SPRING 2026 SYLLABUS
BIEN 4830 BIOKINETICS

Instructor Information

Instructor:	Robert H. Davis	Charlie Nuttelman
Office:	JSCBB D127	JSCBB D1B14
E-mail:	robert.davis@colorado.edu	charles.nuttelman@colorado.edu

Teaching and Course Assistant Information

Advanced TA: Eva Peurrung, eva.peurrung@colorado.edu
Lead CA: Arianna McCarty, arianna.mccarty@colorado.edu
Ugrad CA: Jess Connell, jessica.connell@colorado.edu
Ugrad CA: Sam Dey, aditya.dey@colorado.edu
Ugrad CA: Aslan DeWitt, aslan.dewitt@colorado.edu
Ugrad CA: Andrew Hickman, andrew.hickman@colorado.edu
Ugrad CA: Lizzie Perkins, elizabeth.perkins-1@colorado.edu
Please contact the Advanced TA with any questions about homework and its grading and solutions

Class Times and Information

Lectures:	MW 12:50 – 2:05 pm JSCBB A108 (B231 during 4/6 -4/22)
Course website:	https://canvas.colorado.edu/
Lecture postings:	Lecture outlines and notes will be posted on the Canvas site. Lectures will be recorded, but 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 (Help Sessions)

Wednesday	5:30 – 7:00 pm	JSCBB E1B11
Thursday	4:00 – 6:00 pm	JSCBB E1B11
Friday	12:45 – 2:00 pm	JSCBB E1B11

Professor Davis (W 10:30 – 11:30 am) and Professor Nuttelman (Th 3 – 4 pm) have 1:1 meeting times that may be scheduled via the Google form on Canvas, or you may email them 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 and biological reactions and reactors is what distinguishes chemical and biological engineers from all other engineers – and provides value to the profession and society. As such, students in this class will need to achieve specific learning goals associated both with reaction kinetics and with reactor design.

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

3. Biokinetics and Bioreactors

- Knowledge of enzyme kinetics and cell-growth kinetics

- Ability to analyze and design various types of bioreactors, including batch fermenters, fed-batch bioreactors, continuous cell-culture reactors or chemostats, and perfusion reactors

- Understanding of transport effects in bioreactors

Course Requirements and Grading Scheme

The breakdown of course grades is as follows:

Midterm Exams	40%	Participation questions	7.5%
Mini Project	2.5%	Long Quizzes	5%
Homework	15%	Final Exam	30%

Course Policies

Homework and Mini Project. Homework and mini-project 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. Homework must be prepared and turned in individually, although you may consult your classmates, course assistants, and the internet if needed (direct copying not allowed). Submissions 10 – 60 min late will have a 10% deduction, and submissions 61 – 120 min late will have a 20% deduction. Submissions 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. We will drop the lowest homework score for the semester, including missed assignments due to excused or unexcused absences.

Quizzes/Participation. Participation questions will be given most day via Canvas, based on lecture content for that day; the lowest three scores will be dropped (including absences). There will also be a few take-home quizzes, due on Canvas by 11:59 pm (tentatively scheduled for 2/12, 3/26, 4/23). They will assess your knowledge of the material covered in recent lectures and homework and (more important) help prepare you for exams. *Missed quizzes will not be able to be made up*.

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 for class, such that class can be started as scheduled without interruption, and that COVID-19 safety and professional behavior be exhibited at all times. Any demonstration of a lack of professionalism in class, on Zoom, 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. Sanctions may 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: Th February 19, 7:00-9:00 pm; Review 2/17/2026 4:00 pm
Midterm Exam #2: Th April 2, 7:00-9:00 pm; Review 3/31/2026 4:00 pm
Final Exam: M April 27, 4:30 – 7:00 pm; Review 4/24/2026 12:50 pm (in class)

Required Syllabus Statements: see https://www.colorado.edu/academicaffairs/policies-customs-guidelines/require d-syllabus-statements and the specific version for this course posted on Canvas.

Schedule - Lectures before April 6 will be together with CHEN 4330
Please read the chapters to be covered in lectures BEFORE the dates of the lecture

Day	Date	Class No.	Lecturer	Topic	Reading
M	1/12	1	RD	Introduction & Basic Concepts	Ch. 1 & 2
W	1/14	2	CN	Reaction Mechanisms	Ch. 2 & 3
M	1/19	-	-	*No Class – MLK Day*	-
W	1/21	3	CN	Batch Reactors	Ch. 3
M	1/26	4	CN	Variable Volume Batch Reactors	Ch. 3
W	1/28	5	RD	Continuous Stirred-tank Reactors	Ch. 4 & 5
M	2/2	6	RD	Expansion & Autocatalytic Reactions in CSTRs	Ch. 5
W	2/4	7	CN	Plug-flow Reactors	Ch. 5
M	2/9	8	CN	Batch, CSTR & PFR Comparison & Design	Ch. 6
W	2/11	9	RD	Reactor Profit Optimization	Ch. 6
M	2/16	10	RD/EP	Fed-batch Reactors; Multiple Reactors	Ch. 6
W	2/18	11	RD	Multiple Reactions; Parallel Reactions	Ch. 7
Th	2/19	-	-	***Midterm #1: 7-9 pm***	-
M	2/23	12	RD	Discussion of MT #1; Series Reactions	Ch. 7
W	2/25	13	RD	Series-Parallel Reactions	Ch. 8
M	3/2	14	RD	Kinetics of Life; Numerical Methods (possible guest speakers)	-
W	3/4	15	CN	Temperature Effects in Batch Reactors	Ch. 9
M	3/9	16	CN	Temperature Effects for PFRs & CSTRs	Ch. 9
W	3/11	17	CN	Multiple Steady States in CSTRs	Ch. 9
M	3/16	-	-	Spring Break	-
W	3/18	-	-	Spring Break	-
M	3/23	18	CB/CN	Safety in Reactor Design; Reactor Simulation	-
W	3/25	19	CN	Non-ideal Flow	Ch. 11-14
M	3/30	20	RD/EP	Heterogeneous Reactions & Catalysis (possible guest speakers)	-
W	4/1	21	RD	External Heat and Mass Transfer	-
Th	4/2	-	-	***Midterm #2: 7-9 pm***	-
M	4/6	22	CN	Introduction to Bioreactors; Enzyme Kinetics	Ch. 27, 28
W	4/8	23	CN	Cell Growth Kinetics; Batch Bioreactors	Ch. 29, 30
M	4/13	24	RD	Fed-batch Bioreactors; Chemostats (CSTRs)	Ch. 39, 30
W	4/15	25	RD	Cell Retention & Recycle	-
M	4/20	26	RD	Heat & Mass Transfer in Bioreactors	-
W	4/22	27	RD	Pharmacokinetics	-
F	4/24	28	RD/CN	Course Review	
M	4/27	-	-	***Final Exam: 4:30-7 pm***	-

RD = Robert Davis, CN = Charlie Nuttelman, CB = Chris Bowman, EP = Eva Peurrung
Lectures during 4/6 – 4/22 may be in B231