

SYLLABUS
CHEN 4330 KINETICS AND REACTION ENGINEERING
SPRING 2022

Instructor Information

Instructor: Christopher Bowman (Primary)
Office: JSCBB C121
Office phone: 303-492-3247
E-mail: Christopher.Bowman@colorado.edu

Instructor: Joel Kaar (Secondary)
Office: JSCBB C226
Office phone: 303-492-6031
E-mail: joel.kaar@colorado.edu

Instructor: Tayler Hebner (Secondary)
E-mail: tayler.hebner@colorado.edu

Teaching Assistant Information

Advanced TA:	Chris Calo	Christopher.Calo@Colorado.EDU
Ugrad CA:	Jenna Nielson	Jenna.Nielson@Colorado.EDU
Ugrad CA:	Braden Carroll	Braden.Carroll@Colorado.EDU
Ugrad CA:	Cyrus Haas	Cyrus.Haas@Colorado.EDU
Ugrad CA:	Madeleine Cannon	Madeleine.Cannon@Colorado.EDU
Ugrad CA:	Jackson Shropshire	Jackson.Shropshire@Colorado.EDU

Class Times and Information

Lecture: MWF 12:50 pm – 1:40 pm JSCBB A108
Course Website: Canvas will be used for course materials
Announcements: Announcements concerning assignments, exams, clarifications of course notes, etc. will be made by email. To ensure you receive announcements, please be sure to check or forward your colorado.edu email accordingly.

Office Hours

Wednesday	2:30 – 4:30 pm	E1B11
Thursday	2:30 – 4:30 pm	E1B11
Friday	2:30 – 4:30 pm	E1B11

Please use Google form or email Professors Bowman, Kaar or Hebner to schedule individual meetings.

Textbook

Required: *Chemical Reaction Engineering. Third Edition.* O. Levenspiel John Wiley and Sons, 1999.

Course Purpose and Goals

An understanding of chemical reactions and reactors is what distinguishes chemical engineers from all other engineers – and makes us that much more valuable. As such, students in this class will need to achieve specific learning goals associated both with reaction kinetics and with reactor design. Specific learning goals in each of these areas is as follows:

1. Reaction Kinetics

- Knowledge of reaction order, rate constants, and activation energy
- Ability to determine kinetic parameters and mechanisms from an analysis of kinetic data
- Familiarity with techniques used to determine kinetic data
- Knowledge of the effects of catalysts on the reaction mechanism and reaction kinetics
- Ability to use rate determining step and pseudo steady state assumptions to develop kinetic expressions for multiple reaction mechanisms
- Knowledge of how diffusion, mass transfer and heat transfer affect kinetics

2. Reactor Design and Analysis

- Knowledge of mass and energy balances in batch, semibatch, plug flow, and continuous stirred tank reactors under both steady state and unsteady state conditions with emphasis on simultaneous solution of mass and energy balances
- Ability to apply stoichiometry to mass balances and to design reactors with volume and/or density changes
- Ability to solve coupled mass and energy balances both analytically and numerically
- Ability to calculate adiabatic temperature rise
- Knowledge of multiple reactions, multiple reactors, and reversible reactions in reactors of all types including selectivity and yield determination and optimization
- Ability to determine the residence time distribution for a reactor and determine how that effects the conversion and selectivity
- Understanding of the objective of a chemical reactor , its safety aspects and nonlinear behavior, and how the reactor affects the rest of the chemical plant

Prerequisites

CHEN 3010 Chemical Engineering Thermodynamics (minimum grade C-): required

CHEN 3210 Heat and Mass Transfer (minimum grade C-): highly recommended

Course Requirements and Grading Scheme

The breakdown of course grades is as follows:

Midterm Exam #1	20%
Midterm Exam #2	20%
Homework	15%
Quizzes and In Class Assignments	20%
Final Exam	25%

Course Policies

Homework. Homework assignments will normally be posted on the course website on Friday and will generally be *due at midnight* the following Friday unless notified otherwise. Solution sets must be turned in individually through Canvas, although you are encouraged to consult your classmates as needed. Homework will not be accepted late except for special circumstances such as cases of illness or travel in which case the student should contact the instructor *ahead of the due date* to make alternative arrangements. For each assignment, a random subset (~2-3) of the problems will be graded with emphasis on approach rather than final numerical solution. The lowest homework score for the semester will be dropped.

Quizzes and In Class Assignments. Unannounced quizzes will be periodically given in class throughout the semester. The quizzes are intended to assess your knowledge of the current material, which generally will cover the material from the current or previous homework. A total of approximately 5-7 quizzes will be given. *Missed quizzes will not be able to be made up.* The lowest quiz score for the semester will be dropped to account for both excused and unexcused absences. Various in class assignments will also be done during the semester and collected and graded.

Exams. Missed exams can be made up in extreme cases only, including, among others, illness, which requires medical attention, travel, death of a family member, or job interview. In such cases, the student must provide relevant corroborating documentation such as a doctor's note or plane ticket. If you know you will miss an exam, you must make arrangements to make-up the exam *at least two weeks in advance*. As a course policy, *if your score on the final exam is higher than your cumulative average on the two midterms, your score on the final will replace your cumulative midterm average in determining final grades for the course.* The intent of this policy is to provide an opportunity for showing improvement throughout the course as well as a "second chance" to overcome a poor score (including a zero due to a missed exam) on one or more of the midterms. Note that the final exam will be cumulative and thus serve as a gauge of your overall understanding of the material from the course.

Classroom. It is requested that students make every effort to arrive on-time to class such that class can be started as scheduled without interruption. Also, *any discovered incidents of academic dishonesty will be reported* to the Academic Dishonesty Committee of the Department of Chemical and Biological Engineering and to the CU Honor Code Council. Consequences will include receiving a failing grade in the course.

Exam and Review Session Dates

Review Session #1:	Tues 2/22/22 Review session for midterm #1 6-8pm in A115
Midterm Exam #1:	Wed 2/23/22 Midterm #1 6-8pm in A104, A108, A115
Review Session #2:	Tues 4/5/22 Review session for midterm #2 6-8pm in A115
Midterm Exam #2:	Wed 4/6/22 Midterm #2 6-8pm in A104, A108, A115
Final Exam:	Wed 5/4 Final Exam 1:30 -4:00 A108

In exchange for the evening exams, two lectures will be canceled throughout the semester (NOT necessarily near the corresponding exam dates).

University Policies

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

Requirements for COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu).

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed

on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, [reporting options](#), and the support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.

See the [campus policy regarding religious observances](#) for full details.

Schedule - Lectures through April 9 will be joint with CHEN 4830 and co-Taught with Joel Kaar (JK)
Please read the chapters to be covered in lectures BEFORE the dates of the lecture

Day	Date	Class No.	Lecturer	Topic
M	1/10	1	CB/JK	Syllabus, Course Introduction, Learning Goals
W	1/12	2	CB	Introduction and Basic Concepts and Definitions (Chapter 1)
F	1/14	3	JK	Basic Concepts and Batch Reactors (Chapter 2 & 3)
M	1/17	-	N/A	No Class – Martin Luther King Day
W	1/19	4	JK	Batch Reactors (Chapter 3)
F	1/21	5	JK	Batch Reactors (Chapter 3)
M	1/24	6	JK	Batch Reactors (Chapter 3)
W	1/26	7	JK	Ideal Reactors - CSTR (Chapter 4 & 5)
F	1/28	8	JK	Ideal Reactors - CSTR (Chapter 5)
M	1/31	9	TH	Ideal Reactors - PFR (Chapter 5)
W	2/2	10	TH	Ideal Reactors - PFR (Chapter 5)
F	2/4	11	CB	Comparison of Ideal Reactors – CSTR and PFR
M	2/7	12	CB	Reactor Design for Single Reactions (Chapter 6)
W	2/9	13	CB	Reactor Design for Single Reactions (Chapter 6)
F	2/11	14	CB	Reactor Optimization for Single Reactions (Chapter 6)
M	2/14	15	CB	Reactor Optimization for Single Reactions (Chapter 6)
W	2/16	16	JK	Parallel Reactions (Chapter 7)
F	2/18	17	JK	Parallel Reactions (Chapter 7)
M	2/21	18	CB	Reactor Optimization, Review Session for Exam 1 in Evening
W	2/23	19	JK	Potpourri of Reactions (Chapter 8), Midterm #1 (JSCBB A115/A108/A104 7-9 pm)
F	2/25	20	JK	Potpourri of Reactions (Chapter 8)
M	2/28	21	CB	Temperature and Pressure Effects CSTRs (Chapter 9)
W	3/2	22	CB	Temperature and Pressure Effects CSTRs (Chapter 9)
F	3/4	23	CB	Temperature and Pressure Effects CSTRs (Chapter 9)
M	3/7	24	TH	Temperature and Pressure Effects - Batch (Chapter 9)
W	3/9	25	TH	Temperature and Pressure Effects - PFR (Chapter 9)
F	3/11	26	TH	Simulation of Nonisothermal Reactors
M	3/14	27	CB	Simulation of Nonisothermal Reactors
W	3/16	28	CB	Safety in Chemical Reactor Design and Accidents
F	3/18	29	N/A	Class Canceled in Exchange for Evening Exam
M	3/21	-		No Class – Spring Break
W	3/23	-		No Class – Spring Break
F	3/25	-		No Class – Spring Break
M	3/28	30	CB	Nonideal Flow (Chapter 11)
W	3/30	31	CB	Nonideal Flow (Chapter 11)
F	4/1	32	JK	Nonideal Flow Models (Chapters 12-14)
		-		Review Session for Exam 2 in Evening
M	4/4	33	JK	Nonideal Flow (Chapters 11-14)
W	4/6	34	CB	Coupled Heat/Mass Transfer and Reactions (Chapter 17 & 18), Midterm #2 (JSCBB A115/A108/A104 7-9 pm)
F	4/8	35	CB	Coupled Heat/Mass Transfer and Reactions (Chapter 17 & 18)
M	4/11	36	CB	Class Canceled in Exchange for Evening Exam
W	4/13	37	CB	Coupled Heat/Mass Transfer and Reactions (Chapter 18)
F	4/15	38	TH	Polymerization Reactions (notes and handouts)
M	4/18	39	TH	Polymerization Reactions (notes and handouts)
W	4/20	40	TH	Polymerization Reactions (notes and handouts)
F	4/22	41	CB	Biochemical Reactor Design (Chapter 27)
M	4/25	42	CB	Biochemical Reactor Design (Chapter 29&30)
W	4/27	43	CB	Course Review
	5/4			Final exam May 4 1:30 -4:00 A108