CHE 460L: Chemical Process Dynamics and Control

Units: 4
Fall 2021

Location: VPD-116

Instructor: Pin Wang
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Course Producer(s): TBD

IT Help: Viterbi IT Services
Hours of Service: Normal: M-F 8a to 5p
Other time limited to server and infrastructure support
Contact Info: email: engrhelp@usc.edu
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Walk-in: DRB-205

Course Description

Modeling, dynamics, and automatic control of chemical processes. Analysis of control system design performance and stability, feedback and feedforward schemes. Computer implementation and laboratory applications.

Learning Objectives

Automation plays a central role in the practice of modern chemical engineering; think of the analogy in mechanical engineering; an automobile would not work without a steering wheel, accelerator, and brakes! This course will provide students with the basic understanding of dynamic behavior and control methods to enable them to apply automation to a wide array of systems; among others, chemical, petroleum, food, pharmaceutical, minerals, pulp and paper. In addition, the principles of the course can be applied to dynamic systems in business (inventory management) and life sciences (biochemical reaction pathways).

In Chemical Process Dynamics and Control, students are expected to demonstrate that they are capable of the following:
At the conclusion of this course, you should be able to:

1) Apply knowledge of mathematics and science to process dynamics and control.
2) Analyze and interpret different control systems' transient and frequency response data.
3) Design simple control systems for distillation columns and chemical reactors.
4) Identify, formulate, and solve linear control problems.
5) Use engineering tools for control systems

Prerequisite(s): CHE 120
Co-Requisite(s): Math 245
Concurrent Enrollment: none
Recommended Preparation:
Students are expected to be able to formulate conservation balances for fluid mechanics, heat transfer and mass transfer and use these along reaction kinetics, and thermodynamics to set up chemical engineering problems. Additionally, students are expected to be able to solve differential equations and numerically solve chemical engineering problems using Matlab.

Course Notes

Grading is by letter grade. Course **information is distributed** via Blackboard and via email. Assignments will be completed and submitted on GradeScope. Students are also expected to access e-lessons/videos available on the internet as assigned by the instructor to prepare of in-lecture activities

Technological Proficiency and Hardware/Software Required

The course will be taught via in-person lecturing. The lectures will be also available via the ZOOM for those who have specific reasons being unable to attend in-class lectures. Students will need to be able to access materials from Blackboard and use materials available on-line through the USC Library. Blackboard will be used to communicate, post materials to be used by students in the course, and for the Instructor to communicate to the class. Gradescope will be used to distribute and provide feedback on course assignments.

Students will need to use MATLAB to solve some problems. They can also use Excel in some cases. The design project will either be done in MATLAB or in SimCentral.

USC Technology Support Links

Zoom information for students
Blackboard help for students
Software available to USC Campus

Required Readings and Supplementary Materials

The required course textbook is

Thomas Marlin, P**rocess Control: Designing Processes and Control Systems for Dynamic Performance** (2nd Edition), http://pc-education.mcmaster.ca/Book_links.htm

Additional supplemental materials that students will need to access can be found at **The Process Control Education Website** by Dr. T. E. Marlin.

A secondary textbook (not required) the instructor thinks is a very good textbook is

Process Dynamics and Control, 4e by D E Seborg, T F Edgar, D A Mellichamp, and F J Doyle (2016).

The laboratories for this course will utilize Temperature Modeling and Control hardware developed by Professor John Hedengren at BYU and APMonitor. This hardware can be purchased from Amazon.com or students can use hardware belonging to MFD. The distribution of this hardware will be announce via email/Blackboard and in lecture.

Description and Assessment of Assignments

The course will have two mid-term and a final exam, all cumulative. Additionally, student will complete multiple laboratory assignments and a project. The project will be assigned towards the end of the semester and will apply both the analysis of dynamic systems and process control to a chemical process.

While the instructor reserves the right to change how exams will be taken mid-semester, all exams are likely conducted in a closed book setting with a calculator (not phone and not computer/laptop) and one 8.5x11 page of notes.

Student will be expected to prepare for lecture by completing an e-Lesson designed for each lecture, found at **The Process Control Education Website** (http://pc-education.mcmaster.ca/default.htm) by Dr. T. E. Marlin. In lecture short workshops and quizzes will be used complement the e-Lessons. There will also be homework assigned for outside of lecture. Homework can be done individually or in student selected groups of up to three students. While the group members may collaborate, they should not collaborate with other students. Working problems whether in-class workshops or homework or practice exams, is a best way to learn the material.

The course has laboratory experiments to provide experience applying dynamic modeling and feedback control to real physical process system. The experiments require course material, so the start of the laboratories will be schedule once students have covered to the required material. The experiments will use an Arduino device to control a temperature process. The device measures two temperatures and has two control manipulated variables. While each student will have their own device, the experiments will be done as in groups. The reports will be extended executive summaries with attachments.

The Control Design Project provides an opportunity to integrate many of the course topics to study dynamics and implement control to a realistic chemical process simulation. Students perform the tasks in the project that they will while implementing control in engineering practice. The simulation allows students to deal with a process that cannot be built in a laboratory because of cost and safety limitations. During the exercise, students experience the results of good decisions (high product quality and profit) and poor decisions (including potentially hazardous operation in the simulated environment).

Assignments will be assigned and submitted on-line via GradeScope. You will need to be able save your works as a PDF file. On computers, this can typically be done using the Save-As command. For handwritten work, you will need to be able to scan the work product into a PDF – not JPEGs and other image files cannot be submitted to GradeScope and will not be accepted. While there are several applications that will allow you to do this, Adobe Scan works on cell phones and is very good at adjusting the perspective of the scan to make it readable with good presentation quality.

Grading Breakdown

Homework:	10%
Class workshops/quizzes	5%
Laboratory	15%
Control Design Project	10%
Mid-Term Exam I	10%
Mid-Term Exam II	20%
Final Exam	30%

We will work many more “workshops” in class than will be considered in grading since working problems (workshops) has been demonstrated to be an effective learning tool. While not announce ahead of time, it will be clear in lecture which in-class activities will need to be submitted for credit.

Any question about grading should first be directed to the instructor since the instructor is responsible for assignment of grades in the course.

Assignment Submission Policy

Late submissions will not be accepted because solutions will be posted after the submission time. Students are **encouraged** to contact the instructor with reasonable requests for changes to the due date. These requests will not be acceptable last minute or after the due date. The instructor will decide whether a modified due date will be accepted and with what penalty.

All student submissions must be professionally prepared with the author(s) clearly identified, answers clearly and completely presented, and final results and conclusions clearly identified. Points will be deducted for unprofessional preparation.

Grading Timeline

Every effort is made to provide feedback within 10 days of when the assignment is submitted.

Additional Policies

Classroom Norms

As course instructor

- I will come prepared to present the material for the course and work problems in lecture to assist
- students in learning.
- I will make the effort to learn everyone's name – this is a challenge and will be more so with remote lectures/office hours.
- I will respect all questions asked by students, but I may reserve the right to ask to answer questions later or in a one-on-one discussion. I recognize that you have many competing priorities and will not hold it against you if you are not able to attend class upon occasions.
- If I don't know the answer, I will not try to pretend that I do, I will get back with you with a thoughtful answer.
- I will attempt to provide a diverse learning environment so that student with different learning styles can be successful in the course.
- I do set high standards because I want to see each student succeed in the course and as an engineer.

As students,

- I expect that you will make a solid effort in the course. This means attending lectures, coming to prepared for lecture having watched/read the preparation materials, participating in lecture discussions, and attempting to do the workshops, submitting your own work product.
- I do not judge students based on their questions so you should ask questions to clarify your understanding of the material.
- While I understand grades are important, understand the material and being able to use the material should be every student's goal. This understanding means more than just knowing the formulae/math to solve problems.
- I also expect you to respect your fellow students, contributing equally to group assignments (don't hitchhike on assignments, workshops, or laboratories).
- If other students are waiting to ask questions when you are having significant problems understanding the material, try to be respectful of their time and consider asking for different time to ask more extensive questions.

Finally, if you think I don't know your name or am pronouncing it wrong, help me by letting know what you want to be called and how to pronounce it. Also, if you have a concern I ask that you approach me and we will work though and attempt to mutually resolve your concern.

Bottom line, my goals is to see each of you be successful students and, in the future, engineers. I would like is course to provide a respectful and open environment for learning.

Attendance

As seniors, the students are expected to make their own choices about attending lectures. Missed in-lecture workshops/exercises cannot be made-up.

Academic integrity and Professional Ethics

Professional behavior will be an essential aspect of your engineering career. You have been observing an important standard for ethical behavior since joining USC. We will continue to observe the academic integrity policies in this course.

*The School of Engineering and the Department of Chemical Engineering adhere to the University's policies and procedures governing academic integrity as described in SCampus. Students are expected to be **aware** of and **observe** the academic integrity standards described in SCampus.*

As engineers you will be professionals expected uphold the profession behavior set out by the National Society of Professional Engineers and AIChE. You can find the ethical code of conduct statements at the NSPE and AIChE websites – you should consider reading them.

Sharing Course Materials Outside of the Learning Environment
USC has a policy that prohibits sharing of any synchronous and asynchronous course content outside of the learning environment.

SCampus Section 11.12(B)
Distribution or use of notes or recordings based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study is a violation of the USC Student Conduct Code. This includes, but is not limited to, providing materials for distribution by services publishing class notes. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the Internet or via any other media. (SeeSection C.1 Class Notes Policy).

Course Breakdown

This is an overall course plan for the semester. A detailed guide for student activities is provided separately on Blackboard. Assignment and due dates in this course plan are only a plan and the instructor will adjust the plan as needed during the semester. The detailed guidance document will be updated during the semester and weekly emails will be provided to remind students of the plan for the next week and to communicate any changes to the plan.

CHE 460L Course Schedule			
Date (Mon)	Topics	Book Materials	Assignment
Aug 23	Introduction to Process Control/ Control Objectives and Benefits	Chapter 1/Chapter 2	e-Lessons 1 and 2 HW #1 assigned
Aug 30	Process Dynamic Modelling	Chapter 3	e-Lesson 3a and 3b HW #1 due HW #2 assigned
Sep 6 (Labor Day)		Chapter 4	e-Lesson 4a and 4b HW #2 due HW #3 assigned **Laboratory 0**
Sep 13		Chapter 5	e-Lesson 5a and 5b HW #3 due HW #4 assigned
Sep 20		Chapter 6	e-Lesson 6 HW #4 assigned **Laboratory 1**

Sep 27		Chapter 7	e-Lesson 7 HW #4 due
Oct 4	Single-Input Single Output Control Design and Performance	Chapter 8	e-Lesson 8 **Mid-Term Exam 1**
Oct 11		Chapter 9	e-Lesson 9 HW #5 assigned
Oct 18		Chapter 13	e-Lesson 11 HW #5 due
Oct 25		Chapter 10	e-Lesson 10 **Laboratory 2**
Nov 1	Advanced Topics/Application of Process Control	Chapter 14	e-Lesson 14 HW #6 assigned **Mid-Term Exam 2**
Nov 8		Chapter 15	e-Lesson 15 HW #6 due,
Nov 15		Chapter 18	e-Lesson 18 HW #7 assigned **Laboratory 3**
Nov 22		Chapter 20	e-Lesson 20 HW #7 due
Nov 29	Process Safety, Design and Control		**Project Due**
Dec 13	Final Exam		

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender- based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298 equity.usc.edu, titleix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298 usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776 dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710 campussupport.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101 diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call dps.usc.edu

Non-emergency assistance or information.