CHEMICAL ENG 4B03/6B03: Polymer Reaction Engineering

September – December 2020

INSTRUCTOR: Dr. Boyang Zhang
JHE A416
Email: zhangb97@mcmaster.ca

TEACHING ASSISTANT:

LECTURE HOURS, LOCATION: Monday 11:30-1:20pm and Wednesday 11:30-12:30pm, MS Team

OFFICE HOURS:

COURSE OBJECTIVE:

To study the foundamentals of polymerization reaction (condensation, free radical, controlled radical, anionic, cationic, Ziegler-Natta, and metallocene) followed by a series of case studies that highlight how advances in polymerization and polymer design are applied in biomedical research applications.

COMMUNICATION:

- The course will be on MS Teams. Synchronous lectures will be delivered at scheduled times. The lectures will also be recorded and made available on Avenue shortly after the live lecture
- All course slides and materials will be made available on Avenue. No textbook required. 6B03 students must use 4B03 course shell NOT 6B03
- In-class group exercise will be run on MS Teams using channels to facilitate group work.
- TA/office hours on Teams

TOPICAL OUTLINE:

Unit 1. Introduction to Polymer Reaction Engineering –Review and introduce the topic of polymer reaction engineering and discuss what is polymer and macromolecule; how to classify polymer and polymer properties as well as polymer molecular weight calculation.

Unit 2. Polymerization Mechanisms and Kinetics – Discuss condensation polymerization, free radical polymerization, Ziegler-Natta polymerization, etc.; Polymerization rate and polymer molecular weight distribution; Copolymerization and Copolymer composition; Penultimate model; Branching and crosslinking; Flory's theory of gelation.

Unit 3. Polymer Reaction in Medicine (Case Studies) – Discuss how polymer reaction engineering helped to advance the development of 3D bioprinting, biodegradable polymers, dendritic drug delivery systems, and smart functional materials. This unit is designed to provide students with real life examples of how polymer reaction engineering have impacted medicine and medical research.

ASSESSMENT:

In-class weekly group exercise (10 exercise, 5% each)	50%
Literature review assignment + Science communication Assignment (Grad student only)	20%
Midterm test (10%) and Final examination (20%)	30%

NOTES ON ASSESSMENTS:

- **In-class weekly group exercise** are intended to give practical experience in utilizing the concepts introduced in the lectures to solve specific problems. Students will work as a group to solve these problems. Some of the problem are calculation based while others are design based. These workshop are highly relevant as the midterm and final example questions will reflect the style of the workshop problems. The instructor will join each group periodically to answer any specific questions in class. Attendance will also be taken during this time with consideration for missed workshops only evaluated upon presentation of a McMaster Student Absence Form (MSAF). The weighting for excused absences will be transferred to other workshops, not the final exam. A maximum of two excused absences (of the ten workshops presented) will be considered for accommodation via an MSAF except in exceptional circumstances; further missed workshops will result in a mark of zero being applied to that workshop.

- The **midterm test** and the **final exam** will be **run during class time**. Both the midterm and final exams will be **fully open book** (i.e. you may bring notes and any other reference material you wish to bring). You can also bring your **laptop, but no internet access**. The midterm test 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 ignoring the midterm mark (i.e. the final exam will account for 40% 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 25% of your mark.

- In the **project assignment,** you will find one or two scientific paper published recently (2015 and later) that describes how polymer reaction engineering can be applied to solve problems in medical research. You will provide a 15min recorded presentation on the work. Specifically, you will discuss the significance of the application and describe the polymer reaction involved. You are **strongly suggested** to run your paper of choice past TAs and/or Dr. Zhang prior to starting this assignment to ensure it fits within the scope of the course. *You may start and submit this assignment any time during this course.* Your grade will be provided after your submission on an on-going basis. An example ppt and a marking scheme will be provided.

- In the **scientific communication assignment**, graduate students will, in addition, provide a 5-min animated video to explain the methodology and signficance of the same work to a general audience (Scientific communication assignment). *You may start and submit this assignment any time during this course.* Your grade will be provided shortly after your submission on an on-going basis. An example animated video, and a marking scheme will be provided.

ASSESSMENT POLICIES:

- Late evaluations will be assessed a penalty of 10% per school day late. 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 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 mandatory workshops, as per the guidelines outlined earlier.
- In the event of a snow day, all deadlines will be pushed to the next class unless otherwise announced via Avenue.
- The final percentage grades will be converted to letter grades using the Registrar's recommended procedure. Adjustments to the final grades may be done at the discretion of the instructor.

The following Faculty of Engineering and University Senate policies will be followed in this course:

Plagiarism and Academic Dishonesty: *"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 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. **

Privacy: *In this course, we will be using 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. Continuation in this course will be deemed consent to this disclosure. If you have questions or concerns about such disclosure, please discuss this with the course instructor.*

Disabilities and Adverse Discrimination: *Students with disabilities can receive accommodations to assist them in the completion of their assignments and exams. Please contact the Student Success Centre for advice and for arranging assistance." Further info at:*
https://studentsuccess.mcmaster.ca/

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.

RESOURCES:
There is no textbook for this course. You are not required to read anything other than what is provided by the course instructor on Avenue-to-Learn. However, you might find it useful to expand your learning by referencing the following textbooks and references:

Textbooks:

1. (1) Chem Eng 4B03/6B03 Course Notes (provided by the instructor on Avenue to Learn website).
2. (2) S. Zhu, A.E. Hamielec "Polymerization Kinetic Modeling and Macromolecular Reaction Engineering" In: Matyjaszewski K and Möller M (eds.) Polymer Science: A Comprehensive Reference, Vol 4, pp. 779–831. Amsterdam: Elsevier BV (provided by the instructor on Avenue to Learn website).
3. (3) Paul Hiemenz, Timothy Lodge, "Polymer Chemistry, The Basic Concepts", 2nd edition, Marcel Dekker, 2007
4. (4) George Odian, "Principles of Polymerization", 4th edition, Wiley-Interscience, 2004

References:

1. (1) J.A. Biesenberger, D.H. Sebastian, "Principles of Polymerization Engineering", John Wiley & Sons, 1983
2. (2) A. Rudin, "The Elements of Polymer Science and Engineering", 2nd edition, Academic Press, 1998
3. (3) H.R. Allcock, F.W. Lampe, J.E. Mark, "Contemporary Polymer Chemistry", 3rd edition, Prentice Hall, 2003
4. (4) P.J. Flory, "Principles of Polymer Chemistry", Cornell University Press, 1953
5. (5) J.M.G. Cowie, "Polymers: Chemistry and Physics of Modern Materials" 2nd Edition, Blackie A&P, 1994
6. (6) R.J. Young, P.A. Lovel "Introduction to Polymers" 2nd edition, CRC, 2000
7. (7) T.L. Richardson, "Industrial Plastics: Theory and Application", 2nd ed., Delmar Publishers, 1989

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**.