Spring 2022

CHE 489-002: Process Dynamics and Control

Sagnik Basuray

CHE 489 – Process Dynamics and Control
Spring Semester 2022

1. Logistics

Instructor: Dr. Sagnik Basuray
365 Tiernan Hall
sbasuray@njit.edu
Webex: Check on Canvas
Class Time: M: 10:00 AM - 11:59 AM
W: 10:00 AM - 11:59 AM
Class Location: KUPF 202 (M) KUPF 207 (W)
Office Hours: WebEx (Time to be discussed during the first class)
Text: 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 primary source for preparing for classes, and reading the textbook before each class is necessary. Hand-outs, lecture notes, and presentations will be available on Canvas
Communication: A Canvas website for the course provides assignments, required materials, and a schedule of lectures. Other than regular office hours, you can meet me anytime by appointment or WebEx.

2. Course Information

DESCRIPTION: 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.
COURSE OBJECTIVES: Taking this course, a motivated student will learn to:

- Define process control objectives, classify processes, and identify process control variables
- Develop mathematical models for chemical processes by applying conservation laws and making reasonable assumptions
- Derive dynamic solutions of process models by applying Laplace transformations
- Develop transfer function models in deviation variables to find open-loop solutions to process models
- Identify nonlinear models in chemical processes and linearize them to find an approximate solution
- Classify characteristic inputs and compute responses of first and second-order models
- Simplify higher-order models using Taylor's and Skogestad's methods.
- Define and classify different controllers and their characteristics
- Design controller and find appropriate controller settings for processes
- 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.
- Deliver a professional oral presentation in a team.
- Participate in collaborative teamwork and learn to establish goals and meet deadlines while recognizing the importance of diversity and ineffective teamwork.
- Model dynamic processes using MATLAB and SIMULINK.

PREREQUISITES: ChE 349; ChE 365
CALCULATOR: A high-end calculator (TI-83, TI-84, or TI-84SE) is required for solving numerical problems.

3. Schedule of Classes, Assignments

Number	Topic (preliminary, subject to minor changes)
1	Ch. 0 – Important Heat and Mass Transfer Models
2	Ch. 1 – Introduction to Process Control
3	Exam 1 – Ch. 0 Important Heat and Mass Transfer Models
4	Ch. 2 – Dynamic Models of Chemical Processes
5	Ch. 3 – Laplace Transforms
6	Exam 2 Review
7	Exam 2
8	Ch. 4 – Transfer Function Models
9	Ch. 5 – Dynamic Response of First Order Systems
10	Ch. 5 – Dynamic Response of Second Order Systems
11	Ch. 6 – Dynamics of Higher Order Systems
12	Exam 3 Review
13	Exam 3
14	Ch. 9 – ControlInstrumentation; Ch. 15.3 – Feedforward Control
15	Ch. 8 – Intro to Feedback Control; Ch. 11.1-2 – Servo/Regulator Problem
16	Ch. 11.3 – Dynamics of Feedback Loops, Project Time
17	Ch. 11.4 – Stability of Closed Loop Systems, Project Time
18	Project Presentations
19	Final Exam Review

Note: The professor reserves the right to change the syllabus as needed. Where necessary, the reading from the book will be supplemented by class notes, reading assignments, and other literature.

4. Course Policies

GRADING

Homework: 10%

Exam 1, Exam 2: Exam 3 (Mid-Terms) 45%

Exam 3: (Finals)	25%
Class Participation including quizes:	10%
Final Project:	10% + 5% (Bonus)

QUIZZES

Regular reading quizzes will be given based on the weekly reading material, including concepts and problems. The quizzes will take place at the end of the class. No make-up quizzes will be allowed. All quizzes will be a closed book with no material allowed.

HOMEWORK

1. Homework assignments will be posted on Canvas.
2. Homework assignments are due one week after they are assigned and must be submitted electronically on Canvas.
3. No late homework will be accepted.
4. Students are encouraged to work together on homework assignments, but you must turn in your own solutions. Also, you must list your collaborators names on the first page of the Problem Set.
5. Any question that requires diagrams, graphs, etc., must be made by you. Do NOT copy and paste a figure from a digital source. However, feel free to draw it using any software.
6. If you use a reference (published paper, textbook, website) to find information, including diagrams, graphs, etc., list the source as a reference at the end of the problem you used it in. Use AIChE style for referencing. Not including a reference where a reference is needed will carry a penalty.
7. Each problem will be graded according to the homework guidelines.
8. Lastly, if I or the TA cannot read your handwriting, I will give your sets a zero. So make sure you write neatly so I can give you the grade you deserve.

Homework Grading Guidelines (will be provided to the Teaching Assistant), the score will be awarded using the following guidelines (adapted from the Chemical Engineering Department at the University of Colorado, Boulder):

10. Problem completely correct as intended, or completely correct based on an interpretation that could be correctly inferred from the problem statement
9. Substantially complete and correct - but with one minor error like arithmetic
8. Substantially complete and correct - but with multiple minor errors or one major error such as a bad assumption
7. Demonstrates acceptable understanding of the problem, and knowledge of the proper method of solution; but the solution is neither complete nor correct
6. Minimum passing grade - appears to understand the problem and have a general idea of the correct method of solution
5. Indication of understanding of the problem, but the wrong approach to solution
4. Indication of understanding of the problem. No solution attempted
3. Indication of an incomplete understanding of the problem. No solution or completely wrong approach.
2. Something on papers such as a diagram or equation not provided in the problem statement
1. Nothing on paper that was not provided in the problem statement

EXAM: There will be three midterm exams (100 min long) and one final exam (2.5 hours long). All exams will be an open book and open notes. Shared or copied notes will be considered a violation of academic integrity. You are allowed to use an e-book. Prior permission is needed to use an e-book or e-notes.

TEAM ASSIGNMENTS & PROJECT: Other assignments will require you to work in teams of up to 3 or 4 students, depending on class size. The instructor will post instructions on how to organize the teams. Details on the project will be provided on Canvas.

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.

GRADES: The grades will be based on the following grading scale:
90 – 100 % A
85 – 90 % B+
80 – 85 % B
70 – 80 % C+
60 – 70 % C
50 – 60% D
<50% F

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 an in-person class during the class hours unless otherwise mandated by NJIT. Attending the class is mandatory. Failure to attend the classes 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. No audio or video recording is allowed.

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

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

Questions regarding grades can be discussed in person by appointment.

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

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

To ensure 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, and Grades

A letter grade is based on the final score, calculated using Canvas in accordance with the Tables given in this syllabus. Therefore, 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 other course activities. However, suppose students miss an exam due to extreme circumstances (such as a medical problem). In that case, they need to notify the instructor via email before 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 instructor's discretion.
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 always be evaluated with respect to its reasonability. Therefore, 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.

Statement of Academic Integrity

Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor.

4. Plagiarism and Academic Integrity

The approved "University Code on Academic Integrity" is currently in effect for all courses. Should a student fail a course due to a violation of academic integrity, they will be assigned the grade of "XF" rather than the "F" and this designation will remain permanently on their transcript.
All students are encouraged to look over the University Code on Academic Integrity and understand this document. Students are expected to uphold the integrity of this institution by reporting any violation of academic integrity to the Office of the Dean of Students.
The identity of the student filing the report will be kept anonymous. NJIT will continue to educate top tier students that are academically sound and are self-disciplined to uphold expected standards of professional integrity. ***Academic dishonesty will not be tolerated at this institution.***