CHE 3113 RATE OPERATIONS II
Spring 2022
MWF 11:30 AM-12:20 PM in Engineering North 450

Instructor

Prof. Zheyu Jiang
420 Engineering North
zheyu.jiang@okstate.edu (see email instructions below)

Office hour

No formal office hour will be held. However, the instructor will be happy to meet with students if not otherwise busy. To schedule an appointment, please email the instructor with **"CHE 3113-22" in the subject line**. Failure to do so will likely result in no response due to high volume of emails the instructor receives every day.

Teaching assistant

Sundaram Ramakrishnan
suramak@okstate.edu
Office hour: Thursdays 4-6 PM @ ATRC Lounge

Graders

TBD

References

While we do not officially require any textbooks as lecture notes are self-contained, below are four world-renowned, classic textbooks in mass transfer and separations that are worth reading and keeping in your ChemE book collection:

- *Mass-Transfer Operations*, 3rd ed. (1980), by R.E. Treybal.
- *Diffusion: Mass Transfer in Fluid Systems*, 3rd ed. (2009), by E.L. Cussler.
- *Separation Process Engineering*, 4th ed. (2016), by P. C. Wankat.
- *Separation Process Principles*, 4th ed. (2015), by J. D. Seader, E. J. Henley, and D. K. Roper.

Software

We will use Aspen HYSYS® for process simulation throughout this course. Aspen software suite is available in CEAT computer labs. CEAT students can also download and install Aspen software suite in their PCs by following instructions on https://ceat.okstate.edu/itservices/software/aspen.html.

Attendance

We will try our best to deliver *in-person* class to offer students a more effective learning experience during the COVID-19 pandemic. However, for the first two weeks of class AND should there be a positive case reported in class anytime during the semester, the latest University regulations (sent by OSU Senior Vice President for Health Affairs Dr. Johnny Stephens on December 31, 2021) require us to deliver lectures in one of the following options:

- Two weeks of in-person class with masks REQUIRED for all students attending.
- Two weeks of hybrid format (part Zoom/part in class) to ensure social distancing and reduce further exposure. For students attending an in-person class, masks are REQUIRED.
- Two weeks of online only instruction (via Zoom).

Thus, until there is a further update, we will deliver class **in-person with MANDATORY masks** following the latest University requirement. This implies that **students are required to wear a mask to be eligible for attending**

in-person class. We also ask that any student who feels ill should remain at home and promptly seek medical assistance. An individual Zoom link to the lecture will be sent to the student who possesses valid proof of medical/health condition. For contact tracing purposes, we have been asked to take attendance before each class. Class attendance will be tracked by taking a photo at the beginning of the class.

Grading

Your course grade will be determined by the weighted average of the following items:

- Homework and in-class quizzes – 20%
- Three midterm exams – 30% (10% each)
- Project – 20%
- Final exam (comprehensive) – 30%

The final semester weighted averages of the whole class will be ranked to assign the final letter grades. In other words, the grades will be curved based on class performance and instructor experience and judgment.

Among all components involved in grade assignment, homework/quizzes and project performances may be used to raise or lower a student's final letter grade at the discretion of the instructor. For example, a student with a final semester weighted average that is 1-2% less than the cutoff for a "B" grade may be given a higher letter grade if the student has above average performance on homework/quizzes and project as determined by the instructor. Letter grade adjustments will be reviewed and done at the end of semester.

Homework

Homework assignments will be given throughout the semester. Students will be submitting their assignments (each in a single .pdf file) electronically through Canvas. Homework assignments are due at the beginning of class (M/W/F 11:30 AM). Assignments submitted within one hour of the due time will incur a 50% deduction penalty. Assignments submitted more than an hour late will not be accepted unless special arrangements have been granted from the instructor **prior to** the due time. **Technical issues with Canvas, forgetting the due date, travelling, or busy class/personal schedule are generally not considered as valid excuses for late submission.** Please do not wait until the last few minutes to upload the assignment in case Canvas experiences any technical issue.

Assignments **should not be emailed** to the instructor or teaching assistant. If a technical issue prevents you from uploading the assignment Canvas, you may email the assignment to the course instructor to demonstrate completion. However, you must work with the instructor to electronically submit the assignment through Canvas later. Regrade requests must be submitted in writing to the **teaching assistant** within one week of when the homework assignment is graded and returned.

You are encouraged to study together, but homework turned in must reflect your own work. This includes any computer program or Aspen HYSYS flowsheet used to generate solutions. An assignment deemed similar to another will receive a score of zero, and submission of similar assignments will be treated as a violation of academic integrity.

Exam

Three midterm exams will be administered during the semester. And one comprehensive final exam will be administered during the Finals Week. Exam dates are listed in the tentative course schedule. While unlikely, these dates may change depending on the pace of the class. Announcements will be made at least one week in advance if an exam is moved. Material covered on exams will be taken from lecture notes, assigned readings, class discussions, and homework assignments. Partial credit will be given when appropriate. Regrade requests must be submitted in writing to the **instructor** within one week of when the exam is graded and returned. Absence from an exam can be excused only under the following circumstances:

- When special arrangements are made with the instructor **prior to** the time of the exam
- When a written doctor's certificate indicating that the student is physically unable to take the exam is presented

Makeup exams will not be given without prior consent of the instructor. Unavoidable absences will be dealt with on an individual basis and at the sole discretion of the instructor. **The final exam must be taken at the time scheduled by the Registrar.**

Project

One project will be assigned during the semester. The detailed instructions and deliverables will be available at the time of the project assignment. Students will work in teams of three to four to complete the project. At the completion of the project, each team will submit a final report. A grade sheet with the weighting for each element to be evaluated will be provided. In general, the total project score is divided evenly between technical content and communication as documented in the final report.

Project reports submitted one hour or less after the specified due time will incur a 35% deduction penalty. Project reports submitted more than one hour late will receive a score of zero. **A project report (whether on-time or late) must be submitted in order to pass the course.**

After the final reports have been submitted, each team member will submit an individual assessment of every team member's contribution to the completion of the project. These assessments are confidential and will only be seen by the instructor. **Submission of assessments is a prerequisite for passing the class.** The assessments will be considered in assigning final letter grades of the person being evaluated.

Special accommodation

If you believe you have a disability and need special accommodations of any nature, the instructor will work with you and the Office of Student Accessibility Services, 155 University Health Services, to ensure that you have a fair opportunity to perform in the class. The need for special accommodations must be communicated directly to the instructor from the Office of Student Accessibility Services. Once this has been done, you should meet with the instructor to discuss how the accommodations should be handled.

Students deemed to require additional test taking time are expected to schedule exams through the OSU Testing Center. Exams must be scheduled to start between 1 and 3 PM on the same day as the in-class exam. Testing Center appointments should be scheduled as soon as possible to avoid scheduling issues.

Drop policy

The drop policy as described in the University Academic Regulations, in the OSU Catalog will be observed. Drop dates are listed in the Syllabus Attachment provided with this document.

Canvas site

Course materials, including lecture notes, handouts, and homework/exam solutions will be posted through the Canvas portal on the OSU website (https://canvas.okstate.edu/). All homework assignments and the project reports will be submitted through the Canvas site. Access to course documents is automatically restricted to students enrolled in the course.

Outside of class, the instructors will use the email address registered with Canvas to broadcast course information. It is the student's responsibility to check his/her email regularly for any news/update related to the course. If you change your email address during the semester, you must inform the instructor so that we may update our email list.

Course admin

Below are some guiding principles concerning course administration:

- The course will be conducted in a manner that treats all students fairly and equally.
- Issues cannot be accommodated unless the instructor is notified in advance. Besides medical emergencies, no allowances are made in situations where the instructor is notified after the fact.
- After discussing plans to miss class with the instructor, students must immediately email the instructor to formally document an excused absence. In most cases, the assignment should be submitted before the absence.
- Cell phones and laptops should not be a distraction to you, your fellow classmates, or the instructor. Phones should be silenced and put away when not being used for class purposes. Web browsing and text messaging are not allowed at any time during class. Cell phones and laptops must remain out of sight at all times during exams.

Academic integrity

Oklahoma State University Policy on Academic Integrity

Oklahoma State University is committed to the maintenance of the highest standards of integrity and ethical conduct of its members. This level of ethical behavior and integrity will be maintained in this course. Participating in a behavior that violates academic integrity (e.g., unauthorized collaboration on homework or assignments, plagiarism, multiple submissions of the same assignment, cheating on examinations, fabricating information, helping another person cheat, having unauthorized advance access to examinations, altering or destroying the work of others, and fraudulently altering academic records) will result in your being sanctioned. Violations may subject you to disciplinary action including the following: receiving a failing grade on an assignment, examination or course, receiving a notation of a violation of academic integrity on your transcript, and being suspended from the University. You have the right to appeal the charge. Contact the Office of Academic Affairs, 101 Whitehurst, 405-744-5627, http://academicintegrity.okstate.edu.

Activities such as copying another student's homework or cheating on exams are clearly violations of academic integrity. A subtler, but equally unacceptable, activity is plagiarism. Plagiarism is the representation of someone else's ideas as if they are your own. Where the arguments, data, designs, etc., of someone else are being used in a paper, report, oral presentation, or similar academic project, the fact must be made explicitly clear by **citing appropriate references**. The references must fully indicate the extent to which any parts of the project are not your own work. (For example, it would be plagiarism to credit someone else with the content of only one paragraph in a paper, if in fact you were borrowing two pages of the paper from this source.) You must not assume that only verbatim copying requires crediting. Paraphrasing of someone else's ideas is still using someone else's ideas, and they must be acknowledged.

To avoid the appearance of plagiarism, you must be careful in the way you cite references. If you take material word-for-word from a source, you must put that material within quotes or in indented paragraphs and provide proper references. If you have any questions concerning whether or not the way in which you are using materials could be construed as plagiarism, consult the instructor before you submit the work for credit.

Except when explicitly stated otherwise, we encourage students to study and work together on homework to enhance the learning process. However, we also expect that all work that you submit is your individual effort. That is, it is inappropriate for groups of students to collectively solve a problem and submit duplicate solutions. This is considered a form of plagiarism. Instead, each student should generate their own solution, which at most incorporates the general concepts developed by the group study. Again, if you have any questions on this matter, check with the instructor. An obvious exception to the above is the assignment of a group report.

CHE 3113 Rate Operations II **Course Learning Objectives** Chemical Engineering – Oklahoma State University – August 13, 2018 At the end of the course students will be able to	**Outcome**	**Depth**
Engineering Technical and Science Skills		
1. Apply additional skills in the integration of material and energy balances, phase equilibria, and mass transfer to solve problems in a variety of unit operations.	1	2
2. Apply a basic understanding of equilibrium-based separations, e.g., stripping, absorption, distillation, liquid-liquid extraction, etc.	1	2
3. Apply a basic understanding of rate-based separations (e.g., membrane-based separation, ion exchange, etc.), culminating in a design project.	1,2	3
4. Understand and apply graphical, shortcut, and rigorous methods for designing and evaluating equilibrium-staged separation cascades (e.g., McCabe-Thiele, Fenske-Underwood-Gilliland method, and computer-aided simulation programs), culminating in a design project.	1,2	3
5. Apply experience in the use of rigorous computer-aided calculation procedures (e.g., Aspen HYSYS) and develop appreciation of their capabilities and limitations.	1,2	2
6. Understand the major factors that determine the size of equipment used in equilibrium-based separations and rate-based separations and perform preliminary sizing calculations, e.g., column diameter and height.	1	2
7. Apply a basic understanding of separations by barriers of solid agents, e.g., filtration, membrane-based separations, ion exchange, etc.	1	2
8. Select feasible separation processes based on knowledge of factors involving feeds, products, property differences among components, and characteristics of different separation operations.	2	2
Engineering Effectiveness and Professional Skills		
9. Present written work that is organized, logical, neat, and well documented that (a) employs good practice for presentation of graphical and tabular information and equations, and (b) fulfills the needs of the intended audience.	3	2

CHE 3113 Spring 2022 Tentative Schedule

Jan.	10	M	Course introduction	
	12	W	Thermodynamics – vapor-liquid equilibria, ideal/non-ideal mixture behaviors	
	14	F	Modeling phase equilibria in Aspen HYSYS	
	17	M	University Holiday – Martin Luther King Jr. Day	
	19	W	Binary and multicomponent flash operation	
	21	F	Binary and multicomponent flash operation – continued, HYSYS modeling	HW1 due
	24	M	Designing flash drum and phase separator	
	26	W	Designing flash drum and phase separator – continued	
	28	F	Mass balance and graphical methods for trayed absorption process	
	31	M	Algebraic methods for trayed absorption process, Kremser equation	
Feb.	2	W	Algebraic methods – continued, tray efficiency and column height	
	4	F	Design and operation of trayed absorption columns	HW2 due
	7	M	Design and operation of packed absorption columns	
	9	W	Algebraic and graphical methods for stripping process	
	11	F	Algebraic and graphical methods for stripping process – continued	
	14	M	**MIDTERM EXAM (IN CLASS)**	
	16	W	Binary distillation – mass balances, McCabe-Thiele (MT) method	
	18	F	MT method – q-line, feed stage, reflux ratio, minimum and total reflux	
	21	M	MT method – multiple feeds, intermediate reboiler/condenser, feed preheat	
	23	W	Column pressure, condenser and reboiler, reflux drums	
	25	F	Optimal reflux ratio, tray efficiency, packing vs. tray, sizing and design	
	28	M	HYSYS modeling, multicomponent distillation – degree of freedom	HW3 due
Mar.	2	W	Multicomponent distillation – light/heavy key, shortcut (FUG) method	
	4	F	FUG method – continued, minimum number of stages, feed stage, R_{min}	
	7	M	Geometric interpretation of Underwood method	
	9	W	Distillation sequences, heat integration, heat-pump, double-effect, DWC	
	11	F	**MIDTERM EXAM (IN CLASS)**	
	14	M	Spring break	
	16	W	Spring break	
	18	F	Spring break	
	21	M	Project announcement, liquid-liquid equilibria, single-stage extraction	
	23	W	Multi-stage continuous extraction (Hunter-Nash graphical method)	
	25	F	Sizing of single- and multi-stage liquid-liquid extractor	
	28	M	Extractor sizing – continued	
	30	W	Membrane-based separations – guest lecture from Dr. Seok-Jhin Kim	
Apr.	1	F	Transport through porous membranes, resistance models	HW4 due
	4	M	Resistance model – continued, transport through nonporous membranes	
	6	W	Crossflow model for membrane module	
	8	F	Multicomponent membrane cascade, analogy with distillation configurations	
	11	M	**MIDTERM EXAM (IN CLASS)**	
	13	W	Adsorption – applications, equilibrium models considerations	
	15	F	Mass transfer across adsorption column, breakthrough curve, sizing	
	18	M	Sizing and scaleup of adsorption columns – continued, SMB	
	20	W	Comparison of thermally driven and work driven separations	
	22	F	No class – tentative, students work on project	HW5 due
	25	M	No class – tentative, students work on project	
	27	W	No class – tentative, students work on project	Project due
	29	F	Course summary review, course evaluation	
May	2	M	**FINAL EXAM (10:00 AM – 11:50 AM)**	

v.220109