Unit Operations Laboratory II

ChEn 477 – Fall 2017

Instructors

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Class Place and Time

Room 392 CB M-W 2:00-2:50 pm
Room 217 CB M-W 3:00-4:50 pm

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. It 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. It is often these so-called *soft-skills* that differentiate a good engineering 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 we will have you engage in 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 the university setting in which we are found, 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 three students. Your teammates will change every

project. All three of these projects will require you to collect data in the lab-scale equipment, evaluate from those data parameters necessary to design and operate full-scale equipment, and then perform design and optimization calculations. These three projects will test your understanding of: chemical kinetics and catalysis, thermodynamics and vapor liquid equilibrium and chemical separations through distillation.

In each project, you will conduct experiments, perform analyses, draw conclusion, and make recommendations. You will report you progress and findings in both written and presentation form. Many of the written communications are emailed memos with attached data. Others are longer. Some are done as a team and others are individual assignments. One is a 15-minute team presentation providing a project overview. A team lab notebook is also kept for each project and is explained in more detail in a separate document.

Resources

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.

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. To maximize your 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 Policy

In keeping with the goal of simulating a professional work 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 safety section.

Each class missed will result in a 5-point deduction from your grade unless you receive permission from your instructor and make up work in a manner that is agreeable with your group. Each tardy will result in a 2.5-point deduction. Leaving class early will result in a 2.5-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, or university-excused activities. Sporting events, social engagements, etc. do not

constitute legitimate excuses. Students should not take other classes that are taught during UO Lab class hours. They 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 5-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 5-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

In a professional chemical engineering environment, safety is a primary concern. The following safety standards apply to every project in this course (T*hese are mandatory*):

1. No food or drink is allowed in the laboratory or in the computer area. (The exception is water *in a sealable water bottle* in the computer area but not the lab.) 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 aren't 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, Michael Beliveau, or John Sowa.
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 for the use of the laboratory with Mr. 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. This student should be monitoring the experiment so that emergency procedures can be enacted 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* 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.*

Grading Policy

Unless otherwise noted, all assignments must be turned in *at the beginning of class on the day they are due* 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:

- 75% if turned in within 24 hrs (but class is not missed and report is not worked on in class)
- 60% if turned in within 24 hrs (but class is not missed and report is worked on in class)

- 50% if turned in between 24 and 48 hrs
- 0% if turned in after 48 hrs

Reports

Three projects will be given during the semester. The following outline gives some guidelines for the required written and oral reports. Additional details are provided in the supplemental handout entitled "Experiments and Communication".

Item	Who?	Details
Safety Sheet	Team	Submit by the second lab period for each project. You must review the form with an Instructor or TA prior to starting any experiments. Although no points are given for this assignment, you may not begin any experiments until the form is completed and approved.
Proposal	Team	Submit at the beginning of the second lab period for each project. The grading scheme is given in the online grading sheet (at http://uolab.groups.et.byu.net/che477.htm under the "Other Links" pull down menu). The proposal should include the following: a) Background, including a brief description of the objective; b) Theoretical analysis (equations, etc.) used for assessing the data with any pertinent assumptions; c) Brief experimental methods, including both a brief description and diagram of the apparatus and the experimental design (values of operating variables, number of replicates, etc.), data that will be collected (which parameters, how often, etc.), system issues (warm-up times, assuring steady-state, etc.), and safety issues; and d) Expected outcomes.
Written Reports	Individual (1st project) and Team (2nd project)	Submit a 7-10 page report (double-spaced) for the first and the second projects. Must be in 3rd person format. The grading scheme and content are given in the rubric. Both an initial and a revised report are due for the individual report. The individual report must be completely your own work, including the development of figures and tables for presenting your results (except a figure showing the apparatus used in describing your experimental methods and an appendix with data). Thinking and analysis may be shared by the entire team, but your contribution must be a major part of the project and certainly a major part of your report, for which you will assume total responsibility. Excerpts from the proposal may be used but they must be referenced. Submission of written project reports will be required at the beginning of the lab period according to the attached schedule. Reports turned in late without prior approval from Mr. Beliveau and Dr. Fry will be penalized (see grading section). Please work ahead to ensure that your report is finished on time.
Grading critique	Individual	At the end of the first project, you will be required to critique and grade one of your classmates' reports using the provided grading rubric. You will also need to prepare a report by the end of the same class period outlining the positive aspects of the report and identifying the key areas needing

		improvement. You may mark the report in any manner to provide feedback. Class attendance and participation in the report grading is mandatory during the entire lab period. See grading guidelines in grading section.
Oral Presentation	Team	You will be assigned to present a team oral presentation for the last project. The grading scheme is given in the rubric. The oral presentation should be approximately 15 minutes with 5 minutes for questions. The oral presentation content should be similar to the content of the written reports.
Notebook	Team	Submit a team notebook at the end of each project. As is standard professional practice, all pertinent details of each project must be recorded in ink in your project notebook. You must write in page numbers if not already present. If questions arise about the accuracy and validity of the data in your reports, it should be possible to answer those questions by referring to the project notebook. Recorded details should include, but not be limited to, the following: Dates, times, names, and signatures when experimental work was performed; A brief summary of the objective and project at the beginning of the project; A brief summary of each daily experiment; All raw data (taken by hand or computer data stapled in notebook) with appropriate labels; Pertinent experimental observations and conditions; Calculations performed during the experiment; Key conclusions at the end of the project.

Assignments

Individual Assignments	Points
In-class safety/lab assignment (0, 5, or 10 points)	10
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.	10
Project #1 Quiz	30
Project #1 Initial Individual Report and Team Appendix*	--
Project #1 Grading of another student's report and memo**	10
Project #1 Revised Individual Report	100
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.	10
Project #2 Quiz	30
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.	10
Project #3 Quiz	30

Project #3 Oral Presentation critique	10
Project #3 Executive Summary	50
TOTAL INDIVIDUAL POINTS	**300**

Team Points	Points
Project #1 Team Proposal	30
Project #1 Team Progress Report and Notebook Check	10
Project #1 Team Appendix- final	30
Project #2 Team Proposal	30
Project #2 Team Report	100
Project #2 Team Progress Report and Notebook Check	10
Project #2 Team Appendix	30
Project #3 Team Proposal	30
Project #3 Team Progress Report and Notebook Check	10
Project #3 Team Appendix	30
Project #3 Team Oral Presentation	50
TOTAL TEAM POINTS	**360**
TOTAL POINTS	**660**

* Although no points are given, the initial report should be treated as a final report (i.e., 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.

** This is an in-class assignment. Attendance and participation during the entire lab period is required since this exercise is part of the lab period. If you have to miss this class, please contact the instructor prior to the class to make arrangements for making up the assignment. The points for this assignment will be based on your effort as evaluated by the instructor and TA.

There are 600 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.

BYU Honor Code

In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and our own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Preventing Sexual Discrimination and Harassment

Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education. Title IX covers discrimination in programs, admissions, activities, and student-to-student sexual harassment. BYU's policy against sexual harassment extends not only to employees of the university, but to students as well. If you encounter unlawful sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Employment Office at 422-5895 or 367-5689 (24-hours); or contact the Honor Code Office at 422-2847.

Students with Disabilities

Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the Services for Students with Disabilities Office (422-2767). Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. Services are coordinated with the student and instructor by the SSD Office. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB.

Academic Honesty Policy

The first injunction of the BYU Honor Code is the call to be honest. Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life's work, but also to build character. President David O. McKay taught that 'character is the highest aim of education' (The Aims of a BYU Education, p. 6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.

Plagiarism Policy

Writing submitted for credit at BYU must consist of the student's own ideas presented in sentences and paragraphs of his or her own construction. The work of other writers or speakers may be included when appropriate (as in a research paper or book review), but such material must support the student's own work (not substitute for it) and must be clearly identified by appropriate introduction and punctuation and by footnoting or other standard referencing.

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. Attendance at the Dean's Lecture is required, though it will be recorded in a different class (Plant Design).

Course Schedule

Date	Topics	Assignments Due
Mon – Sep 04	**No Class (Labor Day)**	
Wed – Sep 06	Introduction and safety, Project #1 - Proposal	In-class safety assignment
Mon – Sep 11	Project #1 - Begin experimental work, Lecture #1 - Design of Experiments	Project # 1 - Team Proposal and Safety Sheet
Wed – Sep 13	Project #1 - Experiments, Lecture #2 - Technical Writing	-
Mon – Sep 18	Project #1 - Experiments	-
Wed – Sep 20	Project #1 - Experiments	Progress Report / Notebook Check
Mon – Sep 25	Project #1 - Experiments	-
Wed – Sep 27	Project #1 - Experiments	-
Mon – Oct 02	Project #1: End of Experiments	Project #1 - Peer Evaluation
Wed – Oct 04	Project #1: Writing (Dr. Fry Traveling)	-
Mon – Oct 09	Project #1 - Peer Review	Project #1 – Draft Report (Not Graded), Project #1 - Quiz
Wed – Oct 11	Project #1 - Writing	Project #1 - Peer Review (Not Graded)
Mon – Oct 16	Project #2 - Proposal	Project #1 - Final Report & Team Appendix
Wed – Oct 18	Project #2 - Experiments	Project #2 - Team Proposal and Safety Sheet
Mon – Oct 23	Project #2 - Experiments (Dr. Fry Traveling)	-
Wed – Oct 25	Project #2 - Experiments (Dr. Fry Traveling)	-
Mon – Oct 30	Project #2 - Experiments, Lecture #3 - Team Dynamics	Progress Report / Notebook Check
Wed – Nov 01	Project #2 - Experiments	-
Mon – Nov 06	Project #2 - End of Experiments	Project #2 - Peer Evaluation
Wed – Nov 08	Project #2 - Writing	-
Mon – Nov 13	Project #3 - Proposal	Project #2 - Final Team Report & Appendix, Project #2 - Quiz

Wed – Nov 15	Project #3 - Experiments	Project #3 - Team Proposal and Safety Sheet
Mon – Nov 20	Project #3 - Experiments	-
Wed – Nov 22	**No Class (Thanksgiving)**	
Wed – Nov 27	Project #3 - Experiments	-
Mon – Nov 29	Project #3 - Experiments	Progress Report / Notebook Check
Mon – Dec 04	Project #3 - Experiments	-
Wed – Dec 06	Project #3 - End of Experiments	Project #3 - Peer Evaluation
Mon – Dec 11	Project #3 - Presentation Prep	Project #3 – Executive Summary & Appendix, Project #3 - Quiz
Wed – Dec 13	Project #3 - Oral Presentations	Project #3 - Presentation Critique

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 include student and faculty evaluations at the end of each semester. The competencies for ChEn 477 appear below, together with an indication of the assessment level and usage. This is a relatively large list. We will focus on those designated as assessment level 2 and especially 3 and usage M. The competency numbers come from complete program outcomes. More details appear at the following website:
https://learningoutcomes.byu.edu/wiki/index.php/Chemical_Engineering_BS#Expected_Learning_Outcomes,

Competencies

1.2 Students will gain hands on experience with chemical processes, units, and corresponding equipment through lab experiments. Level: 2. Usage: M.
3.5.2 Students will be able to estimate mass transfer coefficients and use them to determine mass transfer rates for both external and internal flows and across phase boundaries. Level: 3. Usage: R.
3.6.1 Students will understand fundamentals of kinetics including definitions of rate and forms of rate expressions during laboratory experiments. Level: 3. Usage: R
4.1 Students will demonstrate familiarity and experience with the measurement of process variables (e.g., P, T, flow rate, conc.) using manual and/or electronic devices and computers. Level: 2. Usage: M.
4.2 Students will demonstrate knowledge of basic laboratory techniques. Level: 2. Usage: M.
4.3 Students will be able to use the scientific method and problem solving strategies, as well as statistical methods, to design, carry out, and analyze experiments in order to solve engineering problems. Level: 2. Usage: M.
4.5 Students will demonstrate familiarity and experience with chemical process equipment. Level: 1. Usage: M.
4.7 Students will demonstrate an understanding of basic engineering statistics in their laboratory reports. Level: 2. Usage: M.
4.8 Students will be able to determine rate expressions by analyzing reactor data including integral and differential analysis on constant- and/or variable-volume systems in laboratory experiments. Level: 2. Usage: R.
4.9 Students will demonstrate effective interpretation of graphical data. Level: 1. Usage: P.
6.1 Students will demonstrate an ability to solve engineering problems. Level: 3. Usage: P.

6.3 Students will be able to integrate topics from various Chemical Engineering courses to solve realistic problems in the areas of kinetics and separations. Level: 2. Usage: M.
6.4 Students will exhibit critical and creative thinking skills for analysis and evaluation of problems and cause-effect relationships. Level: 2. Usage: P.
6.5 Students will be able to obtain and evaluate appropriate informational/data from databases, hand books, correlations, experiments, literature, etc. Level: 2. Usage: P.
6.6 Students will be able to rationalize units, make order of magnitude estimates, assess reasonableness of solutions, and select appropriate levels of solution sophistication. Level: 2. Usage: P.
7.1 Students will understand and practice safe laboratory and chemicals-handling principles. Level: 3. Usage: M.
8.1 Students will be able to give effective, well organized oral presentations including the handling of questions and the use of appropriate visual aids. Level: 2. Usage: R.
8.2 Students will be able to write effective, well organized technical reports, including formal engineering reports and short letter reports. Level: 2. Usage: M.
9.2 Students will practice good teamwork principles. Level: 2. Usage: M.
10.1.1 Students will be able to size and do performance calculations on single, isothermal plug-flow, CSTR, or batch reactors for a single homogeneous or heterogeneous reaction from experimental data. Level: 3. Usage: R.
10.4.3 Students will be able to design tray-type columns (e.g., number of trays, tray efficiency, column height, column diameter, product specs) and/or packed columns (e.g., height of column, packing material, column diameter, flooding velocity). Level: 2. Usage: R.
12.8 Students will demonstrate effective reading of technical material. Level: 1. Usage: P.

Level of Assessment Key

1 - Student is exposed to material but not necessarily assessed
2 - Competency is assessed in course
3 - Competency is assessed in course and again before graduation

Usage Key

I - (Introductory) The competency is covered at an introductory level
M - (Major) Major exposure to competency occurs in the course
R - (Review) Competency taught previously is reviewed
P - (Programmatic) The competency occurs widely throughout the curriculum and is not specific to a particular course.