NEW YORK UNIVERSITY

DEPARTMENT OF CHEMISTRY

SPRING 2017

CHEM-GA 2420 POLYMER CHEMISTRY

Silver Center, Room 620

Tuesday/Thursday 9:30 am - 10:45

Instructor:	Marcus Weck
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Office Hours:	By appointment

A. Course Description

Greetings! This course is intended to introduce you to the major concepts in polymer chemistry such as polymerizations and reactions of polymers and to prepare you for your research in polymer science.

B. Textbook

- The following textbook has been ordered by the bookstore.

  Odian, *Principles of Polymerization*. Fourth Edition. John Wiley & Sons. ISBN: 978-0-471-27400-1

- In addition, I strongly recommend that you choose a good textbook on organic chemistry and on physical chemistry (perhaps the ones that you used in another course) as a reference. Feel free to come and talk to me before you make your choice.
- I will distribute several hand-outs in lecture several days before they are discussed and assign a large number of review articles on special topics in polymer chemistry.

C. Requirements and Grading

Course requirements: A strong background in organic chemistry (such as a two semester organic chemistry course or its equivalent) and a basic introduction in thermodynamics and kinetics

(basic physical chemistry course or equivalent) are required. The course is open to senior undergraduate students that fulfill these requirements.

Weekly assignments/problem sets: There will be four (4) homework assignments/problem sets that will be worth 100 points each, for a total of 400 points. These assignments are due at the beginning of each class (for due dates, see below). Penalties for late submission: 1 day - 50% off; 2 days - 75% off; more than two days - no credit. You may work in groups of up to three persons on the homework assignments (unless indicated on the homework assignment). However, each group member MUST participate.

Research Proposal: The ability to a) write a scientific statement, and b) develop original research projects independently and to draft research proposals that get you funded are two of your most important skills as a graduate student, and make you competitive as future chemists in industry or academia. Therefore, each student will be required to write an original, well-organized and thought-out research proposal (15 double-spaced pages with 1 inch margins on each side and 1 inch margins at the top and the bottom of each page) on any topic in polymer chemistry (if you hand in a proposal with less than 13 pages or more than 17 pages, 10% of the grade will be deducted per missing or added page). You have to follow NSF proposal guidelines (use the ACS template for ChemDraws!). The detailed guidelines can be found at the National Science Foundation website (http://www.nsf.gov/) by searching for the 'grant proposal guide'. This proposal is worth 1000 points and three HARDCOPIES of the proposal will be due on **Thursday, April 18th**. It should be a description of an experiment or project that has not yet been reported in the literature and NOBODY at NYU is working on (or in a very closely related field). Also it must be a topic you had NO interaction with before this class, *i.e.* it cannot be your undergrad research area. All topics have to be approved by me by **Tuesday, March 28th** (a title has to be handed in and a short paragraph describing the research hypothesis), and a two page outline of the proposal with title, abstract, a detailed proposal outline, and pertinent references (at least 15) has to be handed in by **Thursday, April 6th**.

A good proposal includes the following basic elements: it addresses a specific research question/problem; succinctly reviews prior work in the field and states how your research fits into this context but also how it will distinguish your work from what has been done so far; describes how you will carry out the work (the "experimental part") in detail (however, basic synthetic chemistry should not be described); why it should work while acknowledging any experimental difficulties that you anticipate; and a list of relevant references. Furthermore, you should indicate what will be learned if the experiment does not work and outline general, alternative approaches to the achievement of the ultimate goal of your project.

You can propose any topic as long as it relates to polymer chemistry. I strongly encourage you to meet with me and discuss your ideas before you start writing. Possible topics include, but are not limited to: polymer synthesis, polymer methodology, polymer characterization, polymer properties, supramolecular polymers, and design of polymerization catalysts.

The following key journals are a very useful source and you may want to consult the volumes of the last few years for possible project ideas: Science, Nature, Macromolecules, Angewandte Chemie, Journal of the American Chemical Society, Chemistry: A European Journal, Chemical and Engineering News, Accounts of Chemical Research, Chemical Reviews, Macromolecular Chemistry, Journal of Polymer Science, Polymer Chemistry, Chemistry of

Materials, Advanced Materials, Journal of Materials Chemistry, and reports from meetings and symposia.

You HAVE to use the format outlined in the ACS style guide (references, ChemDraw figures, and schemes). You can also find the general ACS style in the first issue of every year of every ACS journal under 'Notice to Authors'. If you DO NOT use the ACS style guide, 10% of the maximum points (i.e. 100 points) will be deducted automatically.

You have to give a short presentation and defend your research proposal. You need to be able to a) present your research and research ideas and b) defend them to a general audience of polymer scientists and engineers. Each student will be required to present their proposal to the class in a 20-minute presentation with a five-minute question and answer session (the presentation will be worth 200 points). The 20 minutes are a hard deadline. There will be NO extra time. That means you have to prepare your presentation very well. In general, you want to present WHAT the problem and hypotheses are, WHAT is the current state-of-the-art, WHAT do you propose, WHY is it important and innovative and finally present some detail of your proposed science. A slide per minute is a good guideline (that gives you a max of 20 slides).

Finally, you also have to be able to objectively critique other scientist's work. Therefore, you will be assigned two proposals from other students in the class, which you have to critique. You will receive a hardcopy of each of the two proposals on or before **April 20th**. That will give you ample time to study the proposal before the presentations start. Your critique will be twofold: a) you have to ask questions after the proposal presentation that was assigned to you and b) you have to hand in a TWO-PAGE proposal critique for EACH proposal that is assigned to you by **May 2nd**. These two-page critiques as well as your participation during the presentations question and answer sessions will be graded and are worth 15% of your grade. Please note that you are NOT allowed to discuss the proposal OR your critique with the authors once you received the hardcopy.

Class Participation: It is called class participation and NOT class attendance. You will NOT receive full credit if you do not actively take part in the class, ask and answer questions etc.

Grading:	Homework Assignments (400 points)	20%
	Research Proposal and Presentation (1200 points)	60%
	Proposal Critique (300 points)	15%
	Class Participation (100 points)	5%

Tentative Grading Scheme:	1750-2000	A
	1500-1750	B
	1200-1500	C
	1000-1200	D
	0-1000	F

Important note: Attendance in lectures is mandatory!

D. General

All students who may need special accommodations for any sort of disability, or know they will have to schedule a make-up exam because of a religious holiday, please see me during my office hours or contact me after class AT LEAST two weeks BEFORE the conflict arises.

No cellular phones are allowed in class.

This class is called polymer **chemistry**. We will discuss polymer science with a strong emphasis on polymer chemistry (*i.e.* organic transformations and their mechanisms will be essential to the class). That means that two semesters of organic chemistry, one semester of inorganic chemistry and at least one semester of physical chemistry are required to follow the course.

E. Academic Honesty

Students are encouraged to work together on problem sets, however, the solutions that are turned in must be the work of each individual student.

A major problem in advanced courses is plagiarism. Plagiarism is defined as: 'to steal and pass off (the ideas or words) of another as one's own'. You have to quote and attribute any words, sentences, and figues/schemes that are not your own. Do not cut and paste more than 5% of your proposal (that includes Figures and Schemes). Any percentage more than this will be considered plagiarism. If you plagiarize, you will receive an automatic F in the class.

For re-grading, you have to hand in your homework within one week after the distribution. You have to include a written statement why a question should be re-graded.

F. Tentative Dates

Homework assignments:

	Handed-out	Due (in class)
Homework #1	2-16-17	2-23-17
Homework #2	2-28-17	3-09-17
Homework #3	3-23-17	3-30-17
Homework #4	4-13-17	4-20-17

The homework assignments are due in class.

Proposal:

Topic:	Due: 3-28-17
Outline:	Due: 4-06-17
Proposal:	Due: 4-18-17
Proposal Critique:	Due: 5-02-17

G. Tentative Course Schedule

	Lecture Topic	Tentative Dates	Suggested Readings
I.	Introduction and Definitions	1.24 – 1.31	Chapter 1
	Molecular weight		
	Polydispersity		
	Determination of molecular weights and polydispersities		
II.	Step Polymerizations	2.02 – 2.16	Chapter 2
	Kinetics		
	Polyadditions		
	Polycondensations		
	Cycles versus linear polymers		
	Branching/cross-linking		
	Copolymers		
No class		**2.21**	
III.	Chain Polymerizations	2.23 – 2.28	Chapters 3 - 5
	Radical		
	Kinetics		
	Emulsionpolymerizations		
	Suspensionpolymerizations		
	Ionic		
	Anionic		
	Cationic		
	Kinetics		
No class		**3.02**	
IV.	Living polymerizations	3.07 – 3.09	hand-outs
	Definition		
	Determination		
	Living ionic polymerizations		
No Class (Midterm Recess, School Holiday)		**3.13 – 3.17**	
Proposal Topics Due		**3.28.2017 (in class, hardcopies)**	
V.	Copolymerizations	3.21 – 3.23	Chapter 6

VI.	Ring-Opening Polymerizations	3.28	Chapter 7
Proposal Outlines Due		**4.06.2017 (in class, hardcopies)**	
VII.	Metal-catalyzed polymerizations	3.30 – 4.20	Chapter 8 and
	Introduction to organometallic reactions		hand-outs
	Ziegler Natta polymerizations		
	Stereochemistry		
	Controlled radical polymerizations		
	ATRP		
	RAFT		
	Olefin metathesis		
	ROMP		
	ADMET		
	Metal catalyzed ring-opening polymerization		
Proposal Due		**4.18.2017 (in class, 3 hardcopies)**	
Research proposal presentations		4.25 – 5.02	
Proposal Critique Due		**5.02.2017 (in class, hardcopies)**	
VIII.	Supramolecular polymer science	5.04	hand-outs
Last day of Class		5.04.2017	