ChE/Chem C178: Polymer Science and Technology
Spring 2020

Lectures: MWF 11am -noon, 180 Tan Hall

Instructor:

Professor Susan Muller — 201 E Gilman Hall
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Office Hours: Wednesdays 2:30 pm-3:30 pm
Thursdays 11 am-12 pm

Graduate Student Instructor (GSI):

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Office Hours: Tuesdays 11 am-12 pm, 100F Hildebrand
Thursdays 4:30 pm-5:30 pm, 100F Hildebrand

Text: Polymer Chemistry, Second Edition (2007) by Paul C. Hiemenz and Timothy P. Lodge

Website: bcourses.berkeley.edu

Homework: Homework assignments will be posted on bCourses on Friday mornings and will be due by 11 am the following Friday. Completed homework assignments should be submitted via bCourses (handwritten homework assignments should be scanned and uploaded as a PDF or photographed with your phone and uploaded as a jpeg file; please be sure that the electronic version is readable). No late homework assignments will be accepted.

bCourses Discussion: Please post all questions related to homework and course material to the bCourses discussions section so that all members of the class can benefit from the response. We will check the forum for inquiries on Mondays, Wednesdays, and Thursdays at 5 pm and respond shortly thereafter.

Grading:

Homework:	10%
Project:	10%
Midterm 1:	20%
Midterm 2:	20%
Final:	40%

Exams: There will be two in class midterm exams, one on Friday, February 28, and one on Friday, April 3. The final exam is Tuesday, May 12 from 7-10 pm.

Project: The course will require a project, described below, on a topic related to plastics pollution, plastics recycling, or sustainable polymers as a solution to the plastics problem.

Date	Topics	Sections of H & L
1. Introduction		
Week 1	Course introduction, nomenclature & basic definitions, molecular weight	Pgs 1-19
	Molecular weights & molecular weight distributions, intro to polymerization reactions	Pgs 24-35
2. Polymerization		
Week 2	Step growth polymerization; intro & distribution of molecular sizes, kinetics of step growth, ways of controlling mw	Pgs 43-60, 67-71
Week 3	Branching, gelation, & crosslinking	Pgs 381-392
	Chain-Growth Polymerization	Pgs 77-86
	Chain-Growth reaction scheme & kinetics	Pgs 87-96
	MW distribution, radical lifetime, rate constants in chain-growth	Pgs 96-104
Week 4	Chain transfer in chain-growth polymerization	Pgs 104-109
	Living polymerization, anionic and cationic polymerization,	Pgs 117-118, 126-129, 137-140
	Stereo-isomerism, Stereo-regularity, & Ziegler –Natta Catalysts	Pgs 20-24, 193-200, 205-208.
3. Polymer chain shape and thermodynamics		
Week 5	Polymer chain conformations, random walk statistics	Pgs 217-225
	Freely jointed chains, freely rotating chains, radius of gyration	Pgs 230-242
Week 6	Self-avoiding walks, solvent quality, excluded volume	notes
	Intro to thermodynamics of polymer solutions	Pgs 247-254
	MIDTERM 1 = FRIDAY, FEBRUARY 28	
Week 7	Flory Huggins theory	Pgs 254-258
	Flory-Huggins theory & phase behavior of polymer solutions	Pgs 264-275
4. Polymer molecular weight and chain shape characterization		
Week 8	Osmotic pressure & the virial expansion	Pgs 258 -264
	Light Scattering	Pgs 289-312
	Frictional properties of polymers in solution	Pgs 327-334

Week 9	Intrinsic viscometry	Pgs 334-345
	Size Exclusion Chromatography	Pgs 360-373
	MW determination examples	notes

5. Polymer Structure + Mechanics

Week 10	Networks, gels, and deformation of elastomers	Pgs 392-398
	Rubber elasticity theory	Pgs 398-406
	Viscoelasticity & mechanical models	Pgs 419-426
Week 11	Constitutive equations for viscoelastic materials	Pgs 426-432
	Dynamic mechanical spectroscopy & rheometry	Notes
	Bead-spring models of viscoelasticity, MW dependence of properties	Pgs 432-444

MIDTERM 2 = FRIDAY, APRIL 3

Week 12	Amorphous polymers and the glass transition	Pgs 465-471
	The glass transition temperature	Pgs 479-491
	Crystalline polymers	Pgs 511-526, 545-556

6. The Plastics Problem: Project presentations

Week 13	Project presentations	
Week 14	Project presentations	

FINAL EXAM: TUESDAY, MAY 12, 2020 from 7-10 pm

Chem C178 / CBE C178 Project:
Plastics pollution, plastics recycling, and sustainable solutions to the plastics problem

This course requires a project related to "the plastics problem" – broadly defined as the environmental threat related to the accumulation of synthetic, non-biodegradable polymer-based materials in our oceans and landfills, the difficulties associated with recycling these materials, and schemes to mitigate or address this problem.

This is a topic that has recently captured the public's attention, and has led, among other things, to bans on plastic drinking straws, single-use plastic cups, single-use plastic grocery bags, etc. Not all of these policy approaches have succeeded in reducing plastic use; and, for example, a switch from plastic to paper bags may result in higher carbon emissions due to the higher energy use associated with paper manufacture.

Projects will be completed (depending on final enrollment) in teams of 1 to 3 students, so that final oral presentations may be presented to the class in the final 6 class periods. Oral presentations will be roughly 10-minutes (+5 minutes for questions and discussion).

In addition to the oral report, each group will submit (via bCourses) a PDF of the slides used in the oral presentation, and a 3-5 page written report on their topic, including a list of references. The oral and written reports will be weighted equally in terms of your project grade.

There are many resources (including a number of TED talks, a recent PBS special titled "The Plastic Problem: PBS NewsHour Presents", articles in the popular and scientific literature, etc.) related to this important topic that you should consult. Potential topics include:

- Potential schemes for cleaning up the great Pacific garbage patch
- Plastics recycling: successes and challenges
- The plastics stream: identifying the primary contributors to the plastics problem
- Sustainable polymers
- The health and environmental impacts of microplastics

Students may also propose their own presentation topic related to the plastics problem. All groups must submit their proposed topic and a short (3-4 sentence) description of the focus of their project via bCourses by **Friday, March 13** to insure topic approval by Friday, March 20**.** The PDF of the oral presentation should be uploaded to bCourses no later than **10 am on the day of your presentation** (to be assigned); the written report must be submitted **by 5 pm on Friday, April 24.**