ChE 349

Fall 2025

WELCOME

I would like to welcome you to the ChE 349 "*Kinetics and Reactor Design*" course. During the course of the semester, we will learn the basics of chemical reaction engineering. As chemical engineers, we will learn, (a) the various reactor types, (b) the equations governing their operation, (c) how to size a reactor to achieve an objective (e.g., ensuring the effluent from a reactor treating wastes meets environmental regulations), (d) when it is better to use more than one reactor, (e) the characteristics of isothermal and non-isothermal operation, (f) how to maximize the selectivity towards a desired product when multiple reactions are involved, etc. We will consider cases involving liquids as well as gaseous systems; in the latter case, we will learn how to handle cases of operation under constant pressure as well as under constant volume.

As you read this document for the first time, the amount of the material to be covered and the topics may sound overwhelming and alien. I assure you that, working together we will successfully go through the course and meet its objectives.

I am excited about the opportunity to work with you and have no doubt I will be learning from you and you will be learning from me.

INSTRUCTOR

Dr. Basil C. Baltzis
380 Tiernan Hall
Phone: (973) 596-3619
E-mail address: baltzis@njit.edu

I have been at NJIT for over forty years (!) and have served in a number of academic and administrative positions. Teaching is one of my strong passions and I cannot wait to meet and work with you.

PREPARATION FOR THE COURSE

As per the University catalog, the prerequisites for this course are CHEM 236 (*Physical Chemistry for Chemical Engineers*), CHE 342 (Chemical Engineering *Thermodynamics II*), CHE 370 (*Heat and Mass Transfer*), and MATH 222 (*Differential Equations*).

Any student registered for the class has the qualifications needed to succeed in it. Even if you have forgotten parts of the prerequisite knowledge, we will review essential information together when needed, and I will guide you to review things on your own as well.

Work-Learn-Succeed together, will be the motto for this class.

MEETING TIMES AND VENUES

CLASS

We will be meeting on Mondays and Wednesdays from 1:00 PM to 2:20 PM in Room 208 Kupfrian Hall.

Although attending class is not mandatory, extensive research shows a very strong correlation between class attendance and success in any course. I will do my best to create a class environment such that no one would like to miss any meeting.

DISCUSSIONS BEYOND CLASS

Since my office is too small to accommodate visitors, I will be sitting every Thursday from 3 PM to 4 PM and every Friday from 10 AM to 11 AM in 373 Tiernan Hall and waiting to see any one of you, either individually or in groups that you arrange. You may want to see me to introduce yourself, get to know me better, help me get to know you, develop or sharpen your study skills, go deeper with the course material, get help with content or assignments of the course, or, if you think I can be of help, talk about your studies and plans in general. Please note that I will not be available on February 20, March 27, April 17 (all Thursdays) and Friday, January 31.

In case your class schedule or other responsibilities do not allow you to come on the days and times mentioned above, please feel free to e-mail me whenever you want us to meet and I will be doing my best to find a mutually agreeable day and time.

TEXTBOOK

We will be using “Essentials of Chemical Reaction Engineering,” by H. Scott Fogler, 2nd edition, Pearson Education, Inc. (2018). ISBN-13: 978-0-13-466389-0.

We will be covering material from chapters 1 – 8 and chapter 10. I will be posting the specific sections covered once we will have concluded each chapter.

I understand that the cost of textbooks is substantial and thus, I recommend either renting the textbook of this course or share it with a classmate.

COURSE (STUDENT) OUTCOMES

At the end of the course, students will be able to:

1. Derive the performance equation, both in terms of concentration as well as conversion, for isothermal single reactors (batch, CSTR, PFR) and reactor cascades (CSTRs in series) for constant density single reactions.
2. Derive the performance equation, both in terms of concentration as well as conversion, for isothermal continuous flow reactors (CSTR, PFR) for variable density (gaseous) single reactions.
3. Calculate the required volume of a continuous reactor (CSTR, PFR) to achieve a specified conversion (or exit concentration) based on given operating conditions (temperature, flow rate of supply, composition of feed stream).
4. Calculate the required time of operation of a batch reactor to achieve a specified conversion (or final concentration) based on given loading (initial conditions).
5. Use analytical, graphical and/or numerical tools to minimize the reactor volume required to achieve a specified final conversion (e.g., two CSTRs in series and their size, CSTR followed by PFR, etc.).
6. Maximize the selectivity and/or yield of a desired product in complex reactions by properly sizing a continuous reactor.
7. Use transient mass balances to compute concentration (or conversion) versus time profiles in batch and CSTR reactors.
8. Use graphical and analytical tools to find the proper start-up conditions of a CSTR when multiple stable steady states are possible. Determine the desired steady state (e.g., runaway exothermic reactions).
9. Size a reactor under constraints of productivity maximization and simultaneous minimization of waste formation.
10. Compute the conversion and pressure drop in a continuously operated catalytic reactor loaded with a given amount of catalyst.
11. Derive the energy balance of a continuously operated reactor under steady state conditions.
12. Solve the mass and energy balance to determine the temperature of operation and the conversion achieved in a continuously operated steady state reactor.
13. Investigate various aspects of reaction engineering by working on a term-based team project.

COURSE LOGISTICS AND REQUIREMENTS

IN-CLASS WORK

We will be using an instructor-students interaction mode in class. Students will be members of groups and will be working as teams on various activities. Some of the activities will not be graded (will help with formative assessment) while others will be graded (summative assessment). The dates of graded in-class activities will not be announced ahead of time. The maximum score for an in-class activity will be 100 points.

HOMEWORK

Extensive research shows that practicing the knowledge and skills one acquires helps with better understanding the material, and ensuring they have met the course outcomes. For this reason, homework problems will be assigned. One problem from every homework set will be graded to a maximum of 10 points; the problem to be graded will not be previously announced. You will also be getting 1 point for each (non-graded) homework problem you have worked on. The instructor will generate most problems. This will help you get familiar with my style of writing problems and framing questions and thus, it will help you when you take an exam.

EXAMS

FINAL EXAM

The final exam will take place on the date and time that the Registrar's Office will announce soon. The maximum score on the final exam will be 200 points.

EXAMS DURING THE SEMESTER

There will be three exams during the course of the semester and will take place in class on the following dates:

- Exam 1: February 19, 2025
- Exam 2: March 26, 2025
- Exam 3: April 23, 2025

The maximum score on any of the three exams above will be 200 points.

MAKE-UP EXAM

For those students who will be entitled to take a make-up exam (please see section "Structure" below), it will be held on Reading Day 1 (May 8, 2025) at a time and place to be announced later. The make-up exam will have a maximum score of 200 points.

PROJECT

I will ask you to work on one project for this course and will announce it on April 2, 2025. It will be due on May 5, 2025. You will be working on the project in teams. The teams for the project will be different from the teams for the in-class group activities. On May 5 you will have to submit a detailed technical report and make a brief (7 min) presentation on the project communicating your results to a wider (assuming not only chemical engineers) audience. The maximum score on the project will be 100 points.

COURSE STRUCTURE

The key to success for any team, group of people, or organization is the existence of a structure that supports and guides their activities. This structure is described by some rules (policies) but is also based on (at least a few) fundamental assumptions. Following is a description of the structure for this course.

FUNDAMENTAL PRINCIPLES

My fundamental principles for this course are:

I am here to facilitate your learning and help you succeed.
I have high respect for each and every one of you.
I expect you will be treating all members of our group with respect.
I believe you are here because you want to learn and succeed.
I am convinced you can succeed regardless of hurdles.
I believe you are grown-ups and behave as young (trainee) professionals.
I take it for granted you will behave according to the university code of conduct and academic integrity and that you can always refresh your memory on these matters by going to the university catalog as well as to university websites such as http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf
I value your time and material expenses for this course (and your education in general) and empathize with all difficulties you encounter. I expect you do the same towards all members of our group.
I believe each member of our group brings positive things that will help all members grow to a level of better professionals and human beings.

Our learning and actions in this course will have positive consequences for the societal good.
I will be granting accommodations when contacted by the OARS office.

CLASSROOM POLICES

In class, we will be seating with our teammates.
Class attendance is not mandatory, but if we come, we should be there on time.
If we are late or need to leave class early, we should be entering or leaving the classroom in a non-disruptive way.
If we arrive to class late and a graded in-class activity has started, we will have to wait until the activity ends before we enter. We will not be earning credit for an activity we missed for any reason.
To help us focus on the course, we will not be using our cell phones in class; we will turn them to silent mode and put them aside.
We will be able to use calculators in class (including during exams), but we will not use the calculator function on our smart phone.
We will not be volunteering an answer or making a comment unless we have permission to address the class.
We can use our computer in class to keep notes and record discussion, but we will not be using it for purposes unrelated to this course.

GROUP ACTIVITY POLICIES

For any group activity, we will strive to contribute our best to the team effort. We will have the opportunity to evaluate both our teammates and ourselves for their efforts and contributions; completing these evaluations is not optional. These evaluations will help the instructor differentiate (adjust) the grade each student earns from a group activity; in other words, not all teammates will be necessarily getting the same grade for a group activity.

If we have issues with our teammates, we will be bringing them to the attention of the instructor as soon as possible.

If we have difficulties working in a group, we will be discussing it with the appropriate university office (OARS) and, if approved, we will be getting an accommodation.

HOMEWORK POLICIES

Homework is designed to help prove to ourselves that we have understood the course material. Although it is meant to be an individual activity, we can work with classmates but what we submit must be something we understand and "own." Occasionally, we may be asked to solve a homework problem in class. If we are unable to replicate the solution we submitted, we will not be earning credit for that homework problem.

We will be turning in hard copies of our homework solutions in class on the day a homework set is due.

If we have to miss class on a day a homework set is due, we should be e-mailing it to the instructor before the end of class meeting of that day.

The instructor will be posting solutions to the homework problems immediately after the class meeting. For this reason, submissions after the end of class (hard or soft copies) will not be accepted.

EXAM POLICIES

During any exam, we will be able to use a calculator and two sheets (8.5'' X 11", double sided) of personal notes; not copies of solutions to problems. We will be turning in the notes with the exam booklets. The instructor will be providing the examination booklets.

The instructor will be grading exams and returning them in class at the second meeting after the exam took place.

The instructor will be reporting to the Office of the Dean of Students any violation of the academic integrity code observed during the exam or reasonably suspected during grading of the exams.

A student may miss only one (other than the final) exam and take a make-up exam instead. There must be a health or other serious reason for missing an exam and when it happens, the instructor must be notified no later than the day of the exam. The student should be working with the Office of the Dean of Students (DOS@njit.edu) on this issue. If DOS finds the reasons legitimate, the instructor will be notified and the student will be entitled to taking the make-up exam.

The make-up exam will be comprehensive and will be administered on May 8, 2025 (Reading Day 1) at a location and time to be announced later.

If a student misses two exams, even if both are for reasons approved by DOS, the score for one of them will be zero (the lowest grade on the exams will be dropped anyway; see below).

The final exam will be based on the entire course material (comprehensive). A student missing the final exam without a DOS-approved reason earns a zero on it. A student missing the final exam with a DOS-approved reason gets an Incomplete for the course.

DETERMINATION OF COURSE GRADE

The numerical overall score for the performance in the course will be calculated as follows:

Final Exam	200 points	(20%)
Best score in Exams 1, 2, and 3 multiplied by 2	400 points	(40%)
Second best score in Exams 1, 2, and 3	200 points	(20%)
Project	100 points	(10%)
The average score of in-class activities normalized to 50 points after dropping the lowest score	50 points	(5%)
The average score in homework problems normalized to 50 points after dropping the three lowest scores in graded individual problems	50 points	(5%)

As you can see from the above, there are multiple opportunities to recover from a bad performance on an exam or group activity or some homework problems. The idea here is that we all may suffer a failure but everyone working seriously on something (e.g., on a course) deserves opportunities to recover. The issue here is for you making sure you do not “plan on recovery.” What I mean is do not come to an exam unprepared banking on the fact that the next one will be better. Always and for any activity, try your best!

Based on the foregoing, the maximum numerical score for the course is 1,000 points. Based on the numerical score, letter grades will be assigned as follows:

A	850 points and higher
B+	800 – 849 points
B	750 – 799 points

C+	700 – 749 points
C	650 – 699 points
D	550 – 649 points
F	549 points or less

As you can see, there is no curving of grades and there is no competition for grades. The ideal and the target should be for all students to score at least 850 points and thus, all get an A. Let us all set this target and work for it! Getting close to the ideal goal will be a great individual and team success! Good luck!

NOTE: The grading structure is such that it cannot be programmed in a way to be instantly shown in CANVAS. Thus, the course “score” you will be seeing in CANVAS will not be the actual one. The actual course score and grade will be posted in CANVAS at the end of the semester.