PURDUE UNIVERSITY

DAVIDSON SCHOOL
OF CHEMICAL ENGINEERING

Fall 2025

Course Syllabi Packet

The following syllabi were collected from the instructor(s) or through Banner *Course Insights*. Please remember most of these syllabi may be from a previous semester so dates will not align with the Fall 2025 semester.

The Banner *Course Insights* tool is available to you through *myPurdue* and logging in with your Purdue Career Account.

Specific Notes for Fall 2025 Courses:

1) CHE 59700 RSC Rheology of Soft Materials – this is the first time offering this course with Prof. K. Schultz as the instructor. The last time she taught this course she was at Lehigh University and she provided the syllabus that still has Lehigh references. Prof. Schultz's Purdue email is kmschultz@purdue.edu

2) CHE 54300 Polymer Reaction Engr – this is the draft Prof. Hebner provided when this packet was assembled.

3) CHE 59700 Anly Apprch Healthcare Delivery – the course number is now CHE 50200, CRN 27938

Purdue University CHE 20500: Chemical Engineering Calculations, Fall 2024

A. Instructor. Professor Hebner (thebner@purdue.edu) and Professor Morgan (jamorgan@purdue.edu)

B. Catalog Description. Quantitative applications of steady-state mass and energy balances to solve problems involving multi-component systems and multi-unit chemical processes. Single-component and multi-component phase equilibria, single-reaction and multiple-reaction stoichiometry, coupled mass and energy balances, chemical processes involving bypass and recycle streams.

C. Prerequisites. Chemistry 116 or Chemistry 136; Mathematics 161 (or equivalent); Physics 172 (or equivalent)

D. Course Text. *Elementary Principles of Chemical Processes, 4th Edition* **with the WileyPlus account** by R. M. Felder, R. W. Rousseau, and L. G. Bullard. Wiley and Sons, 2016. Purchases can be made through the bookstore or directly from Wiley.

- WileyPLUS Access with downloadable eText ISBN: 9781119498704
- WileyPLUS Access with downloadable eText and Loose Leaf 1 semester ISBN: 9781119760818

E. Course Learning Objectives. It is expected that, by the conclusion of the semester, class participants should be able to:

- Work professionally and ethically as a member of a chemical engineering team.
- State and describe the diverse social, economic, and environmental issues associated with being a chemical engineer.
- Apply the law of conservation of mass and conservation of atomic species in order to solve mass balances in unit operations with and without chemical reactions and with and without recycle streams.
- Determine, using first principles and well-established correlations, the relations between thermodynamic equilibria and multiphase systems.
- Integrate the first law of thermodynamics with the concept of energy balances in unit operations with and without chemical reactions and with and without recycle streams.
- Apply the laws of conservation of mass and energy and thermodynamic equilibrium data in order to formulate solutions for mass and energy flow rates in multi-unit systems.
- Utilize the concepts of transient mass balance problems in order to develop a basis for non-steady state applications.
- Design multi-unit chemical processes using steady-state and transient mass and energy balances in order to create multi-unit operations similar to those in future courses and applications in industry.

F. Course Outcomes. By the end of the course, the student should be able to:

1. Estimate physical properties of real chemical systems (Utilized in CHE 21100, 30600, 34800, 37700, 37800, 42000, 43500, 45000)
2. Evaluate introductory single-component and multi-component phase equilibria and incorporate these concepts into solutions of mass and energy balance problems (Utilized in CHE 21100, 30600, 37800, 43500, 45000)
3. Solve steady state and transient mass and energy balance problems for both reacting and non-reacting systems with or without recycle using analytical and computational methods (Utilized in CHE 21100, 30600, 34800, 37700, 37800, 42000, 43500, 45000, 45600)
4. Work professionally and ethically in teams to solve mass and energy balance problems (Utilized in CHE 30600, 34800, 37700, 37800, 43500, 45000)
5. Identify contemporary chemical engineering problems, including their impact on societal, economic, public welfare, environmental, and global factors (Utilized in CHE 30000, 40000, 42000, 45000)

G. **Davidson School of Chemical Engineering Program Outcomes for ABET.** Graduates of the Charles D. Davidson School of Chemical Engineering at Purdue University will (**bolded items are addressed in this course**):

1. **Apply principles of engineering, science, and mathematics to solve complex chemical engineering problems.**
2. **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. Communicate effectively with a range of audiences.
4. **Recognize ethical and professional responsibilities in chemical engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.**
5. **Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.**
6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. **Acquire and apply new knowledge as needed, using appropriate learning strategies.**

H. **Expectations.** This is a 4 credit hour course, and it is expected that each student will spend a minimum of 12 hours each week (3 hours per credit) outside of lectures working on homework, studying, reading the course text, and completing assessment questions. In many cases, the first year in the university is harder than high school, but it is manageable with noticeably less effort than described above. This class, and all subsequent chemical engineering classes, will be much more challenging, and hence more rewarding, than anything that most students will have seen in previous courses. We encourage you to take studying seriously and establish good study habits (e.g., read the text during the assigned week, practice using additional problems). This will lead to a successful start of the student's chemical engineering career.

I. **Instructors' Commitment.** Your instructors will: (1) be courteous, punctual, well-organized, and prepared for class activities; (2) answer questions clearly in class or through office hours; (3) be available during office hours or notify you beforehand if they are unable to keep to the original office hour schedule; and (4) grade uniformly and consistently to the posted guidelines.

J. **Consulting with the Faculty Members.** We encourage you to discuss academic or personal questions with us during office hours or via email. These discussions need not be limited to CHE 20500 content.

K. **Academic Dishonesty.** Academic dishonesty ***will not be tolerated*** in any form in this course. Specifically, Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Section B-2-a, Code of Student Conduct] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972] All incidents of academic dishonesty will be reported to the Dean of Students. **Such incidents include: (i) possessing or accessing, in hardcopy or electronic form, solutions to the: course text, previous years' homework problems, and exams (e.g., obtaining solutions from websites such as Course Hero, Chegg, Quizlet, etc.); (ii) claiming credit for work that is not your own original work; (iii) enabling other students to create work that is not their original work; and (iv) collaborating with other students (or getting other outside help) during an exam. The punishment for the first offense is a grade of zero for the entire work (exam, quiz, or homework), and the punishment for a second offense is an F mark for the class.**

L. **Academic Integrity.** Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert your instructors and university officials to potential breeches of this value by either emailing integrity@purdue.edu or by calling (765) 494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

M. Student-Initiated Purdue Honors Pledge. As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.

N. Student Professionalism. The highest standards of professionalism and ethics are expected in CHE 20500. Each student is expected to come to class on time and not disrupt the class. Each student is expected to follow Purdue's student conduct code and behave in a professional manner. The rights of students in violation of the code of conduct are outlined on Purdue's website. Each student is expected to exhibit consideration and respect towards the other students, the teaching assistants (TAs), the graders, and the faculty members. Each student is expected to exhibit a positive attitude. Expectations for each student include (but are not limited to):

a. Attending all class sessions.
b. Coming to class on time and prepared by reading assigned material beforehand.
c. Refraining from disrupting class (e.g., turning off or silencing mobile phones, refraining from mobile phone or laptop use during class, and carrying on a loud conversation during class).
d. Maintaining the highest standards of academic honesty and integrity.
e. Being an active contributor to team assignments.
f. Being knowledgeable about the policies and information described in the syllabus.

O. Key Course Dates.

Lectures (in person):	Monday and Wednesday	9:30 a.m. – 11:20 a.m.	MATH 175
Exam 1	Mon 09/23	08:00p - 09:30p	LILY 1105
Exam 2	Mon 10/14	08:00p - 09:30p	PHYS 114
Exam 3	Tue 11/19	8:00p - 09:30p	LILY 1105
Final Exam	To Be Announced, **As Set by the University**		

No Class	9/2	Labor Day
	10/7	Fall break
	11/27	Thanksgiving Break
	10/28, 10/30, 11/25	In lieu of evening exam

Class Drop Deadline with a Withdrawal (W): November 19

P. Emergency Procedure for the MATH building. In the event that the class would need to evacuate MATH (e.g., in the event of a fire alarm), the class should proceed to exit the building and meet by the Beering tribute sculpture. In inclement weather, meet in the lounge inside of BRNG. Do not leave the area as emergency responders will need to count to ensure that all persons have made it from the facility. In the event that we are required to shelter in place (e.g., due to a tornado warning), we will proceed to the appropriate shelter in place area within the basement level of MATH.

Q. Office Hours

a. Professor Hebner thebner@purdue.edu Office: FRNY 2043A)
Office Hours (Location: FRNY B142A): Monday, 3:30 pm – 4:30pm

b. Professor Morgan jamorgan@purdue.edu, Office: FRNY 1053)
Office Hours: Tuesday 1:00 pm – 2:00 pm

c. Zachary Beickman (zbeickma@purdue.edu)
Office Hours (Location: FRNY B142A): Wednesday, 5:30 pm – 7:00 pm

d. Bryan Cruz Delgado (bcruzdel@purdue.edu)
Office Hours (Location: FRNY B142A): Monday, 5:30 pm – 7:00 pm

e. Dylan Fortney (ddfortne@purdue.edu)
Office Hours (Location: FRNY B142A): Tuesday, 5:30 pm – 7:00 pm

R. **Website for Course Information (purdue.brightspace.com/).** This course will use the Brightspace site. The website is limited to enrolled students and will have the syllabus, homework assignments, and other important class information associated with it. To login, use your university name and password. Please check the website regularly for assignments. Important announcements will be posted on the Brightspace page and will not be automatically sent to e-mail. To get an e-mail/text notification of new announcements, follow the directions here.

S. **E-mail.** Occasionally, important class announcements will be disseminated through the class e-mail list. It is your responsibility to regularly check your e-mail every day and to read the e-mails regarding CHE 20500 to receive important class information. E-mail is the preferred mode of contact. Please put CHE 205 in your subject line. If you e-mail the instructors with questions or a request to make an appointment, please allow a minimum of 24 hours for a response during the week or a response by Monday at 5 pm if the e-mail is sent on the weekend.

T. **Assessment of Course Outcomes.** A weighted average grade will be calculated as follows.

Concept Quizzes: 3%	Examinations: 20% each = 60% total
Homework: 15%	Final Examination: 22%

The grading scale will be as follows.

A range: 100 – 85% of the weighted points
B range: 84.9 – 75% of the weighted points
C range: 74.9 – 65% of the weighted points
D range: 64.9 – 55% of the weighted points
F: Less than 55% of the weighted points

If an exam or homework was too difficult (as judged by the faculty instructors), the final course grade may be scaled to a higher value. Grades will never be scaled downward. As a rule, scaling will not be applied. There is no preset distribution of final grades. The grading will reflect demonstrated student capability relative to an absolute performance standard that is expected of all Purdue chemical engineering students, rather than a scale that compares students to a mean performance metric on any evaluation vehicle. In practice, this means the entire class could receive A marks.

U. **Concept Quizzes.** There will be concept quizzes assigned through Wiley Plus. The quizzes are open notes and open book but must be done on your own. You cannot work with others on the quizzes.

V. **Electronic Homework.** Electronic homework will be performed in groups and turned in via Gradescope. ***Begin each problem on a new sheet of paper, and number the pages***. The solution to each problem ***must*** include a picture or flow chart (hand or computer-generated) of the system or problem of interest, a listing of the known quantities and their units of measurement, and a listing of the unknown quantities that must be determined. ***If your solution to a problem does not contain these items, it will not be graded and you will receive a grade of 0 for that problem.*** The homework will be representative of content posed on the midterm and final examinations. As such, the purpose of the homework is to ensure that learners are comfortable with the course content. **Homework solutions will not be posted. It is your responsibility to get help either before the problems are due or after they have been submitted for grading.**

W. **Late Homework.** All assignments are due on the stated date and time given when the homework is assigned. **Late homework will not be accepted.**

X. **Homework Grading.** Homework will be graded on the basis of 10 points per problem. A problem worked perfectly or with 1 or 2 minor errors will get 10 points. A problem with more than 2 minor errors but no major (logic) errors will get 7.5 points. A problem with 1 major error or more than 3 minor errors will get 5 points. A problem with more than 1 major error will get 2.5 points. A problem with no credible effort will get zero points. The assessment of your performance and contribution by your teammates will be used to scale your homework grades. **Your lowest scaled homework score will be dropped**.

Y. Team Evaluations. An ability to function effectively on teams is a learning objective of this course. Students will be assigned to two different teams during the semester to complete homework assignments. The first team pairing will be for the first half of the assignments, and the second team pairing will be for the second half of the assignments. Students will use CATME to submit information used for Team Formation and Peer and Team Evaluations. At the halfway and end points of each team pairing, students will be required to log into CATME and rate their performance as well as the performances of their team members. Each student's point total for the team homework assignments completed in that timeframe will be multiplied by the multiplier to obtain the final point total for those homework assignments. The CATME software will use the evaluations to compute a "multiplier" with a value between 0.00 (very poor contributions to group) and 1.05 (extremely excellent contributions to group) for each group member. If one is interested in how these multipliers are calculated, please see the research papers posted at https://info.catme.org/research/. Note that multipliers of 0.00 are very rare; typically, multipliers are between 0.80 and 1.05.

Z. Homework Cover Page. Each homework assignment must have a cover sheet. A template of the cover sheet is posted on Brightspace (in the Homework module) as a fillable Microsoft Excel sheet. The cover sheet ***must contain*** the printed first and last names of the group members, the date, and the homework assignment number in the appropriate locations. Below this identifying information, the following statement MUST appear:

"Each signature below attests that the signer contributed significantly to the solution of all problems in this homework assignment".

All team members who contributed must sign and print their names next to the signature. The signature and printed names must be clearly legible. IF A TEAMMATE DID NOT PARTICIPATE IN THE SOLUTION OF THE HOMEWORK, THEN THIS TEAMMATE SHOULD NOT SIGN. If multiple groups worked together, indicate that on the cover page. Otherwise, identical solutions will be regarded as cheating. ***If this page is not present, the homework will be awarded a grade of zero and will be returned ungraded. If a team member does not participate in the solution of all the problems on the assignment, that team member will receive a grade of zero on the entire homework assignment.***

AA. Examinations. Timed examinations will be conducted in person. For each examination you will be supplied with one or more pages of relevant equations. You will not be allowed to use any books or notes in addition to these equations pages, which means that all you will be allowed to have on your desk during the examination period is: the exam itself, the notes pages provided, the paper on which you are writing solutions, something with which to write, and a calculator. All other electronic devices are forbidden, including cell phones and pagers. These must be turned off and may not be handled at any time during the exam. Students caught with other materials during an exam will be assumed to be cheating. Remember that no collaboration or outside help is allowed. The final exam is comprehensive (i.e., it will cover the entire contents of the course).

Any student who cannot take an exam as scheduled (e.g., religious holiday, conflicts with another exam) *must* make special arrangements by sending the instructors an e-mail at least one month *before* the exam is given. In cases of extenuating circumstances (e.g., illness, quarantine, bereavement) or extreme duress (e.g., hospitalization), please provide documentation to Prof. Hebner or Prof. Morgan, and if possible, speak to one of the instructors *before* the exam takes place. Travel plans do not constitute extenuating circumstances.

BB. Regrade Requests for Homework and Exams. A student ***has one week after the graded exam or homework has been released*** to submit a regrade request via Gradescope. This is the only means by which to have work re-graded in this course. Any homework assignments or exams submitted for re-grading will be *re-graded in their entirety* and may be marked lower than the original score that was received. For exams, regrade requests will not be accepted until after the exam solutions have been posted and students have compared their solutions to the posted solutions.

CC. Accessibility. Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let us know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: (765) 494-1247. If you are a student with any form of individual learning needs, please speak with the professors whether or not you seek an accommodation so that we are aware of your circumstance and can deliver course content in a manner that is most compatible with your learning situation.

In addition to the University policy, the Davidson School of Chemical Engineering has established procedures for students seeking accommodations. These can be found online at the ChE Undergrad Office website. Only those accommodation requests that conform to both University and ChE policy guidelines will be implemented.

Some important points from the ChE policy include: Please give letters of accommodation to Prof. Hebner, Prof. Morgan, and your academic advisor (and not the graduate TA for office hours). If you have your letter at the start of the term, we strongly recommend you give it to us within the first two weeks of the semester. If your accommodation involves exam conditions, we strongly urge you to provide a minimum of one week notice to ensure that the accommodations requested are available.

DD. Campus Emergencies. In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. ***Here are ways to obtain information about changes in this course. You are expected to check your @purdue.edu email address frequently.***
Course Brightspace Page: Fall 2024 CHE 20500-003 LEC
Instructors' email addresses: thebner@purdue.edu, jamorgan@purdue.edu

EE. Nondiscrimination Statement. Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies and Statements.

FF. Attendance. This course follows the Academic Regulations: Attendance and Office of the Dean of Students: Class Absences policy posted in Brightspace under "University Policies and Statements." This policy states that students are expected to be present for every meeting of the classes in which they are enrolled. It is understood that, occasionally, you may miss lecture due to unforeseen circumstances (e.g., illness – please do not come to class if you are feeling ill), and, in these cases, you can ask any questions about missed concepts during office hours. Unless it falls under the University excused absence regulations (see below), any work due should be submitted on time. In cases falling under excused absence regulations, the student or the student's representative should contact or go to the Office of the Dean of Students (ODOS) website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent medical care.

GG. Illness. If a student becomes sick (e.g., with flu-like symptoms), the student should seek prompt medical attention, and then not come back to class until the student has been symptom-free for more than 24 hours. That is, the student should utilize the resources at the Purdue University Student Health Center (PUSH) or another trained medical professional. Materials will be made available electronically to assist any students who are ill, and reasonable accommodations will be made on an individual basis to ensure that all students have the opportunity to learn. If possible, the student should let Professor Hebner and Professor Morgan know as soon as possible such that they can aid in bringing the student up to speed in the course material as rapidly as possible. In the event of a severe outbreak of illness at Purdue that mandates class not meet, all attempts will be made to deliver the course online.

HH. Mental Health/Wellnes Statement. Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765) 494-6995 during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

II. Basic Needs Security. Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 am - 5 pm Monday through Friday.

JJ. Use of Copyrighted Materials. Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Thus, these materials cannot be posted online (e.g., Chegg, Course Hero, etc.). Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally. Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

KK. Disclaimer. This syllabus is subject to change. If any change occurs, it will be announced in the class and/or posted on Brightspace.

LL. Course Material as Listed by Topic.

1. Materials Balances
   a. Open and Closed Systems
   b. Steady-state Systems
   c. Systems in a Transient State
   d. Multi-unit Systems
   e. Balances on Reactive Systems
   f. Balances on Multiphase Systems
2. Solution Thermodynamics
   a. Raoult's and Henry's Laws
   b. Binary Vapor-Liquid Equilibrium
2. Solution Thermodynamics (Continued)
   c. Binary Liquid-Liquid Equilibrium
   d. Vapor-Liquid-Liquid Equilibrium
3. Energy Balances
   a. First Law of Thermodynamics
   b. Balances on Non-reactive Processes
   c. Balances on Reactive Processes
4. Combined Mass and Energy Balances in Systems in a Transient State

MM. Course Material as Listed by Text Chapter.

Chapters 2, and 3 Engineering Calculations
Chapter 4: Fundamentals of Material Balances
Chapter 5: Single Phase Systems
Chapter 6: Multiphase Systems
Chapter 7: Energy and Energy Balances
Chapter 8: Balances on Nonreactive Processes
Chapter 9: Balances on Reactive Processes
Chapter 10: Balances on Transient Processes

ChE 30600 Design of Staged Separation Processes Fall 2024

A. Instructor:

Professor Enrico Martinez
FRNY G015
(765) 496-6998
marti309@purdue.edu
Office Hours: Tuesdays 4:30-6:00, other times by appointment

B. Teaching assistants:

Chi-Yao Tsao
Annie Sun
Shan Jiang

Office Hours: Fridays 2:00-3:00 pm in Forney 3062A

C. Importance. Separation processes constitute 50% to 90% of the cost (capital and operating) of most chemical plants with distillation being the most commonly used separation method in the chemical and petroleum industries. Separations/mass transfer operations are one of the key items that distinguish chemical engineering from other engineering disciplines.

Classes will meet on Mondays and Wednesdays and some Fridays.

D. Goals. The goal of this course is to apply the principles of mass conservation, energy conservation, phase equilibrium and mass transfer to achieve separations. The concepts and techniques will subsequently be used in ChE 43500 (Chemical Engineering Laboratory) and ChE 45000 (Design and Analysis of Processing Systems). Understanding of separation processes requires a thorough knowledge of mass balances, energy balances, thermodynamics and mass transfer – you must have completed ChE 20500 (C or better) and ChE 21100.

E. Course Objectives. Apply mass balances, energy balances, mass transfer and phase equilibrium to design and analyze separation processes.

F. Course Outcomes.

- Utilize the concepts and relations of phase equilibria, particularly Vapor Liquid Equilibrium, in the analysis, design, and simulation of separation processes (21100→); (→43500, 45000)
- Use mass and energy balances in the analysis of separation processes
- Use the McCabe-Thiele diagram for the solution of problems in binary separations (→43500, 45000)

- Use reflux and multi-stage cascades to increase separation of a given component (20500→); (→43500, 45000)
- Use process simulators for binary and multi-component systems to solve, understand, and design separation processes (→43500, 45000)
- Apply the basic principles of distillation, absorption/stripping, and other unit operations for the solution of problems in separations (21100→); (→37800, 43500, 45000)
- Identify the safety aspects of various separation processes (→42000, 43500, 45000)
- Communicate effectively the results of a designed separation process in writing. (→43500, 45000)

G. Anticipated Course Content

1. Introductory Material..... 1 week

2. Flash Distillation ..... 1 week

3. Binary Distillation ..... 2 weeks

4. Multi-Component Distillation .....2 weeks

5. Complex Distillation Methods ..... 1-2 weeks

6. Batch Distillation ……1 week

7. Staged and Packed Column Design …… 1 week

6. Absorption/Stripping ..... 1-2 weeks

7. Mass Transfer Analysis NTU-HTU Method. 1 week

8. Extraction ..... 1 week

9. Membrane Separations ……..... 2 weeks

10. Adsorption Separations …… 1week

H. Text: P. C. Wankat, *Separation Process Engineering*, 5th edition, Prentice Hall, 2022. Print or e-Book :

9780137468041: Wankat: Separation Process Engineering 5e (Print)
Separation Process Engineering, 5th edition | eTextBook Subscription | Pearson+

I. Software:
During this class, students will gain a working knowledge of the *Aspen Plus* process simulation package.

J. Grading Policy:

Three One Hour Examinations (150 points each) ..... 450 points
Individual Homework Assignments ..... 150 points
Lab Performance/Reports .....150 points
Team Design Project ..... 150 points
TOTAL .....900 points

Course grades will be determined from the adjusted course scores on the following basis:

Adjusted Course Score	**Course Grade**
90 and higher	A- [at least]
80 – 89	B- [at least]
70 – 79	C- [at least]
60 – 69	D- [at least]
Less than 60	F

Course Final grades for this class will be assigned using the +/- system (A+, A, A-, B+, B, etc…)

K. Homework:

Assignments will be posted to Brightspace most Wednesdays after lecture time and are due in completed form by the following Wednesday, beginning of lecture. Late homework will be assessed a penalty of 5 pts if turned in by 6:30 PM. If not received by 6:30, you will receive no credit for that assignment. All late homework should be turned in to one of the teaching assistants. While you may find it helpful to discuss problem sets with one another, *what you turn in must be your own work.* **Written homework's are to be done on Engineering Paper. For team assignments, write the team number and members name on the left top of each page, the course number (CHE 306) at the top middle of each page and the date on the right top of each page. Your homework's are to be neat and legible. Write on one side of the paper only.**

L. Exams

There will be three midterm exams during the semester September 19 at 6:30 pm, October 17 at 8:00 pm and November 21 at 8:00 pm, 50 minutes long all evening exams in WALC 1055.

Occasionally students will have to miss a midterm exam for personal or uncontrollable reasons. However, if an exam needs to me missed, **there will NOT be a makeup exam given during the regular semester**. Instead, the final exam will act as a make-up exam. **PLEASE NOTE**: A student can only miss a midterm exam for a legitimate reason (death in the family, illness, emergency, etc.) and **ONLY** if given permission by Professor Martinez. If a student attends all three exams during the semester, the final exam will not have to be taken.

M. On-line Course Evaluation

It is important for department and instructors to receive thorough feedback on all courses taught, so it is your responsibility to provide such feedback. Participation in the on-line course evaluation is mandatory and will be treated as a homework assignment worth 50 points.

N. Design Project:

There will be one design project in the second half of the semester. The project will be done in teams of 3 students each. Further details of the project will be supplied after the third midterm exam.

O. Student Expectations.

This is a 3-credit hour course, and it is expected that each student will spend 9 hours each week working on homework, studying, and reading the course text (3 hours/credit). This class, and all subsequent chemical engineering classes, will be much more challenging than you are likely used to, and at the same time much more rewarding than anything that most students will have seen before. We encourage you to take studying seriously and establish good study habits such as previewing the reading material ***before*** the lectures and practicing additional problems.

P. Instructors' Commitment.

Your instructor will: 1) be courteous, punctual, well-organized, and prepared for lecture and other class activities; 2) answer questions clearly in class or arrange for detailed discussions out of class if in-class answers are not suitably clear; 3) be available during office hours or notify you beforehand if we are unable to keep them; 4) provide a suitable guest lecturer when we are traveling; and 5) grade uniformly and consistently to the posted guidelines.

Q. Consulting with the Faculty Member.

We encourage you to discuss academic or personal questions with me during my office hours or via email or Hotseat. These discussions need not be limited to ChE 30600 content.

R. Academic Dishonesty.

Academic dishonesty ***will not be tolerated*** in any form in this course. Specifically, Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Section B-2-a, Code of Student Conduct] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15,

1972] All incidents of academic dishonesty will be reported to the Dean of Students. **Such incidents include: i) possessing or accessing, in hardcopy or electronic form, the solution manual to the course text, or to the exams, ii) claiming credit for work that is not your own original work, and iii) enabling other students to create work that is not their original work. The punishment for the first offense is a grade of zero for the entire work (exam or homework), and the punishment for a second offense is an F mark for the class.**

S. Conduct.
University policy states that it is the responsibility of all students to attend all class sessions (http://www.purdue.edu/studentregulations/regulations_procedures/classes.html). Each student is expected to come to class on time and not disrupt the class. Each student is also expected to follow Purdue's codes of student conduct (http://www.purdue.edu/studentregulations/student_conduct/regulations.html) and behave in a professional manner. The rights of students in violation of the code of conduct are outlined. Each student is expected to exhibit consideration and respect towards the other students, the graders, the teaching assistants (TAs), and the faculty member. Each student is expected to exhibit a positive attitude. Your conduct will be a factor in awarding grades to students between two letter grades. Purdue University's student conduct policy specifically addresses academic dishonesty.

T. Violent Behavior Policy.

Purdue University is committed to providing a safe and secure campus environment for members of the University community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent behavior impedes such goals. Therefore, violent behavior is prohibited in or on any University Facility or while participating in any University activity.

U. Nondiscrimination.

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.

W. Emergency Preparedness.
Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, it is important to emphasize the emergency procedures for evacuation and shelter-in-place incidents. Preparedness will be critical if an unexpected event is to occur. Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural
disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. The following is a review of the emergency procedures at Purdue University.

1. For any emergency call 911.

2. There are nearly 300 Emergency Telephone Systems throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected to the PUPD.

3. If there is a fire alarm, we will immediately evacuate the building and proceed to in front of the WALC building. Do not use the elevator.

4. If there is a Shelter-in-Place requirement for a tornado warning, we will shelter in the lowest level of this building away from windows and doors.

5. If there is a Shelter-in-Place requirement for a hazardous materials release, we will shelter in the classroom shutting any open doors and windows.

6. If there is a Shelter-in-Place requirement for a civil disturbance, we will shelter in a room that is securable preferably without windows.

X. Course Meeting Schedule
Lectures: Monday, Wednesday, (some Fridays) 9:30-10:20, ARMS 1010
Lab Sessions: Check Schedule according to your section

Y. Attendance. University policy states that it is the responsibility of all students to attend all class sessions. You are expected to attend all lectures and computer lab periods. iClicker Cloud will be used for class interaction and feedback.
(http://www.purdue.edu/studentregulations/regulations_procedures/classes.html).

Z. Illness. If a student becomes sick with flu-like symptoms, he/she should seek prompt medical attention, and then not come back to class until he/she has been symptom-free for more than 24 hours. A note from P.U.S.H., or another trained medical professional, is required to document illness. Materials will be made available electronically to assist any students who are ill, and reasonable accommodations will be made on an individual basis to ensure that all students have the opportunity to learn. In the event of a severe outbreak of illness at Purdue that mandates class not meet, all attempts will be made to deliver the course online through Brightspace.

AA. Bereavement Policy. Purdue recognizes that a time of bereavement is very difficult for a student. The University therefore provides rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS): http://www.purdue.edu/odos/services/griefabsencepolicyforstudents.php. Students who find themselves in need of assistance in a time of bereavement should contact Professor Bao or Professor Martinez privately to discuss specific needs.

BB. Campus Emergencies. In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructors' control. ***Here are ways to get information about changes in this course. You are expected to check your @purdue.edu email address frequently.***

CC. Individual Learning and Testing Needs.

Any student who feels he/she may need an accommodation with any aspect of the course based on a personal circumstance should contact Professor Martinez privately to discuss his/her specific needs. If you are a student with any form of individual learning needs, please speak with the faculty instructor whether or not you seek an accommodation so that we are aware of your circumstance and can deliver course content in a manner that is most compatible with your situation.

Purdue University ChE 348: Chemical Reaction Engineering (4 cr), Spring 2025

Instructor: Rajamani Gounder (rgounder@purdue.edu, 765-496-7826)
Office Location: 2160 Forney Hall
Office Hours:* Tuesday: 2:00-3:00 pm, FRNY 2142
Wednesday: 11:30am-12:30pm, FRNY 2142

Teaching Assistants: Christopher Dean (dean122@purdue.edu)
Zachary Hillman (zhillma@purdue.edu)
Dhruv Lal (lald@purdue.edu)
Andrew Norfleet (anorfle@purdue.edu)
Office Hours:* Wednesday: 5:00-6:00 pm, HAMP 2117
Thursday: 4:30-5:30 pm, HAMP 2117
Thursday: 5:30-7:30 pm, PHYS 202

*Instructor and TA office hours are subject to change. Please check Brightspace for latest updates.

Class Hours: MWF, 10:30 am-11:20 am, BHEE 170

Recitation Hours:

Recitation Period 1 (DL):	Tue, 9:30 am-10:45 am, HAMP 1266
Recitation Period 2 (AN):	Tue, 11:30 am-12:45 pm, HAMP 1266
Recitation Period 3 (AN):	Tue, 1:30 pm-2:45 pm, STON 215
Recitation Period 4 (ZH):	Thu, 9:30 am-10:45 am, HAMP 1266
Recitation Period 5 (ZH):	Thu, 11:30 am-12:45 pm, HAMP 1266
Recitation Period 6 (CD):	Thu, 1:30 pm-2:45 pm, STON 215

Laboratory Hours:

Lab Period 1 (DL):	Tue, 9:30 am-11:20 am, FRNY G111
Lab Period 2 (AN):	Tue, 11:30 am-1:20 pm, FRNY G111
Lab Period 3 (AN):	Tue, 1:30 pm-3:20 pm, FRNY G111
Lab Period 4 (ZH):	Thu, 9:30 am-11:20 am, FRNY G111
Lab Period 5 (ZH):	Thu, 11:30 am-1:20 pm, FRNY G111
Lab Period 6 (CD):	Thu, 1:30 pm-3:20 pm, FRNY G111

Website: Brightspace (CHE 348). All course materials will be posted on Brightspace. Students are responsible to keep up-to-date with the website. Important and time-sensitive announcements will be e-mailed via Brightspace.

You are expected to read your @purdue.edu e-mail frequently.

Text (Required): H. S. Fogler, Elements of Chemical Reaction Engineering, **SIXTH EDITION**, Prentice Hall, New York. ISBN 0-13-548622-X

Prerequisites: Chemical Engineering 211, Math Selective I, Chemistry 261 (concurrent)

Catalog Description: Application of kinetic rate equations, mass and energy balances to the analysis and design of chemical reactors involving homogeneous and heterogeneous chemical reactions. Chemical equilibria, kinetic rate equations for homogeneous and heterogeneously-catalyzed reactions, design of ideal isothermal reactors, effects of non-isothermal operation, effects of diffusion in porous catalysts, non-ideal mixing in flow reactors.

Course Description: This course will introduce you to topics in: (i) chemical reaction kinetics and (ii) chemical reactor design and operation. Chemical reactors are unit operations that are integral to every chemical process. The combined knowledge of chemical kinetics and reactor design, together with heat and mass transfer, separations, and process control, is what distinguishes you as chemical engineers from the other engineering professions.

This course connects concepts in mass and energy balances (ChE 205), thermodynamics (ChE 211) and momentum, heat and mass transfer. By the end of this course, you will be able to derive rate laws for chemical reactions and model the operation of chemical reactors with different hydrodynamic and heat transfer properties.

Course Objectives: Students should be able to derive equations that describe rates of chemical reactions and heat and mass transfer, and connect them with material and energy balances to model systems in which chemical reactions take place.

Course Outcomes: [*italic numbers in brackets refer to ChE program outcomes for ABET*] (numbers with arrows indicate mapping from/to other ChE courses)

1. Apply fundamental material balances to derive the design equations for CSTR, PFR, PBR, and batch reactors [*1*]. (205→); (→435, 450, 456)
2. Derive rate expressions from both elementary steps and reaction kinetics data for both homogeneous and heterogeneous reactions [*1*]. (→435)
3. Use material and energy balances with kinetic data for both single and multiple reactions to design and analyze the behavior of isothermal and non-isothermal reactors [*1, 2*]. (205, 211→); (→435, 450, 456)
4. Utilize effectiveness factors governing the coupling of reaction and diffusion in the description of heterogeneously catalyzed reactions [*1, 2*]. (→435, 450)
5. Work professionally and ethically in teams to conduct reaction-based laboratory experiments [*3, 5, 6*]. (→435, 450)
6. Effectively report results in written form and practice safety as an integral part of laboratory work [*3, 5, 6*]. (→420, 435, 450)
7. Apply appropriate computational tools for the solution of chemical reaction engineering problems [*1, 7*]. (205, 211→); (→435, 450, 456)

ABET Outcomes: The ABET list of student outcomes for B.S. ChE graduates from Purdue:

1. Apply principles of engineering, science, and mathematics to solve complex chemical engineering problems.
2. 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. Communicate effectively with a range of audiences.
4. Recognize ethical and professional responsibilities in chemical engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Structure: The organization of major course topics (corresponding textbook chapter)

1. Mole balances and basic chemical reactor types (Fogler Ch. 1-2)
2. Chemical kinetics and mechanisms (Fogler Ch. 3, 4, 9)
3. Methods for analysis of rate data (Fogler Ch. 7)
4. Design of reactors for single reactions (Fogler Ch. 5, 6)
5. Energy balances and non-isothermal reactors (Fogler Ch. 11, 12, 13)
6. Design of reactors for multiple reactions (Fogler Ch. 8)
7. Heterogeneous catalysis (Fogler Ch. 10, 14, 15)
8. Residence time distributions and models (Fogler Ch. 16-18)

Course Grades: The final course grade will be determined by the following:

Homework:	15%
Midterm Exams (2):	45%
Final Exam:	30%
Lab Reports:	10%

All grades will be posted to Brightspace and Gradescope so you can monitor your progress during the semester. Grades for individual homeworks, lab reports, and exams will **not** be adjusted by curving or scaling.

There is no preset distribution of final grades. The grading will reflect demonstrated student capability relative to an absolute performance standard that is expected of all Purdue ChE students, rather than a scale or curve that compares students to a mean performance metric on any evaluation vehicle. In practice, this means that if all students in the class demonstrate a high level of mastery of the course content, then all course grades could be A marks.

If your final numerical grade is greater than or equal to the following percentages, your letter grade is guaranteed to be at least:

A: ≥90%
B: ≥80%
C: ≥70%
D: ≥60%

Final numerical grades for the entire class may be scaled up (but never down). Plus and minus modifiers will be used to determine final grades.

Exams:

Midterm 1 (evening): Mon. Feb. 24, 8:00pm-9:15pm, PHYS 112
Midterm 2 (evening): Mon. Apr. 7, 8:00pm-9:15pm, PHYS 112
Final: To be determined by Purdue.
Please do not make travel plans until you know the final exam schedule.

Exams will not be given before or after the scheduled exam period. Absences from a midterm exam will only be excused for a valid reason (e.g., bereavement, illness) with the appropriate documentation and authorization through the Office of the Dean of Students. One makeup midterm (cumulative) will be given in the final week of the semester (4/28/25-5/2/25) for students with an excused absence for either midterm 1 or 2.

Missing any midterm or final exam without a valid reason will result in a zero grade for that exam. Students who miss the final exam for a valid reason that is documented through the Office of the Dean of Students, and who are passing the course at the time, may request an incomplete grade.

Each exam will be comprehensive to-date. Each exam will be closed notes and book, but you will be supplied with a sheet containing useful equations and definitions. All you will be allowed to have on your desk during the exam period is: the exam itself, the notes pages provided, the paper on which you are writing solutions, something to write with, and a calculator. All electronic devices, headphones and devices with communication capabilities (e.g., cell phones), are forbidden. These must be turned off and may not be handled at any time during the exam. Students accessing other materials during an exam will be assumed to be cheating.

Homework:

Homework will be assigned electronically via Gradescope and due on Fridays by 5pm eastern time. Homework solutions will be posted to Brightspace when the Gradescope submission window closes. Late homework submissions will be assigned a zero score.

Your lowest homework grade during the semester will be dropped.

You may discuss the homework assignments and lab reports with other students, but **the final product must be entirely your own work.**

Regrade Requests: A student has one week after an exam or homework has been returned to discuss any grading errors, after which regrade requests will not be possible. Regrade requests on homework must be made through Gradescope.

If a student believes work was misgraded on an exam, a regrade request must be supplied to the TAs and accompanied by a separate sheet of paper that documents the error in question. **This is the only mechanism for addressing potentially misgraded work.** Any papers submitted for re-grading will be re-graded in their entirety and may be marked lower than the original scored that was received.

Re-grade requests will not be accepted until after the homework or exam solutions have been posted and students have compared their solutions to the posted solutions.

Lectures: The tentative course schedule, including lecture topics and the corresponding reading assignment, is given in the course calendar at the end of the syllabus. Lecture periods are held every MWF from 10:30am-11:20am in BHEE 170, except during the holiday and break periods, and the other dates noted in the calendar.

Recitation: There are six recitation periods held each week. You may only attend the recitation section for which you are registered. Recitation will not be held during the weeks of laboratory experiments.

Laboratory: The Fundamentals Laboratory (FRNY G111) will be used to support this course. There are four weeks throughout the semester during which the lab periods, but not recitation, will be held. These lab period dates and the lab report due dates are listed in the calendar at the end of the syllabus.

Lab reports are due one week following the lab experiment, by 5pm eastern time (on the day of your recitation/lab). One lab report per group must be uploaded to Gradescope, and a copy of the report must also be uploaded to Brightspace where it will be checked for plagiarism.

The lab manual containing detailed information about the experiments and lab report guidelines can be found at the following link, and accessed using your Purdue career account login credentials:

https://engineering.purdue.edu/Intranet/Groups/Schools/ChE/FundamentalsLabMaterials

It is important that you read the lab manual one week in advance of your experiment.

In the recitation sessions one week before each lab period, lab teams (typically groups of 3) will be assigned. Part of these recitation sessions will also be spent discussing and preparing for the upcoming lab. After each lab report is turned in, students will be asked to complete peer evaluation forms, which may be used to adjust the lab grades assigned to each team member.

A few reminders:

- Please read, sign and bring the Fundamental Laboratory (FL) safety contract with you on the first day in the FL. You are required to complete the contract each time you start a new course in the FL.

- You are now required to bring your own safety glasses to the FL. The safety glasses should have side shields. You can use the goggles purchased for chemistry labs. If you need to purchase safety glasses, Follett's (across from Mackey Arena on Northwestern) stocks them.

- No coats, backpacks or large bags are allowed into the FL. Students will not be permitted to leave their coats and backpacks outside the FL door, as was permitted in the past. You should have received an e-mail from Sandy Hendryx with your locker assignment for the year and locker combination. If you did not receive an e-mail with this information, please contact Sandy Hendryx (hendryxs@purdue.edu).

- If you miss a lab period for a valid reason, then your grade will be based on averaged grades from the other periods. Please show up 5 minutes early to your lab session. If you show up late to your lab period, you will be dismissed, and there will be no chance to make up missed labs. Missed lab periods without a valid reason will result in a zero grade. If you miss more than two lab periods without a valid reason, then you will be given an I or F grade for the course.

Computer Use: You are expected to use numerical methods programs, such as Polymath, MathCAD, or Matlab, to solve systems of ordinary differential equations and non-linear algebraic equations. In this course, the TAs and instructors will only provide support on Polymath and will provide a short introduction to Polymath during the first week of recitation.

You can access Polymath in one of two ways:

1. Polymath is installed in the FRNY 1022 and 1033 computer labs.
2. Polymath is available on ITaP remote, using the following instructions:
    i. Go to http://goremote.itap.purdue.edu
    ii. Log into Citrix using your Purdue Career account (you can download the Citrix app, or access the light version on the web)
    iii. Search for the Polymath app and open it

Official Purdue University Student Policies

All official up-to-date Purdue University Student Policies can be found on Brightspace. Briefly:

Student Expectations: This is a 4 credit hour course, and it is expected that each student will spend 12 hours each week, including class time, on homework assignments, studying and reading the course textbook.

Student Conduct and Academic Integrity: University policy states that it is the responsibility of all students to attend all class sessions. Each student is expected to come to class on time and not disrupt the class. Each student is expected to follow Purdue's codes of student conduct and behave in a professional manner. The rights of students in violation of the code of conduct are outlined. Each student is expected to exhibit consideration and respect towards the other students, the graders, the teaching assistants, and the faculty. Each student is expected to exhibit a positive attitude. Your conduct will be a factor in awarding grades to students between two letter grades.

Purdue University's student conduct policy specifically addresses academic dishonesty and integrity. All incidents of academic dishonesty will be reported to the Dean of Students. **Such incidents *include*:**

(i) possessing or accessing the solution manual to the course text or to the exams,
(ii) claiming credit for work (either HW or exams) that is not your own original work, and
(iii) enabling another student to create HW or exam work that is not their original work.

Instructors' Commitment: Your instructors will: 1) be courteous, punctual, well-organized, and prepared for lecture and other class activities; 2) answer questions clearly in class or arrange for detailed discussions out of class if in-class answers are not suitably clear; 3) be available during office hours or notify you beforehand if they are unable to keep them; 4) provide a suitable guest lecturer when they are traveling; and 5) grade uniformly and consistently to the posted guidelines. We strongly encourage you to discuss academic or personal questions with the course instructor during office hours or via email. These discussions need not be limited to ChE 348 content.

Use of Copyrighted Materials: Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. All materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor.

ChE 348 – Spring 2025 - Tentative Course Schedule

* Dates on which homework is due at 5pm ET (Gradescope).
** Dates on which lab reports are due at 5pm ET (Gradescope and Brightspace).

Week	Date	Lecture	Topic	Chapter
1	1/13	1	Introduction	Preface
	1/14		*Recitation Period #1A*	
	1/15	2	Definitions of reaction rates, stoichiometry	1
	1/16		*Recitation Period #1B*	
	1/17	3	General mole balance, ideal chemical reactors	1
2	1/20		NO LECTURE (MLK DAY)	
	1/21		*Recitation Period #2A*	
	1/22	4	Conversion, reactor design equations	2
	1/23		*Recitation Period #2B*	
	1/24 *	5	Single reactor design	2
3	1/27	6	Multiple reactor systems	2
	1/28		*Recitation Period #3A*	
	1/29	7	Stoichiometric table, reactions with volume changes	4
	1/30		*Recitation Period #3B*	
	1/31 *	8	Stoichiometric table, reactions with phase changes	4
4	2/3	9	Concepts in chemical kinetics	3
	2/4		*Recitation Period #4A*	
	2/5	10	Reaction rate laws	3
	2/6		*Recitation Period #4B*	
	2/7 *	11	Mechanisms of homogeneous reactions	9
5	2/10	12	Examples of homogeneous reaction mechanisms	9
	2/11		*Lab Period #1A – Reports Due 2/18*	
	2/12	13	Free radical reactions, long chain approximation	9
	2/13		*Lab Period #1B – Reports Due 2/20*	
	2/14 *	14	Methods for analysis of rate data	7
6	2/17	15	Methods for analysis of rate data	7
	2/18 **		*Recitation Period #5A*	
	2/19	16	Isothermal reactor design, equilibrium	4, 5
	2/20 **		*Recitation Period #5B*	
	2/21	17	Pressure drop in reactors	5
7	2/24	18	Recycle reactors	6
	2/24		**MIDTERM EXAM #1 (PHYS 112)**	
	2/25		*Lab Period #2A – Reports Due 3/4*	

	2/26	19	Recycle, membrane, semi-batch reactors	6
	2/27		*Lab Period #2B – Reports Due 3/6*	
	2/28 *	20	Reactor energy balances	11
8	3/3	21	Reactor energy balances	11
	3/4 **		*Recitation Period #6A*	
	3/5	22	Adiabatic reactor design	11
	3/6 **		*Recitation Period #6B*	
	3/7 *	23	Non-adiabatic reactor design	12
9	3/10	24	Multiple steady-states	12
	3/11		*Recitation Period #7A*	
	3/12	25	Multiple steady-states	12
	3/13		*Recitation Period #7B*	
	3/14 *	26	Multiple steady-states, ignition, extinction	12
10	3/17		NO LECTURE (SPRING BREAK)	
	3/19		NO LECTURE (SPRING BREAK)	
	3/21		NO LECTURE (SPRING BREAK)	
11	3/24	27	Reactor runaway and hot spots	12, 13
	3/25		*Lab Period #3A – Reports Due 4/1*	
	3/26	28	Series and parallel reactions	8
	3/27		*Lab Period #3B – Reports Due 4/2*	
	3/28	29	Concepts in heterogeneous catalysis	10
12	3/31	30	Mechanisms of surface-catalyzed reactions	10
	4/1 **		*Recitation Period #8A*	
	4/2	31	Mechanisms of surface-catalyzed reactions	10
	4/3 **		*Recitation Period #8B*	
	4/4 *	32	External mass transfer effects in catalyst particles	14
13	4/7	33	External mass transfer effects in catalyst particles	14
	4/7		**MIDTERM EXAM #2 (PHYS 112)**	
	4/8		*Recitation Period #9A*	
	4/9	34	Internal mass transfer effects in catalyst particles	14
	4/10		*Recitation Period #9B*	
	4/11 *	35	Internal mass transfer effects in catalyst particles	15
14	4/14	36	Internal heat transfer effects in catalyst particles	15
	4/15		*Lab Period #4A – Reports Due 4/22*	
	4/16	37	External heat transfer effects in catalyst particles	15
	4/17		*Lab Period #4B – Reports Due 4/24*	

	4/18 *	38	Residence time distributions and non-ideal flow models	16
15	4/21	39	Residence time distributions and non-ideal flow models	16
	4/22 **		*Recitation Period #10A*	
	4/23	40	Micromixing models (zero-parameter)	17
	4/24 **		*Recitation Period #10B*	
	4/25 *	41	Micromixing models (zero- and one-parameter)	18
16	4/28	42	Course Summary	-
	4/29		*Recitation Period #11A*	
	4/30		SCHEDULED CANCELLATION	
	5/1		*Recitation Period #11B*	
	5/2		SCHEDULED CANCELLATION	
17			**FINAL EXAM - TBD**	

Course Title: Engineering applications of biological molecules (CHE 52300)

Instructor: Chongli Yuan
Room 1154, Forney Hall
Tel: 45824; email cyuan@purdue.edu
Office Hours: by appointment

Classes: Lectures 1:30 – 2:45 MSEE B010

Course Description: This course introduces the engineering applications of biological molecules in different scientific fields. We will discuss the state-of-art recombinant DNA technologies and conduct case-study of their applications in disease treatment, biosensing, nanoelectronics, and computing. The goal of the course is to introduce biotechnology to chemical engineering students and prepare them for research and development work in interdisciplinary environments.

Textbook: Class notes will be disseminated in class.
Prerequisite: Bio230 or equivalent, junior, senior standing and graduate students

Course Objectives: Develop a fundamental understanding of biological molecules and its various applications in different scientific and engineering disciplines.

Course Outcome:
1. Understand the basics concepts of fundamental biological molecules.
2. Understand the basic molecular biology methods to prepare biological molecules.
3. Understand the engineering application of biological molecules.

Course Structure: Lecture The *typical* weekly schedule will be:
Tuesday and Thursday: two lectures
Since the schedule will sometimes deviate from this pattern, follow your detailed course outline.

Assessment:
Grades for the course will be allocated as following
Course Grading: Class participation (25%), team project (25%), final project (50%)
The class session will contain case studies. The case study will be organized as a mock development process of a specific research subject and students will be constantly asked to "make decisions" based on the "current" progress. Active participation from the students is crucial and therefore constitutes 20% of the final grade.
The topics of the final project can be in the broad area of genetic engineering, biotechnology or nanobiotechnology. The topic of the final project needs to be approved by the instructor. The final project includes a written report (6 pages maximum) and an in-class presentation. The following sections need to be included in the final report: (1) Definition of the theme problem; (2) background and literature review; (3) challenges and outlooks; and (4) References. The grade of the final project will be equally weighted between the written report and the presentation.
The course will be graded as follows. Some cut offs may be adjusted depending on the difficulty of the assessment items

Grade	GPA Value	Recommended Range
A	4.0	≥87%
B	3.0	≥77%
C	2.0	≥70%
D	1.0	≥62%
F	0.0	< 60.0

Lecture Notes: Lecture notes will be posted on the blackboard website. Students are encouraged to go through the notes before the lecture.

Ethical Conduct:
Honesty on homework. Your homework answers must reflect your own independent work and thinking. Discussion about homework problems are allowed and encouraged. However, do NOT copy homework and do NOT assist others by making your homework answers available. Any student detected copying or assisting in copying will receive zero credit on the assessment piece.
Honesty on final project. You are expected to work by yourself on your final project. Any usage of published materials needs to be accompanied with proper references. Violations will result in, at least, a failing grade on the assessment piece. Serious cases will result in a failing grade for the course and documentation will be sent to the Dean of Students Office.
No disruption of class. Please turn off cell phones before lecture and recitation sessions. No phone calls and text messaging are allowed in class.

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, Student Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Use of Copyrighted Materials
Students are expected, within the context of the Regulations Governing Student Conduct and other applicable University policies, to act responsibly and ethically by applying the appropriate exception under the Copyright Act to the use of copyrighted works in their activities and studies. The University does not assume legal responsibility for violations of copyright law by students who are not employees of the University.
A Copyrightable Work created by any person subject to this policy primarily to express and preserve scholarship as evidence of academic advancement or academic accomplishment. Such works may include, but are not limited to, scholarly publications, journal articles, research bulletins, monographs, books, plays, poems, musical compositions and other works of artistic imagination, and works of students created in the course of their education, such as exams, projects, theses or dissertations, papers and articles. Please refer to the website below for details
http://www.purdue.edu/policies/academic-research-affairs/ia3.html

Course Syllabus
Week 1-2: General overview of common molecular and cell biology techniques, e.g. cell culture, PCR, gel electrophoresis, protein liquid chromatography and etc.
Week 3-6: CRISPR and related technology. (DNA, RNA and epigenetic editing)
Week 7-10: Single cell analysis. (Microscopy, flow cytometry and image-based data analysis)
Week 11-13: Multi-omics analysis. (RNA- and other sequencing techniques, proteomics and metablomics)
Week 14-15: Final project report

Emergencies
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Relevant changes to this course will be posted onto the course website or can be

obtained by contacting the instructors via email or phone. You are expected to read your @purdue.edu email on a frequent basis. See the University's website for additional information: https://www.purdue.edu/ehps/emergency_preparedness/

Accessibility and Accommodations

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Evaluation Sheet for _____ (Presenter's Name)

	1-Poor, 2-Fair, 3-Good, 4-Very good, 5-Excellent
Clarity (Do you think the problem/concept is well defined and explained?)	
Comprehensiveness (Do you think the presentation has covered all important aspects of the problem/concept?)	
Applicability (Do you feel comfortable using the explained concept to solve a problem or extending the problem solving skills to other similar problems?)	
What will I do differently?	
Additional comments	

Course Expectation:

Please list the biology or biology-related courses that you have already taken.

What do you expect to learn in this class?

Please list the topics that you are most interested in from each Topic areas.

Suggest any topics that you are interested in learning, but are not listed here.

Purdue University CHE 54300 Polymer Reaction Engineering (Polymer Chemistry) – DRAFT SYLLABUS Fall 2025

Instructor: Prof. Tayler Hebner, thebner@purdue.edu

Course Meeting Times: MWF 12:30-1:20 pm, 3 credits
Location: FRNY 1043

Office Hours: TBD

Textbook: George Odian, Principles of Polymerization, 4th edition, 2004

Other useful texts (not used for this class, but good for reference in practice):
Paul Hiemenz and Timothy Lodge, Polymer Chemistry, ISBN 9781466581647
Michael Rubinstein and Ralph Colby, Polymer Physics, ISBN 9780198520597

Course description
This course is an introduction to the chemistry used to create polymers – a foundation that will lead to students being able to synthesize materials with desired physical properties. Technical content will focus on organic chemistry concepts, kinetics of reactions, and molecular structure elements relevant to the design and synthesis of common classes of polymers. Emphasis will be placed on polymerization techniques that are commonly used in laboratory and commercial applications. Students will explore extensions of technical content through discussions of recent literature and completion of a project emphasizing scientific communication and understanding of the broader context of polymer chemistry.

Expected Learning Outcomes
Students will be expected to learn fundamental principles of polymer chemistry, polymer design considerations, and communication skills in this course. Development of understanding of relationships between synthetic methods and correlated polymer properties will be required for successful completion of this course. Students should be able to use the skills developed in this course to extend their knowledge to solving real-world problems through the following specific objectives:

- Select appropriate polymerization reactions and reagents for the synthesis of a polymer with specified properties
- Apply knowledge of reaction kinetics to design polymerization conditions for desired polymer properties
- Identify state-of-the-art and emerging challenges in polymer chemistry at the laboratory scale and industry scale
- Demonstrate fundamental understanding of polymer chemistry through analysis and critique of current literature
- Communicate topics relevant to synthesis and design of polymers to a broad audience via written and oral presentations

Grade Determination

20% Quizzes (10)
30% Project
20% Presentation
20% Literature reviews (10)
10% Participation (lectures and literature discussion)

Course Schedule & Topics Covered
The following topics will be covered in this course on a rolling schedule:

- Introduction to Polymers
- Step Growth Polymerization
- Radical Chain Growth Polymerization
- Emulsion Polymerization
- Cationic Polymerization
- Anionic Polymerization
- Chain Copolymerization
- Ring-Opening Polymerization
- Stereochemistry
- Sustainability of Polymers
- Bonus Topics (tbd based on class interest and as time allows)

Lecture notes will be posted to Canvas *after* each day's class.

Quizzes: Following the completion of each of the 10 core course topics, quiz will be given at the start of the lecture period on the next day of class.

Literature Discussions/Review Assignments
Literature discussions will take place once per week. All students are expected to actively engage and participate in these discussions.

Students are expected to read the assigned journal articles and complete their literature reviews prior to discussions. A template and instructions for these reviews will be provided on Brightspace. Completed review assignments will be due on Brightspace at 12 pm on the day of the corresponding discussion.

Project
The course project will be assigned on the first day of class and due via Canvas submission by 9 am on December 6th. Students will complete the course project on a chosen polymerization topic in groups of 2 or 3. Each group member is expected to contribute an equivalent amount of effort to the work products.

Presentations
Students will give presentations with their project groups on their chosen polymerization topic during the last week of classes. Each group member is expected to contribute an equivalent amount of effort to preparation and presenting.

Late Assignments
Due to the intensive nature of this course and the emphasis on group discussions/presentations related to assignments, late assignments will not be accepted for this course. Failure to submit coursework on time will result in no credit for the assignment.

Group Work
Students are strongly encouraged to work with each other, more advanced students, and the instructor on assignments. However, each student is expected to turn in independent assignments that show evidence of individual thought with the exception of the group project, for which one project will be submitted and students will be asked to provide specific contributions as part of the grading criteria. Sources must be appropriately documented in all assignment submissions.

Accessibility
Purdue University strives to make learning experiences accessible to all participants. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let us know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: (765) 494-1247. If you are a student with any form of individual learning needs, please speak with the professors whether or not you seek an accommodation so that we are aware of your circumstance and can deliver course content in a manner that is most compatible with your learning situation.

In addition to the University policy, the Davidson School of Chemical Engineering has established procedures for students seeking accommodations. These can be found online at the ChE Undergrad Office website. Only those accommodation requests that conform to both University and ChE policy guidelines will be implemented.

Some important points from the ChE policy include: Please give letters of accommodation to Prof. Hebner and your academic advisor. If you have your letter at the start of the term, we strongly recommend you give it to us within the first two weeks of the semester. If your accommodation involves exam conditions, we strongly urge you to provide a minimum of one week notice to ensure that the accommodations requested are available.

Campus Emergencies
In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. ***Here are ways to obtain information about changes in this course. You are expected to check your @purdue.edu email address frequently.***
Course Brightspace Page: Fall 2024 CHE 20500-003 LEC
Email from instructor: thebner@purdue.edu,

Nondiscrimination Statement
Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies and Statements.

Attendance
This course follows the Academic Regulations: Attendance and Office of the Dean of Students: Class Absences policy posted in Brightspace under "University Policies and Statements." This policy states that students are expected to be present for every meeting of the classes in which they are enrolled. It is understood that, occasionally, you may miss lecture due to unforeseen circumstances (e.g., illness – please do not come to class if you are feeling ill), and, in these cases, you can ask any questions about missed concepts during office hours. Unless it falls under the University excused absence regulations (see below), any work due should be submitted on time. In cases falling under excused absence regulations, the student or the student's representative should contact or go to the Office of the Dean of Students (ODOS) website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent medical care.

Illness
If a student becomes sick (e.g., with flu-like symptoms), the student should seek prompt medical attention, and then not come back to class until the student has been symptom-free for more than 24 hours. That is, the student should utilize the resources at the Purdue University Student Health Center (PUSH) or another trained medical professional. Materials will be made available electronically to assist any students who are ill, and reasonable accommodations will be made on an individual basis to ensure that all students have the opportunity to learn. If possible, the student should let Professor Hebner know as soon as possible such that she can aid in bringing the student up to speed in the course material as rapidly as possible. In the event of a severe outbreak of illness at Purdue that mandates class not meet, all attempts will be made to deliver the course online.

Mental Health/Wellnes Statement
Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765) 494-6995 during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

Basic Needs Security
Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 am - 5 pm Monday through Friday.

Use of Copyrighted Materials
Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Thus, these materials cannot be posted online (e.g., Chegg, Course Hero, etc.). Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally. Notes taken in class are, however, generally considered to be “derivative works” of the instructor’s presentations and materials, and they are thus subject to the instructor’s copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Disclaimer
This syllabus is subject to change. If any change occurs, it will be announced in the class and/or posted on Brightspace.

ChE 55300
Pharmaceutical API Process Development and Design
Course Information

Fall 2023

Objective

The development and design of processes for the production of pharmaceutical products involves three important tasks: (1) translation of the recipe for the drug substance (or active pharmaceutical ingredient (API)) that was developed at the laboratory stage to a recipe usable in production; (2) selection, preliminary design, and scale-up of the equipment used to carry out the steps of the recipe; and (3) selection, preliminary design, and scale-up of the equipment used to make the formulation (e.g., tablet or capsule) that is the vehicle for delivery of the API to the patient. In this course the primary focus will be on the engineering methodology which underlies the first two tasks. The lectures on these topics will be supplemented with references from the process systems engineering and pharmaceutical manufacturing literature. The relevant characteristics of the pharmaceutical industry and the key regulatory aspects will also be reviewed. The basic features of batch operations will be discussed and the relative advantages/disadvantages with continuous operation analyzed. The features of common unit operations used in the pharmaceutical industry will reviewed, including batch reaction, solid-liquid separation, crystallization, drying, batch distillation and other separation systems. Both dedicated and multi-product production system design and batch, continuous and hybrid process configurations will be covered. Software for simulation of unit operations (PharmaPY) and process trains will be introduced and used to solve industrially relevant applications. The PharmaPY system is a Python-based framework which has been developed at Purdue University under FDA sponsorship. Use of this system will require rudimentary knowledge of Python. Learning materials and tutorials will be provided as part of the course for those not familiar with Python. The FDA current good manufacturing practices (cGMP) and Design Space concepts will also be reviewed. Recent progress in moving towards continuous processing will be discussed. Case studies will be used to demonstrate the overall design strategy and its operational implementation and to integrate the course material.

Course Organization

Faculty Lecturer: Professor G V Reklaitis
Office: FRNY G027B
reklaiti@purdue.edu
765-494-9662

Guest Lecturers: PharmaPY and Python materials will be presented by members of the PharmaPY development team.
Additionally, there will be one or more industrial guest lectures which may be presented remotely.

Course Materials: There are no required textbooks.

Lecture notes and videos of lectures will be posted on the course Brightspace site. All supplementary reading and reference materials, consisting of articles from the literature and a selection of book chapters will also be made available on the Brightspace site.

Course meetings and consultations:

The class will meet on site in FRNY 1043 on Tuesdays and Thursdays from 1:30 to 2:45 pm. Professor Reklaitis will be available to take questions outside of class time via Webex or Zoom or in office on Tuesdays and Thursdays immediately after the class meeting from 2:45 to 3:30 pm at student's initiative or in response to email. Questions and concern can always be posed via email and every effort will be made to respond to email inquiries within 24 hours of receipt. Additional one-on-one discussions can be scheduled in response to email requests at mutually feasible times.

Schedule of Lecture topics & course-associated activities:

The tentative schedule of lecture topics and lecturers as well as relevant course activities such as help or review sessions will be posted on Brightspace. Course news will be likewise be released via announcements on Brightspace.

Course Requirements:

1. There will be four required assignments on topics such as: basic batch process design, fed-batch reaction, filtration, and crystallization and involving use of PharmaPY. Students are expected to carry out solution to these assignments independently. The assignments will require both written reports and oral presentations in class. Reports should be structured as formal documents, written in good technical English and using figures and tables to present results. Late report submissions can not be accepted without prior arrangement with the instructors.
2. There will be a midterm examination which will be administered as a take-home examination via Brightspace. The exam response can be formulated making use of notes and course materials but students are expected to complete the exam independently. There will be no final examination.
3. There will be a final project required which will be executed by student teams composed of two members and will also require a formal report and oral presentation of project results. The final project will involve the use of PharmaPY to optimize a given process configuration involving batch and/or continuous operations..

Course Grading:

Assignments (4)	50%
Midterm exam:	25%
Final project:	25%

Course policies

- Students are expected to follow Protect Purdue Plan policies, including wearing masks and maintaining distancing when attending on-site class meetings. Please report to the Course Coordinator via email if you are obliged to quarantine.
- It is expected that students will actively follow all lecture presentations, whether on site or remote and will thoroughly review and study all posted reference materials.
- Since non-Purdue guest lecturers may not be able to present on-site, these lectures may be presented remotely but synchronously and thus for those lectures there will be no on-site class meetings.
- If an on-site student has to switch to remote participation, please inform the course coordinator.

Academic Integrity

- Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778.
- Students in this course are expected to subscribe to Purdue's Honor Pledge, "*As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."*
- Dishonesty in the execution of assignments, project or midterm exam constitutes grounds for failure of the course. Cheating, plagiarism and knowlingly furnishing false information are forms of dishonesty.

Emergency Preparedness

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis. Please review the **Emergency Procedures Guidelines** for additional information**.**
https://www.purdue.edu/emergency_preparedness/flipchart/index.html

List of Topics to be covered (typical)

Review of characteristics of the pharmaceutical industry & regulatory aspects
Overview of Pharmaceutical Process Development & Design
Status of relevant engineering software
Batch, hybrid and continuous operation modes and characteristics
Batch reactor design & operation
Reaction calorimetry & reactor safety
Basics of nonlinear parameter estimation
Mixing
Solid-liquid separations
Crystallization
Drying
Batch distillation
Solvent Extraction
Process analytical technology
Impact of API on solid dosage form design
Industrial case studies
Simulation & Optimization of Process Trains

CHE 558 RATE CONTROLLED SEPARATIONS
Fall 2022

INSTRUCTOR: Professor N.-H. Linda Wang
Office: FRNY 1015, Phone 494-4081
E mail: wangn@purdue.edu
Office Hours: To be arranged

LECTURE: MWF 12:30am – 1:20 pm, HAMP 2108

TEXT 1: Wankat, P. C., Separation Process Engineering, Prentice Hall, Fourth Edition. 2017.

TEXT 2: Wankat, P.C., *Rate Controlled Separations*, Blackie Academic & Professional, New York, 1990, Reprinted 1994.

COURSE OBJECTIVES:

1. To develop in-depth understanding of the fundamental concepts and quantitative theories in three important rate-controlled separation techniques: chromatography, membrane separations, and precipitation and crystallization;
2. To develop abilities to learn from reading and discussion and to give presentations and to lead discussion during class;
3. To develop abilities for critical review of key articles in the literature;
4. To develop abilities to use computer simulations to understand complex chromatography processes (optional);
5. To develop abilities in literature search and independent case studies of a separation process with potential applications in producing an important chemical or biochemical; and to present your results in class and in a term paper.

GRADING:

4 Homeworks (5% each)	20%
1 Exam (Take-home)	35%
In-Class Discussion/Teaching	15%
1 Oral Presentation	10%
1 Term Paper	20%
TOTAL	100%

REFERENCE ARTICLES: Lists of key papers on various topics will be posted for review and discussion.

REFERENCE BOOKS:

1. Guiochon, G., S.G. Shirazi, A.M. Katti, *Fundamentals of Preparation and Nonlinear Chromatography,* Academic Press, Boston, 1994. (Most comprehensive text on nonlinear chromatography)
2. Wankat, P.C., *Large Scale Adsorption and Chromatography*, Vol. I and Vol. II, CRC Press, 1986. (Most comprehensive engineering analysis of adsorption and chromatography)
3. Giddings, J.C. *Unified Separation Science*, Wiley, 1991. (Unified treatment of chromatography, electrophoresis, and field-flow fractionation)
4. Bailey, J.E. and D.F. Ollis, *Biochemical Engineering Fundamentals*, 2nd Ed., McGraw Hill, 1979. (Good chapters on biochemical separation)
5. Snyder, L.R. and J.J. Kirkland, *Introduction to Modern Liquid Chromatography*, 2nd Ed., Wiley, 1979. (Most comprehensive treatment of analytical chromatography)
6. King, C.J., *Separation Processes*, 2nd Ed., McGraw Hill, 1980. (In depth discussion on key separation processes; many good problems)
7. Helfferich, F.G. and G. Klein, *Multicomponent Chromatography*. *Theory of Interference*. Marcel Dekker, New York (available from University Microfilms International, Ann Arbor, MI, #2050382) (1970). (The first book on multicomponent chromatography, analyzed using local equilibrium theory (no mass transfer effects).)
8. Aris, R. and N.R. Amundson, *Mathematical Methods in Chemical Engineering, Vol. 2, First Order Partial Differential Equations with Applications*, Prentice-Hall, 1973. (Rigorous mathematical analysis of adsorption/chromatography systems)
9. Ruthven, D.M., *Principles of Adsorption and Adsorption Processes*, Wiley, 1984. (Most comprehensive book on gas phase adsorption)
10. Sherwood, T.K., R.L. Pigford, and C.R. Wilke, *Mass Transfer*, McGraw Hill, 1975. (Good book on mass transfer)
11. Tanford, C., *The Physical Chemistry of Macromolecules*, Wiley, 1961. (Best book on the physical properties of macromolecules)
12. Asenjo, J.A., (ed) *Separation Processes in Biotechnology*, Marcel Dekker, N.Y., 1990. (Comprehensive discussion on biochemical separations).
13. Tien, Chi, Adsorption Calculations and Modeling, Butterworth-Heinemann, Boston, 1994.
14. Committee on Separation Science and Technology, National Research Council, Separation & Purification, Critical Needs and Opportunities, National Academy Press, Washington, D.C., 1987.
15. Nicoud, Roger-Marc, Chromatographic Processes-Modeling, Simulation, and Design, Cambridge University Press, 2015. (Comprehensive discussion on SMB).

CHE 558 TENATIVE OUTLINE

**Reading Notation: §: Chapter; W1: Text1 by Wankat; W2: Text 2 by Wankat 1; R3: Reference 3; R7: Reference 7.

Period	Date	Day	Topic	Reading**	Homework
1	08/22	M	Introduction of Separations; Chromatography	W1 §1 W2 §1, 6, 14	
2	08/24	W	Overview of Chromatography & Applications	W1 §19.1 W2 § 6	
3	08/26	F	Sorbent, Adsorption Equilibrium Solute Movement Theory	W1 §19.2.1 W2 § 6	
4	08/29	M	Linear Theory	W1 §19.2.2	
5	08/31	W	Linear Theories	W1 §19.3; W2 §7 R1 §1-3, 5-6	
6	09/02	F	Nonlinear Theories Shock waves & Diffuse Waves	W1 §19.4; W2 §8	
7	09/05	M	Nonlinear Theories	W2 § 8-11	HW #1
8	09/07	W	Nonlinear Theories		
9	09/09	F	Constant Pattern Solution	R1 § 12	
10	09/12	M	Displacement Chromatography		
11	09/14	W	Ion Exchange	W1 §19.5; W2 §9	
12	09/16	F	Ion Exchange		
13	09/19	M	Ion Exchange		
14	09/21	W	Ion Exchange		HW #2
15	09/23	F	Mass Transfer Effect;	W1 §19.6	
16	09/26	M	Length of Mass Transfer Zone; Bed Utilization	W1 §19.7, 19.8, 19.9	

17	09/28	W	Rate Model Simulations	Handouts	
18	09/30	F	Applications of Simulations		HW#3
19	10/03	M	Surface Diffusion & Pore Diffusion	Handouts	
20	10/05	W	Slow Adsorption or Desorption	Handouts	
21	10/07	F	Aggregation	Handouts	
October Break (Oct. 10-11) No Class					
22	10/12	W	SMB	Handouts	
23	10/14	F	SMB	W § 10	
24	10/17	M	SMB Design	Handouts	
25	10/19	W	SMB		
26	10/21	F	SMB		HW#3
27	10/24	M	Membrane Separations-Intro	W1 §18	
28	10/26	W	Membrane Separations	W2 §12	
29-30	**10/28**	**F**	**Take-home Exam (Due M, Oct. 31)**		
31	10/31	M	Membrane Separations		
32	11/02	W	Membrane Separations		
33	11/04	F	Membrane Separations	W2 § 13	HW#4
34	11/07	M	Membrane Separations		
				Title & Outline of Term Paper Due	
36	11/09	W	Membrane Separations		
37	11/11	F	Membrane Separations		
	11/14	M	**No Class (AIChE meeting)**		

	11/16	W	**No Class (AIChE meeting)**	
38	11/18	F	Precipitation/Crystallization	W1§17; W2 §2
39	11/21	M	Precipitation/Crystallization	W2 §3
	Thanksgiving Vacation (Nov. 23-26)			
40	11/28	M	Crystallization	W2 §3
41	11/30	W	Crystallization	**Presentation slides due**
42	12/02	F	Crystallization	HW#5
43	12/05	M	Term Paper Presentations	
44	12/07	W	Term Paper Presentations	
45	12/09	F	Term Paper Presentation	

Term Paper Due Dec. 12

*Instead of 2 make-up lectures for the 2022 AIChE meeting, we will have a take-home exam (2 hours). Any additional make up lectures, if needed, will be on Saturdays.

**Reading Notation: §: Chapter: W1: Text1 by Wankat; W2: Text 2 by Wankat 1; R3: Reference 3; R7: Reference 7.

Copyright:

"Students may not copy, reproduce or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any work in which they are not the sole or joint author or have not obtained the permission of the author(s)."

Disclaimer:

This syllabus is subject to change. You will be notified of any changes as far in advance as possible via an announcement on Brightspace. Monitor your Purdue email daily for updates.

Course Logistics:

All assignments are due in the beginning of the class on the due date, listed in the Course Schedule.

To encourage you to stay on schedule, 20% of the total points will be deducted for assignments received 1-6 days late; assignments received more than 1 week late will receive 0 points.

An assignment file should be appended by your username, such as "assignment1-kim53.doc." This will make it easier for me to manage assignment files.

Course Information

ChE 56200- Battery Systems Laboratory

Meeting day(s) and time: TBD

Instructor(s) Contact Information

- **Name of the instructor(s):** Prof. Vilas G. Pol
- **Office Location:** FRNY 2146
- **Office Phone Number:** 765-494-0044
- **Purdue Email Address:** vpol@purdue.edu

Office/Consultation hours, times, and location: TBD

Course Description

The Battery Systems Laboratory course introduces undergraduate and graduate students to electrochemistry and electrochemical engineering principles for primary and rechargeable batteries, emphasizing Li-ion technology, primary batteries, nanotechnology integration, and materials design. It covers working principles of conventional systems (Li-ion, Pb-acid) and next-generation technologies (Na-ion, K-ion, solid-state, Li-S), while teaching energy density calculations, fabrication techniques, and testing protocols using engineered electrodes, electrolytes, and separators. Broader discussions address sustainable, cost-effective manufacturing strategies for durable battery systems. This Battery Systems Laboratory course delivers hands-on training in synthesizing battery materials, preparing electrodes, fabricating cells, and testing performance across room, low, and elevated temperatures.

MAJOR TOPICS COVERED:

- Introduction to Energy Storage Systems: Overview, definitions, history, market, theory, thermodynamics, kinetics and safety.
- Challenges of Li-ion Battery Technology, Selection criteria for commercial batteries
- Experimental techniques, Promising cathode materials, Anode materials, Electrolytes, current distribution and related issues
- Electrode slurry preparation, lamination, drying, pressing, manufacturing of coin cell batteries and testing for rate capabilities and long cycle life testing
- Kinetics and thermodynamics of electrochemical reactions
- Beyond Li-ion battery technologies, next generation Li-S batteries, Sodium ion batteries, K-ion batteries will be reviewed.
- Lead acid batteries, Ni-MH batteries
- Primary batteries (Carbon-zinc, Zinc-air, Mg/MnO_2, Zn/HgO, Cd/HgO, Zn/Ag_2O, Zn/O_2, Li-solid cathode, Li-O_2 batteries)
- This Battery Systems Laboratory course offers comprehensive hands-on training in synthesizing battery materials, preparing electrodes, fabricating functional cells, and evaluating performance across room, low, and elevated temperatures for diverse battery chemistries, including lithium-ion and next-generation systems.

Learning Resources, Technology & Texts

- ***Recommended:***
  Handbook of Batteries. 3rd edition Linden and Reddy
  Lithium-Ion Batteries: Science and Technologies, Masaki Yashio, Ralph Brodd, Akiva Kozawa
- **Brightspace learning management system**

Learning Outcomes

This course provides a comprehensive foundation in battery science, technology, and engineering, equipping next-generation researchers to address challenges in lithium-ion batteries (LIBs) and related fields. Students will gain theoretical knowledge and hands-on experience applicable to careers in industries like Apple, Google, and Tesla, national laboratories, or academic roles fostering scientific innovation. Designed for disciplines including MSE, Chemistry, ChE, ME, AAE, Physics, and EE, this advanced elective prepares undergraduate and graduate students with both technical expertise and practical skills for emerging energy storage demands.

Sample language:

"By the end of the course, you will be able to:

1. Identify the battery technologies, understand the basic physical concepts, fundamental operating principles, needs and its social impact.
   - Methods of Evaluation: Quizzes, Participation in weekly discussions, assigned homework

2. Demonstrate the ability of topics understanding and articulation of ideas
   - Methods of Evaluation: Scientific 19 minutes presentations to the class

3. Critique- be able to critically evaluate the utility and viability of technological claims in popular and scientific literature
   - Final exam/research proposal writing skills

Assignments

Your learning will be assessed through participation, homework, a mid-term exam, a scientific presentation, and a final exam or report. Detailed schedules, rubrics, and guidelines for assignments and evaluations will be available on the course website.

Assignments	Due	Points
Participation	Throughout the semester	10
Homework	Twice/Thrice a week	30
Mid-term written Exam	TBD	20
Scientific 19 minutes presentations to the class	See updates on Brightspace	20
Final Exam / Research Proposal	TBD	20
		Total: 100

Syllabus: Catalytic Industrial Processes -CHE 57500

Note - this syllabus is from Fall 2023 and Prof. Miller has indicated it will not significantly change for Fall 2025.

Instructor: Jeff Miller (mill1194@purdue.edu; FRNY 2152)

Short description: A survey course on the process design of major catalytic processes in the refining and petrochemical industries for production of transportation fuels and commodity chemicals.

Rationale: Energy in the form of natural gas, coal and oil are utilized to produce more than 80% of today's energy. This course will discuss the current supply and demand of global energy production. Catalytic process are used primarily to produce transportation fuels and chemicals from petroleum. This course will discuss the chemical composition and specifications for fuels and chemicals and how these are produced at an industrial scale. The process design, catalyst composition and reaction chemistry of the major refining and petrochemical processes will be emphasized. Additionally, the latest catalyst characterization methods, research innovations and industry trends of these processes will be covered. This course is an elective that will benefit those seeking a chemistry or chemical engineering career in the energy and chemical industries.

Course Content

Energy Overview

- Overview of the major energy sources
- Estimates of the energy demand worldwide and regionally and how are these expected to change in the next 25-50 years
- Discussion of developing changes and opportunities in the energy sector

Transportation Fuels

- Molecular compositions of gasoline, diesel and jet fuels
- Overview of the fuel properties of molecular compounds in fuels
- Overview of the regulatory requirements for fuel compositions

Refining Technology Processes (Transportations Fuels Production)

- Overview of petroleum refinery and how these individual process are interconnected
- Overview of Naphtha Reforming, process, chemistry and catalysts
- Overview of Fluid Catalytic Cracking, process, chemistry and catalysts
    - In-depth discussion of zeolite fundamentals and catalytic properties
- Overview of Hydrotreating, process chemistry and catalysts

Auto-Exhaust and Emission Control Catalysts

- Overview of auto emission three-way catalysts
- Overview of diesel emission three-way catalysts
- Regulatory requirements for vehicle exhaust emissions

Petrochemical Processes (Chemical Feedstock Production)

- Overview of Propylene production, process, chemistry and catalysts
- Overview of Aromatics production, process, chemistry and catalysts
- Overview of Ethylene production, process and chemistry

Emerging Technology Developments

- Production of chemicals from biomass
- Production of fuels and chemicals from shale gas

Additional Topics: Catalyst Synthesis and Fundamentals

- Fundamentals of catalyst synthesis
- Commercial Catalyst manufacturing methods
- Single site alkane dehydrogenation catalysts
- Metal alloy catalysts
- Catalyst characterization by MAS NMR, TEM, X-ray spectroscopy, and others
    - Characterization under reaction conditions
- Invited lectures by leading industrial experts, generally senior managers, in 1-2 process technologies covered in this class

Learning Objectives:

1. Understand and analyze the historical, current and potential future roles that hydrocarbons play in the economy for energy, fuels, and chemicals.
2. Understand and compare the ways that energy is used in society, especially the breakdown between electricity/power and fuels. Understand the basic fuel properties of liquid transportation fuels (LPG/LNG, gasoline, diesel and jet).
3. Understand the regulatory requirements, technical specifications and molecular composition of fuels and chemicals.
4. Understand the major refining and petrochemical processes by which hydrocarbons are produced. Additionally, understand the reaction chemistry and role of the catalyst in these chemical transformations.
5. Understand the chemical principles and industrial processes for catalyst manufacture.
6. Understand the structure of the catalytically active site and methods for its determination.
7. Understand the future demands for fuels and chemicals and potential opportunities for changes to the current processes.

CHE 50200: Analytical Approach to Healthcare Delivery (Fall 2024)

A. Instructor. William R. Clark, M.D.

B. Course description. This course provides a "real world" overview of healthcare delivery in the United States (US). The biopharmaceutical industry as the leading medical technology sector is a significant focus - analyses of the research and development, manufacturing, and commercial operations of a typical company are performed. Another highlight of the course is an assessment of a series of critical medical conditions having the highest impact on the US healthcare system. Clinical cases illustrating these conditions along with case studies designed to provide practical examples of healthcare developments and challenges are included. A number of emerging healthcare developments, including precision medicine, artificial intelligence, digital health, and value-based care are addressed. In lieu of examinations, a team project consisting of two oral presentations and a final report is an important aspect of the course.

While the course is relevant to a broad spectrum of students, those planning a career in the healthcare industry may find it particularly useful. The course content is geared especially toward students interested in the biopharmaceutical field.

C. Course requirements. BIOL 23000 or equivalent course is recommended but not mandatory.

D. Instructor Biographical Information: Dr. Clark is a nephrologist (kidney specialist) and chemical engineer by training. He received his M.D. degree along with specialty and sub-specialty training in internal medicine and nephrology, respectively, at Indiana University School of Medicine. In addition, he received both his B.S and M.S. degrees in chemical engineering from Purdue University, at which he is now Professor of Engineering Practice in the Davidson School of Chemical Engineering. Before joining the Purdue faculty, Dr. Clark worked in the medical device (dialysis) industry for more than 20 years in a variety of positions. Dr. Clark continues to serve as a consultant in the medical device industry.

E. Recommended (NOT REQUIRED) Texts.

- *Jonas and Kovner's Health Care Delivery in the United States*, Edited by James R. Knickman and Brian Elbel, Springer, 2019, 12th ed, ISBN: 9780826172723
- *Guyton and Hall Textbook of Medical Physiology*, Edited by John E. Hall, Elsevier, 2016, 13th ed, ISBN: 978-1-4557-7005-2
- *Crowley's An Introduction to Human Disease: Pathology and Pathophysiology Correlations*, Edited by Emily Reisner, Howard Reisner, Jones and Bartlett Learning, 2017, 10th ed, ISBN 978-1284050233

F. Course Learning Outcomes.

- Evaluate the impact of the following conditions, from both a clinical and resource utilization (cost) perspective: coronary artery disease, heart failure, diabetes, cancer, obesity, Alzheimer's disease, chronic kidney disease, stroke, arthritis, sepsis, and acute kidney injury.
- For the biopharmaceutical industry, determine the major components of the drug development process and the manner in which drug pricing factors into the risk/reward equation.
- Assess US health economics by identifying the major cost drivers in the healthcare system (hospital care; physician costs; drugs and other medical products).
- Formulate a basic understanding of the sources of health insurance coverage in the US, including the differences between government-based (Medicare/Medicaid) and commercial payers.
- Explain several evolving trends which have the potential to influence healthcare substantially in the future, including precision medicine, artificial intelligence, digital health, and value-based care.

G. Course Meeting Schedule.

Lectures:	Tuesday/Thursday 3:00-4:15 PM; HAMP 2102
Presentation 1:	October 22: 8:00-10:00 PM (location: FRNY B124)
Presentation 2:	November 25: 8:00-10:00 PM (location: FRNY G124)
Final Report due:	December 11

Early in the semester, students will assemble into groups of 2-3 and choose a high-impact clinical condition to study. Each group will provide two progress updates (Presentations 1 and 2) during the course of the semester in lieu of formal examinations. A complete written summary of each group's assessment (Final Report) will be due at semester's end in lieu of a final examination.

H. Instructor Contact Information.

Professor William R. Clark – Email: clarkw@purdue.edu, Telephone: (765) 496-8647 (office); (317) 691-1438 (cell)
Office: FRNY 1055
Office Hours: TBD

I. Assessment of Course Outcomes. A weighted average grade will be calculated as follows.

Homework assignments (4): 20% of total

#1: assigned September 17/due September 27
#2: assigned September 27/due October 7
#3: assigned October 11/due October 21
#4: assigned November 15/due November 26

Presentations (2): 40% total
Final report: 40% of total

The grading scale will be as follows.

A: 100 – 85% of the weighted points
B: 84.9 – 75% of the weighted points
C: 74.9 – 65% of the weighted points
D: 64.9 – 55% of the weighted points
F: Less than 55% of the weighted points

Note that students with grades within 3 weighted percentage points of either the upper or lower bounds of a grade range listed above will receive a "plus" or "minus" mark, respectively, after his/her score (*e.g.*, scores between 75% and 78% of the total weighted points would earn a B–). Marks of an A– will not be given.

Group projects

Student groups may assess a high-impact clinical condition from the list of those discussed in class or another one (with instructor approval). In either case, each group should plan to meet with Professor Clark before beginning work on the project to set expectations. The assessment will include the clinical characteristics of the disorder along with its causes, demographics, and current treatment – these topics will be presented in Presentation 1. With Professor Clark or another engineering faculty member serving as a mentor, an unmet clinical need for the disorder will be identified along with an engineering-based solution for the problem – these considerations will be the focus of Presentation 2. For a particular disorder, the engineering approach can have a direct clinical effect (e.g., improved medical device treatment) or indirect clinical effect (e.g., novel manufacturing approach for pharmaceuticals).

J. Course Schedule (subject to change)

Lecture	Topic
Lecture 1 (Aug 20)	Introduction and US healthcare system overview
Lecture 2 (Aug 22)	Cardiovascular disease
Lecture 3 (Aug 27)	Obesity
Lecture 4 (Aug 29)	Diabetes
Lecture 5 (Sep 3)	Kidney disease
Lecture 6 (Sep 5)	Clinical case 1
Lecture 7 (Sep 10)	Cancer
Lecture 8 (Sep 12)	Arthritis and autoimmune disease
Lecture 9 (Sep 17)	Neurologic disorders (Alzheimer's disease and stroke)
Lecture 10 (Sep 19)	Chronic liver disease
Lecture 11 (Sep 24)	Critical care medicine (acute kidney injury and sepsis)
Lecture 12 (Sep 26)	Clinical case 2
Lecture 13 (Oct 1)	Biopharmaceutical industry (1)
Lecture 14 (Oct 3)	Biopharmaceutical industry (2)
Lecture 15 (Oct 10)	Biopharmaceutical manufacturing*
Lecture 16 (Oct 15)	Drug discovery*
Lecture 17 (Oct 17)	Medical device industry
Lecture 18 (Oct 22)	Healthcare spending/financing
Lecture 19 (Oct 24)	Health insurance
Lecture 20 (Oct 29)	Case study: technology evolution in healthcare
Lecture 21 (Oct 31)	Clinical research
Lecture 22 (Nov 5)	Emerging healthcare developments (1): precision medicine
Lecture 23 (Nov 7)	Emerging healthcare developments (2): value-based care
Lecture 24 (Nov 12)	Emerging healthcare developments (3): artificial intelligence
Lecture 25 (Nov 14)	Case study: healthcare entrepreneurship*
Lecture 26 (Nov 19)	Emerging healthcare developments (4): digital health*
Lecture 27 (Nov 21)	Case study: Cook Biotech*
Lecture 28 (Nov 26)	The business of medicine/wrap-up
Lecture 29 (Dec 3)	No class**
Lecture 30 (Dec 5)	No class**

*: guest lecturer
**: make-up for evening presentation session

ChE 59700-024: Applied Marketing for Chemical Engineers

Fall 2025, First 8 weeks (8/25/2025-10/12-2025)

Course Information

- Course number and title: CHE 59700-024: Applied Marketing for Chemical Engineers
- Meeting time: Class meets 1:30 to 3:20, Monday, Wednesday and Friday
- Course credit hours **3 credit hours**
- Course information and materials will be available through Brightspace
- Prerequisites: none

Textbook: "Marketing Management" – Phillip Kotler, Kevin Lane Keller, and Alexander Chernov 16th ed.

Instructor Contact Information

Michelle Chutka

Phone: 765-418-1524 (cell)

Email: mchutka@purdue.edu

Office Hours: TBD, or arranged through email

About the Instructor

MICHELLE CHUTKA, M.S. Chemical Engineering

Following a 19-year career in medical devices, Michelle founded SymbioSIS Consulting LLC and is actively supporting medical device companies and other industries, in areas of new product development, manufacturing, and continuous improvement.

In her most recent role at Cook Biotech, Michelle was responsible for strategic direction of the product engineering branch. These teams included early-stage biotechnology platform development, first-generation products seeking clinical trial or FDA clearance, sustaining engineering including support for EU-MDR, as well as device labeling design and regulatory compliance.

Michelle is also passionate about sharing industry experiences and has partnered with Purdue University in a Continuing Lecturer role to design graduate-level coursework for Purdue's Professional Master's Program for Chemical Engineering. Currently, Michelle supports courses related to financial analysis and project management, medical device design and development, and applied marketing principles. She also is the instructor in a section of the Senior Lab ChE 435.

Beyond medical devices, Michelle has experience in the pharmaceutical and automotive industries. She received a Master of Science (M.S.) degree and Bachelor of Science (B.S.) degree in Chemical Engineering from the University of Michigan. She holds US patents 9,827,271 and 10,973,856. Michelle also serves on the Research Review Committee for LittleStar ABA, and volunteers in leadership roles throughout her local community.

Course Description

This course focuses on formulating and implementing marketing management strategies and policies, a task undertaken in most companies at the strategic business unit level. The marketing management process is important at all levels of the organization, regardless of the title applied to the activity. Typically, it is called corporate marketing, strategic marketing, or marketing management. For our purposes, they all involve essentially the same process, even though the actors and activities may differ. The course will provide you with a systematic framework for understanding marketing management and strategy.

Marketing is about identifying and meeting human and social needs. Marketing can also be defined as meeting needs profitably. Marketing management is the science and art of choosing target markets and getting, keeping, and growing customers through creating, delivering, and communicating superior customer value. This course will explore marketing concepts with the goal of helping company executives and managers make decisions. The course will review elements of a marketing strategy, culminating in preparing a marketing plan for a product. The course will enable interaction with several industry representatives with experience in industrial marketing and product management.

The class format will be predominantly case based supported by textbook readings and discussion covering topics listed in the course schedule. Students are expected to read and be familiar with the assigned chapters and supplemental readings before each class and **be active participants in discussion – this point cannot be emphasized enough**. For some classes, a guest speaker will present and lead discussion focused on their experiences and topics that are relevant for marketing management.

Learning Resources, Technology & Textbook

Required Textbook

"Marketing Management" – Phillip Kotler, Kevin Lane Keller, and Alexander Chernov 16th edition

Brightspace Page

You must access the course via Brightspace. It is strongly suggested that you explore and become familiar with the site navigation if you have not already done so.

Instruction

This course will be offered in a live format. There will be times as deemed necessary by the instructor when the class will convene remotely via Teams in order to host remote guest speakers, etc. Attendance will be monitored for all scheduled classes. There may be times where the instructor requires a conversion to a synchronous online or an asynchronous online format, at which point a lecture will be provided via Teams or pre-recorded.

Course Goals

The goal of this course is to develop the knowledge and skills in the essential aspects of marketing management, marketing strategy, and emerging marketing applications, with a focus on the development and execution of programs, audits, and plans. The student should come away with an understanding and appreciation of the concepts of marketing as it pertains to engineering careers and the intersection of marketing and engineering roles.

Objectives

This course is concerned with the development, evaluation, and implementation of marketing management in complex environments. The course deals primarily with an in-depth analysis of a variety of concepts, theories, facts, analytical procedures, techniques, and models. The course addresses strategic issues such as:

- What business should we be in?
- What are our long-term objectives?
- What is our sustainable marketing competitive advantage?
- Should we diversify?
- How should marketing resources be allocated?
- What marketing opportunities and threats do we face?
- What are our marketing organizational strengths and weaknesses?
- What are our marketing strategic alternatives?

To ensure that students have a solid foundation of the fundamental marketing decision-making tools and management of all the elements of the marketing plan, students will be provided the opportunity to apply marketing planning and decision-making skills through an in-depth semester-long project.

Assignments and Grading Scale

The final grade will be based on:

• Participation (100 points). While participation is of course required and expected in all aspects of this course - preparation for and participation during in-class discussion is paramount to success in this course!!!

• Team evaluations (100 points). Teamwork is critical in business and there will be a group evaluation

• Writing assignments/Quizzes (200 points) Individual work; quizzes are auto-graded

• Marketing Plan and Team Presentation (200 points) These are group exercises

• Final Paper (100 points) – individually written; original work only!

All assignments will be shared and collected/uploaded to Brightspace as instructed. Due dates will be shared on Brightspace.

Grades will reflect the sum of your achievement of learning outcomes throughout the semester. You will be graded and accumulate points proportionally as described above, with each assignment graded accordingly. At the end of the semester, final grades will be calculated by adding points earned and translating those into the following letters (there will be no partial points or rounding).

A range: 90 – 100% of the weighted grade

B range: 80 – 89% of the weighted grade

C range: 65 – 79% of the weighted grade

D range: 50 – 64% of the weighted grade

F Less than – 50% of the weighted grade

For the marketing plan and team presentations, members of the class will be divided into groups of four-people who will collaboratively work on a plan as assigned. Each group will prepare team presentations to be given during the last week of classes. More details about the expectations for the plan and presentations will be provided in class. Teamwork is an important element of the grade. Each student will have the opportunity to evaluate and to be evaluated by peers. Even if a team earns the maximum grade for the report, if a teammate's contribution is evaluated by its peers to be inadequate, that student will not earn the maximum grade.

Students are expected to read the chapters and articles assigned for every lecture. There will be regular quizzes/written assignments through Brightspace.

The final write-up assignment will be brief but will be reflective of each individual's work. This is also where you may freely comment and reflect on your team's work styles and improvement opportunities. This write

up must be your own work and plagiarism will result in a zero points grade for both the original work author and all individuals involved in the plagiarism event.

Missed or Late Work

All work is expected to be completed and submitted on time. Late submissions will be penalized by 50% of the grade for each day it is late. Failure to complete an assignment after 48 hrs will result in a zero score, even for final papers or other large portions of the grade.

Academic dishonesty will be dealt with accordingly as per university policy, with escalations through the department as deemed appropriate.

Course Schedule

The course will start on August 25 and end on Oct 10th. Labor Day holiday is observed as a non-lecture day. A separate document is available with the course schedule and assignment due dates via Brightspace.

Attendance

This course follows Purdue's academic regulations regarding attendance, which states that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance will be taken at the beginning of each class and lateness will be noted. When conflicts or absences can be anticipated, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification to the instructor is not possible, the student should contact the instructor as soon as possible by email or phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases falling under excused absence regulations, the student or the student's representative should contact or go to the Office of the Dean of Students (ODOS) website to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted **by ODOS** for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent or urgent care medical care.

Classroom Guidance Regarding Protect Purdue

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines.

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Nondiscrimination Statement

A link to Purdue's nondiscrimination policy is included in Brightspace and can also be found here.

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity.

Accessibility

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

Mental Health Statement

If you need support and information about mental health options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructor via email. You are expected to read your @purdue.edu email on a frequent basis.

Related Considerations and Guidelines

1. For Guidelines on Academic Integrity that have been shared with the instructor – Please see (Appendix A)

2. A supplement (see Appendix B) at the end of this document provides resources to communicate or engage with students in case of unexpected emergencies that affect the West Lafayette campus. Emergency notification is vital!

Appendix A - Guidelines for Academic Integrity

In a society that increasingly questions the value of higher education, upholding academic integrity takes on added significance. The time and effort necessary to champion high expectations of academic integrity are well understood, and the University is in full support of faculty and instructors who uphold these standards. Please consider these five steps for your class.

1. Define academic dishonesty for your class in your syllabus and emphasize it on the first day of class. The OSRR website offers a faculty guide on responding to academic dishonesty. Revisit your expectations at key junctures of the semester (e.g., before an exam or term project).

2. Provide greater clarity to students about what is acceptable and unacceptable. Some classes routinely use team assignments and encourage collaboration for projects, labs, or homework. Yet at other times of the term, students are expected to work independently. Be very clear about your expectations for each assignment.

3. Students should be told prior to – and as part of – the instructions on each test what is acceptable in terms of notes, phones, calculators, etc. From class to class our practices vary widely so, here again, it's important to be very clear in your expectations.

4. Define penalties that will be enforced for academic dishonesty. One example might be:

Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered.

5. At a minimum, if you penalize a student's grade by deducting points, report the instance of scholastic dishonesty using the OSRR reporting form. Reporting all incidents helps to ensure consistent treatment both at the course level and across the institution. Staff members from OSRR are available to consult on an individual basis. Their phone is 765-494-1250.

6. While faculty and instructors have raised concerns about student academic integrity, students have indicated that some instructors appear reluctant to uphold academic standards. Be clear in your syllabus on the steps you will take in your class to uphold academic integrity. In addition, students should be made aware that they can report issues of academic integrity that they observe, and may do so anonymously, through the OSRR by calling 765-494-8778 or emailing integrity@purdue.edu.

Appendix B: Emergency Preparedness Face-to-Face

1. Prior to the first day of class, obtain a copy of the building emergency plan for each building in which you will be teaching. Note the evacuation route and assembly area, as well as the shelter in place locations. BEPs are located on the Emergency Preparedness website.

2. On the first day of class, the following information is required to be presented to students:

1) As we begin this semester, I want to take a few minutes and discuss emergency preparedness. While COVID-19 is currently a major focus of our campus health and safety preparations, we must also take time to be prepared for other possible emergencies as we would in any semester. Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, just as we receive a "safety briefing" each time we get on an aircraft, we want to emphasize our emergency procedures for evacuation and shelter-in-place incidents. Our preparedness will be critical IF an unexpected event occurs!

2) Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let's review the following procedure

• For any emergency text or call 911.

• There are more than 300 Emergency Telephones (aka blue lights) throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected right away.

• If we hear a fire alarm, we will immediately evacuate the building and proceed to the space outside. Do not use the elevator. Go over the evacuation route (see specific Building Emergency Plan).

• If we are notified of a Shelter in Place requirement for a tornado warning we will stop classroom activities and shelter in the lowest level of this building away from windows and doors. Our preferred location is the basement.

• If we are notified of a Shelter in Place requirement for a hazardous materials release, we will shelter in our classroom shutting any open doors and windows.

• If we are notified of a Shelter in Place requirement for an active threat such as a shooting, we will shelter in a room that is securable preferably without windows.

Purdue University
CHE 597 Industrial Chemical Technology
Fall 2024, Tue-Thu 1:30-2:45, FRNY 1043

Instructor: Jeff Siirola, FRNY 1029A, 6-2125, jsiirola@purdue.edu or jjsiirola@gmail.com

Office Hours: Almost anytime; best to make appointment by email

Course Description:

This course traces the historical development of the chemical and related process industries and describes the principal products that are made and the evolution of the raw materials, chemistries, and processes by which they have been made. The scope includes natural products, inorganics, fuels, and commodity and specialty organics. The course also covers topics of current interest including the impacts of modern catalysis, digital computation, and systems engineering on process technology, issues of sustainability, resource conservation, environmental responsibility, product stewardship, and carbon management, and the likely impacts of recently more abundant and less expensive shale gas and oil on the chemical industry.

Course Content:

History and structure of the chemical and allied process industries (1 week)
Natural Products (animal and vegetable products; wood derivatives) (1 week)
Inorganics (dehydration (calcining), reduction (smelting), bases and acids, commodities) (2 weeks)
Fuels (fossil, petroleum refining, synthetic and biofuels) (1.5 weeks)
Organics (wood and coal derivatives, basic building blocks, commodity intermediates and solvents, commodity monomers and polymers, plastics fibers and coatings, fine chemicals, biotechnology) (4 weeks)
Technical Impact Factors (catalysis, computers, innovation) (1.5 weeks)
Current Issues (environmental protection, health and safety, sustainability, carbon dioxide management, shale gas and oil) (3.5 weeks)

Tentative course schedule (subject to change):

Tue 20 Aug	Course introduction; scope of the chemical and allied process industries
Thu 22 Aug	Historical technology development (alchemy, chemistry, processes, unit operations, transport phenomena, process systems); historical milestones (brewing, soap, salt, smelting, soda ash, distillation, electrolysis, high pressure, continuous controlled processes)
Tue 27 Aug	Natural Products 1 - Animal and vegetable fiber, leather, oils, fats, waxes, gelatin, dairy products, food processing
Thu 29 Aug	Natural Products 2 - Pulp and paper, naval stores, resins, turpentine, rosin, rubber (Report 1 Due)
Tue 3 Sep	Inorganics 1 - Chemistry of dehydration/hydration: ceramic pottery, tile, and brick, glass, plaster, cement, mortar, and concrete
Thu 5 Sep	Inorganics 2 - Chemistry of reduction: ore smelting, iron and steel, silicon, copper, brass, bronze, aluminum

Tue 10 Sep	Inorganics 3 - Bases and acids: soda ash, caustic soda, lime, mineral acids (nitric, sulfuric, phosphoric, hydrochloric)
Thu 12 Sep	Inorganics 4 - Commodity inorganics: water, hydrogen, oxygen, nitrogen, chlorine, fertilizers (ammonia, phosphates, potash), titanium dioxide, carbon black, carbon dioxide, phosgene, hydrogen peroxide (Report 2 Due)
Tue 17 Sep	Fuels 1 - Wood, coal, petroleum (gasoline, diesel, jet fuel, fuel oil), LPG, natural gas
Thu 19 Sep	Fuels 2 - Natural gas processing, petroleum refining processes and products
Tue 24 Sep	Fuels 3 - Synthetic fuels: town gas, F-T, SNG, MTG, biofuels
Thu 26 Sep	Organics 1 - Wood and coal chemicals and materials (Report 3 Due)
Tue 1 Oct	Organics 2 - Basic building blocks: acetylene, olefins (ethylene, propylene, butadiene) aromatics (BTX, Styrene), carbon monoxide
Thu 3 Oct	Organics 3 - Commodity intermediates and solvents: alcohols glycols and phenols, aldehydes and ketones, acids, esters, ethers
Tue 8 Oct	No Class - Fall Break
Thu 10 Oct	Organics 4 - Commodity monomers and polymers (PE, PP, PS, PET, PC, SBR) (Report 4 Due)
Tue 15 Oct	Organics 5 - Adhesives, coatings, films, fibers, plastics
Thu 17 Oct	Organics 6 - Fine chemicals: dyes pigments and cosmetics, flavors and fragrances, soap and detergents, explosives, agrichemicals, pharmaceuticals
Tue 22 Oct	Organics 6 continued
Thu 24 Oct	Organics 7 - Fermentation and biochemical processes; biotechnology (Report 5 Due)
Tue 29 Oct	Possible No Class -AIChE Meeting
Thu 31 Oct	Technical Impact Factor 1 - Homogeneous and heterogeneous catalysis
Tue 5 Nov	Technical Impact Factor 2 - Engineering and operational digital computation
Thu 7 Nov	Current Issues 1 - Environmental protection: air, wastewater, land; personnel protection: health and safety (Report 6 Due)
Tue 12 Nov	Current Issues 2 - Loss prevention and process safety
Thu 14Nov	Current Issues 3 - Sustainability: triple bottom line, life cycle analysis, industrial ecology, green chemistry and engineering
Tue 19 Nov	Current Issues 4 - Sustainability: population and economic growth, raw materials and energy demands
Thu 21 Nov	Current Issues 5 - Climate change
Tue 26 Nov	Current Issues 6 - Carbon dioxide management, capture, and sequestration
Thu 28 Nov	Thanksgiving Break
Tue 3 Dec	Current Issues 7 - Impact of shale gas and oil (Report 7 Due; Bonus Report Due)
Thu 5 Dec	No Class

Homework Reports:

Report 1 - Industry Structure and Statistics (Due 29 August)
Report 2 - Reaction Path Synthesis: Solvay Process (Due 12 September)
Report 3 - Block Flow Diagram: Petroleum Refining (Due 26 September)
Report 4 - Process Supply Chain: Polyethylene Terephthalate (Due 10 October)

Report 5 - General Purpose Batch Processing: Fine Chemical Manufacture (Due 24 October)
Report 6 - Safety and Environmental Protection: Methyl Isocyanate (Due 7 November)
Report 7 - Sustainability: Carbon Management (Due 3 December)
Bonus Report: Process Narrative: Major Chemical Intermediate (Due 3 December)

Grading:

20% Attendance and class participation
80% Reports (Report 7 counts double)
Bonus Report: Up to +10 percentage points

Academic Honesty:

Students are individually responsible for each homework report. Cheating will not be tolerated. While discussions of homework among classmates are to be expected, students are responsible for submitting their own work. Copying the work of others, specifically including wholesale copying from electronic sources, is plagiarism and is considered a form of cheating.

Accommodation:

Purdue University strives to make learning experiences as assessable as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let the instructor know so that options may be discussed. You are also encouraged to contact the Disability Resource Center at drc@purdue.edu or by phone at 765-494-1247.

In addition to the University policy, the Davidson School of Chemical Engineering has established procedures for students seeking accommodations. These can be found online at the ChE Undergrad Office website. Only those accommodation requests that conform to both University and ChE policy guidelines will be implemented.

Protect Purdue:

The Protect Purdue Plan, which includes the Protect Purdue Pledge, is a campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center if you feel ill or know you have been exposed to the virus, wearing a mask in classrooms and campus buildings at all times, disinfecting workspace prior to and after use, maintaining proper physical distancing, and maintaining robust personal hygiene. Measures will be taken to provide alternative remote instructional experiences if the course had an on-line delivery option or if on-line delivery becomes mandated during the course of the semester.

References:

Kirk-Othmer Encyclopedia of Chemical Technology (5^{th} Ed and On-line, Wiley)
Ullmann's Encyclopedia of Industrial Chemistry (5^{th} Ed and On-line, Wiley)
Shreve's Chemical Process Industries (5^{th} Ed, McGraw-Hill Special Reprint Edition)
Handbook of Chemical Technology and Pollution Control (Robert Myers, 3^{rd} Ed, Elsevier)
Handbook of Petroleum Refining Processes (Martin Hocking, 2^{nd} Ed, McGraw Hill)

Purdue University ChE 597: Process Synthesis, Fall 2024

Instructor: Prof. Cornelius Masuku (cmasuku@purdue.edu)

Teaching Assistants: None

Lecture Hours: Mon/Wed/Fri, 8:30 am – 9:20 am (Masuku: synchronous, in-person)
Hampton Hall of Civil Engineering: 2102

Office Hours: Wed/Fri, 9:30 am – 10:20 am

Office Hours will be held in-person or via zoom if required and by appointment.

Website: Brightspace (CHE 597). All course material will be posted on Brightspace. It is your responsibility to keep up-to-date with all material posted online. All class announcements will be e-mailed via Brightspace.
You are expected to check/read your @purdue.edu e-mail frequently.

Text (Recommended): D. Ming, D. Glasser, D. Hildebrandt, B. Glasser, M. Metzger, Attainable Region Theory, Wiley, 2016.

D. F. Rudd, G. J. Powers, J. J. Siirola, Process Synthesis, Prentice-Hall, 1976.

Course Objectives: An introduction to the application of process synthesis concepts to design problems. An overview of methodologies that permit the evaluation and design of new processes from a very early stage. This course will discuss the role that design plays in the chemical process industry and in particular the techniques for flowsheet alternatives generation that have potential for industrial applicability.

Course Topics: Topics include alternative paradigms for process synthesis, practical methods for heat exchanger network synthesis, kinetic rate equations for catalyzed reactions, design of ideal isothermal reactors and effects of non-isothermal operation, chemical equilibria, systematic identification of designs which exploit distillation, azeotropic distillation, extractive distillation, reactive distillation, and related separation technologies, techniques for coordinating the specification of separation conditions in a

way to minimize energy requirements and equipment costs, separation synthesis for mixtures with very nonideal solution thermodynamics, reaction network or supply chain network synthesis, and the interaction of process synthesis with control system synthesis.

Prerequisites: ChE 348 – Chemical Reaction Engineering or Equivalent

Lesson Plan: This course is designed for in-person/synchronous learning, supplemented by various synchronous discussions, and office hour meetings. The lesson plan for each week will be uploaded to Brightspace in advance. This document will summarize information about the topics covered and learning objectives for that week, and any assignments/projects due that week. Please review the lesson plan before each week starts.

Lectures: The course will be broken up into modules (each lasting 1 or 2 weeks). These modules are listed in the Tentative Course Schedule.

Discussion Forum: On Brightspace, we have created a discussion forum. Please start a new discussion thread for any question you may want to ask. We encourage each student to participate in all discussions and reply. The instructor will also read this forum and reply on a frequent basis.

Course Grades: The final course grade will be determined by the following:

Homework Problems:	20%
Project 1:	25%
Project 2:	25%
Final Project:	30%
Bonus Activities and Class Participation:	≤10%

All grades will be available on Brightspace so that you can monitor your progress throughout the semester. Grades for individual homework, and projects will **not** be adjusted by curving or scaling.

There is no preset distribution of final grades. The grading will reflect demonstrated student capability relative to an absolute performance standard that is expected of all Purdue ChE students, rather than a scale or curve that compares students to a mean performance metric on any evaluation vehicle. In practice, this means that if all students in the class demonstrate a high level of mastery of the course content, then all course grades could be A marks.

If your final numerical grade is greater than or equal to the following percentages, your letter grade is guaranteed to be at least:

A: ≥90%
B: ≥80%
C: ≥70%
D: ≥60%

Final numerical grades for the entire class may be scaled up (but never down). Plus, and minus modifiers will be used to determine final grades.

Projects:

Project 1: Monday, September 23, 9:20 am
Project 2: Monday, October 28, 9:20 am
Final Project: Monday, December 2, 9:20 am

There is no Final Exam for this course. This is a Projects-Based course.

Homework:

Homework will be assigned via Brightspace, and will be due electronically on Mondays by 8:30 am Eastern time. Late homework submissions will be assigned a zero score.

You may discuss the homework assignments and projects with other students, but **the final product must be entirely your own work.**

Regrade Requests:

You have one week after receiving a graded assignment to submit a regrade request, which must be made to the instructor.

Computer Use:

You are expected to use numerical methods programs, such as Python, or Matlab, for graphical representation and to solve systems of equations. Any of these programs should be sufficient for the types of problems addressed in this course, but you may use other suitable computer programs of your choice.

Simulation software packages such as Aspen Plus may also be used for Projects Flowsheet Simulations.

Official Purdue University Student Policies

Student Expectations: This is a 3-credit hour course, and it is expected that each student will spend 9 hours each week, including class time, on homework assignments, studying and reading the course textbook.

Student Conduct and Academic Integrity: University policy states that it is the responsibility of all students to attend all class sessions. Each student is expected to come to class on time and not disrupt the class. Each student is expected to follow Purdue's codes of student conduct and behave in a professional manner (https://www.purdue.edu/odos/academic-integrity). The rights of students in violation of the code of conduct are outlined. Each student is expected to exhibit consideration and respect towards the other students, the graders, the teaching assistants (TAs), and the faculty. Each student is expected to exhibit a positive attitude. Your conduct will be a factor in awarding grades to students between two letter grades.

Purdue University's student conduct policy specifically addresses academic dishonesty and integrity (http://www.purdue.edu/odos/osrr/academicintegritybrochure.php). All incidents of academic dishonesty will be reported to the Dean of Students. **Such incidents *include*:**

i) possessing or accessing, in hardcopy or electronic form, the solution manual to the course text or to the exams,
ii) claiming credit for work (either HW or exam work) that is not your own original work, and
iii) enabling another student to create HW or exam work that is not their original work.

Instructors' Commitment: Your instructors will: 1) be courteous, punctual, well-organized, and prepared for lecture and other class activities; 2) answer questions clearly in class or arrange for detailed discussions out of class if in-class answers are not suitably clear; 3) be available during office hours or notify you beforehand if they are unable to keep them; 4) provide a suitable guest lecturer when they are traveling; and 5) grade uniformly and consistently to the posted guidelines. We strongly encourage you to discuss academic or personal questions with the course instructor during office hours or via email. These discussions need not be limited to ChE 34800 content.

Use of Copyrighted Materials: Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. All materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructor's presentations and materials, and they are thus subject to the instructor's copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor.

Accessibility and Accommodations: Purdue strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let Prof. Masuku know to discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Grief Absence Policy for Students: Purdue recognizes that a time of bereavement is very difficult for a student. Purdue therefore provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). GAPS Policy: Students will be excused for funeral leave and given the opportunity to earn equivalent credit and to demonstrate evidence of meeting the learning outcomes for missed assignments or assessments in the event of the death of a member of the student's family.

Please visit the University's website for additional information:
http://www.purdue.edu/studentregulations/regulations_procedures/classes.html

Mental Health Statement: If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack, https://purdue.welltrack.com/. Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please see the Office of the Dean of Students, http://www.purdue.edu/odos, for drop-in hours (M-F, 8am- 5pm).

If you are struggling and need mental health services, Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765)494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Violent behavior policy: Purdue is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity.

Please visit the University's website for additional information:
http://www.purdue.edu/policies/facilities-safety/iva3.html

Nondiscrimination Statement: Purdue is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach their own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue views, evaluates, and treats all persons in any University related activity or circumstance in which they may be involved, solely as individuals on the basis of their own personal abilities, qualifications, and other relevant characteristics.

Purdue prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services, and activities consistent with applicable federal, state, and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Purdue's Equal Opportunity, Equal Access and Affirmative Action policy which provides specific contractual rights and remedies. Additionally, the University promotes the full realization of equal employment opportunity for women, minorities, persons with disabilities and veterans through its affirmative action program.

Any question of interpretation regarding this Nondiscrimination Policy Statement shall be referred to the Vice President for Ethics and Compliance for final determination.

Please visit the University's website for additional information:
http://www.purdue.edu/purdue/ea_eou_statement.html

Campus Emergency: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. ***You are expected to read your @purdue.edu email on a frequent basis.***

ChE 597 – Fall 2024 - Tentative Course Schedule

Week	Date	Topic	Comments
1	8/19	Introduction to Process Synthesis	
1	8/21	Objectives, Aims and Motivation	
1	8/23	Technology Assessment	
2	8/26	Process Design	
2	8/28	Mass Balance as a Synthesis Tool	
2	8/30	Mass Balance as a Synthesis Tool	
3	-	Labor Day	
3	9/4	Mass Balance as a Synthesis Tool	
3	9/6	Energy Balance as a Synthesis Tool	
4	9/9	Energy Balance as a Synthesis Tool	**HW1 due on Mon, 8:30 am**
4	9/11	Energy Balance as a Synthesis Tool	
4	9/13	Entropy & Gibbs Energy	
5	9/16	Entropy & Gibbs Energy	
5	9/18	Entropy & Gibbs Energy	
5	9/20	Systematic Methods of Obtaining Targets: Graphical Techniques	
6	**9/23**	**Project 1**	**P1 Due on Mon, 9:20 am**
6	9/25	Mathematical Techniques	
6	9/27	Graphical and Mathematical Techniques	
7	9/30	Entropy & Temperature	**HW2 due on Mon, 8:30 am**
7	10/2	Entropy & Temperature	
7	10/4	Entropy & Temperature	
8	Break		
8	10/9	Classifying Chemical Processes	
8	-	CISTAR Meeting	
9	10/14	Classifying Chemical Processes	**HW3 due on Mon, 8:30 am**
9	10/16	Classifying Chemical Processes	
9	10/18	Solvay Clusters	
10	10/21	Solvay Clusters	
10	10/23	Work Addition by Heat Engines	
10	10/25	Work Addition by Heat Engines	
11	**10/27**	**Project 2**	**P2 Due on Mon, 9:20 am**
11	-	AIChE Annual Meeting	
11	11/1	Work Addition by Heat Engines	
12	11/4	Work Addition by Compression	
12	11/6	Work Addition by Compression	
12	11/8	Work Addition by Compression	
13	11/11	Separation & Separation Equipment	**HW4 due on Mon, 8:30 am**
13	11/13	Separation & Separation Equipment	
13	11/15	Separation & Separation Equipment	

14	11/18	Integrated Process Synthesis	
14	11/20	Integrated Process Synthesis	
14	11/22	Integrated Process Synthesis	
15	11/25	Integrated Process Synthesis	
15	-	Thanksgiving Break	
15	-	Thanksgiving Break	
16	**12/2**	**Final Project**	**P3 Due on Mon, 9:20 am**

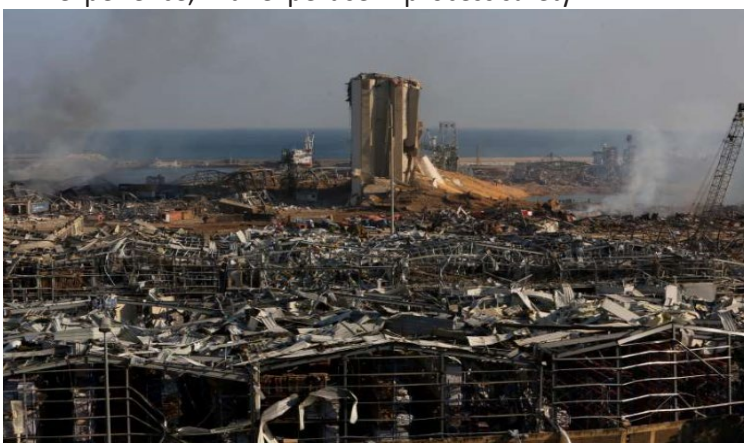
PURDUE UNIVERSITY | Davidson School of Chemical Engineering

CHEMICAL PROCESS SAFETY

CHEN 420/597 (3 CREDITS)

FALL 2024 – TuTh 9:00 – 10:15 am

This course is required for all seniors in the Davidson School of Chemical Engineering and is taught each fall at Purdue. Open to Masters and PhD students, the course addresses how to prevent industrial incidents that can result in significant loss of life, environmental, and facility damage. Several case studies are reviewed and analyzed in a variety of industries, which form the basis for many industry best practices and regulations. Few universities offer this course, and many companies value those who have taken it. The instructor, Dr. Ray Mentzer, has over 30 years of industry experience, with expertise in process safety.



Beirut, Lebanon ammonium nitrate (fertilizer) explosion August 4, 2020 that led to 192 fatalities; ~6,000 injuries; 300,000 left homeless and economic damage estimated at $10 - $15 billion.

February 3, 2023 freight train derailment in East Palestine, Ohio. 38 rail cars derailed, 11 with hazardous material, including toxic & flammable vinyl chloride.

THE COMPREHENSIVE COURSE ADDRESSES:

- How does one design, maintain and operate a facility safely in a variety of industries?
- How does one reduce the chance for fires, explosions, runaway reactions, toxic releases …?
- What regulations exist to foster safe operations?
- How does one conduct hazard and risk analyses?

The Davidson School of Chemical Engineering is well-grounded in process safety with its Purdue Process Safety & Assurance Center (P2SAC) conducting research. Dr. Mentzer serves as Executive Director. Students funded by the Center are encouraged to enroll. Professional Master's students will benefit from this training, since typically over one third of capstone research projects are process safety related and mentored by P2SAC industry sponsors.

DO YOU WANT TO KNOW MORE?

Dr. Ray Mentzer
rmentzer@purdue.edu
Forney Hall of Chemical Engineering 3019
(936) 443-5579

PURDUE UNIVERSITY

SYLLABUS

PROCESS SAFETY MANAGEMENT & ANALYSIS - 2024; CHE 420 / 597

Instructor: Dr. Ray Mentzer
Phone: (936) 443 5579
e-mail: rmentzer@purdue.edu
Class: TuTh 9:00 – 10:15; FRNY G140

The critical importance of Chemical Process Safety is widely recognized after many significant world-wide industrial incidents, such as train derailment and chemical spill in Ohio last spring, the massive fertilizer explosion in Beirut, and numerous incidents in the last few years claiming lives, harming the environment, with significant loss of property. All aspects of chemical process safety and loss prevention are addressed in this course. Process safety is concerned with the identification of potential hazards and risks associated with equipment and chemical processing across a variety of industries: oil & gas, chemicals, pharmaceuticals, agriculture, etc. It includes methods for predicting the possible severity of incident scenarios and preventing or mitigating them. The material is thus different from personnel safety, which addresses slips, trips and falls.

As such, it is necessary to understand the operation of these processes and equipment, and to apply sound engineering fundamentals to the analysis and prediction of performance, under adverse circumstances. Thus, the course emphasizes quantitative engineering analysis, and in a broader context critical thinking, complex reasoning and written communication. This is based on the application of mass and energy balances, fluid mechanics of liquid / gas / two-phase flow, heat transfer and the conservation of energy, mass transfer, reaction kinetics, process control, and diffusion & dispersion under highly variable conditions.

Techniques for performing process hazard analysis, risk assessment, and accident investigations are covered, including the review of numerous significant industrial incidents. Course topics follow those in the text: Daniel A. Crowl and Joseph F. Louvar, **'Chemical Process Safety: Fundamentals with Applications'**, Prentice Hall (4th edition), which will be supplemented with other pertinent materials, such as videos of incident investigations by the US Chemical Safety Board. All students will perform an incident investigation of a significant industrial incident. CHE 597 graduate students have additional homework problems and a research project with a written report.

Course Materials / Lectures: Pertinent class materials will be posted on Brightspace. Students are encouraged to use the Discussion feature under Course Tools to communicate among each other, the professor and TAs as to questions, etc.

Teams: Students will be grouped into teams of ~3 by the CATME system, and work on homework assignments and project(s) as a team. **Every student will submit homework,** which will **not** be identical among teammates**.** The purpose of working in teams is not to 'spread the work around' but to capture the synergies of teamwork, benefiting from each member's perspective. Team members will periodically evaluate each other in terms of their contribution to homework and team project(s), which will be reflected in course grades.

Homework: Homework will generally be assigned each week and **due at noon ET on Friday's**. Late homework will **not** be accepted, except with prior approval. Homework will be submitted, graded and solutions posted on Brightspace. Copying from a Solutions Manual or classmates will not be tolerated, with a zero given on homework assignments for infractions.

Attendance: Class attendance is important. Class participation is encouraged, material will be covered in class beyond the text, including several videos and there will be unannounced quizzes. Notify the instructor **in advance** for all excused absences (e.g., job interviews).

Incident Investigation: Each team will investigate a major incident and prepare a report (selected from a list of incidents provided or another of their choice). Topics will be distributed during the 4th week of class, teams will submit their top three choices by September 19, with the final topic confirmed by the Instructor on September 24. The report will be due on October 29. Grading of the report is based on the written report and teammate evaluations of individual contributions.

Project: ***For 597 students only.*** Each team will prepare a research project (selected from a list of topics provided or another of their choice) and submit a formal report. Topics will be distributed the 6th week of class, teams will submit their top three topics by October 3, with the final topic confirmed by the Instructor on October 10. An abstract is due on November 5 and the report due on December 3, both electronically and as a hard copy. Grading of the project is based on the abstract, written report, and teammate evaluations.

Exams & Quizzes: There will be three exams and three quizzes during the term, all given during scheduled class time in G140. **All exams will be open-book and thus it is imperative that each student have access to a hard copy of the text (no xeroxed copies).** Exam III will not be comprehensive. Missing a quiz / exam results in a zero, unless arrangements were made with the Instructor in advance. Regrade requests for exams / quizzes and homework should be made to the party who did the initial grading, the TAs for the former and Graders for the latter. Any such requests must be made within two weeks of the posting of the graded work product in Brightspace.

Grading Criteria:

	CHE 420	CHE 597
Homework	20%	20%
Incident Investigation	15%	10%
Project Report	0%	10%
Quizzes	10%	5%
Exams	55%	55%

Grades:

90-100	A
80-89	B
70-79	C
60-69	D
<60	F

Grading may also include +/- for each grade level.

Support: Professor Ray Mentzer (rmentzer@purdue.edu)

TAs –
Sarah Gustafson – gustaf14@purdue.edu
Ry Sekiya – rsekiya@purdue.edu
Yuanhao Tang – tang571@purdue.edu
Esra Ulgey – eulgey@purdue.edu

Graders –

The TAs will conduct two one-hour weekly help sessions:

NOTICES:

- It is tantamount that students reflect on and adhere to the **Purdue Honors Pledge**, *"As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."* Integrity / ethics violations such as plagiarism, copying from others work, or use of unauthorized online services (e.g., Chegg) will not be tolerated. Penalties include up to a failing grade and notifying the Dean of Students. While students may use AI tools for research, written material from ChatGPT, etc may not be incorporated within class submissions.

  Specifically, Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Section B-2-a, Code of Student Conduct] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972] All incidents of academic dishonesty will be reported to the Dean of Students. Such incidents include: i) possessing or accessing, in hardcopy or electronic form, the solution manual to the course text, or to the exams, ii) claiming credit for work that is not your own original work, and iii) enabling other students to create work that is not their original work.
- Non-discrimination: Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach their potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.
- Accommodations - Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let the instructor know and to discuss options. You are also encouraged to contact the Disability Resource Center at drc@purdue.edu or by phone: 765-494-1247.
- Mental Health / Wellness: If you find yourself struggling to find a healthy balance between academics, social life, stress, etc., sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell.

CHE 420 / 597 Chemical Process Safety (Fall, 2024)

Course Schedule

Date		Topics	Note
August	Wk1a-8/20	Why study process safety? Syllabus & Chapter 1	Piper Alpha video
	Wk1b – 8/22	Chapter 1. Introduction – cont'd	
	Wk2a-8/27	Chapter 1. Introduction – cont'd	
	Wk2b -8/29	Regulations & Mgmt Systems	Fatal Exposure – DuPont video
	Wk3a-9/3	Regs; Teamwork	
	Wk3b – 9/5	Chapter 2. Toxicology	**Quiz 1**
	Wk4a-9/10	Incident Investigations	Bhopal disaster; Incident investigation project introduced
September	Wk4b – 9/12	Chapter 3. Industrial Hygiene	BP TX City video
	Wk5a-9/17	**Exam I**	
	Wk5b – 9/19	Chapter 4. Source Models – I	Teams select incidents
	Wk6a-9/24	Ch #4 Source Models II	Instructor confirms projects; *597 Project topics distributed*
	Wk6b – 9/26	Chapter 5. Toxic Releases	MGPI, Mixed Connection, Toxic Result video
	Wk7a-10/1	Toxic Releases - cont'd	
	Wk7b – 10/3	Chapter 6. Fires & Explosions - I	Imperial Sugar video; *597 Teams select topics*
	Wk8a-10/10	Chapter 6. Fires & Explosions – II	**Quiz 2;** *Instructor confirms 597 project topics*
	Wk 9a– 10/15	Chapter 7. Designs to Prevent Fires & Explosions	Static Electricity video
	Wk9b-10/17	Chapter 8. Chemical Reactivity	T-2 Incident video
	Wk10a -10/22	**Exam II**	
October	Wk10b-10/24	Safe Designs & Operations	Blast Waves in Danvers video
	Wk11a -10/29	Safe Designs & Operations – cont'd	Teams submit incident investigation reports & team member evaluations
	Wk10b-10/31	Chapter 9. Intro to Reliefs	'Without Safeguards Pressure Vessels can be Deadly' CSB video
	Wk12a – 11/5	Chapter 10. Relief Sizing	*597 Project abstract due*
	Wk12b-11/7	Chapter 10. Relief Sizing - cont'd	Univ Laboratory Safety video
November	Wk13a- 11/12	Chapter 11. Hazards Identification – I	West Explosion video
	Wk13b-11/14	Chapter 11. Hazards Identification – I I	**Quiz 3**
	Wk14a- 11/19	Chapter 11. Hazards ID – II–cont'd	DeRidder Pulp & Paper video
	Wk14b-11/21	Chapter 12. Risk Assessment	
December	Wk15a-11/26	Chapter 12. Risk Assess. – cont'd **Thanksgiving Break**	ExxonMobil Torrance Refinery video
	Wk16a – 12/3	Emergency Response	Emergency Preparedness video; *597 Project reports due*
	Wk16b – 12/5	**Exam III**	

Student Outcomes (***specific to 420***)

Our graduates will be able to:

1	***Apply principles of engineering, science, and mathematics to solve complex chemical engineering problems.***
2	***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	Communicate effectively with a range of audiences.
4	***Recognize ethical and professional responsibilities in chemical engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.***
5	Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6	Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7	***Acquire and apply new knowledge as needed, using appropriate learning strategies.***

ABET Syllabus

1. **CHE 42000: Process Safety Management and Analysis**

2. **Credits and contact hours:**
   3 credits
   Lecture – 2 days per week at 75 minutes each for 16 weeks

3. **Instructor's or course coordinator's name:** Professor Ray Mentzer

4. **Textbook(s):**
   a. Daniel A. Crowl and Joseph F. Louvar, **'Chemical Process Safety: Fundamentals with Applications'**, Prentice Hall (4th edition)

5. **Specific course information**
   a. **Catalog description:** Develop knowledge of process safety management and analysis in the process industries – including hazard identification, hazard analysis and risk management.
   b. **Prerequisites:** CHE 34800, 37800 (both concurrent)
   c. **Course Status:** Required

6. **Specific goals for the course**
   a. **Specific outcomes of instruction**
   - Demonstrate knowledge and understanding of the elements of process safety management (→45000)
   - Apply the techniques, analytical skills, and modern computational tools necessary for performing process safety calculations in the design of safety equipment (20500, 21100, 34800, 37700, 37800→); (→45000)

- Demonstrate an understanding and appreciation of the need for professional integrity and ethical decision making to promote safety in the workplace (20000, 30000, 40000→); (→45000)
- Be able to pro-actively identify and analyze safety hazards (→45000)
- Demonstrate an understanding of the detrimental effects of the unsafe operation of chemical facilities on environmental, health, and safety issues and other public interests. Our graduates will be aware of the wide-reaching effects that engineering decisions have on society, our global community and our natural environment (20000, 30000, 34800, 37700, 37800, 40000→); (→45000)
- Demonstrate knowledge and understanding of risk management tools, programs and processes associated with process safety. (→45000)

b. Student outcomes addressed by the course:

1) Apply principles of engineering, science, and mathematics to solve complex chemical engineering problems.

2) 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.

4) Recognize ethical and professional responsibilities in chemical engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

5) Acquire and apply new knowledge as needed, using appropriate learning strategies.

7. Topics

Process Safety Management and Hazard Identification

Regulations – 29 CFR 1910.119

People, Technology, Facilities

Management/Leadership, Required Management Systems

Analysis of Hazards

Numerous Case Studies (14): Piper Alpha, Bhopal, BP TX City, Imperial Sugar, T2 Laboratories, West Explosion, ...

What If, Checklist, Hazard and Operability (HAZOP) Study

Hazard vs. Risk, Qualitative & Quantitative Risk Assessment

Failure Mode and Effects Analysis

Fault Tree Analysis

Risk Management

Safety Culture

Regulations and Audits, Ethics and Safety

Operating Procedures, Safe Work Practices

Asset Integrity

Training, Management of Change

Contractor Management

Operations: Start-up/Shutdown/Unsteady State

Emergency Management

Incident Investigation

Process Safety Calculations and Design

Toxicology and Industrial Hygiene

Liquid & Gas Source Models

Toxic Releases & Dispersion Modeling

Flammability and Explosions & Designs for Prevention

Chemical Reactivity
Sizing Relief Valves
Knockout Drums & Flares

7-30-24

CHE 397: RHEOLOGY OF SOFT MATERIALS
SPRING 2019

Instructor: **Professor Kelly Schultz**
Office: Iacocca Hall, B-316
Office phone: (610) 758-2012
E-mail: kes513@lehigh.edu
***Please use "CHE 397:…" as the subject of any course-related e-mail*
Office hours: By appointment

Homepage: https://coursesite.lehigh.edu/ This course website will be used for posting lecture supplements. Announcements and critical updates to the course syllabus will also be posted on Course Site.

Lectures: Tuesday and Thursday, 10:45 AM- 12:00 PM, *Iacocca B013*

Required Texts: Ronald G. Larson, *The Structure and Rheology of Complex Fluids*, Oxford University Press, 1999.

Supplemental Texts: Christopher W. Macosko, *Rheology Principles, Measurements and Applications*, Wiley-VCH, 1994.

Faith A. Morrison, *Understanding Rheology*, Oxford University Press, 2001.

Eric M. Furst and Todd M. Squires, *Microrheology*, Oxford University Press, 2017.

Course overview: This course intends to develop a fundamental understanding of rheological characterization of soft materials. There is a wealth of information that can be gained using rheology and this course will cover how data is collected and interpreted to better understand complex materials. The overarching objectives of the course are: 1. Understand the fundamentals of rheological measurements including how to 2. design experiments and 3. interpret experimental data. The skills learned in this course will enable in depth rheological characterization of materials leading to a better understanding of the material properties and structure as well as how best to use this knowledge to enhance design of new materials and their applications. This material will be relevant across disciplines and will be relevant for both academic and industrial careers.

Course Learning Objectives: The course content is structured to meet the following learning objectives. By the end of the semester, each student should be able to

1. Understand the fundamentals of rheological measurements including how experiments are designed and how forces relate to material properties
2. Understand the fundamentals of passive and active microrheological characterization to obtain measurements of equilibrium and nonequilibrium material properties
3. Understand polymers rheology at the extreme concentration ranges; including basic theories and methods of data interpretation
4. Interpret rheological measurements of polymeric gels for both physical and chemical gel systems at equilibrium and during dynamic gelation and degradation processes
5. Develop a knowledge base of suspension rheology for hard-spheres, nonspherical particles and particulate gels
6. Understand the microstructure and rheological properties of surfactant solutions

COURSE PROCEDURES AND POLICIES

ATTENDANCE OF LECTURES AND LABS

Both *attendance* of and *active participation* in *all* lectures is required. The course will roughly follow the book but additional information will be provided during the lectures. There will be whole topics that will

be tested that are not part of the required text. Due to this attendance, *attendance at all lectures will be required for understanding and mastery of the course material.*

GRADING

Grades will be assigned based upon completion of and performance on problem sets and exams as well as possible quizzes. Class attendance and participation will also be considered in the final grade. Grading of homeworks, exams and possible quizzes will always be carried out with the utmost fairness. *Partial credit* will *always* be given for progression towards a solution. Below is a breakdown of the relative weight of each component in the final grade:

30%	Exam 1
30%	Problem sets
40%	End-of-semester project

RE-GRADING Great effort will be made to carefully and fairly grade all homeworks, quizzes, and exams. Should you feel that a mistake has been made on the grading of quizzes or exams, please submit a ***written request*** that **1)** specifies the problem requiring re-grading and **2)** provides an explanation of the reasoning behind the request. Unless otherwise noted, this must be submitted by the end of the class period in which the quiz or exam is returned. Please note, that the complete problem(s) will be re-graded, with no guarantee about the relative change in the grade.

PROBLEM SETS

Assignments are intended to develop deeper understanding of concepts/techniques and their applicability. Each problem and assignment will be assigned to increase your depth of knowledge not just crunch numbers through equations. Each assignment should be given serious attention and effort. These assignments will enhance your understanding and will help develop skills that will be tested in possible quizzes and exams.

- Homeworks will be assigned (in most cases) a week before the due date.
- Homeworks must be submitted *on the due date at the beginning* of the corresponding lecture or recitation. Late assignments (without prior permission) *will not be accepted*, and will receive a zero.
- Your work should be prepared in a clear, organized, and well-documented fashion. It should be combined in a *stapled packet* with *your name, name of any classmates you have worked with, problem set number, and due date* prominently displayed on the first page.

➢ **The lowest grade from among the semester assignments will be dropped from the calculation of the course grade IF ALL assignments have been completed. *You will forfeit this benefit if you fail to satisfactorily complete and hand in one or more assignments.***

QUIZZES & EXAMS

Announced and unannounced quizzes may occur throughout the semester during lectures or labs. There will also be one hour-exam and one final exam (*comprehensive*, 3 hours). The format of these exercises (i.e., open or closed-book/notes, programming) will be clearly specified. **Without prior approval from Professor Schultz, failure to complete any quiz or exam at the time that it is given will result in a zero for that quiz/exam.** No opportunities will be given to make up any previously unexcused quizzes or exams.

FINAL PROJECT

Individual projects will be assigned near the end of the semester. These projects will give you the opportunity to pick a topic that we have covered in lecture and expand upon this looking back into the literature. You will be expected to thoroughly understanding the original concepts that you have chosen and find how these topics have been expanded and adapted as research has evolved over the years. More details about the project will be given when it is assigned in the final weeks of the semester.

GROUP WORK AND STUDY

By now, you have likely discovered your most effective learning style. It is important to recognize that there is great benefit that can be gained from personally working through the homework sets as well as discussing problem sets with your classmates. No matter which approach or combination of approaches you take, ***you*** *are responsible for working through and understanding each problem within a given problem set*. As such, *each student must hand in his or her* ***own work***. Verbatim copying of another classmate's homework set or previous homework solutions is strictly prohibited (see Plagiarism section below**). If you have worked together with other students, each student must submit their own work with their name on top, also list the names of the people you worked with on the first page.**

OTHER POLICIES AND PRACTICES

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

If you have a disability for which you are or may be requesting accommodations, please contact both Prof. Schultz and Disability Support Services, Williams Hall Suite 301, (610) 758-4152 as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

THE PRINCIPLES OF OUR EQUITABLE COMMUNITY

Lehigh University endorses *The Principles of Our Equitable Community*, which can be found at http://studentaffairs.lehigh.edu/content/principles-our-equitable-community. We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

RETAINED COPIES OF STUDENT WORK

The instructor reserves the right to retain copies of any student materials submitted for the course, primarily for the purpose of department accreditation or in the case of suspected plagiarism (see below). Student rights will not be violated in the process.

PLAGIARISM AND ACADEMIC INTEGRITY

It is your responsibility to be familiar with and respect Lehigh University's policies on plagiarism and academic integrity. Evidence of plagiarism or cheating in any form will be referred to the University Committee on Discipline. Plagiarism and cheating are punishable by failure of the course.

ChE 397: Rheology of soft materials
***Tentative* Course Schedule and Reading Assignments – Spring 2019**

Week	Lecture	Analytic Topic	Reading
Jan. 21	01/02	Introduction to complex fluids/ rheological measurements and properties	Ch. 1
Jan. 28	03/04	Flow, slip and yield/ basic forces/ Geometries	Ch. 1,2/ Supplemental
Feb. 4	05/06	Geometries/ Introduction to microrheology	Supplemental
Feb. 11	--	Passive and active microrheological characterization and applications	Supplemental
Feb. 18	07/08	Introduction to polymers/ elementary molecular principles	Ch.3/ Supplemental
Feb. 25	09/10	Bulk and microrheology of dilute polymer solutions and entangled polymers	Ch. 3/ Supplemental
March 4	11/12	Introduction to polymer gels/ gelation theories/ rheology of chemical and physical gels	Ch. 5
March 11	--	SPRING BREAK NO CLASS	--
March 18	13/14	Microrheology of polymer gels	Ch. 5/ Supplemental
March 25	15/16	Introduction to particulate suspensions and suspension rheology/ nonspherical particles	Ch. 6
April 1	17	Small angle neutron scattering	Supplemental
April 4	--	***1 hour exam***	--
April 8	18/19	Introduction to and rheology of particulate gels	Ch. 7
April 15	20/21	Microrheology of particulate gels/ introduction to surfactant solutions/ predicting microstructure	Supplemental/ Ch.12
April 22	22/23	Micellar solutions/ Introduction to block copolymers	Ch.12/ Ch.13
April 29	24/25	***Final project presentations***	
May 4 – 6	--	Review/ study period	
May 7 – 15	--	***Final Exams***	

ChE 633: Probabilistic Methods in Chemical Engineering

Instructor: D. Ramkrishna

Fall 2023

Primary Source:

"Stochastic Modeling in Engineering and Biology" D. Ramkrishna (in preparation)

1. "Handbook of Stochastic Methods," by C. G. Gardiner, Springer Verlag, 2003. Third Edition.
2. "Stochastic Processes in Physics & Chemistry," by N. G. Van Kampen, North Holland, 1981.

This course will introduce the students to the application of probability and stochastic processes to engineering problems. Thus, stochastic analysis of chemical reaction systems of great interest to biology and nanotechnology will be developed through the application of the Chemical Master equation. There are no exams for the course. However, each student can sign up for a project on their research or other choices with which I can help for a final course grade. Alternatively, you can submit solutions to assigned problems.

Course Outline: ChE 633

Topics

1. Stochastic systems in engineering. External and internal noise. Probability concepts.

2. Random variables & Distribution Functions. Expectations. The Central Limit theorem and consequences. Poisson and Gaussian processes.

3. Stochastic processes. Continuous and Jump processes. Levy Flights.

4. Ito calculus and stochastic differential equations.

5. Solution techniques. Brownian dynamics.

6. Brownian Bridge and Applications.

7. The Chemical Master equation. Macroscopic laws from System-Size expansion of Van Kampen. Modeling of systems with Internal noise. Applications to biological signaling processes.

8. Direct Methods for solving stochastic processes. Tau-leap methods.

9. Stochastic Point Processes, Stochastic population balances and their applications.

Since the material is diverse, all efforts will be made to restrict coverage to areas of interest to the enrolled students.

Purdue University ChE 666: Methods in Catalysis, Fall 2023

Instructor: Rajamani Gounder (rgounder@purdue.edu)
Office Location: 2160 Forney Hall
Office Phone: 765-496-7826
Office Hours:* Thursday, 12:00 pm-1:00 pm, FRNY 2160

Teaching Assistant: None (times are tough)

*Instructor office hours are subject to change.

Class Hours: TR, 10:30 am-11:45 am, Forestry 216 (3 credit hours)

Website: Brightspace (CHE 666). All course materials, handouts, homework sets, and solutions will be posted on Brightspace. It is the student's responsibility to keep up-to-date with all material posted online. Important and time-sensitive class announcements will be e-mailed via Brightspace. ***You are expected to read your @purdue.edu e-mail frequently.***

Textbook: [1] J. W. Niemantsverdriet, *Spectroscopy in Catalysis*, 3rd edition, Wiley-VCH, 2007. *(Required)*

Other useful texts:

[2] G. A. Somorjai, *Introduction to Surface Chemistry and Catalysis*, Wiley, ISBN 0-471-03192-5

[3] J. M. Thomas, W. J. Thomas, *Principles and Practice of Heterogeneous Catalysis,* VCH, ISBN 3-527-29288-8

Additional texts and original research will be distributed throughout the semester and should be reviewed before the lecture in which their contents will be covered.

Catalog Description: Various spectroscopic and other techniques for characterizing catalysts and for probing the chemistry of solid surfaces and their interactions with adsorbing and reacting gases are discussed. Topics include infrared, X-ray photoelectron, Mössbauer, and secondary ion mass spectroscopies. Emphasis is on understanding the principles underlying each method and gaining an awareness of the kind of information each can provide in a broad spectrum of research problems.

Prerequisites: Chemistry 375 – Physical Chemistry (or equivalent)

Course Topics: A list of major course topics is as follows:

1. General Catalyst Characterization (AAS/ICP/EDS, PSD…)
2. Temperature Programmed Techniques (TPD, TPR, TPO, TPSR…)
3. Diffraction and X-Ray Techniques (XRD, XAS, XES, EXAFS…)
4. Photoemission and Auger Spectroscopy (XPS, UPS, Auger, …)
5. Microscopy and Related Techniques (TEM, SEM, AFM, STM, …)
6. Vibrational Spectroscopies (IR, UV-Vis, Raman…)
7. Magnetic Resonance Spectroscopies (NMR, EPR…)

Course Grades: The final course grade will be determined by the following:

Attendance and Participation:	25%
Midterm (take-home):	25%
Final Project (written):	25%
Final Project (oral):	25%

There is no preset distribution of final grades. Plus and minus modifiers will be used in assigning final grades.

Midterm: A take-home midterm will be given with 3-4 weeks notice, and due late in the semester. You may discuss the exam problems with other students. The final product, however, must be entirely your own work.

Final Project: Each student will choose a topic of current interest in catalysis from the "recent" literature (perhaps also relevant to their own research project).

Written Assignment: Prepare a five-page "extended abstract" (single-spaced, 12-point font, including figures, tables, and references). Instead of a "conclusions" section, please write be an "exam question" based on the contents of the article(s) used, for which the answer can be inferred from, but is not contained within, the article(s). The answer to the "exam question" should also be provided.

Oral Assignment: The topic chosen will be summarized by each student in 10 minute oral presentations, to take place during the last two weeks of the term. The format is meant to be that of a pedagogical class lecture.

Student Policies: Please see the syllabus addendum document on the Blackboard Learn website for an abridged list of official Purdue University student policies. This includes student expectations, student conduct and academic integrity, use of copyrighted materials, grief absence policies, individual learning and testing needs, illness, and campus emergency preparedness.

ChE 666 - Fall 2023 - Tentative Course Schedule

Week	Date	Lecture	Topic
1	8/22	1	Introduction
	8/24	2	Vibrational Spectroscopy – IR – I
2	8/29	3	Vibrational Spectroscopy – IR – II
	8/31	4	Vibrational Spectroscopy – DR, UV-Visible, Raman
3	9/5	5	Crystal Structures
	9/7	6	X-ray Diffraction
4	9/12	7	X-ray Absorption, EXAFS (Jeffrey Miller)
	9/14	8	X-ray Absorption, EXAFS (Jeffrey Miller)
5	9/19	9	Temp. Programmed Techniques (TPR, TPO, TPS)
	9/21	10	Temp. Programmed Surface Reactions (TPSR)
6	9/26	11	Temp. Programmed Techniques (Redhead, Porous Materials)
	9/28		**NO LECTURE (Cancelled)**
7	10/3	12	Kinetic Analysis (Enrique Iglesia)
	10/5	13	Isotopic Methods in Catalysis (Enrique Iglesia)
8	10/10		**NO LECTURE (FALL BREAK)**
	10/12		*1-on-1 Meetings Scheduled with Students*
9	10/17	14	NMR Spectroscopy
	10/19	15	EPR Spectroscopy
10	10/24	16	Adsorption/Desorption Isotherms, Pore Volume
	10/26	17	Elemental Analysis (AAS, ICP, EDX)
11	10/31	18	Ion Spectroscopies (SIMS, SNMS, ISS), Mossbauer
	11/2	19	Theoretical Methods in Catalysis (Jeff Greeley)
12	11/7	20	Photoemission / Auger Spectroscopy (Dima Zemlyanov)
	11/9	21	Photoemission / Auger Spectroscopy (Dima Zemlyanov)
13	11/14	22	Microscopy – TEM, SEM (Rosa Diaz)
	11/16		Birck Nanotechnology Center Tour (Electron Microsopy)
14	11/21 *	23	Microscopy – TEM, SEM (Rosa Diaz)
	11/23		**NO LECTURE (THANKSGIVING)**
15	11/28	24	STM / AFM (Dima Zemlyanov)
	11/30 **	25	STM / AFM (Dima Zemlyanov)
16	12/5		Final Project Presentations
	12/7		Final Project Presentations
17	TBD	Final	Final Project Presentations (TBD)

** Take-home midterm exam due in Gradescope.*

*** Final project written reports due in Gradescope.*

CHE 69700 S Statistical Methods and Modeling for Chemical Engineers

Fall 2024

Class Times: Lectures Tues and Thurs 12:00-1:15 (BHEE 226)

Instructors: Kendall Thomson (Instructor)
Room 1152 Forney Hall
Tel: 496-6706
Office Hours: TBA
thomsonk@purdue.edu

Graduate Teaching Assistant:

Jeonghui Kim, kim4017@purdue.edu

Course Objective

Introduce the mathematical basis for statistical analysis and develop and apply statistical methods, including designing experiments and building models from experimental data for use in engineering and science research. This course is offered as part of the required graduate chemical engineering curriculum.

Required Text: *Introduction to Mathematical Statistics, 7th Ed,* Hogg, McKean and Craig; Pearson (Boston). **ISBN-10: 0-321-79543-1**

Software: During this class, students will utilize mathematical tools (Mat Lab, Mathematica, etc.)

Grading Policy:

Homework Assignments	35 pts
Two 1-hour Exams	200 pts
Final Exam (Take home)	150 pts
Total	385 pts

Course Grading

Final grades for this class will be assigned using the +/- system (A+, A, A-, B+, B, etc…)

Homework:

Assignments will be handed out most Thursdays during lecture and are due in completed form in two weeks, on Thursday, beginning of lecture. Late homework will not be accepted. While you may find it helpful to discuss problem sets with one another, *what you turn in must be your own work.*

Course Topics:

Part I

- Set theory and measure theory
- Measure spaces and probability spaces
- Probability theory
- Random variables
- Sample spaces, outcomes, and events
- Conditional probabilities
- Probability theorems
- Bayes' theorem

Part II

- Discrete probability distributions
- Continuous probability distributions
- Probability mass functions and density functions
- Expectation value and variance
- Properties and theorems of distributions
- Moment generating functions
- The Bernoulli process and the binomial distribution
- The Poisson distribution
- The gamma function and the gamma distribution
- Multivariate and joint probability distributions
- Marginal distribution functions
- Bivariate transformations
- Gaussian integrals
- The normal distribution
- Single and multivariable analysis of variance
- Covariance and correlation
- The central limit theorem and Student's theorem
- The Student T-distribution and chi-square distribution
- The beta distribution
- The F-ratio distribution
- Matrices and the eigenproblem
- The spectral resolution theorem
- The multivariate normal distribution

Part III

- Introduction to statistical inference
- Hypothesis testing
- Biased and unbiased estimators
- Type I and type II errors
- Simple hypotheses on the mean and variance
- Hypotheses on difference of two means

- Hypotheses on variance ratios.
- Analysis of Variances (ANOVA)
- Maximum likelihood methods
- Maximum likelihood estimators
- Fisher's information
- Scores function
- Rao-Cramèr Lower Bound and efficient estimators
- Likelihood ratio tests
- Wald type and Scores type tests
- Multiparameter hypotheses testing

Part IV

- Introduction to Bayesian statistics
- The prior and posterior distributions
- Likelihood and marginal likelihoods
- Conjugate priors
- Improper priors
- Future predictions
- Marginal posterior distributions
- The Bayesian estimator
- Confidence intervals and Bayesian coverage
- Binomial distribution example
- Poisson distribution example
- The inverse gamma distribution
- Bayesian analysis on the normal distribution
- Exponential family of distributions
- The Gibbs sampler
- The Jefferies and uniform priors
- Bayesian statistical inference
- Hypothesis testing
- Prior and posterior odds and the Bayes factor
- Advanced Bayesian methods