155: 422 Process Simulation and Control Spring 2012

Web page: Sakai webpage
Lectures: Mon, Wed 3:20-4:40pm, SEC 208
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Course Description: The course is an introductory presentation of the basic fundamental principles of automatic control of processes of general interest to chemical engineers. Elements of mathematical simulation of process dynamics for open-and-closed loop operations are presented for both linear and non-linear systems. Concepts of feedback, feedforward, and cascade control of processes using popular control algorithms are covered, including aspects of stability, controller tuning, and safety.

Course Objectives:

Equip the student with necessary fundamental control theory tools in order to answer the following questions:

- Why is automated control necessary and how is it done?
- What is the difference between "open" and "closed" loop system dynamics?
- What are the elements of a "closed-loop" automated control system?
- When, where, and why does a closed loop automated control system become unstable and how can a control engineer correct instability?

Textbooks:

Process Dynamics and Control, 2nd Edition
By Dale E. Seborg, Thomas F. Edgar, and Duncan A. Mellichamp
Published by John Wiley & Sons, 2004.

Software:

Matlab/Simulink: This is an interactive environment for system simulation and design. Utilizing a block diagram interface, it can be used to model, simulate, and analyze multidomain systems for process control and understand system dynamics. It is installed on all PCs in the Microcomputer Lab (room C233).

Class Participation:

To encourage class participation, students with most presence in the class will get up to 10 points extra in their final grade.

Assessment: *Quizes: 15%, Homeworks 15%, Exams: 40%, Control Project: 30%*

Course Context:

Week	Date	Topic	Chapter
1	Jan.18	Course Organization-Introduction to Process Control	1
2	Jan. 23	Introduction to Process Dynamics and Simulations	2
	Jan. 25	Introduction to Process Dynamics and Simulations (Simulink)	2
3	Jan. 30	Laplace Transforms	3
	Feb. 1	Laplace Transforms	3
4	Feb. 6	Transfer Functions and State space Models	4
	Feb. 8	Transfer Functions and State space Models	4
5	Feb. 13	Dynamic Response of First and Second Order Systems	5
	Feb. 15	Dynamic Response of First and Second Order Systems	5
6	Feb. 20	Josh Davies (Control Associates)	
	Feb. 22	Dynamic Response of Second Order Systems	5
7	Feb. 27	Dynamic Response of More complicated Processes	6
	Feb. 29	**First Exam**	
8	Mar. 5	Feedback Controllers	8
	Mar. 7	Feedback Controllers	8
9	Mar. 10-18	Happy Spring Break	
10	Mar. 19	Closed Loop Control Systems	11
	Mar. 21	Closed Loop Control Systems	11
11	Mar. 26	PID Controller	12
	Mar. 28	PID Controller	12
11	Apr. 2	Control Design	12
	Apr. 4	**Second Exam**	
12	Apr. 9	Feedforward Control	15
	Apr. 11	Multi-loop and Multivariable Control	18
13	Apr. 16	Multi-loop and Multivariable Control	18

	Apr. 18	Real-Time Optimization	19
14	Apr. 23	Model Predictive Control	20
	Apr. 25	Model Predictive Control	20
15	**Apr. 30**	**Control Project Presentations/Project Reports Due**	

ABET Outcomes and Assessment:

Program Outcomes

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function in multi-disciplinary/multi-functional teams (this can be defined as a mix of biochemical and chemical engineers, or as a group of students working on a different roles of a project)
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Mapping of content in program core curriculum to program outcomes. Highlighted entries represent the highest weighted assessment points

Outcome Course	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
155:201	**✓**		✓		**✓**	✓	✓		✓		**✓**
:208	**✓**				**✓**						**✓**
:303	**✓**	✓		✓	**✓**	✓					**✓**
:304	**✓**	✓		✓	**✓**	✓					**✓**
:307	**✓**	✓			**✓**	✓			✓		**✓**
:324	**✓**	✓	✓	✓	**✓**		✓		✓		**✓**
440:407	**✓**				**✓**				✓	✓	
155:409	**✓**				**✓**	**✓**					**✓**
:411	**✓**		✓		**✓**						**✓**
:415	**✓**	**✓**		**✓**			**✓**	✓			**✓**
:416	**✓**	**✓**		**✓**			**✓**	✓			**✓**

:422	✓				✓		✓				✓
:427	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
:428	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
:441	✓	✓	✓		✓						✓
:491,492									✓		
societies							✓		✓	✓	

Societies: student professional organizations include AIChE, ISPE, SWE, OXE

The achievement of outcomes (a), (e), (g), and (k) will be assessed in this course as follows:

Outcome (a): an ability to apply knowledge of mathematics, science and engineering

(1) Assessment test: 1st day of class – same test at the time of the first exam (after the basics have been revisited).

(2) Exams – Homeworks : Most of the problems test the ability to apply knowledge of mathematics, science and engineering in problem solving

Outcome (e): an ability to identify, formulate, and solve engineering problems

Course projects: The project will require the formulation of the problem described, identification of the main challenges, investigation of multiple solution approaches, report of the alternatives.

Outcome (g): an ability to communicate effectively

The project will involve intermediate and final written and oral report. At the intermediate stage feedback will be given from (a) class evaluations (b) instructor evaluations

Outcome (k): an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Homework assignments and the project will require the use of Simulink as software to perform dynamic simulations and control. The evaluation of the use of this tool will be tabulated for the whole class and additional sessions will be scheduled as appropriate.