CHEM ENG 2D04 — CHEMICAL ENGINEERING PRINCIPLES I
Fall 2023, Course Outline

INSTRUCTOR:
Drew Higgins (he/him), ABB 428, higgid2@mcmaster.ca,
Preferred name: **Drew**
Office hours: By appointment and I will also make every effort to stick around after lectures

TEACHING ASSISTANTS AND OFFICE HOURS:
- Alejandra Ibarra (she/her), aleja1@mcmaster.ca (Will stick around after tutorials)
- Thomas Baker, bakert4@mcmaster.ca (Will stick around after tutorials)
- Ecem Yelekli (she/her), yeleklie@mcmaster.ca (Available by appointment on Wednesdays for help on assignments that are due Thursdays)
- Storm Gourley (he/him), gourles@mcmaster.ca
- Robert Ngunjuri (he/him), ngunjirr@mcmaster.ca

SCHEDULE:
6 contact hours per week. Three lecture hours (Tuesdays and Thursdays), one as-needed** lecture hour (Mondays) and a two hour tutorial (Monday or Friday depending on your group). Please see A2L for specific times/locations.

**Lecture on an "as needed" basis. We will let you know in advance if this lecture is taking place in any given week.

TAs (Alejandra, Thomas) will run tutorials and Drew will run lectures. Lectures will present new material and go through simple examples. During tutorials you will solve exam/test style problems, working alongside your peers with guidance from the teaching team. **It is crucial that you attend tutorials!** Students who regularly attend and participate in tutorials generally do very well in this course.

This is an in-person course, and **attendance at all lectures and tutorials is expected**. Echo360 will capture lecture content and post to A2L if you want to go back and review the material. We will do our best to ensure recordings are done properly, however the teaching team cannot make any guarantees about the quality of the recordings as it is an automated process. All tests require in-person attendance.

FORMAL COURSE DESCRIPTION
Steady-state mass balances in chemical processes and the first law of thermodynamics. The behaviour of gases and liquids, and their physical equilibria. Recycle in steady state operation.

INFORMAL COURSE DESCRIPTION

Chemical engineering processes are central to life as we know it, from the production of food that we eat, medicines to keep us healthy, plastics that we use in everyday life, and fertilizers that enable the agricultural sector to support the world's rapidly growing populations. Being able to analyze, understand, design, develop, implement and improve chemical engineering processes by applying principles of science and mathematics allows chemical engineers to contribute to life as we know it. This course will provide an introduction to the key concepts and principles of chemical engineering that you will use throughout your entire careers.

REQUIRED TEXTBOOK

R.M. Felder, R.W. Rousseau and L. G. Bullard, *Elementary Principles of Chemical Processes, 4th Edition,* Wiley, 2000.

Please note that the 4th edition is strongly suggested as there are several revisions from previous versions and the question numbers covered in lectures and tutorials may not align between versions.

Term tests and exams will be open book, so it will be to your advantage to have a hard copy or printed our version of the textbook (or relevant sections of the textbook). I will make the tables from the textbook that will be required for solving problems available as a pdf, and if you do not have a hard copy of the textbook, it will be your responsibility to print these and bring them with you to class/tests/exams.

COMMUNICATION

All course announcements and information will be **posted on Avenue**. You are responsible for checking regularly. If you want to reach Drew, please correspond by **email**: higgid2@mcmaster.ca

There is an **anonymous feedback form** available throughout the term that Drew will check weekly. Please share any thoughts/comments/feedback (even compliments 😊) that may be helpful for improving the course offering. The survey is available at: https://forms.gle/jfVmD8A3fQrCKNys6

GRADING ASSESSMENT:

Weekly homework assignments:	20%
Term Test 1 (Open textbook)	20%
Term Test 2 (Open textbook)	20%
Final Examination (Open textbook)	40%

Open book/notes tests and final exam (hard copies only!). The course textbook will be very helpful as it has unit conversions tables and other important information. Electronic versions of the textbook cannot be used. The final percentage grade will be converted to a letter grade using the standard conversion in the Undergraduate Calendar. In three lectures throughout the term, we will give a **bonus problem** for you to solve and submit (via Avenue) that will be counted as a bonus mark towards your term tests and final exams.

BASIC COURSE PROTOCOL:

A few basic ground-rules to help you develop good habits for future courses and work:

1. All homework must be clear, legible and submitted via Avenue by the due date.
2. Work must be neatly organized with intermediate calculations shown.
3. Use consistent units in your calculations.
4. If the units of the problem are British units, you must do the calculations in British units. Marks will be taken off for converting to metric and then converting back to British units at the end.
5. For ALL assessments, please show **all units, equations, intermediary calculations and processes to receive full marks**. This will show us that you know how to solve the problem, and if you make a small mistake in calculations you will still get a large portion of the marks.
6. If you get stuck when solving a problem, make (and state) reasonable assumptions that will enable you to continue to progress and solve the question so that you can demonstrate that you know what you are doing and receive as many marks as possible.
7. Use diagrams to explain your solution, if appropriate.
8. Make sure that **you have your name and student number** on the first page of everything you submit.

COURSE POLICIES

Term Tests (Please note this may be subject to minor change)

- Term tests will be held during the Thursday lecture slot (2:30-3:20pm). Open notes and textbook. Electronic versions of the textbook are not permitted. You must bring your student ID and have it on display. There will be a sign in form that each student must sign.
- If you are absent for a term test the grade will automatically be shifted to the final exam.
    - **Term Test 1** – Thursday, October 26th (2:30-3:20pm, T13 127)
    - **Term Test 2** – Thursday, November 23rd (2:30-3:20pm, T13 127)

Assignments

- 6 assignments throughout the term posted on A2L. All assignment solutions must be submitted through A2L. The lowest grade assignment will be dropped. Solutions to the assignment problems will be available online. Late assignment submissions will not be

accepted. Assignments will generally be due **Thursdays by 11:59pm**, with office hours from Ecem to provide extra help on the assignments taking place on Wednesdays by appointment.

OFFICE HOURS

I do not set office hours, because they are restrictive. I am eager to get to know you and to help, so please reach out by email. I will do my best to respond in a timely fashion, but please note I do not generally check emails on evenings and weekends as I will be spending time with my family. If you don't heard back from me in 2 business days, please send me a gentle reminder — I will appreciate it. I will also stick around after lectures (when possible) for discussions.

STUDENT ACCESSIBILITY SERVICES (SAS)

We are happy to accommodate all requests through McMaster's SAS program. Please forward and optionally discuss with me what you need to succeed. Whenever possible please do your best to coordinate your own accommodations and I will support whenever I can. Please also let Drew know (early!) every time something is required from him. If you have caregiving responsibilities that may interfere with this class, please contact me and we can try to find flexible solutions.

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

COURSE LEARNING OBJECTIVES

By the end of this course, students should be able to:

LO1. **Perform basic engineering calculations**
   a. Convert quantities from one set of units to another
   b. Define, calculate and estimate properties of materials and compounds
   c. Calculate/estimate important process operation parameters including fluid density, flow rate, chemical compositions expressed as mass or mole fractions, concentrations, fluid pressure and temperature
   d. Identify and clearly indicate assumptions used and limitations of engineering calculations performed

LO2. **Perform material and energy balance calculations**
   a. Draw and label a process flow diagram based on a verbal or qualitative description
   b. Carry out a degree of freedom analysis – i.e., determine which variables can be changed and which are fixed by constraints

c. Write and solve material and energy balance equations for single and multiple unit processes, which may or may not include recycle(s), bypass(es), and reactive processes.

d. Use spreadsheets to solve material and energy balance problems

LO3. **Apply physical chemistry principles**

a. Perform pressure-volume-temperature calculations for ideal and non-ideal gases

b. Perform vapour-liquid calculations for systems with one condensable component and for ideal multicomponent solutions

c. Calculate changes in internal energy for process fluids undergoing specified changes in temperature, pressure, phase and chemical composition.

d. Incorporate these thermodynamic results into process material and energy balance calculations.

LO4. **Perform other chemical engineering practices**

a. Examine different processes to understand process flow diagrams

b. Examine processes to identify the impacts of engineering activities on the environment, society and various stakeholders.

c. Survey types of process equipment and analyze its function, principles of operation, cost and size.

d. Show linkages of topics in ChE2D04 to future courses:

   i. Material and energy balances: ChE 2F04, 3G04

   ii. Thermodynamics, vapour pressure, phase change: ChE 2F04, 3D04, 3G04, 3M04

   iii. Process systems: ChE 2F04, 3G04, 3P04

   iv. Calculations and modelling: ChE 2F04, 3G03, 2E04, 3P03

   v. Pressure drop and fluid flow: ChE 2O04

   vi. Reactions, stoichiometry: ChE 3K04

   vii. Heat balances: ChE 3A04

ACCREDICATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's actual grade in the course. This course will measure the following graduate attribute indicators through the indicated learning outcomes below.

Indicators	Mapped Learning Outcomes
1.3 Competence in Engineering Fundamentals	LO1, LO2, LO3, LO4
1.4 Competence in Specialized Engineering knowledge	LO1, LO2, LO3, LO4
2.1 Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.	LO1, LO2, LO3, LO4

2.2 Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions	LO1, LO2, LO3, LO4
9.1 Evaluates the environmental impact of engineering activities, identifies uncertainties in decisions, and promotes sustainable design.	LO4

ADDITIONAL RESOURCES

Textbook with Additional Explanations and Example Questions

D.M. Himmelblau, *Basic Principles and Calculations in Chemical Engineering, 6th edition*, Prentice-Hall, 1996.

Online Resources

Wiley has a "Student Companion Site" that supplements the textbook, consisting of some interesting resources that you should explore:

http://bcs.wiley.com/he-bcs/Books?action=index&bcsId=9771&itemId=1118431227

- Encyclopedia of chemical engineering equipment – throughout the course you will need to look up equipment and explain how it works and this is a good starting point.
- Electronic versions of the Figures and Tables from the textbook.
- Analysis of Processes with Excel® (APEx) —an Excel Add-In that integrates the tabular data found in Felder, Rousseau and Bullard's Elementary Principles of Chemical Processes and assists students in learning to solve systems of algebraic equations using Excel's Solver tool.
- Instructional tutorials – self tests and small problems based on the concepts covered in the book.

TENTATIVE COURSE OUTLINE

Below outlines the topics that will be covered in the course, which will be subject to change. The chapters numbers indicate are for the required course textbook (Felder, Roussea and Bullard).

1. Introduction to Chemical Engingeering (Chapter 1)
2. Unit conversions (Chapter 2)
3. Engineering Calculations (Chapter 2)
4. Process variables: mass, flow, composition, temperature, pressure (Chapter 3)
5. Material balances (Chapter 4)
   a. general equations, single units
   b. degrees of freedom
   c. multiple units and recycles
   d. reactive systems
   e. combustion
6. Single phase systems (Chapter 5)

   a. Liquids and ideal gases
   b. Non-ideal gases
7. Multiphase systems (Chapter 6)
   a. Vapour-liquid equilibrium
   b. Solids- liquids
   c. Two liquid phases
   d. Adsorption
8. Final Examination Review

The P.R.O.C.E.S.S.

As some of you may already be aware, the department of Chemical Engineering has a storied history of education. In addition to teaching and learning, the department is proud of our graduates not only for their academic success, but their more intrinsic traits that make them respected members of the engineering community.

Recently, several high-ranking graduates from the McMaster Chemical Engineering Program employed in various industries (oil/gas, financials, *etc*.) were interviewed to ask what traits they look for when hiring for engineering positions. Using this information, the department would like to present to you the **PROCESS**: a code of conduct that we hope will guide our students throughout this program and their careers to come.

- **P**rofessionalism
- **R**esponsibility
- **O**wnership
- **C**uriosity
- **E**mpathy
- **S**elflessness
- **S**ervice

It is up to YOU to interpret these traits and apply them to your time at McMaster and your career as you see fit. These traits will not be assessed for grades but will be strongly encouraged throughout your time at McMaster. We hope that you identify with these character traits and what they mean to you, and that you **trust the process**.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

In the event of an absence for medical or other reasons, students should review and follow the [Policy on Requests for Relief for Missed Academic Term Work.](#)

Please also note that for any missed term tests the grade weighting will be automatically shifted to the final exam, and for assignments the lowest grade assignment mark will be dropped.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

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 behaviour 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. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Academic credentials you earn are rooted in principles of honesty and academic integrity. Please remember that copying, cloning, or "borrowing" other people's solutions and assignments is cheating – academic dishonesty. Many engineering problems involve working in groups, so you are encouraged to work with others on assignments. However, you must each hand in your own assignments having solved the problems on your own. The best way to learn the material is to go through the problems and understand what you are doing. Since this course forms the basis of so much of what you will do in Chemical Engineering, it is particularly important to understand the material presented and be able to solve the problems from this course.

AVENUE TO LEARN (A2L)

This course uses A2L and email for communications. Students should be aware that, when they access the electronic components of a course using these elements, 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 a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMODATION FOR RELGIOUS, INDIGENEOUS, OR SPIRITUAL (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office *normally within 10 working days* of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.