Chemical Engineering 4Z03/6Z03

Interfacial Engineering

Course Outline - Winter 2026

Course Details

Instructor:		**Dr. Stuart Linley**	**linleys@mcmaster.ca** **(365) 883 1683**	**JHE 345/A**
Teaching Assistant:		Alibek Kurbanov	kurbanoa@mcmaster.ca	JHE 296
Website:		Avenue2Learn	avenue.mcmaster.ca	
Lectures*:		See A2L*	See A2L*	See A2L*
Tutorials/Labs*:		N/A		
Office Hours:	**INST:** **TA:**	Tuesday TBD	13:30 – 15:30 or **drop in**	
Prerequisites:	Registration in final level of any Engineering program or permission of the Department			
Course Materials:	Lecture notes, assignments, and solutions will be posted on A2L Grades will be posted on A2L but are not official until released on MOSAIC.			
Optional Textbooks:	J.C. Berg: *An Introduction to Interfaces & Colloids*. World Scientific. (2010): Library D. F. Evans & H. Wennerström: *The Colloidal Domain: Where Physics, Chemistry, and Biology Meet*. Wiley. Second Edition (1999): Library P.C. Hiemenz & R. Rajagopalan: *Principles of Colloid and Surface Chemistry*. Marcel Dekker. Third Edition (2016): Library (available online)			

*Based on University inclusion and safety policies, this information is available separately on Avenue to Learn.

Course Description

Chemical Engineering 4Z03 focuses on the fundamental interactions that contribute to surface phenomena and how we can apply chemistry and physics tailor surface interactions for useful purposes. The following topics will be discussed:

Interactions:

- Van der Waals interactions – their physical basis and how they effect surface potentials and macroscopic interactions between particles and surfaces
- Hydrophobic forces – their physical basis and how they influence particle-particle/particle-surface interactions

- Electrostatic forces – their physical basis and how they influence particle-particle/particle-surface interactions
- Steric and Depletion interactions – how steric interactions can stabilize particles in suspension and the origin of osmotic repulsive forces
- DLVO Theory – how the above interactions can be combined to model particle interactions in suspension

Interfaces:

- Interfacial energies – surface tension and similar surface energies (liquid-vapour/liquid-solid systems)
- Behaviour of pure liquids on flat and porous surfaces – Contact angle, curvature and pressure differential, physical origin and application of capillary forces
- Solutes and interfaces – solute effect on surface tension, solute gradients at surfaces, Marangoni flow
- Surfactants – Structure and properties, solution behaviour: micellization, cloud point, kraft point, self-assembly geometry, adsorption, emulsions, HLB
- Polymers at Interfaces – Solution properties: overlap concentration, radius of gyration, measurement tools; surface adsorption and surface concentration; particle stabilization

Nanoparticles:

- Overview – general properties, examples of nano-dispersions, nucleation and growth model
- Charge density and Zeta potential – surface charge and nanoparticle dispersion stability; measuring zeta potential
- Particle size and shape characterization – dynamic light scattering (major focus), transmission electron microscopy (minor focus)
- Rheology of dispersions – polymer solutions vs. suspensions of small spheres; viscosity and shear
- Nanoparticle aggregation – aggregation behaviour, kinetics, forced aggregation: coagulation with salts, polymer flocculation, depletion flocculation

Engineering Interfaces:

- Surface characterization tools – X-ray photoelectron spectroscopy, gas adsorption isotherms, cyclic voltammetry; chemically modifying surfaces
- Adhesion, friction, and lubrication – origins of macro- and micro-scale adhesion, work of adhesion, introduction to tribology
- Self-assembling systems – making useful surfaces with surfactants and measuring their properties

Learning Objectives

After completing this course, the student should be able to:

L.1. Explain how fundamental molecular interactions contribute to macroscopic forces in colloidal systems

L.2. Use physical relationships and DLVO theory to model interfacial interactions

L.3. Explain how interfacial energies contribute to the behaviour of liquids on flat and porous surfaces

L.4. Use physical relationships to model and predict liquid behaviour at interfaces

L.5. Relate surfactant properties to physical phenomena and solution properties

L.6. Predict how polymers will interact with surfaces and how they can be used to stabilize colloids

L.7. Relate zeta-potential to nanoparticle stability and explain aggregation mechanisms

L.8. Relate chemical and physical interfacial properties to applications: characterization, lubrication, stabilization, and surface coating

Grading Policies

Please be aware of the following grading policies for ChE 4Z03/6Z03:

- The instructor retains the right to modify course weights or components; this is typically only enforced for the student's benefit. All grades are **unofficial** until final grades are posted on MOSAIC.
- Final grades will be converted to the standard McMaster 12-point scale.
- Submissions for coursework (assignments) will be accepted electronically through A2L or by hard copy in class. Examinations will be written, hard copy only.
- Any copying of assignment or examination solutions from other students, prior versions of this course, or resources online, including generative AI agents or large language models, will be considered a violation of McMaster's academic integrity policy.

Grading Breakdown

Weight	Component	Comments
20%	Assignments	Approximately 5 sets of questions covering lecture materials. Questions will be short answer and/or calculation-based, and will require interpretation of physical and chemical course theory.
10% **(0%)**	Project Paper	Required, individual paper for graduate students (6Z03) Optional paper completed in pairs for undergraduate students (4Z03) Details on project paper will be released after the midterm. Due on the last day of classes.
20% **(30%)**	Midterm Exam	To be completed individually. A short exam covering course content up to and including liquid interactions with surfaces.
50%	Final Exam	To be completed individually. A long exam covering all course content. Exams will be structured to assess knowledge (~30%), application (50%), and extension of theory (20%).

Academic Honesty

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.

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

- All assessments must be done individually, except where specified, with no additional collaboration.
- Plagiarism, improper collaboration, copying unauthorized tests or aids, and other academic dishonesty will not be tolerated. **Your first offence will be reported** to the Office of Academic Integrity.
- The default penalty for academic dishonesty is a zero on the entire assignment / exam, even if the dishonesty occurred on just one portion or question of that assignment / exam. However, if Academic Integrity chooses to hold a hearing, they will determine the penalty.

Use of Generative AI (Artificial Intelligence) in Coursework

While generative AI may be a useful tool in aiding your understanding of algorithms and python, the use of generative AI in submitted work for assessments is prohibited. In accordance with the provost's guidelines on the use of generative AI in teaching and learning, this course outline sets the expectation for use of generative AI: The use of generative AI to produce whole or partial solutions to assessment materials constitutes a violation of the academic integrity policy. Submission of such material for course credit with uncited or unacknowledged work not created by the student(s) who submitted it also violates academic integrity.

Accessibility and Mental Health

The instructor aims to make this class accessible to all students. Please forward and optionally discuss any accommodation granted by Student Accessibility Services (SAS) with the instructor *before the third week of the course*. Please raise any other accessibility issues with the instructor as soon as possible, *e.g.* accessibility of the course website and course materials.

My office (or online video portal) is a **safe space** to discuss issues both academic and otherwise, and you are welcome to contact me at any time to chat.

Course Feedback

Please do not hesitate to let me know your thoughts on the course or what you might want to change at any time. You can reach me at linleys@mcmaster.ca or discuss with me in person. I can facilitate an anonymous dropbox if the class feels it is necessary.

Class Recordings

Attendance of in-class lectures is expected and strongly encouraged. The classroom is equipped with ECHO360 capture hardware, and lecture recordings will be automatically uploaded to A2L following class. I cannot guarantee the quality of these recordings and work on the blackboard/whiteboard may not be captured, though I will try to do most in-class examples using digital note-taking software.

Important Dates

There is one midterm test for this course. Please commit this date to your calendar:

- Written Midterm March 2 @ 18:00 TBD

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

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**.

McMASTER APPROVED ADVISORY STATEMENTS

Authenticity / Plagiarism

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). 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.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

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 Accommodation of Students with Disabilities

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.

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.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (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.