

Chemical Engineering  
CHEMENG 3Q03  
Introduction to Polymer Science  
*Winter 2024*



**ENGINEERING**

## Instructor Information

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Todd Ryan Hoare

**Email:** hoaretr@mcmaster.ca

**Office:** JHE A409

**Office Hours:**

To be set in consultation with the class in the first lecture.

Appointments can be booked with the instructor via e-mail or MS Teams chat.

## TA Information

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**Name:** Nate Dowdall

**Email:** dowdalln@mcmaster.ca

**Name:** Seyed Saeid Tayebi

**Email:** tayebis@mcmaster.ca

## Class Times

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**Wednesdays** 11:30-12:20

**Fridays** 10:30-12:30

## Class Format

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In Person - Lectures will be held in T13-107 and recorded via Echo360 to be accessed the following day but will not be live streamed.

**Course Dates:** 01/08/2024 - 04/10/2024

**Units:** 3.00

**Course Delivery Mode:** In Person

**Course Description:** An overview of important synthetic and natural polymers and key concepts in polymer science, with an emphasis on polymer structure-property-application relationships. Principles of polymer synthesis and characterization are related to applied polymer design challenges. Three lectures; second term Prerequisite(s): CHEM 2E03 or 2OA3 and 2OB3, or permission of the Department

## **Instructor-Specific Course Information**

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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. You are responsible for checking Avenue to Learn and your McMaster email to receive communications from the instructor and/or TAs throughout the course.

## **Meeting Details**

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This course has an Avenue to Learn site which will be used as the primary location for posting lecture notes (solutions to in-class example problems will *not* be posted), assignments, and solutions to both assignments and midterm tests. Marks will also be disseminated through Avenue to Learn. A discussion board is available to post questions about the course and will be monitored regularly by the TAs and the instructor. Questions regarding course material should be posted on the discussion board, not e-mailed individually to the professor. Questions about individual performance in the course should be directed to the professor by e-mail or MS Teams private chat.

All lectures and workshops will be delivered in-person unless weather or health issues prevent in-person delivery, in which case lectures will proceed via MS Teams.

Attendance is expected for the workshops (typically comprising one hour of the 2 hour Thursday lecture slot, the hour of which may vary by week but will be announced in advance), with workshop deliverables to be submitted at the end of the workshop period. Should attendance be physically impossible due to health, required quarantining, or other reasonable accommodations, the student should contact the instructor and arrange for alternate assessment before the workshop/assignment session.

## Important Links

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- [Mosaic](#)
- [Avenue to Learn](#)
- [Student Accessibility Services - Accommodations](#)
- [McMaster University Library](#)
- [eReserves](#)

## Course Learning Outcomes

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- To introduce the fundamentals of polymer science for advanced polymer courses (Polymer Processing, Polymer Reaction Engineering, etc.)
- To reinforce industrially important organic and physical chemistry concepts within the context of polymer science
- To acquire an intuition for how polymer structure relates to material properties and the design of industrially-important polymer-based products
- To gain insight into emerging topics in polymer science and engineering

## Graduate Attributes

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The Canadian Engineering Accreditation Board (CEAB) is a division of Engineers Canada and is responsible for accrediting undergraduate engineering programs across Canada. Accreditation by the CEAB ensures that the engineering programs meet a

national standard of quality and cover essential educational requirements. Graduate Attributes are a set of qualities and skills that the CEAB expects engineering graduates to possess. These attributes are a benchmark for the learning outcomes of accredited engineering programs. This section lists the Graduate Attribute Indicators associated with the Learning Outcomes in this course:

1.2 Competence in Natural Sciences

1.4 Competence in Specialized Engineering knowledge

2.1 Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem

2.2 Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions

6.1 Actively contributes to the planning and execution of a team project

7.1 Demonstrates comprehension of technical and non-technical instructions and questions

7.2 Composes an effective written document for the intended audience

7.3 Composes and delivers an effective oral presentation for the intended audience

## Course Schedule

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<b>Weeks</b>	<b>Topic</b>	<b>Assessment</b>
1	Introduction and Definitions - Polymer definitions, polymer nomenclature	Polymer scavenger hunt
2-4	Classification of Polymers - Polymer chain architectures, polymerization mechanisms, polymer compositions, thermal properties, polymer sourcing, polymer degradation	Assignment #1 Workshop #2
5-6	Characterizing Polymer Properties – Molecular weight, dispersity, glass transition, crystallinity, viscoelasticity, rheology, solubility/miscibility	Assignment #2 Workshop #3
7-8	Polymer Chain Dynamics – Polymer conformations, solvent-polymer interactions	Assignment #3

Weeks	Topic	Assessment
9-11	Polymer Synthesis – Step versus chain growth polymerization, chemistry, mechanisms, and kinetics of polymer synthesis, free radical polymerization/co-polymerization, ionic polymerization, coordination polymerization	Assignment #4
12	Methods of Polymerization – Bulk, solution, precipitation, suspension, emulsion, interfacial, step-by-step	Final exam only
13	(Time permitting) Emerging Trends in Polymer Science	N/A

## Required Materials and Texts

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Textbook Listing: <https://textbooks.mcmaster.ca>

### **Introduction to Polymer Science and Chemistry: A Problem-Solving Approach**

**ISBN:** 978-1-4665-5384-2

**Authors:** Manas Chanda

**Publisher:** CRC Press

**Publication Date:** 2013

**Edition:** 2nd Edition

Please note this is NOT a required textbook - all material required to complete all assignments and evaluations will be included in the provided lecture notes. However, this book is recommended should you want an additional resource. Other recommended additional resources include:

(1) Paul Hiemenz, Timothy Lodge, "Polymer Chemistry, The Basic Concepts", 2nd Ed., Marcel Dekker, 2007

(2) George Odian, "Principles of Polymerization", 4th Ed., Wiley-Interscience, 2004

(3) A. Rudin, "The Elements of Polymer Science and Engineering", 2nd Ed., Academic Press, 1998

(4) H.R. Allcock, F.W. Lampe, J.E. Mark, "Contemporary Polymer Chemistry", 3rd Ed., Prentice Hall, 2003.

(5) P.J. Flory, "Principles of Polymer Chemistry", Cornell University Press, 1953

## Course Evaluation

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Polymer Pioneers presentation	10%
Product Design Project (pre-interview, presentation, and technical report)	20%
Assignments (best 3/4 × 5% each)	15%
Workshops (best 5/6 × 2% each)	10%
Midterm exam (optional) + Final exam (15% + 30%)	45%

## Course Evaluation Details

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**Assignments and In-Class Workshops** are designed to give practical experience in utilizing the concepts introduced in the lectures to solve specific problems and/or practice making decisions in polymer-based product design. Students will work in groups of 3-4 (self-chosen). Workshop activities will involve a deliverable that will be due at the end of workshop period, while Assignments will be due by 11:59PM on the date indicated via upload to Avenue. Any absence, particularly in Workshop weeks in which marks are granted based on an in-class activity, must be cleared in advance of the workshop; otherwise, a mark of zero will be assigned. You may choose not to submit one of the six workshop activities and one of the four assignments over the course of the semester without penalty or explanation; only 3 of the 4 assignments and 5 of the 6 workshops will be counted in your final mark. If you choose to attend all workshops and/or submit all assignments, your lowest mark in either category will be dropped.

The assignment/workshop dates are as follows.

1. **Bonus Activity** – January 12 - Polymer scavenger hunt (due at end of class)
2. **Workshop 1** – January 19 – How to read polymer papers (due at end of class)
3. **Assignment 1** – submit to Avenue by 11:59PM January 29
4. **Workshop 2** – February 2 – Polymer design workshop (due at end of class)
5. **Assignment 2** – submit to Avenue by 11:59PM February 12
6. **Workshop 3** – February 16 – Polymer characterization workshop (due at end of class)
7. **Workshop 4** – March 8 – Paper critique/analysis (due at end of class)
8. **Assignment 3** – submit to Avenue by 11:59PM March 18
9. **Workshop 5** – March 22 – Hands-on polymer science (due at end of class)
10. **Assignment 4** – submit to Avenue by 11:59PM April 1
11. **Workshop 6** – April 10 – Polymer contest (due at end of class)

The **Midterm Exam** will be held during the Friday lecture slot on **March 1** and will be open book (i.e. you may use notes and any other reference material you wish to use). The midterm exam is optional, with no make-up tests to be arranged and no MSAFs considered. If you write the midterm test and do better on the final exam, your final mark will be calculated by ignoring the midterm mark (i.e. the final exam will account for 45% of the course mark). Alternately, if you do better on the midterm test than the final exam, the midterm test will count for 15% of your mark and the final exam will count for 30% of your mark. If you do not write the midterm, the final exam will be worth 45%.

In the **Polymer Pioneers** presentation evaluation, you will choose a pioneering researcher in polymer science and engineering and deliver a <5 minute presentation (in-class on **February 9**) about the person, what their key contribution(s) are, and what the practical impact (current or future) of their contributions is. Additional instructions and a marking rubric are provided on Avenue in addition to a list of potential applications from which to choose. You may perform this assignment alone or in pairs – sign up your group and topic through the spreadsheet on Avenue (no more than one group per person) by **January 19**.

In the **Product Design Project**, you will design a new polymeric device, technology, or product that leverages new polymer chemistry, fabrication techniques, and/or assemblies to solve an identified environmental, technological, biomedical, or industrial challenge, as per your interests. You are strongly suggested to run your topic past a TA and/or Dr. Hoare prior to starting work on your design to ensure it fits within the scope of the course and is appropriate in scope. This assignment will be done in groups of four students and will include four evaluated components. Marking schemes or heuristics for each component are available on Avenue.

1) A *group pre-interview* (~10 minutes long) will be scheduled during the workshop on **March 8** in which the group will present its technical design idea within 3 minutes (visual aids are allowed). Technical questions will follow on the idea, with the ultimate goal being to ensure the topic is appropriate and the design is technically feasible (15% of total project mark).

2) A *maximum 5-minute in-person pitch* to promote your design to your targeted customers (consumer, industrial, investor, clinician, government official, or other) by explaining the need for your product in the market, what your product is, how your product's performance meets the identified market need (contrasting with other available product(s)), and why your customer should buy/invest in your product. These pitches will be done in-class on **April 5**, followed by 5 minutes of live questions from an expert panel about your product (40% of total project mark).

3) A *summative written report* focused on the scientific design of the product as well as a justification for the type of customer you targeted. Reports should consist of a maximum of 5 pages of text (12 pt. font, 1" margins), excluding figures, schematics, tables and references. The report is due on **April 12**. (40% of total project mark)

4) *Group evaluations* ensuring all group members participated fully in the work (5% of total project mark, due on **April 12**).

The **Final Examination** will be scheduled in the examination period and will be an open-resource (i.e. any book or online resource is allowed) but individual evaluation. The exam will consist of two parts to be conducted consecutively on the date selected by the exams scheduling office: (1) a 30-minute oral component in which you will be asked to defend your answers to design-oriented questions posted on Avenue 24 hours in advance; and (2) a 2-hour written component to be written immediately after your oral exam focusing



on more fundamental aspects of the course. Each part will be weighted equally to calculate your final exam mark. For the oral component, you will be asked to sign a declaration that you prepared your answers individually.

## Grading Scale

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The McMaster 12 Point Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

## Late Assignments

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Late evaluations will be assessed a penalty of 10% per day late (weekends or weekdays).

## Absences, Missed Work, Illness

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If deadlines cannot be met due to sickness or other valid reasons, you must complete the McMaster Student Absence Form and forward it to the instructor within the required time frame as noted in the MSAF policies to receive consideration for waived late penalties and/or arrange alternate due dates. Please note that the requirement for an MSAF also

pertains to requests for consideration for missed workshops, as per the guidelines outlined earlier.

## Course Modification

In the event of a university-wide cancellation for any reason, all deadlines will be pushed to the next class unless otherwise announced via Avenue. In the event of a snow cancellation for any in-person class, the class will be held instead via MS Teams.

Public health guidance may require changes in either the course schedule or the nature and/or weighting of planned course evaluation components. Any change will be communicated with the class as early as possible via Avenue and in class.

The instructor reserves the right to make changes in course schedule or evaluation procedures if deemed necessary during the semester. Such changes (if required) will be communicated as early as possible via Avenue and in class.

## Generative AI: Some Use Permitted

Students may use generative AI for editing/translating/outlining/brainstorming/revising their work throughout the course so long as the use of generative AI is referenced and cited following citation instructions given in the syllabus. Use of generative AI outside the stated use without citation will constitute academic dishonesty. It is the student's responsibility to be clear on the limitations for use and to be clear on the expectations for citation and reference and to do so appropriately.

## APPROVED ADVISORY STATEMENTS

### **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](https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/), 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.

## **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.

## **Equity, Diversity, and Inclusion**

The Faculty of Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Faculty, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

## **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](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [Academic Accommodation of Students with Disabilities](#) policy.

## **Academic Advising**

For any academic inquires please reach out to the Office of the Associate Dean (Academic) in Engineering located in JHE-Hatch 301.

Details on academic supports and contact information are available from:

<https://www.eng.mcmaster.ca/programs/academic-advising>

## **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.