Process Dynamics and Control
CBE 162, Spring 2018

Instructor: Ali Mesbah
GSIs: Abraham Beyene, Karl Schaettle

Course Objective:
The objective of this course is to introduce Chemical Engineering undergraduate students to the theory and practice of dynamic modeling and control of chemical processes. This course enables students to integrate their knowledge from other courses (such as transport and separation processes, thermodynamics, and kinetics and reaction engineering) to develop process models and analyze process dynamics. The course considers a model-based approach to control system design. The course covers the general notions of first-principles modeling based on conservation laws, empirical modeling (aka black-box model identification), analysis of process dynamics, feedback control, internal model control PID design, frequency-domain techniques for stability analysis, feedforward/cascade control, and closed-loop interaction. The course demonstrates the various steps of design of a control system through interactive simulations using MATLAB/Simulink.

Textbook:
Process Control: Modeling, Design, and Simulation
Wayne Bequette (Publisher: Prentice Hall, 2003)

Website:
bCourses

Software:
MATLAB and Simulink (Control Toolbox)
For access to MATLAB on campus computers:
login: !chmfcheme162 password: c@1process

Time and Location:
Lectures Tu, Th: 11-12:30, Tan Hall 180
Lab We, Fr: 1 – 2:30 pm, Tolman 1535

Office Hours:
Ali Mesbah, Thursdays 1:00 - 2:00, 316 Gilman Hall
Karl Schaettle (TBD)
Abraham Beyene (TBD
Every weekend, questions posted on bCourses before Saturday 4pm will be answered by Sunday noon

Grading:
Homework Assignments and Quizzes: 15 %
Lab Section Assignments: 10%
Final Project: 20 %
Written Mid-term Exam: 20 %
Written Final Exam: 35 %

General Course Policies:

- Homework assignments are posted on Tuesdays and are due on **the following Tuesdays at 11:00**. Students should upload a soft copy to bCourses with the name format *LastName_FirstName_HW_HomeworkNumber.pdf*, and turn in a hard copy to a GSI before the class starts. Each individual student is responsible for his/her homework. Homework assignments may be discussed with others, but solutions cannot be shared in any form. Late homework assignments will not be accepted.
- The lab section assignments are posted on Tuesdays. Lab section attendance is mandatory. You can only attend the lab section in which you are enrolled. You are required to upload your solutions at the end of the session.
- Please make sure your Name, Student ID Number, Date, and Assignment Number are in the top-right hand corner of the front page of any homework and assignment that you submit. Only use the front side of the page and number all pages in the bottom-right hand corner. Questions should be in order. Please describe your thought process and state all assumptions made for each question. For numerical answers, place a box around your final answer and indicate the units. The given templates/formats should be followed for all homework assignments, quizzes, and the project report. If the formatting is incorrect, the assignment will not be considered for grading.
- Closed-book quizzes will be during the first half hour of the class on **Thursdays February 8th, March 1st, and April 12th** (please be on time!). There will be no make-up quizzes.
- The final project will be posted on bCourses on **Tuesday March 20th** and is due on **Friday April 27th**. You will work in groups of three to develop a control system for a chemical process. The project involves multiple phases including model development, process identification, control structure selection, controller tuning for SISO systems, and multiple SISO loop tuning. Every group will have to turn in one comprehensive report of the project, thoroughly discussing all the steps taken and all the engineering decisions made to develop the control system. A soft copy of the report should be uploaded to bCourses with the name format *LastNameStudent1_ LastNameStudent1_GroupNumber.pdf* . A hard copy of the report should be turned in to a GSI right on Friday April 27th. You can select your group members. Every group should fill out the Google Doc (which will be posted on bCourses) with the name and student number of each team member. All groups should be finalized by **Thursday March 15th**. Note that even though the project will be carried out by the group, each individual is responsible for the contents covered in the report, and may be asked to discuss the project report if deemed necessary. Groups may discuss the problems with other groups, but solutions and reports cannot be shared in any form. Violations will be handled in accordance with the university procedures and regulations.
- Grade appeals can be requested up to one week after the grades have been assigned. The entire assignment will be regarded (the revised grade can be higher or lower than the original grade). The grade appeals should state the specific reason(s) for the regrade request, and can be submitted to Abraham and Karl.

Course Schedule:

Week		Tuesday	Thursday	Assignments*
1	15 Jan. – 19 Jan.	Class	Class	HW / Lab (Tutorial)
2	22 Jan. – 26 Jan.	Class	Class	HW / Lab
3	29 Jan. – 2 Feb.	Class	Class	HW / Lab
4	5 Feb. – 9 Feb.	Class	Class/**Quiz 1**	HW / Lab
5	12 Feb. – 16 Feb.	Class	Class	HW / Lab
6	19 Feb. – 23 Feb.	Class	Class	HW / Lab
7	26 Feb. – 2 March	Class	Class/**Quiz 2**	HW / Lab
8	5 March – 9 March	Class	Class	HW / Lab
9	12 March – 16 March	Class	Class	Lab
10	19 March – 23 March	**Mid-term Exam**	Class	HW / Lab
11	26 March – 30 March	**Spring Recess**		
12	2 April – 6 April	Class	Class	HW / Lab
13	9 April – 13 April	Class	Class/**Quiz 3**	HW / Lab
14	16 April – 20 April	Class	Class	HW
15	23 April – 27 April	Class	Class **(Final Project Due)**	
16	30 April – 4 May	Reading/Review/Recitation Week		
17	7 May – 11 May	**Exam Week**		

* New homework and/or lab assignments will be assigned in these weeks.

Tentative Course Content:

Week	Topic	Textbook Chapter
1	Introduction to process control and the course outline	1
2	Fundamentals of first-principles dynamic modeling	2
3	Fundamentals of first-principles dynamic modeling	2
4	Dynamic analysis of process systems	3
5	Dynamic analysis of process systems	3
6	Dynamic analysis of process systems / Empirical modeling	3 / 4
7	Feedback control and PID controllers	5
8	Feedback control and PID controllers	5
9	Feedback control and PID controllers	5
10	PID tuning	6
11	**Spring Recess**	
12	IMC-PID tuning	9
13	Feedforward/cascade control	10
14	Closed-loop interaction	13
15	Frequency-domain techniques for stability analysis	7
16	Reading/Review/Recitation week	-
17	**Exam Week**	