CHEN 4520: Chemical Process Synthesis
Syllabus ~ Fall 2024

Instructors Trevor Franklin, Assistant Teaching Professor
JSCBB E1B45 trevor.franklin@colorado.edu

Wendy Young, Teaching Professor and Associate Chair
JSCBB D1B20 wendy.young@colorado.edu

Class Email chen4520@colorado.edu

Teaching Assistants

Abby Bole Abigail.Bole@colorado.edu
Daniel Folino Daniel.FolinoJr@colorado.edu
Taskina Jui Taskina.Jui@colorado.edu
Emily Nay Emily.Nay@colorado.edu
Cindy Wong Cindy.Wong@colorado.edu

Lectures

CHEN 4520-001: T/Th 8:30-9:45 am in BIOT A108
CHEN 4520-002: T/Th 10:00-11:15 am in BIOT A108
You must attend your enrolled section in person in order to receive clicker points.

Office Hours

Note: times subject to change due to student need; see Canvas home page for most up to date times.

Mon: 12:15-1:15pm in E1B11
Tues: 1:00-2:00pm in A115
Wed: 1:30-3:00pm in E1B11
7:00-8:00pm in B231 and zoom (address TBD)
Thurs: 5:00-6:00 in B115

Text *Product and Process Design Principles (4th Edition)* by Warren D. Seider, Daniel R. Lewin, J.D. Seader, Soemantri Widagdo, Rafiqul Gani and Ka Ming Ng; 2017 (Wiley)

Prerequisites

CHEN 3010, 3210, 3320 (all C- or higher)
CHEN 3220 "Separations" (C- or higher)
CHEN 4330 "Kinetics" (C- or higher)
This is the 1st course in the capstone design sequence of classes. The Chemical and Biological Engineering Department enforces all pre-requisites.

Course Content

The fall semester CHEN 4520 Chemical Process Synthesis course, along with the spring semester CHEN 4530 Design Projects course, is the *capstone* course sequence in chemical and chemical & biological engineering. The design-synthesis activities, the considerations of numerous options, and the practical application of the fundamentals all need to be integrated from first year courses through to this senior design course. The sequence provides a culmination for all previous chemical and biological engineering courses (transport processes, thermodynamics, reaction kinetics, unit

operations, etc.). Students are expected to know the basics of fluids, heat transfer, separations, and reactor engineering (kinetics). In CHEN 4520, students will be exposed to design of pumps, compressors, heat exchangers, distillation columns (ideal and non-ideal), and chemical reactors (fixed bed and CSTRs). Students will be taught how to select process units and interconnect them in an overall process flowsheet with the primary goal being to find the optimal design conditions for the best possible design scenario among various conceptualized alternatives. With the exception of cost estimation, process economics, heat integration, separation trains, & simulation tools, the material is not new, but the conceptualization approach required to build a process flowsheet will help students to take their understanding of previous subjects to a new and higher level.

Course Objectives

- Provide a culminating major engineering design experience that incorporates appropriate engineering standards and constraints and is based on the knowledge and skills acquired in earlier course work
- Emphasize safety, ethical responsibilities, and impacts of engineering solutions in global, economic, environmental and societal contexts
- Review and apply prerequisite knowledge, including fluid mechanics, heat transfer, separations, and reaction kinetics, in conceptualizing chemical processes
- Complete a well-defined, team-based chemical process design project, including process material and energy balances, equipment design, and economic analysis, and write a detailed project report
- Utilize software and prepare a Gantt chart for team project management
- Set up complex chemical process material and energy balance systems and use commercial chemical and biological process simulation software to solve them and to specify unit operations equipment – software includes Aspen Plus™, Aspen HYSYS™, and SuperPro Designer™
- Employ AutoCAD Plant 3D or other software for schematic diagrams
- Incorporate heat integration methodology for efficiency improvement
- Carry out economic analysis for chemical processes, including capital cost, variable cost, cash flow, and profitability analysis
- Prepare students with working knowledge to carry out a capstone design project in CHEN4530, working with an external liaison

Every student who passes Chemical Process Synthesis, CHEN-4520, will be well-prepared to tackle Design Projects, CHEN-4530, from Day 1. Students will "hit the ground running" and will know exactly how to approach the undefined project problems posed in CHEN-4530.

Simulation, Design, Costing, and Economics Software

Students are expected to know how to carry out spreadsheet type engineering calculations using Microsoft Excel™ or equivalent, as well as how to use differential equation solvers such as Matlab. The process simulation programs Aspen HYSYS™, Aspen Plus™ and Super Pro Designer® will be used extensively throughout the course and for the design projects. It is the responsibility of the students to learn how to use the process simulators and all software programs as needed. Basic instruction will be given for process simulation via tutorials. All of the simulation software is available in the BIOT computer lab A205, in the Engineering Center computer labs, and remotely; remote access instructions will be given separately. Students will also use AutoCAD Plant 3D or other software for flow sheet preparation. Tutorials will be provided. Students are also encouraged to use the many screencasts available for Design on LearnChemE.com.

ABET Student Outcomes Addressed

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(3) an ability to communicate effectively with a range of audiences

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Recording of Lectures and Office Hours

Lectures will be recorded and available on Canvas under "Lecture Videos" on the left sidebar. Class recordings will not be distributed outside the audience of students, instructors, and other class staff. Access to a recording is limited to class participants and staff through one's CU Boulder IdentiKey. Only the course instructors and staff are authorized to record a class; students are not authorized to record a class through any means.

Course Communication

All class slides, extra reading materials, tutorials/homework, and videos will be placed on Canvas for students to download.

Overall Course Grading

Overall Grade Breakdown	Grading Scheme	
10% - Clicker Questions (drop lowest 4)	*90/93.33/100*	*A-, A*
30% - Homework	*80/83.33/86.67/90*	*B-, B, B+*
40% - Design Report	*70/73.33/76.67/80*	*C-, C, C+*
20% - Peer/Instructor Review	*60/63.33/66.67/70*	*D-, D, D+*
	<60	*F*

Homework

NO LATE *GROUP* HOMEWORK WILL BE ACCEPTED FOR ANY REASON because you are on a team; make sure to have a backup and a backup of the backup. When Canvas closes the submission folder, no additional submissions can be made regardless of the reason (for instance, it was done but not turned in; our submitter got sick; turned in the wrong file; missed one file by accident; it took a long time to upload; don't want teammates to suffer because of my mistake).

Talk with the instructors AHEAD OF THE DEADLINE if there are extenuating circumstances warranting a deadline push.

Clicker Questions

Clickers will be used in this course and every student needs one for class; we will NOT be using phones for clickers because of past cheating and because our classroom A108 has poor internet (OIT rates it "Poor" on its scale of Poor, Fair, Good, Great). The lowest four (4) clicker scores will be discarded; note this is 20% of the total lectures with clickers. One point will be awarded for each incorrect answer and two points for correct answers. Each student can only click for themself; if a student is found clicking for another student for any reason both will fail the class. For the structure of the class to provide a high learning value, students need to come prepared by reading the assigned pre-class material shown in the class schedule at the end of this syllabus.

Team Organization

Following the first class, you will receive an invitation via your CU email to complete a survey on a platform called CATME. Please complete the survey by the start of the second class on August 29th. The professors will use your responses to assign groups of 3-4 students (members of a group will all be in the same class section), which will be posted to Canvas. Because teams will be assigned after the first class, switching sections after the start of classes will not be permitted. Instructors maintain the option to reorganize teams as necessary throughout the semester, **potentially resulting in some students working with fewer team members (for instance, on 2- or 3-person teams) or even on their own**.

Peer-Review

Instructors determine the final allocation of points based on observed workloads, but heavily consider peer-review input. It is extremely important that everyone contributes to important aspects of group work. Students do not want to receive poor peer reviews because they did not have a lot of responsibility – take responsibility and come through for the team! Students will be asked to complete three peer- and self-evaluations throughout the semester in order to provide feedback regarding team and personal effort to both the instructors and teammates. It cannot be overemphasized how important it is for the team to be functional and bring out the best in all members.

UNIVERSITY POLICIES

The campus policies can also be found here.

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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 classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Requirements for Infectious Diseases

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all applicable campus policies and public health guidelines to reduce the risk of spreading infectious diseases. If public health conditions require, the university may also invoke related requirements for student conduct and disability accommodation that will apply to this class.

If you feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the guidance of the Centers for Disease Control and Prevention (CDC) for isolation and testing. If you have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home but should follow the guidance of the CDC for masking and testing.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

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.

If you have a required medical isolation for which you require adjustment, please talk with the instructors.

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. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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 Student Conduct & Conflict Resolution: honor@colorado.edu, 303-492-5550. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and support resources can be found on the OIEC website.

Please know that faculty and graduate instructors must inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about resolution options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page.

Religious Holidays

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, please talk with the instructors if there are conflicts.

See the campus policy regarding religious observances for full details.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

Fall, 2024 CHEN-4520 Honor Code

Please turn in the signed Honor Code to Canvas (1st week)

On my honor, as a University of Colorado Boulder student in the Department of Chemical and Biological Engineering, I will neither give nor receive assistance of any kind for CHEN4520 clicker quizzes that is not explicitly authorized by the instructors; nor will I receive unauthorized assistance outside of my team on homework or the final project. I will not attempt to obtain or use any prior year's course project information that may be available to me through personal contacts or organized filing systems whether electronic or paper. I will not utilize any AI such as ChatGPT or Bard in any of my assignments or final report. I will not complete any clicker questions other than my own and I will only click in if I am in the classroom JSCBB A108 during class. I understand that course work submitted by me, if contrived/completed/written in part or in whole by someone other than myself, shall be considered to constitute fraud under the University Honor Code, and will result in the assignment of an 'F' for the entire course. I understand that plagiarism for work will be investigated using software available to the University of Colorado. I understand that 20% of my grade in CHEN 4520 is based on peer-reviews within my team per the guidelines in the Syllabus. I understand that Instructors maintain the option to reorganize teams as necessary, **potentially resulting in some students working with fewer team members or on their own**.

I understand the CHEN-4520 class Honor Code as stipulated herein and understand the ramifications for breaking the code.

_____ Signed

_____ Printed Name

Tentative CHEN 4520 Course Schedule – Fall 2024

SUBJECT TO CHANGE

Week	Tuesday	Thursday
#1 8/27	L01 Intro to the Class; Teamwork (Ch 1)	L02 Process Design, Engineering Standards & Heuristics, Gross Profit (Ch 2 & 6)
#2 9/3	L03 Safety (Ch 3)	L04 HAZOP, P&IDs, Lean Six Sigma & FMEA (Ch 3) HW#1 due 11:59pm Thurs
#3 9/10	L05 Impacts, Regulations & Ethics (Ch 3)	L06 Pumps (Ch 14) HW#2 due 11:59pm Thurs
#4 9/17	L07 Compressors & Heat Exchanger Design (Ch 12)	L08 HX (cont'd) HW#3 Due 11:59pm Thurs
#5 9/24	L09 Separation Tower & Train Design (Ch 9 & 13)	L10 Heat Integration (Ch 11) HW#4 Due 11:59pm Thurs Peer Review #1 Due Fri 9/27 at midnight
#6 10/1	L11 Filtration & Chromatography	L12 Product Design & Batch Processing (Ch 22) HW#5 Due 11:59pm Thurs
#7 10/8	L13 Batch Scheduling (Ch 22)	L14 Reactor Design (Ch 15) HW#6 Due 11:59pm Thurs
#8 10/15	L15 Reactor Design (cont'd) (Ch 15)	L16 Cost Accounting & Capital Estimation; Economics Excel sheet (Ch 16) HW#7 Due 11:59pm Thurs
#9 10/22	L17 Estimating Total Capital Investment (Ch 16)	L18 Cash Flow Analysis & Depreciation (Ch 17) HW#8 Due 11:59pm Thurs
#10 10/29	L19 Profitability Analysis (Ch 17)	L20 Design Project Description; Technical Writing HW#9 Due 11:59pm Thurs Peer Review #2 Due Fri 11/1 at midnight
#11 11/5	No lecture, meeting with groups	No lecture, meeting with groups
#12 11/12	No lecture, meeting with groups	No lecture, meeting with groups
#13 11/19	No lecture, meeting with groups	No lecture, meeting with groups
11/26	Fall Break	Fall Break
#14 12/3	No lecture, meeting with groups	No lecture, meeting with groups
#15 12/10	No lecture, meeting with groups	No lecture, meeting with groups (last day of classes) Design Report Due Thurs, Dec 12 by 11:59 pm
#16	Peer Review #3 Due Sat 12/14 at midnight ~ **No Final**	