

Spring 2021

CHE 489-002: Process Dynamics and Control

Richard Cimino

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Cimino, Richard, "CHE 489-002: Process Dynamics and Control" (2021). *Chemical and Materials Engineering Syllabi*. 152.

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ChE 489: Chemical Process Safety Spring 2021 - Section 002

Instructor: Dr. Richard T. Cimino, Senior Lecturer

Office: 376 Tiernan Hall, Phone: 973-596-5729, E-mail: cimino@njit.edu

Class: Monday 7:30-9:25 AM Synchronous Online, Thursday, 9-10:55 AM Converged

Office Hours: By arrangement only - please sign up online at <https://drcimino.youcanbook.me>

Course Description and Requirements

This course is an introduction to chemical process dynamics and control. Topics include analysis of the dynamics of open-loop systems, the design of control systems, and the dynamics of closed-loop systems. Control techniques and methodologies, used by practicing chemical engineers, are emphasized.

Prerequisites: ChE 349; ChE 365

Corequisites: None

Course Objectives

Taking this course, a motivated student will learn to:

1. Define process control objectives, classify processes, and identify process control variables
2. Develop mathematical models for chemical processes by applying conservation laws and making reasonable assumptions
3. Derive dynamic solutions of process models by applying Laplace transformations
4. Develop transfer function models in deviation variables to find open loop solutions to process models
5. Identify nonlinear models in chemical processes and linearize them to find an approximate solution
6. Classify characteristic inputs and compute responses of first and second order models
7. Simplify higher order models using Taylor's and Skogestad's methods.
8. Define and classify different controllers and their characteristics
9. Design controller and find appropriate controller settings for processes
10. Write a professional technical report based upon a process control scenario, incorporating numerical calculations and recommendations for reducing the risk of instability in the process control system.
11. Deliver a professional oral presentation in a team.
12. Participate in collaborative teamwork and learn to establish goals and meet deadlines, while recognizing the importance of diversity and in effective teamwork.
13. Model dynamic processes using MATLAB and SIMULINK.

Learning Materials

Textbook

D. E. Seborg, T. F. Edgar, D. A. Mellichamp and F. J. Doyle, "Process Dynamics and Control," 4th Edition, 2012, Wiley, Hoboken, NJ. The textbook is the main source for preparing for classes and reading the textbook before each class is necessary. Additional materials will be posted on Canvas.

Calculator: A high-end calculator (TI-83, TI-84 or TI-84SE) is required for solving numerical problems.

Required Hardware:

A working computer equipped with a working webcam and a working microphone. Note - tablet devices are not acceptable as test-taking devices for this course.

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Required Software: Google Chrome browser or Firefox browser; Respondus Lockdown Browser, Google docs, sheets, drive. MATLAB and SIMULINK

Internet Access: You must have a reliable internet connection for your device.

Note: If you do not meet all of these requirements you cannot take the course online and must instead take it in person at another time.

Course Outline

Week	Date(s)	Topic (preliminary, subject to minor changes)
1	1/21	Ch. 1 - Introduction to Process Control
2	1/25-28	Ch. 2 - Dynamic Models of Chemical Processes
3	2/1-4	Ch. 3 - Laplace Transforms
4	2/8-11	Exam 1 Review, Ch. 4 - Transfer Function Models
5	2/15-18	Exam 1; Ch. 4 - Transfer Function Models
6	2/22-25	Ch. 5 - Dynamic Response of First Order Systems
7	3/1-4	Ch. 5 - Dynamic Response of Second Order Systems
8	3/8-11	Ch. 6 - Dynamics of Higher Order Systems
-	3/15-18	Spring Break
9	3/22-25	Exam 2 Review, Exam 2
10	3/29-4/1	Ch. 9 - Control Instrumentation; Ch. 15.3 - Feedforward Control
11	4/5-8	Ch. 8 - Intro to Feedback Control; Ch. 11.1-2 - Servo/Regulator Problem
12	4/12-15	Ch. 11.3 - Dynamics of Feedback Loops, Project Time
13	4/19-22	Ch. 11.4 - Stability of Closed Loop Systems, Project Time
14	4/26-29	Project Time, Final Exam Review

Assessment and Grading

Homework: Homework assignments will be posted weekly on Canvas. Homework assignments are due one week after they are assigned, and must be submitted electronically on Canvas. No late homework will be accepted. Students must submit homework individually.

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Team Assignments & Project: Other assignments will require you to work in teams of up to 4 students. The instructor will designate the teams.

Peer Evaluation: You will use the Comprehensive Assessment of Team Effectiveness (CATME, www.catme.org) to evaluate the teaming behaviors of yourself and your teammates. These evaluations will be incorporated into the assignment of final grades.

Quizzes: Regular reading quizzes will be given based on the weekly reading material, including both concepts and problems. The quizzes will take place in class at the beginning of the period on Canvas. No make-up quizzes will be allowed. All quizzes will be closed book with no material allowed.

Exams: There will be two midterm exams (80 min long) and one final exam (2.5 hours long). All exams will be open book, and a handwritten sheet (double-sided, letter size) with materials used to prepare for exams will be allowed for the midterm exams. Two sheets will be allowed for the final exam. Shared or copied preparation sheets, as well as use of any electronic materials including e-books will be considered as a violation of academic integrity.

Grading: Your final course grade will be calculated by weighted average, using the following weights:

Category	Weight
Homework (individual work)	20%
Project (team and individual work)	15%
In-Class Activities	5%
Midterms (x2)	40%
Final Exam	20%
Total	100%

Final course grades will be assigned according to the following rubric:

Lower Bound	Letter Grade	Upper Bound
90	A	100
85	B+	89
80	B	84
75	C+	79
70	C	74
60	D	69
0	F	59

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Important Dates

Add/Drop: Jan 25, 2021

Midterm exam #1: Feb. 15, 2021

Withdraw Deadline: March 8, 2021

Midterm exam #2: Mar. 25, 2021

Final Exam: between May 7-13, 2021

Policies

NJIT Honor Code: The NJIT Honor Code will be upheld and any violations will be brought to the immediate attention of the Dean of Students.

Special Needs: If you need accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

Lectures

This course is a combination of synchronous online and converged modes. This means that each lecture will take place online (Mondays) or in-person + online (Thursdays) during the class hours. Attending the sessions is mandatory. Failure to attend the sessions may result in being marked as "unattended" for the course, which may negatively impact your financial aid status. Additionally, the examples discussed in the class are not necessarily from the main textbook and therefore missing a class will have consequences for your preparation for quizzes and exams.

Students must be in the online meeting room or in the classroom by the start time. Being late to class may have consequences for your final course grade.

No audio or video recording is allowed. All sessions will be automatically recorded for you to review at a later date.

Cellphones should be turned off during both lectures and exams and not allowed under any circumstances.

You must keep your webcam ON and your microphone OFF (muted) unless otherwise notified.

Course materials, office hours and correspondence

The course Canvas page is the main platform for delivering information about the course. All relevant course materials and assignments will be posted on Canvas, so a student should check it regularly.

Students must upload a professional-looking headshot for their Canvas profile.

Students are strongly encouraged to attend Office Hours. Long questions which require derivations will be discussed only during the Office Hours and will not be answered by email. Questions regarding grades can be discussed only during the Office Hours.

E-mail and Canvas correspondence is intended only for quick questions. Questions which require a detailed discussion should be discussed in person during the Office Hours.

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All correspondence should be conducted in a professional style, using formal English.

To assure a quick response to your emails, please add ``ChE489'' in the subject of your emails.

The instructor reserves the right not to respond to emails if the email does not have a greeting or a signature.

Exams, Quizzes, Homework and Grades

A letter grade is based on the final score, calculated using Canvas in accordance with the Tables given in this syllabus. The assigned letter grade is final and cannot be negotiated.

A student can dispute the exam scores within a week after the announcement of the score. Exam scores can only be disputed during the official Office Hours, not during class time or via email.

Students will get zero for not coming to quizzes, exams, or any other course activity. If students miss an exam due to extreme circumstances (such as a medical problem), they need to notify the instructor via email before the beginning of the exam, and bring proof of the circumstance to the Dean of Student's office. Only in the case of official approval from the Dean of Student's office, may a make-up be given at the discretion of the instructor.

A student must show full details when solving a problem during an exam or a quiz. Not showing the work will cause the losing points even if the final answer is correct.

Partial credit can be given for solving the exam and quiz problems, though no partial credit will be given if there are not enough details to follow.

The final answer should be always evaluated with respect to its reasonability. No partial credit will be given if the final answer is wrong and unreasonable, and it is not stated.

If a student misses a quiz due to a legitimate reason (absence approved by the Dean of Students), this quiz is excluded from the quiz average calculation.

Student handwriting must be legible in order to receive points.