Chemical Engineering 477

Unit Operations Laboratory II

Spring 2019

Instructors
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Class Place and Time
Room 217 CB
Tu-Th 12:00-5:50 pm

Teaching Assistant:

Course Overview

The senior year of the chemical engineering curriculum at BYU is designed to be a capstone-like experience for students. The two Unit Operations courses (ChEn 475 and 477) as well as Plant Design (ChEn 451) form the core of this instruction whose purpose is to move beyond the basic theoretical principles learned in previous classes. UO Lab contributes to this aim by helping students develop engineering intuition about the physical processes and equipment explained in previous courses. This is done by performing hands-on experiments and analyses of real data that do not always conform to theoretical expectations. This course also helps hone problem-solving skills by presenting students with more open-ended problems than typical textbook homework seen in previous courses.

Another aim of this course is to help simulate daily work activities that engineers commonly encounter. These include working on projects with a team, evaluating the performance of others, writing technical reports and emails, and giving oral presentations. These so-called *soft-skills* often differentiate a good engineer from a great one.

This course can be one of the best classes that you have taken at the university if you "buy-in" to the process. We cannot fully simulate the daily work activities you will experience in future jobs, but we come close. Most of the equipment you will use in the lab is pilot-scale, but it behaves in a manner that is similar to larger equipment found in industry. Also, the teamwork and leadership activities in which you will engage are specifically suited to your short time in UO lab, but they closely mimic the yearly performance evaluations that you will write about others and that will be written about you. In short, due to our university setting, and the department's responsibility to assess learning, there is a temptation to look at some of the things we do in UO Lab as just "jumping through hoops" or "busy work." However, if you resist this urge, and trust that your instructors have your best interests in mind, including making you competent and confident engineer, this class will be great.

Course Mechanics

The professional engineering environment will be simulated to the extent possible. You will complete three projects during the semester in teams of ~four students: catalytic methanation (to analyze a heterogeneous catalytic reaction and design a reactor to produce industrial amounts of methane), ebulliometer (dealing with the thermodynamics of azeotropes and design of a separation system to

produce relatively pure products), and continuous distillation (to analyze the performance of a lab scale distillation column in simple binary distillation and then use those results to design an industrial scale column).

In each project, you will conduct experiments, perform analyses, draw conclusions, and make recommendations. You will report you progress and findings in both written and presentation form. Some of the written communications are small emails and attached slides. Others are longer. Some are done as a team and others are individual assignments. A team lab notebook is also kept for each project and is explained in more detail on the UO website.

Use of Team-Generated Material in Individual Assignments

For the individual assignments, there is often a question about what may be shared between teammates. For this class, the main graphs, figures, and tables generated by the team during the course of the experiment may be shared among group members for inclusion in individual reports. However, because writing styles and analysis methods may differ among members of the team, it could be suboptimal to use the same graph as your teammates. The data you provide in the document must support what is written, so you may need to change the presentation format of the data to fit your style. Other aspects of the report, such as the actual text and layout of the document, must be individual work.

Use of Materials or Information from Other Semesters or Teams

To maximize the learning experience, you are not allowed to talk to other teams about how they are doing (or did) a particular project. Moreover, you are not permitted to use materials, data, or reports from previous semesters. Remember, the purpose of the class is to give each student *the maximum opportunity for learning*. Using the work of others will weaken your education and ultimately give you less confidence in your abilities.

Attendance

In keeping with the goal of simulating the professional environment, you must 1) be in attendance ("at work") for the *entire* lab period on each day of the lab and 2) comply with the lab safety rules as presented in the next section.

Each class missed will result in a 50 point deduction from your grade, unless you receive prior permission from your instructor and make up work in a manner that is agreeable with your group. Each tardy will result in a 20-point deduction. Leaving class early will result in a 20 point deduction for each instance. For emergencies or other pressing circumstances, please communicate with Mike Beliveau or your instructor just as you would with an employer. "Pressing circumstances" include job-search activities, professional meeting attendance, university-excused activities, or serious illness. Sporting events, social engagements, etc. do not constitute legitimate excuses. You should not take other classes that are taught during UO Lab class hours. You should not attend research group or club meetings during class hours.

Deductions for attendance will be made if you do not follow the UO Lab Safety Rules explained in the next section. Any class period where you are not in compliance with the UO Lab Safety Rules will result in a 25 point deduction from your grade. Students usually have problems with this aspect of attendance by not wearing safety glasses, long pants, and covered shoes.

Deductions for attendance will be made if you do not follow the BYU Honor Code including the Dress and Grooming Standards. Any class period where you are not in compliance with the Honor Code will result in a 25 point deduction from your grade. You can review the official BYU Honor Code, which includes the Dress and Grooming Standards, at https://policy.byu.edu/view/index.php?p=26.

Safety

All students are required to follow the following safety rules. (*These are mandatory.*)

1. No food or drink is allowed in the laboratory or in the computer area. You may take a short break during non-lecture times to eat lunch or dinner, but do *not* do so in the lab or computer area.
2. All personnel in the laboratory area are required to wear safety glasses, long pants, and covered shoes (no sandals or flip-flops). Long pants and covered shoes are required each class day—even if you are not planning on being in the lab.
3. All students are required to complete ChEn 311 (where HAZCOM training takes place).
4. No labs/equipment may be run/started before the specific lab safety training has been done and the specific lab safety sheet has been passed off with either the instructor or Michael Beliveau.
5. Experimental work should be completed during the regular class periods. If additional time is needed in the laboratory, you must clear it with your instructor and make an appointment to use the laboratory with Mike Beliveau. At least two students must be present during those additional hours (no one is permitted to work in the lab alone).
6. At least one student from each team must be in the lab when running experiments to monitor the experiment and enact emergency procedures, if problems occur.
7. Students who operate *any* equipment in *any* unsafe manner or in a manner that damages the equipment or results in a user-preventable accident will incur a *significant* (i.e., at least one letter) grade penalty. This includes not knowing how to run the equipment or shut it down. *All team members should know how to safely run the equipment.*

Teamwork

Due to the small number of students, you will be assigned the same team for each project. You will need to work cooperatively, sharing a fair portion of the work-load. At the conclusion of each project, the other members of your team will be required to evaluate how well you performed as a team member (attendance, abilities, contributions, demeanor, etc.).

Resources

Written Materials

This course has no official text. Some textbooks and engineering handbooks are kept in the laboratory for your use, but please do not remove them from the room and please return them at the end of each period. A significant amount of information is also available on the course website at http://www.et.byu.edu/groups/uolab/. Of course, your textbooks from previous courses will also be helpful. Remember, you may not use or look at previous reports.

Hardware

Instruments, supplies, manuals, etc., may be checked out from the Laboratory Supervisor (Michael Beliveau). All materials checked out during the laboratory must be returned to the stockroom at the end of the laboratory period. Most of the information you will need has been placed on the UO Lab webpage for each individual experiment.

Lectures

Lectures will be given periodically in 217 (or 256 or 254) CB in order to provide guidance about report writing, data analysis, etc. I hope that these will be helpful. I welcome your feedback on these lectures as well as suggestions for additional topics.

Safety Sheets

You are required to complete a safety sheet *before* starting any experiment or operating any equipment. The purpose of the safety sheet is to demonstrate safety precautions that should be taken when performing

experiments, familiarity with the equipment, start-up/shutdown procedures, and emergency procedures. Each member of the group is expected to know this information, so each student will turn in a separate safety sheet.

Grading and Due Dates

Unless otherwise noted, all assignments must be turned in *at the beginning of class* to receive possible full credit. See the class schedule for the due dates for each item. For each late assignment, you may obtain up to the following maximum credit:

- 80% if turned in within 24 h (but class is not missed and report is not worked on in class)
- 60% if turned in within 24 h (but class is not missed and report is worked on in class)
- 50% if turned in between 24 and 48 h
- 0% if turned in after 48 h

The assignments are found below. Note that this list is subject to change.

Individual Points	Points
In-class safety/lab assignment (0, 15, or 30 points)	30
Project #1 Individual contribution determined by instructor based on team evaluations and instructor assessment. To be eligible for the points, you must turn in a team evaluation.	20
Project #1 Quiz	50
Project #1 Initial Individual Report and Team Appendix*	--
Project #1 Completeness of draft and/or improvement from draft to final individual report.	30
Project #1 Revised Individual Report	200
Project #2 Individual contribution determined by instructor based on team evaluations and instructor assessment. To be eligible for the points, you must turn in a team evaluation.	20
Project #2 Quiz	50
Project #3 Individual contribution determined by instructor based on team evaluations and instructor assessment. To be eligible for the points, you must turn in a team evaluation.	20
Project #3 Quiz	50
Project #3 Oral Presentation critique	30
TOTAL INDIVIDUAL POINTS	500

Team Points	Points
Project #1 Team Preplan Proposal	10
Project #1 Team Notebook	10
Project #1 Team Appendix—final	10
Project #2 Team Preplan Proposal	10
Project #2 Team Report	200
Project #2 Team Notebook	10
Project #2 Team Appendix	15
Project #3 Team Preplan Proposal	10
Project #3 Team Executive Summary	100
Project #3 Team Notebook	10
Project #3 Team Appendix	15
Project #3 Team Oral Presentation	100
TOTAL TEAM POINTS	500
TOTAL POINTS	1000

*The initial report should be treated as a draft final report, meaning it should be complete (i.e., the Appendix must also be turned in). Late penalties still apply and will be applied to the final report grade. In

addition, your effort in each of the following categories will be evaluated by the instructor: 1) Introduction and Methods, 2) Analysis, 3) Results and Conclusions, 4) Figures and Tables, and 5) Appendix. For each category, up to 5 points can be subtracted from the final report grade based on reduced effort.

There are 1000 points. Students achieving the following percentages are guaranteed the following grades. The instructors reserve the right to lower the percentages corresponding to the letter grades depending on natural breaks in the course grade distribution and their perception of overall class performance.

A	93.5%	B+	87%	C+	77%	D	60%
A-	90%	B	84%	C	74%	F	< 60%
		B-	80%	C-	70%		

Devotional, Forum and Dean's Lecture Attendance Policy

Brigham Young University's devotional and forum assemblies are an important part of your BYU experience. As Elder Dallin H. Oaks stated, "You neglect your education and fail to use a unique resource of this university if you miss a single one." (from the address "Challenges for the Year Ahead", 6 September 1973). Your attendance at each forum and devotional is strongly encouraged.

Schedule

The schedule for the course, including the due dates for assignments, is shown below. Please be aware of what is due each day.

Date	Topics	Assignments Due
4/30	Introduction and safety; Writing; Prepare preplan proposal Project #1: Begin experimental work	In-class safety assignment Project # 1: Team preplan proposal and safety sheet
5/2	Project #1	
5/7	Project #1	
5/9	Project #1: End experimental work	
5/14	Project #1: Project writing Project #1 report and provide feedback	Project #1: Draft individual report, team appendix and notebook due at 5:50 p.m. Individual **quiz** and peer evaluation.
5/16	Project #2: Prepare preplan proposal Project #2: Begin experimental work	Project #1: Final individual written report and team appendix (at noon) Project #2: Team preplan proposal and safety sheet
5/21	Project #2	
5/23	Project #2	
5/28	Project #2: End experimental work	
5/30	Project #2: Project writing Project #3: Prepare preplan proposal	Project #2: Final team written report and team appendix (at 3:00 p.m.). Individual **quiz** and peer evaluation. Project #3: Team preplan proposal and safety sheet
6/4	Project #3: Begin experimental work	
6/6	Project #3	
6/11	Project #3: End experimental work	
6/13	Project #3: Oral presentation preparation Project #3: Oral Presentations, 20 minutes/group	Project #3: Team 1 page executive summary, team appendix and notebook due at 3:00 p.m. Individual **quiz** and peer evaluation. Project #3: Oral presentations begin by 5:00 p.m.

Appendix – Competencies for ChEn 477

All BYU chemical engineering core courses include a set of skills or competencies that students should acquire or improve during the course. The most essential of these are included in the student and faculty evaluations at the end of each semester. The competencies for ChEn 477 appear below. The competency numbers come from a larger list of complete program outcomes.

Outcome	Topic	Competency	Expectation
2	Design	4	Students will be able to size and do performance calculations on single, isothermal plug-flow, CSTR, and batch reactors for a single homogeneous or heterogeneous reaction.
2	Design	6	Students will be able to select and size isothermal reactors for series and/or parallel reactions.
2	Design	19	Students will understand the need for safe engineering practices; demonstrate knowledge of pertinent safety laws and regulations; understand and have a basic knowledge of how safety considerations are incorporated into engineering design.
3	Communication	0	Students will be able to communicate effectively with a range of audiences.
3	Communication	1	Students will be able to give effective, well-organized oral presentations to a technical audience.
3	Communication	3	Students will be able to write effective, well-organized reports.
4	Ethics	0	Students will be able to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
4	Ethics	1	Students will understand and commit to practice the AIChE code and other professional codes of ethics.
5	Teamwork	0	Students will function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6	Experimentation & Analysis	0	Students will be able to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
6	Experimentation & Analysis	1	Students will understand process variables (e.g., P, T, flow rate, conc.) including procedures and equipment for their measurement.
8	Engineering Fundamentals	46	Students will be able to operate a process control system and understand the components of such a system.
8	Engineering Fundamentals	47	Students will be able to explain and operate real process equipment.
8	Engineering Fundamentals	48	Students will understand basic engineering statistics.