced model based control methods.

Topics –

Programmable Logic Control - Initial experiments considered will use basic Programmable Logic Control (PLC) problems involving discrete logic. Experiments will include simple logic implementation using lights/switches.

Real-time Control - In the laboratory, students will work with the inverted pendulum experiment. Here students will examine the effect of sampling time and changes in controller parameters using a real time system.

Filtering - Noise filtering plays an important role in control implementation. The inverted pendulum can be used with addition of electric noise on the signal. Students will design and implement a low-pass filter to remove system noise.

Model Predictive Control - Model Predictive Control is often used in the chemical industry for control of interacting time-delay systems with actuator constraints. Students can develop and test a MPC controller for an interacting multiple pressure tank system.

Measurement and Estimation - Different types of measurement devices may be considered. For example, given limited information and a model of the system, students can attempt to estimate tank levels or leakage flow rates. Topics would include the Luenberger Observer, the Kalman Filter, the Extended Kalman Filter, and moving horizon estimation.

Hybrid Systems – Dynamic systems often exhibit qualitatively different behavior depending on the region of operation. Modeling, simulation, and control of theses systems will be considered.

Goals –

Develop a working understanding of dynamic systems and feedback control, focusing on multivariable and discrete time systems. Topics include Programmable Logic Control (PLC), discrete-time modeling and control, process measurement and instrumentation, state estimation methods, model-based control, and nonlinear control systems.

Textbook –

Reading assignments will be provided for most class lectures. Ideally, students should review the topics before coming to class. Students should read the assignments before attempting homework assignments.

Optional Course Textbook – Process Dynamics, Modeling, and Control. B. A. Ogunnaike and W. H. Ray. Oxford University Press, 1994.

Supplemental Textbook – Process Dynamics and Control. Seborg *et. al*. Wiley, 1989.

Expectations –

The workload and assignments should require up to 5 hours each week in addition to the 3 hours of class. Please let me know if assignments require more time.

Students are expected to give **advance notification** for scheduled absence from quizzes and exams. A **doctor's note or copy of a relevant obituary** is required for unscheduled absences from exams and quizzes. Exams and quizzes will not be made up without proper notification. Late assignments will not be accepted.

Common courtesy is expected in lectures with respect to cell phones, latecomers, and side conversations. Relevant questions and contributions are encouraged during class.

Students are encouraged to work and study in groups. Each individual must turn in distinct homework assignments. Late assignments will not be accepted. Workload for group assignments is expected to be shared among students in the group. Please notify the instructor if a group member fails to adequately contribute to group assignments.

Homework –

Homework is assigned for your benefit to reinforce concepts discussed in class and prepare you for examinations and quizzes. You may consult classmates, but do not blindly copy the solution.

Late homework will be reduced 20% per day. Homework will not be accepted more than two days late. Use one side of 8½"x11" paper starting each problem on a new page and circling answers. Includes a cover sheet including your name and date of submission. Staple your homework in the upper left corner.

Labs –

Laboratory exercises consist of experiments and simulation laboratories. Groups will receive a grade as a group. Simulation labs will be performed individually unless otherwise noted.

Examinations –

Two exams and a final exam are scheduled. All exams are open note, open textbook.

Class Participation –

During lectures, individual or group exercises / discussion topics may be presented. Each student should hand in a written record of these exercises at the end of each class. This will be used to help gauge attendance and class participation. Students can also submit comments and suggestions as course feedback using this written record.

From
http://www.sc.edu/bulletin/ugrad/acadregs.html#class%20atten.

> "Students are obligated to complete all assigned work promptly, to attend class regularly, and to participate in whatever class discussion may occur.
>
> Absence from more than 10 percent of the scheduled class sessions, whether excused or unexcused, is excessive and the instructor may choose to exact a grade penalty for such absences.
>
> The instructor's attendance policy should be ascertained by the student at the beginning of the semester. It is of particular importance that a student who anticipates absences in excess of 10 percent of the scheduled class sessions receive prior approval from the instructor before the last day to change schedule as published in the academic and refund calendars on the registrar's Web site.
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> ***It must be emphasized that the "10 percent rule" stated above applies to both excused and unexcused absences.*** Faculty members should notify classes specifically of the attendance policy which they intend to follow in each class."

Three absences are permitted. Each subsequent absence will reduce your class participation grade by 10 points to a maximum of 50 points total reduction.

Email the instructor (gatzke@sc.edu) before missing class for excused absences that are not due to illness (interviews, school sponsored trips).

Grading –

Grading mistakes must be submitted for consideration in writing within a week of being returned. Papers submitted for consideration may raise or lower final grade. **Students taking this course for graduate credit will be expected to complete additional homework exercises. Additionally, their homework exercises will be graded more rigorously than those of the undergraduate students.**

Evaluation breakdown grading weights for both undergraduate and graduate students:

Homework Exercises	20%
2 Exams	30%
1 Cumulative Final Exam	15%
Labs / Projects	15%
Class participation	**20% (will range from 20% to -30%)**

The final grading scale is not fixed. Final letter grade values will be determined at the end of the semester. Approximate nonbinding values are:

A	>90%	Excellent
B	>80%	Good
C	>70%	Fair
D	>60%	Poor
F	<60%	Failing