Process Dynamics and Control
CBE 162, Spring 2019

Instructor: Ali Mesbah (mesbah@berkeley.edu)
GSIs: Angelo D. Bonzanini (adbonzanini@berkeley.edu) and Ashley Bird (a.bird@berkeley.edu)

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)

Websites:
1) *bCourses*: Announcements and assignments can be found here. Submit your lab assignments here.
2) *Piazza*: The system is highly catered to getting you help fast and efficiently from the GSIs. Please post your questions on Pizza rather than emailing questions to the teaching staff.
Sign-up link: piazza.com/berkeley/spring2019/chmeng162
3) *Gradescope*: Please submit your homework on Gradescope.
Course entry code: MNY34N

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. Wed: 210 Wheeler. Fr: 56 Barrows.

Office Hours:
Ali Mesbah, Thursdays 1:00 – 2:00, 316 Gilman Hall
Angelo Bonzanini: Fridays 3:00 – 4:00, D75 Tan Hall
Ashley Bird: Mondays 5:30 – 6:30, 403 Latimer Hall
Every weekend, questions posted on Piazza before Saturday 4 pm will be answered by Sunday evening.

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 Tuesday at 11:00**. Students should upload a soft copy to Gradescope with the name format *LastName_FirstName_HW_HomeworkNumber.pdf*. 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 on bCourses **before noon of the following Monday**.
- 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 21st and April 18th** (please be on time!). There will be no make-up quizzes.
- The final project will be posted on bCourses on **Friday March 22nd** and is due on **Friday May 3rd**. 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 May 3rd. 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 **Friday 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 the GSIs.

Course Schedule:

Week		Tuesday	Thursday	Assignments*
1	21 Jan. – 25 Jan.	Class	Class	HW / Lab (Tutorial)
2	28 Jan. – 1 Feb.	Class	Class	HW / Lab
3	4 Feb. – 8 Feb.	Class	Class	HW / Lab
4	11 Feb. – 15 Feb.	Class	Class	HW / Lab
5	18 Feb. – 22 Feb.	Class	Class / **Quiz 1**	HW / Lab
6	25 Feb. – 1 March	Class	Class	HW / Lab
7	4 March – 8 March	Class	Class	HW / Lab
8	11 March – 15 March	Class	Class	HW / Lab
9	18 March – 22 March	Class	**Mid-term Exam**	Lab
10	25 March – 29 March	**Spring Recess**		
11	1 April – 5 April	Class	Class	HW / Lab
12	8 April – 12 April	Class	Class	HW / Lab
13	15 April – 19 April	Class	Class / **Quiz 2**	HW / Lab
14	22 April – 26 April	Class	Class	HW
15	29 April – 3 May	Class	Class **(Final Project Due)**	
16	6 May – 10 May	Reading/Review/Recitation Week		
17	13 May – 17 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	**Spring Recess**	
11	PID tuning	6
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**	