

ChE 371 – Chemical Engineering Laboratory I
Fall Semester – 2016

Description	Required Course - A laboratory course designed to illustrate the application of chemical engineering principles to chemical engineering operations and processes. <i>Total 3 Credits (1.5 credits per semester).</i> <i>Pre- and co-requisites: ChE 121/332, ChE 141/342, ChE 142/352</i>
Textbook	No required textbook
References	Seader, J.D. et al., "Separation Process Principles", 3 rd Edition, Wiley (2010) Geankoplis, C., "Transport Processes and Separation Process Principles", 4 th Ed., Pearson (2003) Treybal, R. E., "Mass-Transfer Operations", 3 rd Edition, McGraw-Hill. (1987) McCabe, W. L., et al., "Unit Operations of Chemical Engineering", 7th Ed., McGraw-Hill (2004) "Coulson and Richardson's Chemical Engineering", Volumes 1-3, Butterworth-Heinemann (1999) Levenspiel, O., "Chemical Reaction Engineering", 3 rd Edition, Wiley (1999) Perry, R. H., and Green, D., "Perry's Chemical Engineering Handbook", 8 th Ed., McGraw-Hill. (2007)
Instructors	Professor Benjamin Davis (Sec A), Professor Daniel Lepek (Sec B)
Course Objectives	<ol style="list-style-type: none">1. Apply the fundamentals of fluid dynamics, heat and mass transfer, and reaction engineering to small-scale unit operation experiments.2. Experience the practical considerations needed to use chemical engineering fundamentals successfully.3. Introduce the inconsistencies that arise between theoretical and "real" behavior.4. Develop and practice skills in the oral and written communication of technical material for a range of scenarios.
Experiments	<i>Fall Semester</i> <ol style="list-style-type: none">1. Fluid Flow - determination of friction losses and friction loss coefficients for water passing through different pipes, valves, fittings etc. (Bernoulli equation).2. Heat Exchanger - investigation of the effects of temperature and flowrate on the overall heat transfer coefficient for a variety of heat exchangers. Determination of heat exchanger efficiency. (Armfield HT 30XC, HT33, HT 36, HT37)3. Flooding Point in a Packed Column - experimental investigation of the loading points and flooding points of a counter-current gas-liquid contactor.4. Filtration - determine the specific cake resistance and the degree of compressibility for a solid-liquid slurry using a Lanco plate and frame filter unit.5. Reactor(s) - determination of kinetic rate equation and the effect of feed rate on conversion in a tubular reactor (design equation for ideal plug flow reactor, kinetics and stoichiometry, titration). Confirmation of kinetics using a batch reactor.
Schedule	The class meets once per week for a 4-hour session. Section A meets on Wednesdays (12:00 pm – 3:50 pm) and Section B meets on Thursdays (12:00 pm – 3:50 pm). Each lab group will complete the five experiments listed for each semester. Groups are limited to three students per group. Except for the first experiments of each semester, which are assigned three laboratory sessions, each experiment must be completed in two sessions.
Professional Component	The course directly addresses engineering topics consisting of engineering sciences and engineering design appropriate to chemical engineering. It includes the application of advanced mathematics and sciences to solving engineering problems. The course also addresses issues involving safety, hazards, and risk analysis.
Program Objectives	The course directly addresses the Chemical Engineering Department's Program Objectives 1, 3, and 5, and ABET Criterion 3 Student Outcomes a, b, c, e, f, g, l, and k.

Course Outline

The course will meet once a week in rooms 303 and 304. There must be strict adherence to laboratory safety rules, which are prominently posted and presented below. Course information will be available on the Moodle course website. The first session of the semester will be an introduction to the experiments that will be performed that semester and an opportunity to finalize laboratory group members. Shortly after that session, a schedule of experiments will be posted. The experiments and schedule will follow the outlines given above but occasionally equipment failure may result in last minute changes during the semester.

Laboratory reports will be of various types, including, but not limited to:

- Formal laboratory reports
- Posters
- Memoranda
- Research proposals
- Oral presentations

You will be told what type of report you should prepare for each experiment and given guidelines and sometimes coaching to help you prepare the reports. Final reports are typically due two weeks after the completion of the experiment. Drafts might be required in addition to the final report. Laboratory reports are to be submitted both electronically and in hard-copy format.

Safety Rules and Regulations

The following procedures are mandatory for all engineering school courses that are either wholly laboratory courses, or courses with a laboratory component.

1. MSDS Sheets

All students must be aware of the physical dangers presented by all chemicals used in a laboratory. Students must be familiar with MSDS sheets and understand the information they contain, including handling procedures, safety precautions and disposal procedures for chemicals. MSDS sheets must be present in a binder immediately outside of the laboratory.

2. Safety Goggles and Gloves

Safety goggles and other protective gear (e.g., ear protection) must be used when required for the safe conduct of an experiment. Students should wear safety goggles as the default condition unless advised that it is safe not to wear them for a particular experiment. Instruction must be available in the proper use of gloves to protect one's hands and to prevent cross-contamination. The removal or application of contact lenses is not permitted in the lab. Contact lenses should be worn with special safety goggles. Visitors to the lab must comply with the same eye protection policy required of students and employees.

3. Clothing

All students must wear suitable clothing to protect from splashes, burns, rotating machine parts, and other potential hazards. No open-toe shoes should be worn in the lab and students must tie up long hair. Clothing that may hang loose should not be worn in the lab. Violation of this rule constitutes grounds to exclude the student from the laboratory.

4. Safety Equipment

All students must know the location of all safety equipment, such as showers, first aid kits, fire blankets, eyewashes, ear protection and other equipment. (Some of this equipment will be in the lab, some will be in the corridor.) All safety equipment must be in proper working order. Students must be aware of exits for use in an emergency, and be instructed on what to do in case of an accident (e.g., rinsing an eye with water for 15 minutes to dilute a chemical splash to that eye.).

5. Food and Drink

No food or drink may be consumed in the lab or placed in a laboratory refrigerator or cabinet. Chewing gum is not allowed in the lab.

6. Power Tools

Only students who have been properly trained and certified by the Cooper Union staff are permitted to use power tools in the lab and only under the conditions and hours specified by their lab supervisor or appropriate authority. All power tools and similar equipment must be in good repair to be eligible for use.

7. Injuries

All non-trivial injuries must be reported immediately to instructors and an incident report must be filed promptly with the Department of Buildings and Grounds. Instructions on the incident report must be followed. (See attached sample incident report)

8. Disposal of Waste

Students must dispose of all used and unused chemical or biological waste in properly labeled waste containers, which are located in each laboratory. Students should use sharps containers when appropriate. Cooper Union hazardous waste disposal procedures must be posted and followed at all times.

9. Fume Hoods

Students must work under a fume hood when the safe conduct of an experiment requires it. Fume hoods must be in good working order and functioning when used.

10. Visitors in the Lab

There are different rules for two categories of lab visitors:

- i) Individuals who are NOT associated with The Cooper Union (i.e., not CU students, faculty, staff or administrators) may, with the prior express permission of an instructor, enter a laboratory and observe, but not perform, lab work. Such visitors must be aware of, and comply with, safety policies (e.g., wearing goggles, limitations on where to stand in the lab) that the instructor deems appropriate.
- ii) Individuals who ARE associated with The Cooper Union, but are NOT officially registered members of a class or program (e.g. the Summer High School Internship) may, with the prior express permission of an instructor, enter a laboratory and perform lab work that has been authorized by the instructor. Such individuals must be aware of (and to the extent possible, comply with) both safety policies, (e.g. wearing goggles and gloves), and the scope of permissible work (which experiments may be performed, which tools may be used, which techniques may be employed, etc.). This rule does not permit an instructor to authorize lab access, or permit work that conflicts with other established lab policies (e.g., limited hours of access to labs).

11. Clean Up

Students must have sufficient time to clean up their work area before they leave the lab. Students must wash their hands immediately after finishing the lab.

12. Electrical Hazards

The circumventing or disabling of any grounding circuit, on any electrical machinery, instrument or tool, is expressly forbidden, and may lead to a ban of the student from future laboratory access.

13. Storage Spacing Personal Items

Students must keep coats and books away from their work space and aisles and corridors in the lab must be kept clear of trip and similar hazards.

14. Behavior in the Lab

Students may not "fool around" in the lab, e.g., throwing objects across the lab or acting in a boisterous manner.

15. Unauthorized Experimentation

Students may not conduct unauthorized experiments in the lab. Students should not work in the lab unless another person is present, except when working on a purely computer-based project.

16. Chemical Spills

Chemical spills must be dealt with according to the procedures laid out in Cooper Union's Spill Policy.

Attendance

Attendance is required for all students for all experiments! Unexcused absences and lateness will affect your grade!

Plagiarism

Plagiarism will not be tolerated. According to the Cooper Union Course Catalog, "plagiarism is the presentation of another person's 'work product' (ideas, words, equations, computer code, graphics, lab data, etc...) as one's own. Whether done intentionally or unintentionally, plagiarism will not be tolerated in the School of Engineering." Please refer to the Cooper Union Course Catalog for more information.

Prepared by: Professors Richard Stock, Daniel Lepek, and Benjamin Davis, Department of Chemical Engineering.

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