Chemical Engineering 4L02
ADVANCED LABORATORY SKILLS
September – December 2017

Instructor: Dr. Darko Ljubic JHE-A105/C (ext. 27200) ljubicd@mcmaster.ca

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Course Description:
The course consists of a series of three 3-week laboratory projects in the areas of mass transfer operations, process control, biotechnology, polymer processing, and industrial-scale operations. Results from prescribed experiments as well as self-directed learning modules will be presented through formal write-ups and one oral presentation. There will also be bi-weekly lectures for the first half of the course.

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and the course Avenue site weekly during the term and to note any changes.

Course Objectives:
The laboratory sessions, lectures, and review meetings are planned to:

1. Provide practical experiments that illustrate the fundamental ideas from course lectures
2. Give practice in realistic measurement and interpretation of data using statistical techniques.
3. Act as an educational precursor to ChE 4C03 (engineering stats), ChE 4G03 (optimization), CivE 4V04 (waste water treatment), ChE 4E03 (process control II)
4. Give experience in analyzing relevant industrial scale equipment.
5. Give practice in formulating questions in the form of scientific hypotheses and investigating these hypotheses using laboratory equipment.
6. Give practice using the literature (textbooks, handbooks, journals, and vendor information).
7. Give practice with manual laboratory skills and laboratory equipment.
8. Give first-hand experience in safety assessment of experimental work.
9. Give practice in the preparation of formal written reports.
10. Give practice in verbal technical discussions, both formal and informal.

11. Give practice using the technical communication and problem-solving skills.

It is expected that the laboratory experiments and reports will be carried out in more depth and technical detail than in ChE 3L02. Problems will be more open-ended, and it will be necessary to formulate objectives that can be achieved using the provided equipment. The self-directed learning (SDL) component of the lab will be more significant in ChE 4L02, with more background preparation expected and formal hypotheses/experimental plans to be completed for each experiment.

Course Texts: **REQUIRED - ChE 4L02 Custom Courseware (print at your own convenience)**
***** Some special material for some experiments may be required (provided in-lab or on the Avenue site for the course).

For writing technical reports, please refer to Bliqc & Moretto "Technically-Write!" Prentice Hall. This text has been used previously for ChE 2G03 & 3L02 and copies are available in Thode library.

Course Organization:

Laboratory sessions will be held on Monday (L05), Tuesday (L01), Wednesday (L03), Thursday (L04) and Friday (L06) in JHE-A106 from 2:30-5:20 PM; and Thursday (L02) in JHE-A106 from 9:30AM-12:20PM. Students will work in groups of 2 to 5; each student will get experience in working on real equipment, analyzing and presenting data in a formal environment and working in groups. Students must be present at the start of each laboratory period unless a special arrangement has been made with the instructor.

Laboratory handouts and report guidelines are included later in this courseware package. Students must complete all tasks for the experimental period by the end of the lab session. No one will be permitted to stay in the laboratory past this time. With TA & Lab technician approval, the student can come in before the original start time of the lab. The TAs will be available in the lab throughout each lab session for questions. The instructor will be available for consultation by appointment in her office. Permission of the course instructor will be required for changes in the schedule. Note that employment interviews are not an acceptable reason for rescheduling laboratory work. Students must attend all laboratory periods; exceptions are only allowed with a medical certificate or with the permission of the instructor. If two days are missed for the same lab cycle, the student will have to do another experiment during the next lab cycle with a different class time. If the 3rd lab cycle labs are missed, the student will have to do another experiment alone during the exam period.

Lectures

2017 SCHEDULE:	C01	Tuesday	1:30 – 2:20	MDCL 1110
		Thursday	12:30 – 1:20	MDCL 1110

Lecture periods are devoted to the development of key experimental design and analysis skills applicable both to this course and any technical experimental setting. Lecture notes for these sessions are posted on Avenue to Learn for download. The lectures are designed as a series of professional development workshops that will be of benefit both in terms of improving your mark in this course and by progressing/solidifying translatable job skills.

A tentative schedule of lecture topics is provided below (schedule subject to change):

Lecture 1	Tuesday September 5	Course introduction: lab orientation, course structure, laboratory safety
Lecture 2	Thursday September 7	Statistical analysis of laboratory data
Lecture 3	Tuesday September 12	Guest Speaker: Dr. Jake Nease – Design of experiments
Lecture 4	Thursday September 14	Guest Speaker: Dr. David Latulippe- Principles of process control
Lecture 5	Tuesday September 19	Designing effective experiments: hypothesis development and testing strategies
Lecture 6	Thursday September 21	Writing scientific reports: structure and strategies
Lecture 7	Tuesday September 26	Tips and tricks for effectively using Microsoft Office The Great Grammar Showdown (aka common writing errors)
Lecture 8	Tuesday October 3	Giving effective oral presentations
Lecture 9	Thursday September 28	Guest Speaker: Dr. Peter Margetts (McMaster) – Hemodialysis
Lecture 10	Thursday October 5	TAs are people too! Using 4L02 skills in the "real world"

Course Assignments and Grading: (see page ~34 for more details)

The course will be graded based on the following scheme:

Lecture assignments (4 @ 2.5% each)	10%
Cycle 1 Laboratory Report (*Group*)	30%
Cycle 2 Laboratory Report (*Group*)	30%
Cycle 3 Laboratory Presentation & Report (*Group*)	30%

Lab Report Marking Summary:

Lab preparation	5%
Preliminary reports	10%
SDL Plan document	5%
Report submission	80%

Each student will do three laboratory experiments, each consisting of 3 weeks. The various experiments are listed at the end of this course outline. Unlike in 3L02, you can indicate a preference for which experiments you will do. **To submit your experiment preferences, you MUST complete the 'Experiment Sign-up Form' quiz on Avenue before 6:00 pm on Friday September 8th.**
You will also be asked to indicate whether you are studying towards a process systems engineering, polymer materials and manufacturing, or water and energy technologies stream specialization, as specific experiments are required for these designations that may not be available to you later in the term. Bio students are also required to complete a specific lab and must indicate this on their form. Students who have not taken 3P04 must have approval by the instructor to complete the process control labs. **Note that, all things being equal, you are more likely to get the experiments of your choice if you submit your preferences early (including potentially Cycle 1).**

Lab Preparation (5%):

- Excel spreadsheet and or experimental tables ready for experimental data input
- Smooth transition into the laboratory experiments with minimal TA assistance
- Punctual and ready to start at the beginning of the laboratory scheduled time
- Demonstrated knowledge and understanding of all lab manual content

Preliminary Reports (10%)*:* A **preliminary report (PR)** must be submitted following the completion of the week 1 and week 2 laboratory sessions. The purpose is to oblige you to start the data analysis (rather than right before the formal report is due) and ensure you are on the right track in performing the experiment. The PR component will account for 10% of the total mark assigned for the lab report.

PR format: (succinct, 2-3 page max.)

Clearly list the following:

a. Experiment title and date
b. Group members with respective student numbers & McMaster email addresses

Then in 500 words or less clearly state the following:

c. Objectives examined this day
d. Methods used (very brief – **only necessary if procedure deviated from manual procedure**)
e. Preliminary results presentation and discussion

Include raw data tables or figures as specified in the individual lab write-ups. Figures and/or tables should include appropriate statistical analysis; for example, y (flow rate) is linear in x (rotameter setting) as y = mx + b with a correlation coefficient of $R^2 = 0.98$, m = ... ± 95% Confidence Interval and b = ... ± 95% Confidence Interval. The corresponding 'preliminary discussion' could be as brief as: "Flow rate is linear in rotameter setting with an $R^2 = 0.98$". Use regression analysis; 'trendline' is not acceptable (except for drawing the line of curve on the figure). Data spreadsheets may be submitted as part of your raw data presentation. Reporting the R^2 is insufficient as an independent statistical metric; confidence intervals and/or Standard Error (SE) should always be used in accordance with an error propagation analysis. Interpreting ANOVA tables and using these statistical methods will be outlined in the in-class lectures.

PR is due by midnight on typically the day that corresponds to two weekdays following the laboratory session. You MUST send the PR as an attachment in an email to the appropriate TA supervising your experiment. An electronic copy of your graded PR will be returned to you at the beginning of the following lab session to help you with the preparation of your formal report.

Self-Directed Learning (Group) (5%): In the third & final week of each experiment, you will perform a **self-directed learning (SDL) module** in which you will define a knowledge-based learning goal that is related to your laboratory and is directed to improving your understanding of practical and theoretical aspects of the experiment. Your plan should include a program of investigation to achieve a certain goal and/or prove a specific hypothesis. The program can include experimental, theoretical, and literature tasks but must include some experimentation in the lab.

For each laboratory, groups will be expected to perform the following tasks associated with the development and execution of their self-directed learning module:

Week 1 – Learn about how the apparatus works and formulate ideas regarding the type of self-directed learning experiment you wish to do. You may ask the TA, the lab technician, or instructor how the equipment works and what can be safely changed in the experiment.

Week 2 – Each group should brainstorm 2-3 proposed SDL ideas *prior to entering the lab* and will discuss the feasibility and relevance of those ideas with the instructor, the lab technician, and/or your laboratory TA during the laboratory period. The laboratory manual for each experiment provides a list of additional equipment or chemicals available for your use in conducting your SDL experiment to help you identify potential ideas; however, you may choose to use the same equipment and chemicals but change some process condition (i.e. flow rate, flow direction, temperature, etc.) for your SDL investigation as well.

Week 3 – At the start of the lab, each group must submit a **maximum one-page SDL plan,** including a formal hypothesis for the proposed experiment, a list of equipment/chemicals to be used, and a detailed procedure for the experiment to be performed, including specific conditions/states to test, any required controls, and a brief outline of anticipated calculations. **Note: there is no need to repeat protocols identified in the laboratory manual – you just need to highlight any changes you choose to make to these protocols in your SDL plan**. This plan will be marked out of 10 (2 marks for the brainstormed ideas in week 2, 4 marks for the quality of the hypothesis, and 4 marks for the quality of the experimental plan) and will account for 5% of the final mark on each laboratory report. **Bonus marks** may be awarded for particularly original SDL plans that utilize the available equipment in a novel way and/or investigate a novel hypothesis. Your laboratory TA will review your SDL plan and offer feedback on safety and/or feasibility concerns before you begin the SDL experiments.

In your **formal report**, you should:

- Explain why you selected your SDL goals
- Explain how you designed the program
- Show the data you collected and interpret it in the context of your other experimental data
- State specific conclusions you arrived at during your investigation (based on your hypothesis).

These components are normally integrated throughout the report instead of in a separate section, such that the whole three weeks of your experiment are written as a single investigation. As such, this component of the SDL section is incorporated into the formal report grading scheme.

Formal Reports (80%): The all three experiments will require **group formal reports (FR).** The third lab will instead use a group formal report and presentation format, followed by questions, a graphical abstract/executive summary and a group evaluation.

Hard copies of formal reports must be handed in no later than 12:00 noon on the specified deadline date (see course calendar) to the Chemical Engineering Office (JHE 374). As well, a separate, but identical, electronic copy must be uploaded to TurnItIn.com (using the same account you first established in 2G03) at the same time. A standard deduction of 20% per day overdue applies; for example, a report awarded 75% but handed in 1 day late will receive a grade of 55%. The late penalty will be waived only on the presentation of a medical certificate. **Note that due to changes to the MSAF requirements, MSAF will not apply for any formal reports or the group presentation. All reports must be completed and handed in for a course credit. Failure to hand in any one laboratory report will result in automatic course failure.**

Laboratory reports will be marked according to the guidelines for report writing and the detailed grading scheme included in this courseware package. Reports are expected to be clear and concise. **A 15-page writing limit (not including Title Page, Table of Contents, Appendices, Tables or Figures), double spaced**, will be applied to all reports. Reports exceeding this limit will be penalized, and excess pages will not be marked. The formal report will account for 80% of the total mark assigned to each experiment.

Students will have the opportunity to review their graded FR with the TA and/or the instructor. The student may sign out the report from the lab technician in JHE-A106 but **must return the graded report to Tim Stephens within seven days** – failure to do so will result in zero for that laboratory. Senate regulations require that the instructor must retain the laboratories. These marks are tentative and may be raised or lowered by the instructor to account for differences in the TAs grading styles.

Laboratory Presentation: A 20 to 25-minute presentation followed by questions from the instructors and TAs will be conducted in groups on the results of the third labs during the week of November 27 – December 1. A schedule for presentations will be posted on Avenue to Learn and in the lab closer to the date. The group presentation mark may be adjusted for individual students in the group according to each student's performance during the presentation. The presentation will be marked according to the detailed grading scheme included in this courseware package and the guidelines to be discussed in the lecture period. The presentation will account for 15% of the final grade assigned in the course.

Lecture assignments: Assignments will be due at the start of lecture on the day it is due. Late assignments will NOT be accepted. Excused lateness must be worked out with the instructors **before** the assignment is due, or submit a McMaster Student Absence Form (MSAF). A total of four assignments worth 2.5% each will cover topics that are general to the course material and not a specific experiment. The value of any assignment that is missed with a valid MSAF, will be moved to the Laboratory Presentation grade.

Final grades will be converted to the 12-point scale using the Senate recommended conversion scale.

A schedule indicating all key laboratory, lecture, and meeting slots relevant for each lab section is included in this course package. Students will NOT be permitted to switch lab sections after completing the first laboratory session.

Centre for Student Development:

"Students with disabilities can receive accommodations to assist them in the completion of their assignments and exams. Please contact the Centre for Student Development for advice and for arranging assistance." Further info at: ***http://csd.mcmaster.ca***

Senate and The Faculty of Engineering Policies:

"The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem, that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible."

Plagiarism and Academic Dishonesty

Plagiarism is a serious issue to you as an academic and a future professional, and will be treated as such in this course should it occur. You will be using Turnitin.com to verify the originality of your laboratory reports throughout the course. Please note the following for Turnitin.com:

1. Most of you will have already used Turnitin.com for ChE 2G03 and/or ChE 3L02. Use your email address and the same password you used before to login. If you have forgotten your password then use "Forgot your Password?" for help.
2. Replies from Turnitin.com may go to your spam box, so check there for messages or responses.

3. The originality report should show up to the left of the box marked "reviews", which initially may be inaccessible. When the originality report is ready, this box will be accessible and will show up with your report as an overall %; clicking will give a detailed report.
4. Generation of the originality report may not be available until after the report is due.
5. As several years of reports on similar laboratories are in the database, it is inevitable that some identical phrases or expressions may occur between your report and previous reports – this is to be expected. We are not looking for a particular percentage of 'originality' but rather looking through the full originality report to confirm the laboratory report is your original work.

Please refer to the university policy on academic dishonesty (reproduced below) for the definition of plagiarism as it pertains to this course: Please note that plagiarism cases *will be reported* and the procedures outlined below *will be followed* if an issue were to occur.

"You are expected to exhibit honesty and use ethical behavior in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity."

"Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behavior can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university."

"It is your responsibility to understand what constitutes academic dishonesty. For information, the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity"

The following illustrates only three forms of academic dishonesty:

1. *Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained. **
2. *Improper collaboration in group work. **
3. *Copying or using unauthorized aids in tests and examinations. **

*In particular, in this course, copying of previously submitted laboratory reports or data is considered to be an extreme case of academic dishonesty/plagiarism.

In this course, we will be using Turnitin.com and Avenue to Learn. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.