CHM 457, CHM1300: Introduction to Polymer Chemistry Fall 2024 Course Syllabus CONTACTS

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I COURSE OVERVIEW

COURSE DESCRIPTION:
This course is an introduction to polymer chemistry. The first part of the course will describe the shapes and sizes of polymer molecules, molecular weight determination, polymer properties in solution and in the solid state. This part will also include phase separation and self-assembly. The second part of the course will focus on polymer synthesis with an emphasis on polymerization mechanisms and on controlling end groups. Examples will illustrate selected applications.

STUDENT LEARNING OUTCOMES:
By the end of this course, students will be able to:

- identify and describe different polymer structures and understand how the chemical structure affects the properties of a polymer in solution and in the solid state.
- understand different techniques used to characterize polymer materials in the solid state and in solution.
- understand different techniques to determine molecular weights and molecular weight distribution of polymers
- use Excel or other spreadsheet programs to fit osmotic pressure data or polymer viscosity data to determine molecular weights.
- understand various polymerization mechanisms and how they can be used to construct polymers of different compositions.

PREREQUISITE COURSE(S) for CHM457: CHM220H1/CHM222H1, CHM247H1/ CHM249H1 or equivalent courses. CHM355H is recommended.

Both courses assume that you have a fundamental understanding of basic organic chemistry and organic reaction mechanisms; and basic physical chemistry (including thermodynamics and reaction kinetics).

READINGS:
Required: Painter P.C.; *Polymer Science and Engineering e-book*
Prof Painter has made this e-book available online for USD$19.95. It is an excellent book. The hard copy version of the previous edition cost ~$200!!
https://polymer-ebook.flickrocket.com/us/polymer-science- -engineering/p/190444

Supplemental: Young, R.L.; Lovell, P.A. *Introduction to Polymers*, 2nd ed.
Sperling, L.H., *Physical Polymer Science*, 2nd or 3rd ed.

II HOW THE COURSE IS ORGANIZED

The lectures and tutorials will be delivered in class, unless announced otherwise..

Classes: **Tuesdays 5 - 7 pm. SS 1083**
Tutorials: **Fridays 2 – 3 pm . UC 52**

An additional lecture is scheduled for Friday Nov 15 (likely 5 to 7 pm) to make up for the term test to be held on Nov 26.

A list of course topics is presented at the end of this syllabus.

TUTORIALS
Early tutorials will demonstrate how to use online programs to draw chemical structures, as well as how to fit data using Excel and how to transfer plots from Excel to PowerPoint and to Word. Later tutorials will be devoted to answering questions from the students about material presented in class.

III EVALUATION/GRADING SCHEME

RELEVANT SESSIONAL DATES AND MARKING SCHEME:

Dates	Assignments	Weight
Oct 18	Term test 1	20%
Nov 26	Term test 2	20%
Sept. 16, 30, Nov 4, 18	Problem Sets (4)	20%
Due Monday Dec 2, by noon	Term paper	40%

The higher term test mark 25%, the lower term test mark 15%
Note: Arts &Science Reading Week is Oct 28-Nov 1

Problem sets are to be submitted on Quercus by 10 am (EDT/EST) on the **Monday following the assignment**. The term paper is to be submitted by noon on December 2 on Quercus and as a hard copy (see separate files with upload instructions and guidelines for term papers.)

Non-programmable calculators are allowed for term tests.

Note: if an unexpected technical issue occurs with a university system (e.g., Quercus services, network outage) that affects availability or functionality, it may be necessary to revise the timing or weighting of the assessments.

IV COURSE POLICIES

- Each member of this course is expected to maintain a

(i) professional and respectful attitude during all course activities, including classes, laboratories, tutorials, and online activity.
(ii) personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met.
(iii) collection of notes recorded independently based on concepts covered in course activities (students registered with Accessibility Services requiring a class note-taker will have access to this accommodation)
(iv) familiarity with the university policy on Academic Integrity (overleaf)

- The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. As a Course Instructor, I will neither condone nor tolerate behaviour that undermines the dignity or self-esteem of any individual in this course and wish to be alerted to any attempt to create an intimidating or hostile environment. It is our collective responsibility to create a space that is inclusive and welcomes discussion. Discrimination, harassment and hate speech will not be tolerated. If you have any questions, comments, or concerns, we encourage you to reach out to the staff in our Equity Offices.

If you are absent from your studies due to illness or other reasons and unable to complete course work (e.g., a term test or an assignment) then a piece of written documentation is required. The following four items are the recognized forms of documentation:

1. Absence Declaration via ACORN (please note the circumstances under which an absence declaration can and cannot be submitted)
2. U of T Verification of Illness or Injury Form
3. College Registrar's letter
4. Letter of Academic Accommodation from Accessibility Services

Students who complete the ACORN Absence Declaration form must additionally contact me/the course coordinator/the course administrator to discuss their situation within five business days of the missed piece of work. This is essential action for any consideration to be granted.

For extended absences and for absences due to non-medical reasons, make sure to contact your College Registrar's Office. They can help you decide between a request for an extension or other types of academic consideration.

If you suspect or know that you have a disability that is affecting your studies, learn about the

services and supports available through Accessibility Services. A disability can be physical disability, sensory disability, a learning disability, mental health disorder or a short-term disability like an injury. If you are not sure whether you have a disability, you can confidentially contact Accessibility Services with your questions.

- For term papers, Generative Artificial Intelligence (AI) can be in certain instances to improve the quality of writing. This has to be stated at the end of the term paper.

- Communication with Instructors will respond to students' emails 48 hrs on weekdays. Please put chm457 or chm1300 in the subject line of your email.

- Privacy language and appropriate use of course materials: see the syllabus "Copyright" section.

- Late policy for term work submissions: a penalty of 5% of the maximum mark per day for the term paper and 10% for problem sets will be deducted daily for term work submitted past the deadline unless:

- Policy for reweighting due to missed pieces of academic work. For students missing one term test for a valid reason, an option of the make up test will be offered. For students missing two tests for valid reasons the mark for the missing tests will be replaced by a cumulative, two-hour assessment to be written in-person. This assessment will cover all aspects of both the laboratory and classroom components of the course.

- Assignment submission methods: use Quercus only.

- Process for requesting re-grading of course work. All requests should be submitted in writing, with an appropriate explanation of the reason for re-grading.

VI TECHNOLOGY REQUIREMENTS

- Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: https://www.viceprovoststudents.utoronto.ca/student-policies-guidelines/tech-requirements-online-learning/

- Advice for students writing online assessments (quizzes etc.): https://studentlife.utoronto.ca/task/online-exams-and-tests/

- This course requires the use of computers, and technical issues are possible. When working on a piece of academic work, students are responsible for scheduling enough time to allow for reasonable delays due to technical difficulties to be overcome, so such issues will not be acceptable grounds for deadline extension. Particularly, maintaining an up-to-date independent backup copy of your work is strongly recommended to guard against hard-drive failures, corrupted files, lost computers, etc.

VII INSTITUTIONAL POLICIES & SUPPORT

ACADEMIC INTEGRITY

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In laboratory reports:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any report. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post laboratory report material/questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**

On quizzes and term tests:

1. Using or possessing unauthorized aids. **Please note that the use of websites (such as Chegg.com or the course discussion board) to post quiz/term test questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.**
2. Looking at someone else's answers or collaborating/discussing answers during a quiz or term test.
3. Misrepresenting your identity.

In general academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see www.academicintegrity.utoronto.ca/).

Plagiarism Detection

The University of Toronto plagiarism detection tool can be used for detection of plagiarism in term papers.

COPYRIGHT

If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely

prohibited.

ACCESSIBILITY NEEDS
Students with diverse learning styles and needs are extremely welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact Accessibility Services as soon as possible.

ACCOMMODATIONS FOR RELIGIOUS OBSERVANCES
Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

ADDITIONAL SERVICES & SUPPORT
The following are some important links to help you with academic and/or technical service and support:

- General student services and resources at Student Life
- Full library service through University of Toronto Libraries
- Resources on conducting online research through University Libraries Research
- Resources on academic support from the Academic Success Centre
- Learner support at the Writing Centre
- Information for Quercus Support

ACKNOWLEDGEMENT OF TRADITIONAL LANDS
We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

V LIST OF TOPICS TO BE COVERED

1. Introduction

Classification of polymers
Overview of polymer structure, composition, architecture
General concepts of molecular weight distribution

2. Experimental determination of the shapes and sizes (molecular weights) of macromolecules

Conformation of macromolecules
End-group analysis
Osmometry
Scattering techniques
Viscometric techniques

3. Polymer solutions

Polymer interactions in solutions; concentration regimes, solvent quality
Solution and melt thermodynamics (Flory-Huggins theory)
Solubility parameter approach
Association in polymer solution and melts
Phase separation

4. Polymers in the bulk state

Melts and amorphous states
Glass transition
Crystalline polymers
Morphology
Macroconformation, packing, chain folding
Kinetics of crystallization
Mechanical properties of polymers.

5. Polymer synthesis: anionic, cationic, and ring opening living polymerization.

Polymerization of styrene, methacrylates, tetrahydrofuran, ethylene oxide.
Block copolymer synthesis

6. Polymer synthesis: Free radical polymerization

Kinetics and mechanism
Controlling M_n, chain transfer
Copolymerization and reactivity ratios

7. "Living/controlled" Radical polymerization

Nitroxide mediated polymerization (NMP, also called SFRP)

Reversible addition-fragmentation transfer (RAFT) polymerization
Atom transfer radical polymerization (ATRP)
Comparison of "living/controlled" radical polymerization and free radical polymerization

8. Step-growth polymerization

Mechanism and statistics of step-growth polymerization
Gel formation

9. Polymer synthesis: other topics

Ring-opening metathesis polymerization