CS/CHEM 3090 (3 credits) Introduction to Polymer Chemistry

Term
Winter 2012

Time and Location

Lectures (CLH 110)	M/W/F	8:30 – 9:30
Office hours (PSE 145)	W	9:30 – 10:30

Course Description
This course serves as an introduction to polymer chemistry. The course deals with fundamental aspects with special focus on polymer synthesis, polymerization mechanisms, kinetics and key factors that governs molecular weight, polymer architecture and properties.

The following topics will be covered over the semester.

- Introduction to polymers (types of polymers, polymerization mechanisms, nomenclature, physical states, amorphous vs. crystalline polymers, T_g, T_m and applications)
- Physical characterization of polymers (NMR, osmotic pressure, light scattering, viscometry, size exclusion chromatography)
- Step Polymerization (theoretical considerations, kinetics, molecular weight control, crosslinking, copolymerization, industrial process conditions)
- Radical Chain Polymerization (mechanism, kinetics, molecular weight control and molecular weight distribution, autoacceleration, living radical polymerization)
- Emulsion Polymerization (general considerations, molecular weight and particle size distributions)
- Ionic Chain Polymerization (cationic and anionic polymerization, initiation and termination, block and other polymer architectures)
- Chain Copolymerization (kinetics, terminal and penultimate model, types of copolymerization behaviour, copolymer composition vs. feed composition)
- Ring-Opening Polymerization (cyclic esters and amides, ring-opening metathesis polymerization)
- Stereochemistry of Polymerization (types of stereoisomerism, properties of stereoregular polymers, Ziegler-Natta initiators, metallocenes, post-metallocenes)
- Mechanical and Rheological Properties (stress, strain, shear, creep, viscoelastic behaviour, time-temperature dependence, relaxation, WLF equation, shift factor)

Prerequesite
SC/CHEM 2020 Organic Chemistry
Students are also strongly encouraged to review basic physical chemistry/thermodynamics principles.

Course Director
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Purpose and Objectives of the Course
The purpose of the course is to introduce fundamental aspects of polymer chemistry and build upon knowledge gained in previous organic, inorganic, physical and analytical chemistry courses. Particular attention will be paid to the synthetic aspects of polymers, the understanding of reaction chemistry, of polymers physical properties and of the structure–property relationships. Students will also be introduced to the time-dependence behaviour of polymers.

At the end of the course, the students should be able to:

1. communicate effectively with chemists in the field using proper nomenclature;
2. propose means to prepare different types of polymers with control over the composition of the polymer, its microstructure and its molecular weight;
3. determine and rationalize the properties of polymers;
4. explain which and how analytical tools can be used to elucidate the chemical structure of polymers;
5. read, understand and summarize important points from the polymer literature.

Organization of the Course
A number of pedagogical approaches will be used to deliver the course and achieve the objectives. Much of the lectures will be delivered by the Course Director but will require active participation of the students in various ways, including short oral presentations, group problem solving, and the like. Lecture notes will be posted ahead of the class on Moodle. It is the student's responsibility to sign up for an account. See https://moodle10.yorku.ca/moodle/ for details.

Problem sets will be assigned and posted on Moodle on a regular basis to facilitate learning of concepts presented in class. Those problem sets will NOT be graded but are still a fair (10%) component of the final grade. Every **fully completed** problem set turned in on time is worth 100%, as long as a reasonable effort was demonstrated by the student (even if the answers to the questions are not right).

Evaluation
The level of proficiency in the material will be assessed through problems sets and exams. The final grade for the course will be based on the following items weighted as indicated.

Problem sets (up to 5)	10%
Mid-term exam (total of two, held during class)	50% (25% each)
Final exam (3 h)	40%

No make-up mid-term exam will be available. The missed marks will be distributed equally amongst the other tests/exams only if a valid reason is provided to the Course Director, such as the official Registrar's Office "Attending Physician's Statement" filled out by a registered medical doctor, M.D. within 7 days of the missed test. A simple doctor note will NOT be accepted. If the proper document is not produced by the student and/or if the Course Director deems the reason not valid, the student who did not write the test will receive a zero for that missed test. A deferred final exam, if needed, would likely be held on or about August 17th. All students should be familiar with the "New Missed Exam Policy" document available on the Chemistry website (http://www.chem.yorku.ca)

Important Dates

January 30	First Mid-term (held in class)
February 18 – 24	Reading Week (no class)
March 5	Second Mid-term (held in class)
March 9	Last day to drop course without receiving a grade
April 2	Last class
April 6	Good Friday (University Closed)
April 4 – 20	Final exam (students MUST not make commitments that would prevent them from writing the final exam at the date determined by the Registrar's Office)

Textbooks

Much of the course will be based on the following **highly recommended** textbook:

> Painter, P. C., Coleman, M. M. (2009). *Essentials of Polymer Science and Engineering.* DEStech Publications. ISBN 978-1-932078-75-6
>
> or, the related earlier black-and-white version:
>
> Painter, P. C., Coleman, M. M. (1997). *Fundamentals of Polymer Science. An Introductory Text.* Second Ed. Technomic Publishing Co. ISBN 1-56676-559-5.

Synthesis aspects and control over molecular weight and structure are best covered in a separate **recommended** textbook, also available as an e-textbook through the library:

> Odian, G. (2004). *Principles of Polymerization.* Fourth Ed. Wiley-Interscience Publication. ISBN 0-471-27400-3.

The last two textbooks are on reserve at the Steacie Library and are available for a 2-hour loan. The first one is still not available at the library. As soon as it is received, it will also be available for a 2-hour loan.

E-mail Communications

All course-related questions and issues will be addressed during class or during office hours. Any administrative questions and issues will likely be best addressed by the Undergraduate Program Assistants in the Chemistry Building (CB 124). E-mail communications should ONLY be used in case of emergencies and should have "CHEM 3090" as subject line. All messages received WITHOUT this tag will be ignored and deleted. Messages will be replied to within 48 hours, except during weekends or holidays. For a more rapid reply, students are however encouraged to use the Forum in Moodle where peers can help answer questions. This Forum will be monitored by the Course Director on a regular basis.

Grading Scheme, Assignment Submissions, Lateness Penalties, Academic Integrity

The grading scheme for the course conforms to the point system used in other undergraduate programs at York. The final grade for the course will be calculated using the grading scheme listed above under "**Evaluation**".

Proper academic performance depends on students doing their work not only well, but on time. Accordingly, the assignments must be received on the due date specified for the assignment, which are to be handed at class on the due date or in PSE 145. Assignments should NOT be deposited in the Course Director's mailbox. **Assignments received later than 9:20 AM on the due date will result in no credit (0%).** This is so that the answer set can be posted as soon as possible to help you prepare for mid-term exams and for the final exam. Exceptions to the lateness penalty will be entertained by the Course Director only when supported by written documentation (see above). The grading scheme will be adjusted accordingly.

In addition, students are expected to abide by rules set forth by York University. Any cases of academic misconduct will be treated accordingly. Ignorance of the Policies is not an acceptable excuse and students are strongly encouraged to become familiar with such Policies. The link to the Academic Integrity for Students web site is provided for convenience (http://www.yorku.ca/academicintegrity/students/index.htm). Students MUST also complete the Academic Integrity Tutorial, if they haven't already done so (http://www.yorku.ca/tutorial/academic_integrity/).

Disabilities

According to York University policy, arrangements for students with disabilities should be made before the start of the academic term. Failure to do so may prevent services from being available (http://www.yorku.ca/web/futurestudents/requirements/disabilities.html).

(updated on January 3, 2012)