

# CHE 4162

## UNIT OPERATIONS LABORATORY

### SYLLABUS



*FALL 2020 – REVISION A*

## COURSE LOGISTICS

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This first part of the ChE 4162 course syllabus contains information on the course and its objectives, instructors, staff, texts, and other required materials. This logistics section also discusses an outline of the semester’s activities, the list of experimental apparatuses, the course calendar, a detailed discussion of all course policies, the role of safety in the laboratory, academic misconduct, and – lastly – grading.

Students, you should know and understand the information contained in the [ChE 4162 Course Syllabus](#) if you are to get the most out of your experience in UO Lab. Indeed, complying with the requirements stated herein is essential to learning the most and obtaining the best assessment of that learning. To assure knowledge of UO Lab course requirements, students must complete a Moodle®-facilitated quiz based on the content of this section and the entire syllabus document before they begin any lab work in this course.

### Course Information

Unit Operations Laboratory, ChE 4162, is a required core course in chemical engineering. The LSU General Catalog description for ChE 4162 advises that students must engage in “... obtaining and

interpreting data needed to solve typical problems in the design or operation of chemical engineering equipment.” Prerequisites for ChE 4162 are the completion of ChE 3104 as well as credit or registration in ChE 4151.

## Instructor and Staff Information

The table below contains the list of instructors, their days in the lab this semester, office location, phone number, and email.

Instructor	Days in Lab	Office	Phone	Email
Harry Toups, Instructor of Record	Mon, Tue, Wed, Thu	3314N	578.3068	<a href="mailto:hjtoups@lsu.edu">hjtoups@lsu.edu</a>
Chris Arges	Tue, Thu	3315S	578.3060	<a href="mailto:carges@lsu.edu">carges@lsu.edu</a>
Luis Manuel	Mon, Tue, Wed, Thu	3304	N/A	<a href="mailto:lmanu14@lsu.edu">lmanu14@lsu.edu</a>
Craig Plaisance	Tue, Thu	3314P	578.6320	<a href="mailto:plaisance@lsu.edu">plaisance@lsu.edu</a>
José Romagnoli	Mon, Wed	3308A	578.2173	<a href="mailto:jose@lsu.edu">jose@lsu.edu</a>
Jerry Spivey	Mon, Tue, Wed, Thu	3314L	578.3690	<a href="mailto:jjspivey@lsu.edu">jjspivey@lsu.edu</a>
David (Boz) Bowles, Coordinator, Chevron Center for Engineering Education	Negotiated with Instructor of Record	COE Studio 1501 PFT	578.9952	<a href="mailto:dbowles@lsu.edu">dbowles@lsu.edu</a>
Mark Lee, Manager of Operations	Mon, Tue, Wed, Thu	3308B	N/A	<a href="mailto:marklee@lsu.edu">marklee@lsu.edu</a>
Joe Bell	N/A	ChE Shop	578.1448	<a href="mailto:jbelle8@lsu.edu">jbelle8@lsu.edu</a>

## Text(s), Readings, Materials

Current textbooks for ChE 4151 – Unit Operations Design, ChE 4190 – Chemical Reaction Engineering and ChE 4198 – Process Dynamics serve as the principal domain-related references for ChE 4162. An additional text – [Practical Numerical Methods for Chemical Engineers by Davis \(4<sup>th</sup> edition\)](#) – is required, to provide students with computational Excel™ background methodology and VBA-implemented tools.

Many assignments in ChE 4162 entail the review and use of one or more additional readings; for example, literature articles or other reference material, typically available online. If these represent required reading, instructors often provide such links to these sources or the documents themselves.

Laboratory staff members make required safety equipment available, with the first pair of ANSI-approved glasses gratis.

### Course Moodle

The ChE 4162 Moodle site should appear in your list of courses just before the start of the semester. Information needed to navigate portions of the course content, and laboratory documentation (e.g., the syllabus, safety information, operating manuals, and other guidance for each experiment) are found there as well as pre-laboratory quizzes and, of course, grades for completed course deliverables, as they become available. The UO Lab Workshop materials are also present on the course Moodle site.

### Course Description and Objectives

The LSU General Catalog description for ChE 4162 advises that students must engage in “... obtaining and interpreting data needed to solve typical problems in the design or operation of chemical engineering equipment.”

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#### STUDENT LEARNING OBJECTIVES

After this course, students should have demonstrated the following learning outcomes:

- Apply chemical engineering principles and process simulation to solve complex, open-ended problems in kinetics, separations, and process dynamics/control, in high-performance teams working on physical equipment,
- Determine clear experimental objective(s), using knowledge and skills gained from unit operations, kinetics, reactor design, process dynamics/control, optimization, and economics,
- Design and conduct realistic experiments, analyze resulting data using standard statistical methods,
- Build knowledge and practice of personnel safety, process safety, and environmental protection, and
- Communicate the experimental steps, findings, conclusions, and recommendations through the written and spoken word.

ChE 4162 is a learner-centered course of instruction in which your instructors focus not so much on what they do (e.g., lecturing), but on what you are learning, how you are learning, and how you can use the learning [1].

### COMMUNICATION-INTENSIVE (C-I) COURSE

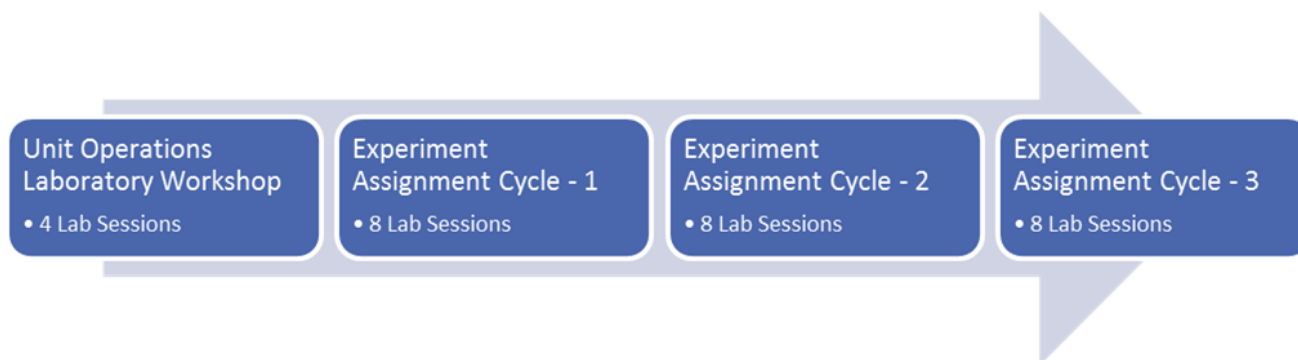
ChE 4162 is a certified Communication-Intensive (C-I) course which meets all of the requirements set forth by LSU's [Communication across the Curriculum program](#), including the following:

- Instruction and assignments emphasizing informal and formal writing and speaking
- The teaching of discipline-specific communication techniques
- Use of feedback loops for learning
- 40% of the course grade rooted in communication-based work, and
- The practice of ethical and professional work standards

Students interested in pursuing the LSU Distinguished Communicator certification may use this C-I course for credit. For more information about this student recognition program, visit the [Communication across the Curriculum website](#). Also see [Student Resources at CxC](#).

### Course Outline

The course workflow breaks down into two activities: a) a workshop, and b) a series of three experiment assignment cycles, as shown below. In the next sections, we discuss these activities, as well as the complement of the lab equipment available.



### UNIT OPERATIONS LABORATORY WORKSHOP

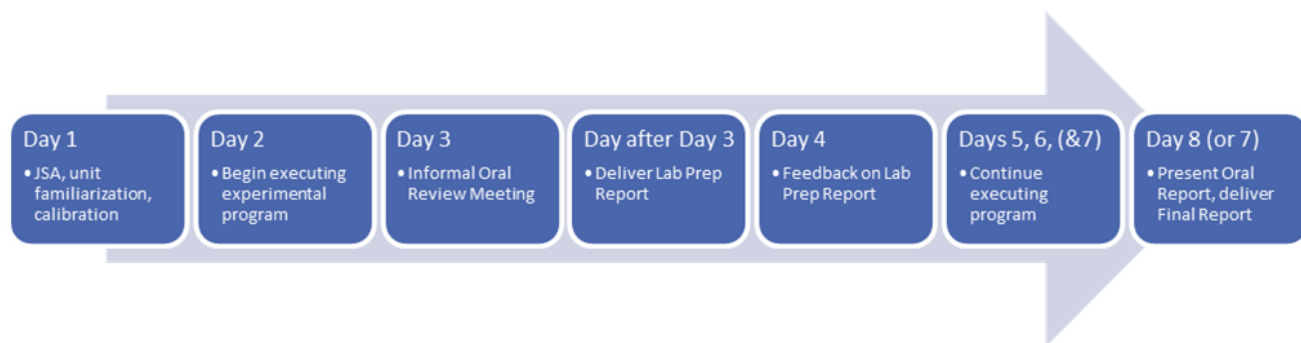
Each semester begins with a **Unit Operations Laboratory Workshop** lasting four (4) lab sessions. This workshop is designed to make sure that you sharpen the skills necessary for experimental studies before you begin lab work in earnest. Participation in and completion of this workshop is not an optional

activity in ChE 4162. The first three days of the workshop primarily consist of lecture and student activities in experimental uncertainty estimation, modeling, and hypothesis testing, all performed around an in-class example problem. Day 4 of the workshop consists of individual student oral presentations. The Instructor of Record makes full details of the workshop available on Moodle prior to the first day of class.

### ASSIGNMENT CYCLE

Students typically work in teams of three, or one or two teams-of-two, in the case of student enrollment not evenly divisible by three. Each team conducts three experiments during the semester. All team members are expected to participate jointly in planning and performing each of these three experiments, evaluating experimental data, analyzing results, and writing reports.

The figure below shows the flow plan of a typical experiment assignment cycle.



Typically, there are eight (8) lab periods allotted to each experimental assignment cycle; seven (7) in some cases. Before beginning actual experimental work in each cycle, each team must submit a completed [Job Safety Analysis Form](#), or JSA, for the experiment in question and have it reviewed for accuracy and completeness by their instructor. (See the course Moodle site for the form, complete with instructions and hover tooltips.)

First and second class periods are typically devoted to becoming familiar with the equipment, preparing a team's experimental plan, and starting the experimental program. Instructors meet with student teams during these days, engaging them in oral reflection on the requirements of the assignment and their progress. During the 3<sup>rd</sup> lab period, your instructor meets with each team for an **Informal Oral Review**. In this review, instructor and students discuss unresolved issues of theory, explore and clarify experimental goals and plans, and examine sample calculations trouble spots. Students test organizational and content relevancy for the upcoming written report. During the **Informal Oral Review**, the student team designates a team member to present the **Individual Oral Report** on Day 8. That student gives a brief oral draft of the structure or flow of her/his upcoming **Individual Oral Report**.

Armed with the output from this review – feedback from the instructor meshing with their first-pass notions – students come away prepared to make constructive revisions to their experimental program and the communications deliverables, both oral and written. Additionally, the instructor gains insight into the students' current level of understanding.

**Lab Prep Report** materials are submitted electronically by 6:00 PM, the *day after* the 3<sup>rd</sup> lab period of each cycle; **Final Report** materials by 1:30 PM, at the *start* of the 8<sup>th</sup> (or last) lab period of each cycle.

Each student presents an **Individual Oral Report** once during the semester, delivered during the 8<sup>th</sup> (or last) lab period of each cycle. All students attend all presentations.

Tutoring session(s) with a College of Engineering (COE) Technical Communications Instructor may be required for individuals or teams, depending upon performance in written and oral reports.

### LIST OF EXPERIMENTS

The Unit Operations Laboratory contains some of the best experimental equipment available to undergraduates pursuing a degree in chemical engineering. With a couple of exceptions, each experimental platform includes data acquisition and control capabilities afforded by industry-standard distributed control systems. Listed below are the experimental platforms available this semester.

List of Experimental Platforms Available for the Current Semester
Gas/Solid & Liquid/Solid Adsorption (ADSG & ADSL)
Liquid-Liquid Extraction (LLE)
Tray Distillation (TDU)
Antisolvent Crystallization (CRUA)
Biological Reactor (BIO1/BIO2)
Polymerization Reaction / Separation (POLY)
Permeameter (LCU, PERM)
Packed Bed Catalytic Reactor (CAT)
Exothermic Reactor Simulators [ERU1/2/3/4 (Control)]
Nonlinear (pH Neutralization) Control (NCU1/NCU2)

### ACCESS TO THE LAB AND LAB ASSETS

Students have access to the UO Lab (Rm. 1114 and high bay area), Analytical Lab (Rm. 1122), and Control Room (Rm. 1112) from 12:30 PM to 6:00 PM, Monday through Thursday, unless otherwise informed. During those times, laboratory staff members are available to assure student safety. Students currently registered in ChE 4162 have access to the UO Lab Control Room from 8:30 AM through close of business on class days, through 4:30 PM on Fridays, unless otherwise informed. Students have access to the UO Lab (Rm. 1114 and high bay area) and Analytical Lab (Rm. 1112) between 8:30 AM and 12:30 PM on Mondays through Thursdays ONLY for a pre-approved short list of unit preparation activities. Such activities include, for example, heating the CAT unit and inoculating E. coli cultures. ONLY after your instructor, the Instructor of Record, or the Manager of Operations has seen to your training in the particular task is this permitted. Ask the Instructor of Record for this list if needed.

Students do NOT typically have access to the Unit Operations Laboratory (Rm. 1114 and adjacent high bay area), or analytical facilities on Fridays or presentation days and never on weekends or holidays. However, off-hours (i.e., Fridays or presentation days) student lab access is possible with permission. For example, we permit access to the operating area or analytical lab on these days by instructor authorization only. The instructor must inform the Manager of Operations beforehand. Typical activities might include using a GC to perform off-line analysis of samples from an earlier run, performing viscosity tests, photographing or measuring crystals under the microscope. Students for whom the Manager of Operations has not received prior authorization must leave until the instructor grants permission and notifies the Manager of Operations.

Access to the UO Lab to perform actual off-hours experimentation on physical equipment is permitted only when equipment, materials, instructional misguidance or an act of God (e.g., power outage) has resulted in the loss of adequate experimentation opportunity. Additionally, the instructor for that team must concur that granting additional access is needed to complete a meaningful experimental program. Instructors do not give access 'to make more runs' or because students have designed their program poorly. In any case, the instructor, after granting permission, must inform the Manager of Operations before student activity can begin. The instructor for that team (or, by agreement, another lab instructor) must be physically present in Patrick F. Taylor Hall for the duration of student activity. Additionally, students must notify the Manager of Operations after their work to ensure the opportunity for restoration of equipment and materials to readiness.

### Course Calendar / Schedule

The detailed course calendar for this semester, including university holidays and breaks, appears below:

Fall 2020 Semester Calendar													
August 2020							November 2020						
M	Tu	W	Th	F			M	Tu	W	Th	F		
							2 Day 8	3 Day 1	4 Day 1	5 Day 2	6 Closed		
							9 Day 2	10 Day 3	11 Day 3	12 Day 4	13 Closed		
17 Find	18 Team	19 Mates	20 This	21 Week			16 Day 4	17 Day 5	18 Day 5	19 Day 6	20 Closed		
24 WS-1	25 WS-1	26 WS-2	27 WS-2	28 Closed			23 Day 6	24 Extra Day	25 Thanks	26 Giving	27 Holiday		
31 WS-3							30 Day 7						
September 2020							December 2020						
M	Tu	W	Th	F			M	Tu	W	Th	F		
	1 WS-3	2 WS-4	3 WS-4	4 Closed				1 Day 7	2 Day 8	3 Day 8	4 Closed		
7 Labor Day	8 Day 1	9 Day 1	10 Day 2	11 Closed									
14 Day 2	15 Day 3	16 Day 3	17 Day 4	18 Closed									
21 Day 4	22 Day 5	23 Day 5	24 Day 6	25 Closed									
28 Day 6	29 Day 7	30 Day 7											
October 2020							Day 1 signifies the first day of a cycle, etc. Closed indicates that the UO Lab is unavailable 						
M	Tu	W	Th	F									
					1 Day 8	2 Closed							
5 Day 8	6 Day 1	7 Day 1	8 Day 2	9 Closed									
12 Day 2	13 Day 3	14 Day 3	15 Day 4	16 Closed									
19 Day 4	20 Day 5	21 Day 5	22 Day 6	23 Closed									
26 Day 6	27 Day 7	28 Day 7	29 Day 8	30 Closed									

## Course Policies

This section covers the most significant course policies. These often connect to or are dependent on Department or University policies. Where this is so, an appropriate reference is provided.

### ATTENDANCE / LATENESS / CLASS PARTICIPATION

The nature of laboratory studies is that they are time and activity intensive and resource limited. Therefore, attendance at regularly scheduled class sessions is vital to successfully producing required deliverables. Additionally, team members depend on the availability of each other to maximize the value of the team’s work products. Finally, laboratory resources cannot always be made available to accommodate work not accomplished during normal class hours. Please refer to the [LSU Policy Statement 22](#) for attendance policy, including the understanding that each student is responsible for providing reasonable notice and appropriate documentation of the reason for any absence.

### STUDENTS WITH DISABILITIES

If you have a hidden or visible disability that may require classroom or test accommodations, please contact the Instructor of Record as soon as possible. If you have not already done so, please register with the Office of Disability Services, 112 Johnston Hall, 225.578.5919, which is the department responsible for coordinating accommodations and services for students with disabilities. You can find additional information on the [website of the Office of Disability Services](#).



## Safety across the ChE Curriculum – ChE 4162 Components

### LABORATORY SAFETY

Ensuring the safety of personnel and protection of facilities are paramount in any laboratory experience. The Cain Department of Chemical Engineering's document on [Minimum Safety Regulations](#) is your guidance in this regard. You must a) read this document, b) sign, and submit through Moodle, a statement to the effect that you have read and understood the contents, and that you intend to comply with the regulations contained therein, and c) complete a Moodle®-facilitated quiz based on the content of this document. You must meet these obligations before you begin any lab work in this course.

### JOB SAFETY ANALYSIS

Our coverage of important laboratory safety issues discussed just previously does not get at the specific process safety, health, and environmental aspects of individual experiments in UO Lab. We address those concerns by requiring students to conduct a review of each operation and the apparatus before work may begin. After examining the equipment, viewing a safety walkthrough video (where available) and noting the safety, health and environmental implications of the assignment for that experimental cycle, student teams complete the [Job Safety Analysis Form](#) discussed earlier in this syllabus document. After review and approval by an instructor, students can begin experimental work.

### SACHE CERTIFICATE PROGRAM

Finally, we require all ChE 4162 students to complete the following two SACHE® (Safety and Chemical Engineering Education) process safety modules as part of the Unit Operations Laboratory course:

[Toxicological Hazards \(ELA961\)](#)

[Common Chemicals and Their Major Hazards \(ELA993\)](#)

SACHE® has developed these instructional modules. SACHE® is an outreach committee of the AIChE (American Institute of Chemical Engineers) dedicated to improving the process safety knowledge and skills of both students and practicing chemical engineers. Upon successful completion of each of these modules, SACHE® issues a **Certificate of Completion** to students, and they received credit for 3.0 and 4.0 (respectively) Professional Development Hours (PDHs). To take and complete these modules you must be a student member of the AIChE, so if you are not already a member (as most of our students already are), [sign up for student membership](#) as soon as possible. It is free!

Students must complete the first module, obtain the certificate pdf, and upload that certificate file to the corresponding Moodle assignment prior to 1:30 PM on October 6<sup>th</sup>, 2020.

Students must complete the second module, obtain the certificate pdf, and upload that certificate file to the corresponding Moodle assignment prior to 1:30 PM on November 3<sup>rd</sup>, 2020.

Students receive quantitative course credit for completing these, as outlined later in this syllabus.

### Academic Misconduct

The [LSU Code of Student Conduct](#) describes in some detail behavior constituting academic misconduct. Two items discussed therein merit further discussion here: collaboration and plagiarism. A [helpful LSU ChE video](#) on some of these topics is available.

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#### COLLABORATION

The activities of conducting experiments, analyzing the results, and producing written reports are teamwork. Maximally efficient use of teamwork skills in teamwork is required to complete each study on time and deliver a quality work product. In this course, the team is defined solely as the three (or, in some cases two) students to whom an instructor has given an assignment. The work of or materials from other student teams – former or current – is not to be consulted or used unless your instructor has expressly given you such work or materials (e.g., for purposes of historical data comparisons). However, students are permitted, even encouraged to share laboratory know-how (e.g., some technique your team learned to make an instrument or piece of equipment perform well) with other teams, if asked.

Preparation and delivery of an individual oral presentation are considered individual work, produced by the individual student responsible for the oral presentation that cycle. However, the oral presenter must actively consult with the other team member(s) to be knowledgeable of all facets of the experimental work and findings and to prepare presentation materials and script. Additionally, the oral presenter is firmly encouraged to rehearse the presentation with another team member as an audience. Remember: on the day of the presentation, the oral presenter is ‘alone on the stage’ in delivering the **Individual Oral Report**, and must answer questions without the aid of other team members.

**PLAGIARISM**

The LSU Code of Student Conduct defines plagiarism as “the unacknowledged inclusion of someone else's words, structure, ideas, or data.” Faculty and staff are required to use the procedures outlined in that code when they become aware of behavior that may violate the standards of conduct listed therein [2]. To avoid even the appearance of plagiarism, one must learn when and how to cite sources correctly. Fortunately, there are many helpful websites where one can learn the skill of proper citation, a good one being the ‘*What is Plagiarism?*’ page at [plagiarism.org](http://plagiarism.org) [3].

Additionally, you can find Turnitin™ assignment links on the course Moodle page to allow you to get feedback on your Lab Prep Report writing from a plagiarism point of view. Instructors, at their discretion, may request student teams to submit written reports through these links in addition to the usual X: drive team folder submission requirement. In no case, however, are Turnitin™ results used to compute your grade.

**Grading**

The final grade is determined from the aggregate of all graded objects with weights and grading as follows:

Graded Objects	Weights, % of Final Grade
Workshop Case Study Oral Presentation	1
Workshop Case Study Assertion-Evidence Title/Abstract	1
Workshop Case Study Three Completely Worked Out Excel™ Files	1
SACHE Certification – Toxicological Hazards	1
SACHE Certification – Common Chemicals and Their Major Hazards	1
Lab Prep Reports (3 @ 9 %each)	27
Final Reports (3 @ 17% each)	51
Individual Oral Report	17
<b>Total Graded Objects</b>	<b>100</b>

The ChE 4162 course grading scale is as follows:

Letter Grade	Point Range	Letter Grade	Point Range
A+	93.0 +	C+	$76.0 \leq X < 79.5$
A	$91.0 \leq X < 93.0$	C	$72.5 \leq X < 76.0$
A-	$89.5 \leq X < 91.0$	C-	$69.5 \leq X < 72.5$
B+	$86.0 \leq X < 89.5$	D+	$66.0 \leq X < 69.5$
B	$82.5 \leq X < 86.0$	D	$62.5 \leq X < 66.0$
B-	$79.5 \leq X < 82.5$	D-	$59.5 \leq X < 62.5$
		F	$X < 59.5$

The following attributes constitute the basis for assessment of written reports:

- Completeness (inclusion of all relevant content and report sections specified)
- Organization (orderly and logical flow of material), clarity, conciseness, grammatical correctness and sentence construction – 20 points
- Technical correctness of calculations
- Technical correctness of analysis of results and conclusions, and
- Signs of student initiative, defined as original work to more efficiently achieve objectives or go beyond the project’s stated objectives.

The following attributes constitute the basis for assessment of oral reports:

- Overall presentation quality,
- Accuracy and clarity of statements,
- Quality of data presentation and analysis, and
- The degree of comprehension displayed for the technical aspects of the experiment.

Many, if not all, of your instructors, use the same grading rubrics for written reports and oral presentations, rubrics which incorporate the attributes listed above. The course Moodle page contains a link to these rubrics.

Instructors often assign a single team grade to all team members on written reports unless it is apparent to the instructor that contributions to the work products have not been of roughly equivalent quality and quantity, individuals have been absent unexcused or have failed to apply teamwork skills. In such cases, there is justification for differential grading. (Additionally, see guidance on the concept of **Lead Author** in the *Course Deliverables* section of this syllabus for another example of differential grading.)

The presenter of the **Individual Oral Report** receives the grade on this object. The presenters of the Workshop’s **Low-Stakes Team Oral Presentation** receive individual grades that reflect the team’s content contribution and individual presentation skills.

**GRADING ADJUSTMENTS**

In addition to an assessment based on academic merit, additional grading adjustments may ensue for noncompliance with other course requirements, including late work, unattended operating experimental equipment, safety violations, and failure to attend required tutoring, or failing to meet oral presentation participation requirements. The table below outlines critical noncompliance issues and associated grading adjustment ramifications.

Nature of the Noncompliance	Grading Adjustment
<b>Late reports without prior permission</b>	Maximum one (1) letter grade per day, at the discretion of the instructor.
<b>Unattended experiment without permission (i.e., unless permitted otherwise, at least one team member must be present in the general UO Lab work area at all times if an experimental unit is in operation)</b>	Minimum one (1) letter grade on <b>Lab Prep Report</b> for the first offense; a grade of 59 (F) on <b>Lab Prep Report</b> for the 2 <sup>nd</sup> .
<b>Safety violations (e.g., not wearing safety glasses, long pants, close-toed shoes; food or drink in the lab; improper/late shutdown, lack of housekeeping)</b>	Maximum ½ letter grade on <b>Lab Prep Report</b> for each offense, at the discretion of the instructor.
<b>Failure to attend required tutoring session with COE Communications Instructor</b>	Maximum one (1) letter grade on <b>Lab Prep Report</b> for that cycle.
<b>Unexcused absence from, manifest inattention paid or disruptive behavior during the oral presentations of others</b>	Maximum ½ letter grade on <b>Final Report</b>

### APPEAL OF GRADING

Students wishing to appeal for a redress of grading must make in writing to your instructor within five (5) university school days of your receipt of the graded object. This written request must include your justification for the appeal. Instructors would redress any actual, objective errors in assessing student work. Instructors, however, reserve the right to determine the relative value of components of individual work beyond that stated previously here, the quality of those pieces and their weighted contribution to the final grade on any deliverable.

### GRADE EXCLUSION

**Please take note:** This class is ineligible for grade exclusion through [LSU's Grade Exclusion Policy](#). If you take ChE 4162 more than once, each grade earned in each attempt becomes part of your grade point average or GPA. This policy applies to your LSU GPA and your chemical engineering GPA. The ChE Department maintains a [list of chemical engineering courses at LSU in which you may not replace a grade](#).

## COURSE DELIVERABLES

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This second part of the ChE 4162 course syllabus contains information on the critical course deliverables: the Lab Prep, Final, and Oral reports (and accompanying files) required from each of the three experiment assignment cycles.

Just as with the preceding Course Logistics section, to get the most out of your course experience, it is vital for you to know and understand the information contained in this part of the syllabus. Indeed, complying with the requirements stated here is essential to learning the most and obtaining the best assessment of that learning. To assure knowledge of UO Lab course requirements, students must complete a Moodle®-facilitated quiz based on the content of this section and the entire syllabus document before they begin any lab work in this course.

### Technical Writing / Documentation Minimum Performance Standards

For all the deliverables discussed below, we expect that 4<sup>th</sup>-year students of chemical engineering should be able to produce works that are free from minor writing errors, such as misspelled words or use of improper grammar (e.g., subject-verb number agreement, incorrect verb tense). Moreover, modern word processing tools such as Microsoft Word© provide strong aides for eliminating such errors, making their presence in a professional deliverable even more egregious.

Additionally, your instructors expect that 4<sup>th</sup>-year students make a serious attempt to observe technical writing best practice as well. Best practice includes such things as numbering the pages of a multi-page written report, supplying engineering units when displaying numbers, numbering sequentially and captioning all figures and charts, and referring to every figure and chart in the text.

In the workplace, failure to observe technical writing best practice detracts from the professionalism of your work. However, failing to provide deliverables free of minor writing errors will often entirely discredit your work product, ruin the hard efforts expended in conducting a study and in analyzing its results, and damage the reputation of you and your team irreparably.

### The Digital Lab Notebook

Laboratory notebooks are the lifeblood of engineers conducting experimental work. Details of methods, observations, and resulting data fill the pages of such books. In Unit Operations Laboratory, however, the laboratory notebook is not made of paper. You are to use what industry refers to as a *digital laboratory notebook* or DLN. Such notebooks have found acceptance as legal documents and represent a far more flexible method of recording and storing intellectual property information.

The *digital lab notebook* in UO Lab consists of a series of Excel workbook files. Each team places each day's record of observations, raw experimental data (and routine calculations, if desired) in a separate workbook file, each worksheet of which includes your names and the date of data (or observation) collection. Each of these files must be self-contained; i.e., ***no dynamic links to other files***. Instructors may assume that raw data appearing in the **Final Reports** or appendices that are not present in one of the workbook files of the *digital lab notebook* represent plagiarized information.

## General Information on Work Products

Assume that your audience is composed of engineers and technical managers who understand technical matters, have taken typical core chemical engineering courses, but do not have specific knowledge of your experiment or any unique theory applicable to it. The table below catalogs some broad commonalities and differences between Unit Operations Laboratory work products.

Deliverable	When Due
Lab Notebook	Each day's workbook posted to the team folder by the end of all workdays on which team collects observation or data
Lab Prep Report	Posted to team folder by 6 PM one university school day after Day 3 of each cycle
Final Report	Posted to team folder by the start of class (1:30 PM) on Day 8 (or last day) of each cycle
Appendix Files	Posted to team folder with the same deadline as the written report file
Oral Report Slides	Posted to team folder by the start of class (1:30 PM) on Day 8 (or last day) of each cycle
SACHE Certificate	Posted to team folder before the start of the next cycle or before the end of class that semester, whichever comes first



Each of these work products is a file of some type. Each file name should conform to the naming convention defined below:

Deliverable	Medium	Naming Convention
Lab Notebook	Excel	SsTtCD.xlsx
Lab Prep Report	Word	PSsTtC.docx
Final Report	Word	FSsTtC.docx
Appendix Files	Excel	PSsTtC.xlsx or FSsTtC.xlsx or .xlsm files, if macros are included
Oral Report Slides	PowerPoint	OssTtC.pptx
SACHE Certificates	pdf	<ufficient for me to understand>.pdf

Here, **Ss** is the session (use MW or TT), **Tt** is the two-digit team number ( use 01 through 10), **C** is the experiment cycle (use 1 through 3), **D** is the day [use 1 through 7 (or 6)], **P** stands for Lab Prep, **F** stands for Final, and **O** stands for Oral. Files produced with current Microsoft Office products have extensions that are four characters long, an 'x' being the last character. Examples: a workbook from Day 3, Cycle 1, for Team 6, Tuesday-Thursday session: TT0613.xlsx; a final report from the same team: FTT061.docx. For the SACHE certificate naming, put your name and some distinguishing information.

## Lab Prep Report

The **Lab Prep Report** constitutes the first installment payment on full reporting of your experimental program, and in some ways is the first draft – but certainly a formal one – of several sections of the **Final Report**. The principal deliverables within the **Lab Prep Report** are the Introduction, Literature Review/Theory, Experimental, and Anticipated Results and Discussion sections. The **Final Report** – completed after you complete all work – delivers a complete, polished report. In submitting the **Lab Prep Report** on the day after Day 3, you demonstrate completion of the preparation phase of your experimental program. The **Lab Prep Report** contents attest to your understanding of the problem, of its context in theory and the literature, and of a suitable approach to performing the experimental work and analyzing its results. An adequately prepared **Lab Prep Report** saves much time in the later phases of the experiment and reduces the chances of errors in data collection and analysis. The **Lab Prep Report** should consist of the following sections:

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## TITLE PAGE

The title page is a single page and should contain: (a) Report title; (b) Name and affiliation of the recipient; (c) Authors and affiliation; and (d) Date. Typically, your assignment has context (e.g., company names, positions of responsibility). Where you supply these, be sure to use any supplied business context and not treat your reporting exercise as though you were students. The title itself should contain key words that describe your specific study, not some generic study in the discipline.

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## INTRODUCTION

You must present relevant background and descriptive information about your project if your audience is to ‘connect the dots’ of later sections of your report. Typically, there is both an organizational need and a technical problem, so you should *briefly* introduce the purpose of the study, the nature of the technical issue, and argue for this work’s importance by putting it in the context of the organizational need or the state of knowledge. This information emanates from the problem description or scenario for the assignment. This section is not substantially different from the more succinct first portion of the Summary section of the **Final Report** described later.

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## LITERATURE REVIEW/THEORY

The Literature Review / Theory section is a *brief* consideration of relevant ideas from the primary field and the notable work of others who have come before, and more intensive coverage of the specific topic at hand – in your words. Only cite relevant articles or textbook materials relevant to the assigned topic(s). The literature may reveal conflicting views and opinions on the subject; include these in the review in an unbiased way. Present the underlying physical principles, laws, and governing equations relevant to the problem. State the assumptions and limitations of the theory. Charts, diagrams, and other exhibits are most helpful in developing and explaining the theory, primarily if they aid clarity and conciseness. As with any meaty section of a report, appropriate use of paragraph breaks and subheadings is in play.

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## EXPERIMENTAL

This section must be clear, concise, and specific, but its specific contents depend on the actual experimental program you have undertaken. Typical subjects covered within this section might include some or all of the following, or perhaps other, more relevant items:

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### SYSTEM STUDIED

Describe the system under investigation. Are you studying the growth rate of a particular strain of bacterium? Are you studying the separation of alcohol-water mixtures in a packed distillation column?

Are you studying the flow characteristics of non-viscous liquids in porous media (e.g., glass beads of a particular diameter and roughness)? Be specific but concise.

### APPARATUS/EQUIPMENT USED

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Include a description of the principal and auxiliary apparatus used; a schematic diagram (or, perhaps, photo), suitably labeled usually accompanies the text description.

### METHODS OF CHEMICAL/BIOLOGICAL ANALYSIS

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Describe these; not in excruciating detail, however.

### STATISTICAL ANALYSIS

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Describe the statistical and calibration methods used to estimate/reduce experimental uncertainty. Be specific. For which results will you estimate uncertainty and how? How many replicates? What confidence interval? How will one measure the goodness of fit? Which hypothesis tests are appropriate?

### MATHEMATICAL ANALYSIS METHODS

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If you plan to use an unusual or novel data work-up method, it may be worth discussing that explicitly in this section of your **Lab Prep Report**. On other occasions, however, examples of your methodology should show up in the Sample Calculations, and you might refer to those here in the Experimental section.

### MODELS/SIMULATORS

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Describe any model or simulator you use or build. Also, describe how you intend to use the model or simulator.

### EXPERIMENTAL PROGRAM/PLAN/RUNS

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Describe the nature of the experimental program you intend to achieve the objectives. Outline the general procedural plans and the number, order, conditions, and other details of experimental runs that you plan to conduct, including the information desired and variables you investigate **by** those plans, **from** those runs. This subsection does not require a detailed, step-by-step operating procedure; instead, the variables to be studied are stated, along with their methods of measurement and control, as well as nominal values or ranges for each run or range of runs. A table of planned runs is often an effective way to do this. In any case, your experimental program should be evident to the reader and not require the reader to guess at what you intend to do.

## ANTICIPATED RESULTS AND DISCUSSION

One does not ordinarily find a section like this in a single complete written technical report. Since your written reporting effort does not take final shape until the **Final Report** is complete, look at this section as a very early version of some of what goes into the Results section and the Discussion section of the **Final Report**. Discuss the anticipated magnitude of your results and how you intend to present them. Prepare sketches or mockups of tables or figures with the expected trends and order of magnitude of the results.

Discuss *why* you anticipate these results, *why* you are hypothesizing these findings. The *whys* mainly fall out of the theory you have presented earlier in this report. If you appear to be struggling with what you should anticipate and why you should do so, perhaps your earlier discussion of relevant theory and the literature on the subject should be reexamined and possibly revised. Include in this section discussion about any relevant intermediate results and the likely efficacy of the primary methods as well, though a full discourse on these has to await the **Final Report**.

By the time you are writing this section, you may have already completed some significant experimental work and already have some results. You need not summarize all results obtained to date; but, if you have finished a significant task, you may summarize those results here. It is too early at this point to make sweeping conclusions or essential recommendations for the study as a whole, so leave those elements to the **Final Report**.

## NOMENCLATURE

All symbols and acronyms used in the report and its appendices must be listed and defined in a Nomenclature section with the consistent set of units used for calculation/reporting of results. Arrange symbols in alphabetical order, Latin terms (e.g., a, b, D, Re, Pr) first, followed by Greek (e.g.,  $\alpha$ ,  $\beta$ ), and finally subscripts (e.g., i, j, k). Head up the Greek and subscript sets by the titles 'Greek' and 'Subscripts.'

In addition to the Nomenclature section proper, introduce these symbols where they first appear using either running text or a list set off from the running text.

If a dozen or fewer symbols are used and called out in the report body, you may rely on that in-text introduction of symbols and acronyms alone and forego a separate Nomenclature section altogether.

## LITERATURE CITED

The Literature Cited section includes all references to the material you *cited explicitly* in *this* report. It does *not* contain materials read or consulted but not cited. It *does* include citations listed in any appendix document (e.g., citing of handbooks from which you may have extracted property data). A

report without ANY cited literature is typically not a credible piece of work. Citing the literature typically strengthens any case you are making in your reporting.

The in-text citation plus the full reference in the Literature Cited section make it possible for the reader to find the material. We discuss citation style guidelines later in this document. Microsoft® Word contains excellent reference handling tools; tools which allow you to manage citation sources, insert citations, and format a consistent Literature Cited section. Additionally, you can add EndNote to Word for more powerful citation literature management.

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### REPORTING RESPONSIBILITIES

Written reports in this course represent the work product of a team of authors, not a single author. Team members do not take turns writing reports. All written reports are the result of a shared effort. However, in each report, three major sections represent considerable work effort. In teams with three members, each one of the members assumes the role of **Lead Author** for one of these sections. (In teams of two, both members assume that role for one of the major sections.)

### LEAD AUTHOR RESPONSIBILITIES

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The Lead Author of a section writes the draft for that section and integrates comments by the other authors of the report into a final work product. Course instructors may, but are not required to use this information to adjust an individual team member’s report grade to account for outstanding quality or lack thereof as seen in that section’s writing.

### REQUIRED CONTENT FOR THIS SECTION

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In this, the **Lab Prep Report**, include a table such as the one below to indicate Lead Author responsibilities for this report and your team’s choice for production and delivery of the **Oral Report**.

<i>Lab Prep Report</i>	<i>Deliverable</i>	<i>Lead Author</i>
	Literature Review / Theory	<supply name>
	Experimental	<supply name>
	Anticipated Results and Discussion	<supply name>
<i>Oral Report</i>	<i>Deliverable</i>	<i>Sole Author</i>
	Presentation and Slides	<supply name>

## APPENDIX

The Appendix in the **Lab Prep Report** contains raw data taken during the first two-to-three laboratory periods, requested or representative sample calculations, and any early calculated results. Calibration curves prepared using the data collected should be included. All raw data must be the same as in your digital lab notebook (DLN) files. Explain calculation procedures you propose to use later in the experiment; don't merely fill cells with formulae and numbers. If the assignment does not specify particular sample calculations, present at least one calculation using each applicable procedure involved. All calculations must be live working calculations (not pasted text or formulae), such as those in an active spreadsheet or a functioning Mathcad program. All quantities must be identified, with accompanying engineering units.

A very straightforward construction of such an Appendix is the creation and submission of a separate single Excel workbook (not embedded digitally within the report file) that contains several individual worksheets. There might be worksheets from the Day 1 through Day 3 laboratory notebook files or selected content from these, other worksheets containing requested and representative sample calculations, and worksheets showing calibrations. Any other Appendix submissions should be copied and pasted into the report Word file. Typically, no additional files – beyond this one Excel file (**without** dynamic links to other Excel files) – are to be submitted, unless specifically requested or permitted by your instructor. In some cases, especially when using macro-equipped Excel™ workbooks (e.g., Monte Carlo calculations, models), additional Excel™ files are permitted. Carefully document this exception in your report and by your file naming convention.

If you use Mathcad for calculations, for example, one can place the actual calculations into Word using *Paste Special* or insert the entire file object with icon via Word's *Insert Object* feature. If a computer program **other than Excel or Mathcad** is used to perform calculations, **attach a listing of the program, input, and some sample program results as an Appendix to the report. Cut and paste program material into the Word or Excel file.** Programs, tables, and graphs from other packages (e.g., MATLAB, Maple, or VBA programs) can be copied and pasted in any report, but adequate commenting/variable definitions must accompany any program code.

Some helpful additional notes on tables of data and results (preliminary or otherwise):

- In any tables of data and results (preliminary or otherwise), exercise care in labeling – with proper units – the columns of data and results. Additionally, there is no good excuse for making engineering units conversion errors. There are applications (e.g., [free dedicated computer software](#) and [online tools](#)) available for generating conversion factors used in chemical engineering. Use these if you need help finding convenient engineering conversion factors.

- Give the source for all physical property data on the worksheet(s) on which they are first listed or used.
- Columns of results should follow the sequence in which you performed the calculations and equations for the calculations should appear in some accompanying form. In Excel, there are several ways to do this. One can type a text formula of each equation in a cell adjacent to the computing of that equation using plain text or Office's equation editor, (for non-array formulae) name the cells with an appropriate variable name and use that in the formulae or do both. Mathcad is reasonably self-documenting as far as formulae are concerned, but if your method is not clear additional commenting may be needed. In any case, it should be abundantly clear to the reader what the source of raw data is for these equations, which equations are at play, and how the sequence of calculations link together. Other software tools may require special attention to methods of providing clear documentation.
- Occasionally runs must be discarded. In such cases do not omit such data from the table; instead, indicate next to the table that you have rejected that set of data from your analysis and the reason why.

Include the completed **Job Safety Analysis Form** as an exhibit in the **Lab Prep Report Appendix**.

## THE FINAL REPORT

Your **Final Report** should tell what you did, why you did it, what you learned, and the significance of your results. The report does not have to be extremely long. The key to writing an excellent report lies in presenting your response to the objectives of the project concisely and justifying that response with appropriate documentation. The **Final Report** should consist of the following sections:

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### TITLE PAGE

The title page is a single page and should contain: (a) Report title; (b) Name and affiliation of the recipient; (c) Authors and affiliation; and (d) Date. Typically, your assignment has context (e.g., company names, positions of responsibility). Where you supply these, be sure to use any provided business context and not treat your reporting exercise as though you were students. The title itself should contain key words that describe your specific study, not some generic study in the discipline.

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### SUMMARY

The Summary, sometimes called the Executive Summary, should present a succinct statement of the purpose/motivation for the study, the scope/method(s) of the investigation, a summary of the primary results, principal findings, and appropriate recommendations. This section is critical. In the industrial workplace, supervisors may not be interested in or have the time to explore the details of the problem.

They are concerned primarily with the conclusions and may read only this section of the report. The Summary section is a preview of the entire **Final Report** and assists in the intelligent digestion of the details which follow. See the excellent video references from Purdue University [4],[5] on the general ideas on how to construct this section, but typically this section (most often limited to 1-to-1½ pages) should include:

- Prose describing the background of the problem addressed (i.e., purpose, motivation), as well as the scope, modes, or methods employed. This section is not a review of the literature but merely the *why* and *how* of the study.
- Statements of the quantitative results obtained that relate to the purpose and method(s) described above. One can usually present results more clearly by a typical or average set of results and uncertainties, plus the range of operating variables where appropriate. Be specific. Pairing method and results for clarity often makes sense.
- State the definite conclusions drawn from the results. Leave speculative conclusions to the **Discussion** section at the end of this **Final Report**.
- Finally, actionable recommendations – based on the conclusions above – are given.

### INTRODUCTION

The Final Report's Introduction section is a rewrite – with proper verb tenses, with any needed additions, corrections, and improvements – of the Introduction section from the **Lab Prep Report**. In effect, the Introduction section from the **Lab Prep Report** represented the first draft of this final version in this, the **Final Report**. This rewrite should reflect your clearer, more in-depth understanding of the reasons for and goals of your experimental program.

### LITERATURE REVIEW / THEORY

Again, this section is a rewrite – with proper verb tenses, any needed additions, corrections, and improvements – of the Literature Review / Theory section from the **Lab Prep Report**. In effect, the Literature Review / Theory section from the **Lab Prep Report** represented the first draft of this final version in this, the **Final Report**. This rewrite should reflect a better identification and understanding of the relevant theory and work of others, enabling a better discussion of results in this report's Discussion section.

### EXPERIMENTAL

The Final Report's Experimental section is a rewrite – with proper verb tenses, with any needed additions, corrections, and improvements – of the Experimental section from the **Lab Prep Report**. In effect, the Experimental section from the **Lab Prep Report** represented the first draft of this final version



in this, the **Final Report**. This rewrite should now reflect the actual experimental program as implemented by your team, and thus be consistent with the upcoming Results section and Discussion section.

## RESULTS

The Results section delivers the evidence that helps answer the questions raised by the objectives of the investigation, should prepare readers for the more detailed upcoming discussion, and justify the conclusions that one draws in the next section.

Observations, data, and calculated results (in a consistent set of units) often render best as graphs or charts, mainly if it is essential to illustrate trends. However, tables make sense when you need to present accurate data and specific facts or demonstrate the relationships between numerical and descriptive data [6, 58-63]. Figures and tables should include – whenever possible – published, theoretical, and model/simulation values available from the literature or produced programmatically. Do not place tables of raw experimental data in this section; report those in Appendices. Calibration curves and other results that do not relate directly to the future discussion might function best in the Appendix or referenced from the **Lab Prep Report** – it does not always make sense to place these in the Results section. We often summarize or *reduce* data for presentation. Reducing the data allows one to make generalizations and to point out [7, 56]. Doing so does not mean that one should only show examples of run results. Depict all key intermediate and final results in some manner or other to meet the objectives of the experimental program.

Appropriate text and the data reduction equations used to generate the results shown must accompany charts and tables. The Results section should not consist of page after page of charts and tables with no accompanying explanation. Of course, every figure or table itself is numbered and supplied with a brief but descriptive title or caption. Build graphics and other visual displays so that, with their accompanying description, they are self-explanatory. Consult a useful reference for guidelines on producing quality graphs and tables [8, 149-160; 179-182]. The key here is that the Results section contains text that briefly explains how one obtained the results from the experimental data, gives the appropriate data reduction equations, the associated quantitative uncertainty (e.g., confidence limits, standard error), and any additional critical assumptions or approximations made in obtaining the results. However, best practice in bringing together your exhibits and your words is accomplished by referring readers to graphics explicitly and telling them what trends to notice [7, 57], though not the meaning or import of these, which we reserve for the Discussion section.

### DISCUSSION

If the Results section delivers the evidence, the Discussion section makes the case in court. In the Discussion section, you explain what your experimental results mean by relating them to the concepts and ideas presented in the Introduction and Literature Review/Theory sections; that is, putting them in context. Introduction and Literature Review / Theory sections absent of relevant contextual material inevitably leads to a shallow or disconnected Discussion section.

Many questions could be answered in the Discussion section so you should not limit yourself to those offered here as examples. Address those matters that make the most sense for your work.

- Do the results agree with the theory, with the work of others, with models/simulation? If so, how? If results do not agree, why is this so? Can the disagreement be explained?
- What are the most likely sources of experimental error and have these affected your ability to draw sound conclusions? How might these errors have been reduced or eliminated?
- Did your results reveal problems with the experimental plan, method, or equipment? How might these be improved?
- Were your assumptions suspect or reliable?
- What definite conclusions can you draw from your results? What conclusions are more speculative?
- What implications do your results have for current practice or theory?
- What questions remain unanswered? What questions should researchers answer next?

Avoid inserting new results or additional theory here in the Discussion section, or making broad sweeping conclusions not justified by the scope of your study or your results. Another common error one finds in a Discussion is the suggestion that all results are inconclusive while failing to provide an explanation, method of redress or recommendations for such results. Finally, do not fail to answer critical questions, or fail to discuss significant results, as well [9].

Note that the UO Lab Final Report format does not call for separate Conclusions or Recommendations sections. Present this material within the Discussion section. As for conclusions, some may be more definitive than others. These should make it to the Summary section, as mentioned earlier. Others are perhaps more speculative or less significant. Those would appear only here. It is for you to judge which are which. Recommendations made should be specific, related to your results or the methods employed to obtain these, supported by your conclusions and appear in the Summary section as well.

NOMENCLATURE, LITERATURE CITED

See discussion in the **Lab Prep Report** section of this document.

REPORTING RESPONSIBILITIES

See discussion in the **Lab Prep Report** section of this document.

REQUIRED CONTENT FOR THIS SECTION

In this, the **Final Report**, do include a table such as the one below to indicate reporting responsibilities.

<i>Final Report</i>	<i>Deliverable</i>	<i>Lead Author</i>
	Summary	<supply name>
	Results	<supply name>
	Discussion	<supply name>

APPENDIX

See discussion in the **Lab Prep Report** section of this document for most of the guidance you need on this, but the Appendix of the **Final Report** now includes all the original raw data and observations; all the calculations to generate results, along with those results; and all exhibits produced from these results. Calculations must be live working calculations, not pasted text or formulae, such as those in an active spreadsheet or a functioning Mathcad program. All quantities must be identified, with accompanying engineering units. Your workflow and methods should be visible, and all calculations should be traceable to original raw data. If readers cannot trace your final results to original raw data, your work is not transparent, cannot be relied upon, may be considered doctored or plagiarized, and an assessment levied in keeping with the degree of non-transparency.

Just as in the **Lab Prep Report**, straightforward construction of such an Appendix entails the creation and submission of a separate single Excel workbook (not embedded digitally within the report itself) that contains several individual worksheets. One would find worksheets from each day's laboratory notebook files or selected content from these, other worksheets containing the extensive calculation of results [10]worksheets showing calibrations. Any other Appendix submissions should be copied and pasted into

the report Word file. No additional files – beyond this one Excel file (**without** dynamic links to other Excel files) – are to be submitted. (See the exception noted in the section on the **Lab Prep Report**.)

The Appendices include any other computer programs and their results not previously given. List all programs with some sample input and results. These can be cut and pasted as text into an Appendix. The report itself can include no file other than one Word file for the report body (and within-report Appendices, if desired), and one Excel file as the primary data, calculations and results appendix. Adequate commenting and variable definitions are always a must.

## THE Individual ORAL REPORT

### SCOPE

Regardless of your specific assigned experiment's problem or question, one or more particular objectives provided the impetus for your work. Your efforts took place in context (where your work fits in the field of endeavor), You carried out your study by a method or plan, and you produced meaningful results leading to conclusions and recommendations, as appropriate. These are the matter from which you create the **Individual Oral Report** (or, for that matter, the Workshop's **Low-Stakes Team Oral Report**).

We require the use of the Assertion-Evidence approach for building your presentation and supporting PowerPoint™ materials[11]. There is clear evidence that this approach results in better and more lasting understanding by your audience. Built into the titling of each slide is the assertion you wish the audience to buy into, with the body of the slide composed primarily of graphical evidence that the assertion is reasonable. A (set of) mapping slide(s) serves as an outline and one always finishes with a summary slide or slides. Summary slide(s) must truly deliver findings and not merely repeat results. In a very brief presentation (i.e., 15 minutes or less), one must be efficient in delivery your premises and proofs. The Assertion-Evidence approach aids in that effort.

There are many common mistakes to be made. Here are a few of the more common:

- Plunge into the details of data and results without informing the audience of your objective(s), context, and methods.
- Talk too long (e.g., including minutia, trying to apologize for poor results, failing to rehearse) or too short (e.g., failing to cover all essential objectives, failing to report and discuss the impact of uncertainty, failing to analyze deeply enough and come up with relevant conclusions).
- Focus too much on how you did what you did – experimental detail (i.e., failing to realize that the **Oral Report** is not a reflection of where we spent our research time but instead a reflection

of what we learned and what is most important – results, discussion, conclusions, and recommendations).

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#### ATTIRE

The grooming and attire of the presenter should not distract attention from the information presented. Use of business casual dress is perfectly adequate.

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#### DURATION

The **Individual Oral Report** (delivered in Cycle 1 or 2) should last roughly **15 minutes**. Don't underestimate the difficulty in effectively delivering these **short** oral reports. Going long is typically a greater offense than running short unless the reason for running short was the omission of or inadequate coverage of material that should have been better covered. Nonetheless, the most common student tendency is to run short, having failed to cover the material adequately.

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#### FORMAT

To complete a compelling talk in the allotted time, you need to prepare a computer-based (e.g., Microsoft® Office PowerPoint) presentation. Historically, technical presentation speakers would plan to use two minutes per PowerPoint slide, not counting the title slide. But this rule of thumb makes little sense when using the Assertion-Evidence approach. Some slides might take a few seconds if we're showing a simple picture of evidence, while others might take much longer when explaining a more complicated chart and what it shows. The right number of slides is the number it takes to make you're your assertions and defend them. The right pace for moving through slides is the pace at which your audience can assimilate your material by understanding and accepting your assertions and evidence.

One trick is to place slides for less critical material behind your presentation where they are at the ready in case questions are asked for which such material represents the answers. In any case, your slides should make sense even without your spoken words. Making an effective oral presentation is not easy to do, but it is your goal. Finally, remember that **readability and correctness** are more critical than computer-generated perfection – chemical engineering, not cosmetic engineering. To that end, you probably should limit 'ink' on your slides to elements which convey needed information only.

## PROCESS

Instructors or students, whether sitting in the back of the room or viewing within a Zoom session, should be able to read everything on every visual and hear your words as well. Give your **Individual Oral Report**, keeping to the time target indicated above. After each report, student peers and instructors ask questions, and a discussion ensues. Expect to be questioned on any element of the experimental program in addition to the actual material presented. You may go back through your slides to answer audience questions. Presenters may not solicit the assistance of any other team member in answering questions.

You receive verbal feedback on all aspects of your oral presentation, from your public speaking skills to your level of understanding of the assignment. You may be asked to suggest how you would revise part(s) of your presentation or its delivery, were you to give the presentation again. Instructors may also provide additional *written* feedback on your **Individual Oral Report**.

## Technical Report Writing, Oral Presentation, and Citation Guidance

In matters of technical writing and oral presentation, consider using the resources provided by the COE's Engineering Communications Studio. Their staff specializes in helping engineering students develop the skills needed to meet both the challenges of the curriculum and those they experience as working engineers. We outline other help below.

### TECHNICAL REPORT WRITING GUIDANCE

There are abundant sources for advice on this subject. Older references [13] are still viable, and newer texts are always becoming available [6], [7], [8]. Indeed, one can find considerable help from online sources as reputable as the Massachusetts Institute of Technology [14], some giving guidance tips on how to write as a team [15]. You can find most texts cited herein in the LSU Library. You may borrow Deter and Donnell from Dr. Toups.

### ORAL PRESENTATION GUIDANCE

Numerous library [6], [7] and online references are available to help with the preparation and delivery of oral technical presentations, from the most general [16] to those aimed directly at helping engineers [17]. Of specific concern to you as you prepare the supporting PowerPoint file for the **Oral Report** is that PowerPoint can be a particularly poor medium for presentation if one does not take care to use it well. Again, there are online references that address this issue.

**We require the use of the Assertion-Evidence approach for creating your oral presentation slides.**

Instead of the usual, information-lean titles which traditional presentation formats use, the slide header

contains two lines (at most) of an assertion key to your arguments. The slide body contains the evidence – mostly graphical – with as few words as necessary – to back up your assertion [11]. We explain and model this approach in the two-week UO Lab workshop.

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### CITATION GUIDANCE

Though technical journals often identify specific formatting standards for articles submitted for publication, you are not submitting a paper to a journal – you are writing a technical report. When you take employment in the future, your employer may very well prescribe the formatting of citations, perhaps even every formatting feature for your entire report! Still, it would be best to learn by practice one of the more traditional citation formats used in the chemical engineering literature.

We would recommend either the CEP (Chemical Engineering Progress) format required by the AIChE [18], or the AIChE Journal format – which is essentially the same as the AMA Style 10<sup>th</sup> Edition [19]. Another acceptable possibility is the IEEE (Institute of Electrical and Electronics Engineers) format [20]. All of these use sequential numbering for citations and Literature Cited sections. APA Style (i.e., using author-date for the in-text citations) is often used in student academic settings but is far less suitable for engineering reports.

Word, in Microsoft© Office 2019, comes equipped with features to facilitate both in-text and bibliography entries using the IEEE style and Endnote 8 (and later) either has or can be set up with the AMA or AIChE style. EndNote 8 and the IEEE style served admirably in the creation of this document.

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