SPRING 2025 SYLLABUS
CHEN 4330 KINETICS AND REACTION ENGINEERING

Instructor Information

Instructor: Christopher N. Bowman Office Hours: R 4 – 5 pm
Office: JSCBB C121
E-mail: christopher.bowman@colorado.edu

Co-Instructor: Ben Nelson Office Hours: R 2 – 3 pm (after 2/11)
Office:
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Teaching and Course Assistant Information

Grad ATA: Zachary Mora Zachary.Mora@colorado.edu
Grad TA: Ashbey Manning Ashbey.Manning@colorado.edu
Numerous Undergrad CAs will assist in the course, especially during office hours

Please contact the Advanced TAs with any questions about homework and its grading and solutions.

Class Times and Information

Lectures:	MWF 12:50 pm – 1:40 pm JSCBB A108
Course website:	https://canvas.colorado.edu/
Lecture postings:	Lecture outlines and completed notes will be posted on the Canvas site. We strongly encourage students to attend class and take notes, using the outlines if helpful.
Announcements:	Announcements concerning assignments, exams, clarification of course notes, etc. will be made on Canvas and/or by email. To ensure you receive announcements, please be sure to check or forward your colorado.edu email accordingly.

Office Hours

Wednesday	3:00 – 6:00 pm	JSCBB E1B11
Thursday	4:00 – 6:00 pm	JSCBB E1B11
Friday	3:00 – 6:00 pm	JSCBB E1B11

"Recitation" Thursday 3:00 – 4:00 JSCBB A104 run by Zack Mora

We are delighted to have additional meetings when arranged in advance -- please email Chris or Ben to schedule individual meetings.

Textbook

Required: *Chemical Reaction Engineering. Third Edition.* O. Levenspiel, John Wiley and Sons, 1999. It is available through the CU library website as an eBook on Knovel (link)

Prerequisites

CHEN 3010 Chemical Engineering Thermodynamics (minimum grade C-): required
CHEN 3210 Heat and Mass Transfer (minimum grade C-): required

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 are 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 diffusive and convective heat and mass transfer affect reactions

2. Reactor Design and Analysis

- Knowledge of mass and energy balances in batch, semi-batch, plug-flow, and continuous-stirred-tank reactors under both steady-state and unsteady 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 how it affects 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

Course Requirements and Grading Scheme

The breakdown of course grades is as follows:

Midterm Exam #1	20%		
Midterm Exam #2	20%	Quizzes (daily 10% and extended 5%)	15%
Homework	15%	Final Exam	30%

Canvas will NOT reflect your overall course grade correctly. It will be used to reflect accurately the individual scores for each assignment but is not useful for calculating or showing the overall average due to drops for quizzes and HWs, the exam policy, etc. Please do NOT use canvas's overall average as a reflection of your grade in any way.

Overall course grades will be determined from a curved scale at the end of the semester. There will be a curve in the course (in the students' favor!) overall but individual assignments will not be curved.

Course Policies

Homework. Homework assignments will normally be posted on the course website at least one week in advance and *due via Gradescope at 11:59 pm* on Fridays unless notified otherwise. Solution sets must be turned in individually, although you are encouraged to consult your classmates and course assistants as needed. Homework 0 – 60 min late will have a 10% deduction, and homework 61 – 120 min late will have a 20% deduction. Homework will not be accepted more than two hours late, except for special circumstances such as cases of illness or professional travel, in which case the student should contact an instructor *ahead of the due date* to make alternative arrangements. The lowest homework score for the semester will be dropped, including missed assignments due to excused or unexcused absences.

Quizzes/Participation. Participation quizzes will be given most days, based on lecture content for that day and due on Canvas at 11:59 pm; the lowest score(s) will be dropped depending on the number of daily exercises assigned. There will also be a few extended quizzes, due on Canvas by 11:59 pm. They will assess your knowledge of the material covered in recent lectures and homework and (more importantly) help prepare you for exams. *Missed quizzes will not be able to be made up*. Approximately the lowest 10% of daily quizzes will be dropped though the few extended ones and in class exercises will not be dropped.

Exams. There will be two midterm exams. Missed exams can be made up or waived in extreme cases only, including, among others, illness that requires medical attention, death of a family member, or professional travel. If you know you will miss an exam, please contact one of the instructors *at least two days 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 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 course material.

Classroom & Behavior. It is requested that students make every effort to arrive on-time to class, such that class can be started as scheduled without interruption, and that professional behavior be exhibited at all times. Any demonstration of a lack of professionalism in class or in treatment of faculty, CAs/TAs, or fellow students will result in a sanction for the first instance of up to a letter grade and of failing the class for subsequent instances. Also, *any discovered incidents of academic dishonesty will be reported* to the CU Honor Code Council. Potential sanctions will include receiving a failing grade in the course.

The instructors, assistants and students in this course affirm the value of all individuals and agree to treat one another with equity and respect. Please see the college webpage for our commitment to diversity, equity and inclusion: https://www.colorado.edu/engineering/about/diversity-equity-and-inclusion.

Exam Dates (Review Sessions)
Midterm Exam #1: T February 11th, 6:00-8:00 pm; Review M 2/10/2024 6:00 pm
Midterm Exam #2: M April 7th, 6:00-8:00 pm; Review S 4/6/2024 6:00 pm
Final Exam: W May 7th 1:30 – 4:00 pm; Review in final class period
In exchange for the evening midterm exams, two regular class meetings will be canceled during the semester.

Required Syllabus Statements: see https://www.colorado.edu/academicaffairs/about/policies-customs-guidelines/required-syllabus-statements

Schedule - Lectures through April 9 and on April 25 and 30 will be joint with BIEN 4830
Please read the chapters to be covered in lectures BEFORE the dates of the lecture

Day	Date	Class No.	Lecturer	Topic
M	1/13	1	CB	Syllabus, Course Introduction, Learning Goals
W	1/15	2	CB	Introduction and Basic Concepts and Definitions (Chapter 1)
F	1/17	3	CB	Basic Concepts and Batch Reactors (Chapter 2 & 3)
W	1/22	4	CB	Batch Reactors (Chapter 3)
F	1/24	5	CB	Batch Reactors (Chapter 3)
M	1/27	6	CB	Batch Reactors (Chapter 3)
W	1/29	7	CB	Ideal Reactors - CSTR (Chapter 4 & 5)
F	1/31	8	CB	Ideal Reactors - CSTR (Chapter 5)
M	2/3	9	CB	Ideal Reactors – CSTR and Start PFR (Chapter 5)
W	2/5	10	CB	Ideal Reactors - PFR (Chapter 5)
F	2/7	11	CB	Comparison of Ideal Reactors – CSTR and PFR
M	2/10	12	CB	Reactor Design for Single Reactions (Chapter 6)
T	2/11	-	-	***Midterm #1 (JSCBB A104, A108, B231) 6-8 pm***
W	2/12	13	CB	Reactor Design for Single Reactions (Chapter 6)
F	2/14	14	-	***Class Cancelled in Exchange for Evening Exam***
M	2/17	15	CB	Reactor Optimization for Single Reactions (Chapter 6)
W	2/19	16	CB	Reactor Optimization for Single Reactions (Chapter 6)
F	2/21	17	BN	Parallel Reactions (Chapter 7)
M	2/24	18	BN	Parallel Reactions / Enzymatic and Catalytic Reactions (Chapter 7/8)
W	2/26	19	BN	Enzymatic and Catalytic Reactions (Chapter 8)
F	2/28	20	BN	Numerical Methods in Reactor Design
M	3/3	21	CB	Kinetics of Life
W	3/5	22	CB	Temperature Effects in CSTRs (Chapter 9)
F	3/7	23	CB	Multiple Steady States in CSTRs (Chapter 9)
M	3/10	24	CB	Optimization of CSTRs (Chapter 9)
W	3/12	25	CB	Temperature and Pressure Effects - Batch (Chapter 9)
F	3/14	26	CB	Temperature and Pressure Effects - PFR (Chapter 9)
M	3/17	27	CB	Simulation of Nonisothermal Reactors
W	3/19	28	CB	Safety in Chemical Reactor Design and Accidents
F	3/21	-	-	***Class Canceled in Exchange for Evening Exam***
M	3/31	29	BN	Nonideal Flow (Chapter 11)
W	4/2	30	BN	Nonideal Flow (Chapter 11-14)
F	4/4	31	BN	Nonideal Flow Lumped-parameter Models (Chapter 13-14)
M	4/7	32	CB	Heterogeneous Reactions
M	4/7	-	-	***Midterm #2 (JSCBB A104, A108, B331) 6-8 pm***
W	4/9	33	CB	External Heat and Mass Transfer
F	4/11	34	CB	Coupled Heat/Mass Transfer and Reactions (Chapter 17 & 18)
M	4/14	35	CB	Coupled Heat/Mass Transfer and Reactions (Chapter 17 & 18)
W	4/16	36	CB	Coupled Heat/Mass Transfer and Reactions (Chapter 18)
F	4/18	37	BN	Polymerization Reactions (notes and handouts)
M	4/21	38	BN	Polymerization Reactions (notes and handouts)
W	4/23	39	BN	Polymerization Reactions (notes and handouts)

F	4/25	40	CB	Special Lecture – Greg Bunker (Combined)
M	4/28	41	BN	Biochemical Reactor Design (Selected from Chapters 27, 29 & 30)
W	4/30	42	CB	Course Review (Combined)
W	5/7	-	-	***Final exam 1:30 -4:00***

CB = Chris Bowman; BN = Ben Nelson