

The Organic Chemistry of Polymers - CHM 5275 Syllabus

version 1

CHM 5275-3504 (Class#11451), Fall 2020, Tuesday, Thursday, 1:55 pm – 2:45 pm

Room: TBA. Lectures will be delivered synchronously on Canvas/Zoom

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Course Description. Classification of polymerization types and mechanisms from a mechanistic organic point of view. The structure of synthetic and natural polymers and polyelectrolytes. Reaction of polymers. Practical synthetic methods of polymer preparation.

Course Coverage. Mechanisms of polymerization reactions of monomers and molecular weight distributions of products; principles, limitations, and advantages of most important methods of molecular weight determination; relationship of physical properties to structure and composition; correlations of applications with chemical constitution. Topics will include: basics of polymerization; condensation polymerization, radical chain polymerization, ionic chain polymerization, copolymerization, ring-opening polymerization, metal-catalyzed polymerization, chemical modifications of polymers, recent developments in polymers, polymer characterization, polymer properties, and biological polymers.

Prerequisites. CHM 2210, 2211 (sophomore organic chemistry) or equivalent.

Recommended. CHM 3120 (junior analytical chemistry) or equivalent.

Course Goals.

- Deduction of monomer(s) given a polymeric structure
- Deduction of polymer given a monomeric structure
- Understanding basic techniques for polymer characterization
- Understanding of molecular weight and molecular weight distributions
- Understanding of basic techniques for molecular weight determination
- Understanding of polymerization mechanisms
- Recognition of compatibility of monomers with various polymerization mechanisms/reaction conditions
- Understanding polymer structure/polymer property relationships
- Classification of polymers based on chemical structure

1	September 1	Introduction, Overview, History, Polymer Types, Mechanism 1-1 (reading assignments from <i>Odian</i>)
2	September 3	Nomenclature, Structure, Molecular Weight 1-2, 1-3, 1-4
3	September 8	Physical State, Applications 1-5, 1-6
4	September 10	Step Polymerization, Reactivity, Kinetics, Equilibrium, Cyclization 2-1, 2-2 – 2-2a-3, 2-4, 2-5
5	September 15	Molecular Weight, Stoichiometry, Distribution, Process, Polyesters 2-6 – 2-6b, 2-7 – 2-7a, 2-8c, 2-8d
6	September 17	Polycarbonates, Polyamides, Crosslinking 2-8e – 2-8g, 2-10 – 2-10a-1, 2-12 – 2-12c PS#1
7	September 22	Step Copolymerization, High Performance Polymers 2-13, 2-14
8	September 24	Inorganic and Organometallic Polymers, Dendrimers, Miscellaneous 2-15, 2-16, 2-17 PS#2
9	September 29	Midterm Examination I. (Chapters 1, 2)
10	October 1	Radical Chain Polymerization, Structure, Initiation, Rate 3-1, 3-2, 3-4, 3-3 (not b-2, c-3, g)
11	October 6	Molecular Weight, Thermodynamics 3-5, 3-6d, 3-9b, 3-9c
12	October 8	Commercial Polymers via Radical Polymerization, Living Polymerizations 3-14, 3-15 – 3-15b-1
13	October 13	Ionic Chain Polymerization, Cationic Polymerization 5-1, 5-2 – 5-2d, 5-2h, 5-2i PS#3
14	October 15	Anionic Polymerization, Group Transfer Polymerization 5-3
15	October 20	Block Architectures, Distinguishing Between Radical, Cationic, and Anionic 5-4, 5-5
16	October 22	Carbonyl Polymerization, Miscellaneous Polymerizations 5-6, 5-7 PS#4
17	October 27	Midterm Examination II. (Chapters 3, 5)
18	October 29	Chain Copolymerization, Radical Copolym., Q-e Schemes 6-1, 6-2 – 6-2d, 6-2g, 6-3 – 6-3b
19	November 3	Ionic Copolymerization, Dienes, Other Copolymerizations, Applications 6-4, 6-6, 6-7, 6-8
20	November 5	Ring-Opening Polymerization, Cyclic Ethers 7-1, 7-2 – 7-2b-4, 7-2b-6-b, 7-2b-7 PS#5
21	November 10	Ring-Opening Polymerization, Lactams, Heterocyclics, Lactones 7-3, 7-4, 7-5
22	November 12	Ring-Opening Polymerization, Cycloalkenes 7-8
23	November 17	Stereochemistry of Polymerization, Stereoisomerism, Tacticity, Properties 8-1, 8-2
24	November 19	Stereoregulation, Ziegler-Natta, Metallocenes, Applications 8-3, 8-4, 8-5, 8-11 PS#6
25	November 24	Midterm Examination III. (Chapters 6, 7, 8)
	November 26	No Class. Thanksgiving
26	December 1	Reactions of Polymers, Principles of Polymer Reactivity, Crosslinking, Cellulose 9-1, 9-2, 9-3
27	December 3	Reactions of Polymers 9-4, 9-5, 9-6, 9-7, 9-8, 9-9
28	December 8	Natural Polymers, Polysaccharides, Polypeptides, Nucleic Acids Stevens 18 PS#7
29	December 17	Final Exam. (Chapters 1-3, 5-9, 18) Thursday, December 17, 3:00 pm - 5:00 pm

Required Textbook: Odian, G. *Principles of Polymerization, Fourth Edition*; Wiley-Interscience: New York, 2004. (ISBN 0471274003; amazon.com, \$147.89; paperback, \$26.30).
<http://www.netLibrary.com/urlapi.asp?action=summary&v=1&bookid=106946>
(E-book, licensed for UF students, faculty and staff)

Highly Recommended Textbook:

Stevens, M. P. *Polymer Chemistry: An Introduction, Third Edition*; Oxford University Press: New York, 1999 (ISBN 0195124448; amazon.com, \$44.01).
<https://global.oup.com/academic/product/polymer-chemistry-9780195124446?cc=us&lang=en&>

Recommended Textbooks:

- 1) Fried, J. D. *Polymer Science and Technology*; Prentice Hall: Englewood Cliffs, New Jersey, 1995.
<https://www.pearson.com/us/higher-education/program/Fried-Polymer-Science-and-Technology-3rd-Edition/PGM312153.html>
- 2) Carraher, C. E. *Polymer Chemistry, Sixth Edition*; Marcel Dekker: New York, 2003.
https://www.academia.edu/29185976/Seymour_Carraher_Polymer_Chemistry_Sixth_Edition
- 3) Matyjaszewski, K.; Davis, T. P. *Handbook of radical polymerization*; Wiley-Interscience: Hoboken, N.J., 2002.
<http://www.netLibrary.com/urlapi.asp?action=summary&v=1&bookid=85508>
- 4) Kuran, W. *Principles of coordination polymerisation: heterogeneous and homogeneous catalysis in polymer chemistry-polymerisation of hydrocarbon, heterocyclic, and heterounsaturated monomers*; John Wiley: Chichester, England, 2001.
<http://www.netLibrary.com/urlapi.asp?action=summary&v=1&bookid=78966>
- 5) Brandrup, J.; Grulke, E. A.; Immergut, E. H. *Polymer handbook*; Wiley: New York, 1999.
<http://www.knovel.com/knovel2/Toc.jsp?BookID=1163>
- 6) Lodge, T. P.; Hiemenz, P.C *Polymer Chemistry*, Third Edition; CRC Press: Boca Raton, FL, 2020.
<https://doi.org/10.1201/9780429190810>

Canvas Website. All students will have access to the Canvas website: <https://ufl.instructure.com/>

You will login with your Gatorlink account username and password. This is where you will find general class information, important news, office hours, handouts, class notes, and keys. This is also where you will be able to find out your point totals and histograms.

Class Requirements:

- 1) Seven problem sets (40 points each; 240 points max; the lowest score will be dropped)
 - 2) Six in-class quizzes (10 points each = 60 points)
 - 3) Three midterm examinations (150 points each = 450 total)
 - 4) Final examination (250 points)
- = 1000 points total**

Problem Sets. Problem sets will be **due at 11:59 pm** on the designated due dates. Answer keys will be posted around this time. Please write your answers in the space provided on the problem set itself. The problem sets may be spot-graded; this means that only some or parts of the problems may be scored and contribute to the 40 points. The lowest of the seven scores will be dropped. You may work in groups or alone. But, you may not copy answers. The problem sets are designed to prepare you for the examinations. Problem sets cover the following chapters:

PS#1 Chapters 1, 2
PS#2 Chapter 2
PS#3 Chapter 3
PS#4 Chapter 5
PS#5 Chapter 6
PS#6 Chapters 7,8
PS#7 Chapters 9, Stevens 18

In-class Quizzes. The six in-class quizzes, which will be **unannounced and randomly distributed** during the semester, will be short and are designed to encourage you to attend class and to keep up with the course. They should be very easy for those who have read the assigned material for that day. The quizzes can only be taken during the class period in which they are administered. They cannot be made up without an official, written University excuse.

Midterm Examinations. There will be three midterm examinations and each will focus on the chapters designated. The midterms are not designed to be cumulative; but you should expect some natural amount of material from a previous midterm to be important and necessary. Please bring and display your Gator1 Card for the exams.

Final Examination. The final examination will be cumulative. To do well, it will be important to keep up during the semester and review all notes and assignments for the course. **Working problems—frequently and consistently**—may be the best overall approach to mastering the course material. Please bring and display your Gator1 Card for the final.

Extra Credit. Additional opportunities *should* arise for extra credit (e.g., extensive class participation, attending a lecture outside of class, extra credit quizzes, extra credit problems on the homework, or an extra credit question on an exam). In any event, no more than 50 extra credit points may be earned. Extra credit will be applied after the curve is assigned for the course. This may allow some students to raise their grade by one grade increment (e.g., B+ to A-).

Grading. Grades will be curved based on points earned out of 1000. The extra-credit will then be added to those who have earned it to determine if an increase in the final grade is achieved.

Assignment Regrading. If you have a question concerning the grading of an assignment, you may submit the entire assignment for complete regrading. The assignment must be submitted for regrading by the next class meeting after the date the assignment was returned to the class.

Online Lecture Notes (Templates) will be available on Canvas (see above) in pdf format. They are organized by book chapter. The Lecture Notes show important course material, but have blank space for your notes to be taken during lecture. This method is designed to require less time writing and allow more time thinking. Students are encouraged to download and/or print the Lecture Notes and bring them to class to facilitate notetaking

Office Hours. Office hours will likely be held Thursdays from 3:00 to 3:50 pm in a room to be announced. If I am not present, check my office (LEI 318A). Additional office hours should be possible and should be scheduled by email.

Conflict Examinations. *Conflict examinations* will be given only for University-excused absences provided the appropriate documentation is supplied. Conflict exams are ideally administered *before* the regularly scheduled examination—not after. If for some reason you take an exam late, do not download or otherwise view the posted exam or exam key, or consult any classmates about exam content. Any such downloading or consultation will result in a zero for the exam.

Class Numbers. To facilitate the return of assignments, I request that you write your name and number (to be assigned) on the **front and back** of each assignment that is turned in. Thus, I will be able to turn them upside-down and alphabetize them for mass distribution on a table at the front of class.

Accommodations for students with disabilities. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

Course Evaluations. “Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.”

UF Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.

On all work submitted for credit by students at the university, the following pledge is either required or implied: **“On my honor, I have neither given nor received unauthorized aid in doing this assignment.”** “The university requires all members of its community to be honest in all endeavors. A fundamental principle is that the whole process of learning and pursuit of knowledge is diminished by cheating, plagiarism and other acts of academic dishonesty. In addition, every dishonest act in the academic environment affects other students adversely, from the skewing of the grading curve to giving unfair advantage for honors or for professional or graduate school admission. Therefore, the university will take severe action against dishonest students. Similarly, measures will be taken against faculty, staff and administrators who practice dishonest or demeaning behavior.”

Cheating and Plagiarism. Cheating and/or plagiarism will not be tolerated. The minimum penalty will be an automatic zero on the assignment in question. Suspension from the University may also result. Do not risk it. It is not worth it. Plagiarism consists of passing off as one's own the ideas, words, writings, etc. that belong to someone else. You are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have that person's permission. See: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>

Copyright Notice. All handouts used in this course are copyrighted and may not be copied without my expressly granted permission. "Handouts" include all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, problems, in-class materials, lecture note templates, lecture notes, review sheets, problem sets, or other materials. Tutors and tutoring services are expressly forbidden from copying any or all of these materials, unless you pay me two million dollars. Only students currently enrolled in the class may make a single copy of this material for their personal use.

COVID-19 Statements:

Privacy. Our class sessions may be audio-visually recorded for students in the class to refer and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate verbally are agreeing to have their voices recorded.

If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared.

As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Safety Practices. We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.
 - This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
 - Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
 - Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
 - If you are experiencing COVID-19 symptoms (Click here for guidance from the CDC on symptoms of coronavirus <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>), please use the UF Health screening system and follow the instructions on whether you are able to attend class. Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms <https://coronavirus.uflhealth.org/screen-test-protect-2/frequently-asked-questions/covid-19-exposure-and-symptoms-who-do-i-call-if/>.
 - Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information on the university attendance policies, click here <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>.
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