Polymer Physics
EMA 4161/EMA6165
MWF Period 3 (9:35–10:25 am), online
New Engineering Building (NEB), Room 0102
Fall 2024

Instructor: Prof. Angelika Neitzel, aneitzel@ufl.edu, 352-294-6609, Rhines 216. Office hours by appointment.

TA: Pouriya Nayebpashaei (pnayebpashaei@ufl.edu), TBD in Rhines Library

Course Description: This course introduces fundamental aspects of polymer physical chemistry. Four general subject areas will be emphasized: (*i*) polymer molecular characteristics and molecular characterization; (*ii*) chain conformations and thermodynamics of polymer systems; (*iii*) scattering from polymer systems; and (*iv*) polymer solids, including glassy, semicrystalline, and rubbery states.

Course Pre-Requisites: EMA 3066 or one semester of college organic chemistry. Basic knowledge of physical chemistry (thermodynamics) will be assumed.

Required Textbook: Polymer Chemistry; T.P. Lodge and P.C. Hiemenz; 3rd Ed.; ISBN: 978-1-4665-8164-7 (hardback); 978-0-429-19081-0 (e-book)

Course Objectives:
- Structural features of polymers (e.g., monomer units, chain architecture, regiochemistry), molecular weight distributions and averages, and relevant characterization methods.
- Polymer chain conformations in solution and melt states
- Thermodynamics (i.e., phase behavior) of polymer solutions, melts, blends, and copolymers
- Characterization of polymer solutions, melts, blends, and copolymers via scattering with X-rays/neutrons/light
- Dynamics in dilute solutions and characterization; dynamics of melts and viscoelasticity
- Rubber elasticity, networks, and gels
- Thermal properties and structure of polymer glasses/melts, relevant characterization methods

Exam Schedule: In-class exams: I. Monday 9/23/2024
II. Monday 10/21/2024
III. Wednesday 12/04/2024
Final exam: 12/12/2024 12:30–2:30 pm; NEB 0102

Missed exams will count for zero. If a midterm is missed due to a university-sanctioned conflict, a grade reflective of the performance on the other two midterms will be substituted. It is your responsibility to alert the instructor of any *scheduled conflicts* well in advance of the exam. Requirements for class attendance and make-up exams, assignments, and other work in the course are consistent with university policies. *See UF Academic Regulations and Policies for more information regarding the University Attendance Policies*.

EDGE students: EDGE students will take their exams online via Honorlock. This requires a microphone, camera, and downloading Honorlock well in advance of any exams. For help with technical issues, visit the help desk website, https://elearning.ufl.edu/student-help/, or call 352-392-4357. EDGE students are to complete the exams within two days of the in-class exam.

Problem Sets: There will be 10 problem sets. Problem sets will be provided on Canvas after class on Fridays. They will be due in class on Fridays, 1 week later, unless otherwise noted. Late submissions will not be accepted; problem sets done in pencil will not be eligible for regrade consideration. Problem sets should be written clearly, on numbered, stapled pages. Students are encouraged to discuss the concepts involved with other students, but should prepare their own solutions.

EDGE/online students: EDGE students are to submit problem sets within 3 days of the in-class due date (i.e., Mondays by 9:35 am). Completed problem sets are to be uploaded as a PDF in Canvas by the due date.
Quizzes: In most class periods there will be a very short, multiple-choice quiz taken from the textbook reading assigned for that day. Students will be given 5 minutes to complete the quiz. Online students are to submit quiz answers online using Honorlock within 2 days of the in-class quiz. As in-class quizzes are not announced ahead of time, please make sure to check Canvas regularly.

Grading:	In-class/online quizzes	10%
	Problem sets	30%
	Midterm exams	30%
	Final exam	30%

For any questions, refer to UF grades and grading policy.

Students Requiring Accommodations: Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs as early as possible in the semester.

In-Class Recording: Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled (see https://aa.ufl.edu/policies/in-class-recording/).

Course Website: This course will use Canvas as a communication and archival tool. Students can access relevant course information (course notes, quizzes, problem sets, solutions, announcements, grades, etc.) via: https://elearning.ufl.edu/ or https://ufl.instructure.com.

Course Evaluation: 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/

University Honesty Policy: UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions.

Professional Component (ABET): 3 credits Engineering Topics

Relation to Program Outcomes (ABET)	**Coverage***
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	Medium
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	Low
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	High
4. An ability to communicate effectively with a range of audiences	High
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Low
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	High

**Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.*

Course schedule:

Week	Class	Date	Topic	Problem sets	Reading
1	1	8/23	Introduction to polymers, P1	P1	1.1–1.6
2	2	8/26	Molar mass averages and distributions		1.7
	3	8/28	Characterization of polymer molecular characteristics		1.8
	4	8/30	Chain conformations: random walk	**P1 due**, P2	6.1–6.3
3	**–**	**9/2**	**Holiday, no class**		**–**
	5	9/4	Semi-flexible chains; radius of gyration		6.4–6.5
	6	9/6	Gaussian distribution; excluded volume	**P2 due**, P3	6.6–6.8
4	7	9/9	Thermodynamics of mixing: Flory-Huggins theory		7.1–7.3
	8	9/11	Osmotic pressure		7.4
	9	9/13	Phase diagram in the temperature-composition plane	**P3 due**, P4	7.5
5	10	9/16	Polymer blends and block copolymers		7.6–7.8
	11	9/18	Basic concepts of scattering		8.1–8.3
	12	9/20	Scattering from dilute polymer solution, Zimm plot	**P4 due**	8.4–8.6
6	**13**	**9/23**	**Exam 1**		**1, 6–7**
	14	9/25	Small angle scattering with X-rays/neutrons		8.8
	15	9/27	Small angle scattering with X-rays/neutrons	P5	8.8
7	16	9/30	Intrinsic viscosity; particles and polymers		9.1–9.3
	17	10/02	Size-exclusion chromatography, theory & practice		9.8
	18	10/04	Size-exclusion chromatography, theory & practice	**P5 due**, P6	9.8
8	19	10/07	Diffusion processes and dynamic light scattering		9.5–9.6
	20	10/09	Networks: the gel point		10.1–10.2
	21	10/11	Carothers equation; elasticity of materials	**P6 due**, P7	10.2–10.3
9	22	10/14	Rubber elasticity: classical and statistical theories		10.4–10.5
	23	10/16	Swelling of gels	**P7 due**	10.7
	–	**10/18**	**Homecoming, no class**		**–**
10	**24**	**10/21**	**Exam 2**		**8–10**
	25	10/23	Viscoelasticity: Maxwell model and material functions		11.1–11.2
	26	10/25	Rouse model and mode spectrum; entanglement	P8	11.4–11.5
11	27	10/28	Reptation model		11.6–11.7
	28	10/30	Introduction to experimental rheometry		11.8
	29	11/1	Glass transition I	**P8 due**, P9	12.1–12.3
12	30	11/4	Glass transition II, free volume		12.4, 12.6
	31	11/6	Time-temperature superposition		12.5
	32	11/9	Mechanical properties of polymers	**P9 due**, P10	12.7
13	–	**11/11**	**Holiday, no class**		
	33	11/13	Polymer crystallization: structure and unit cells		13.1–13.2
	34	11/15	Crystalline lamellae; melting	**P10 due**	13.4
Thanksgiving 11/24–12/1					
15	35	12/2	Kinetics of crystallization; nucleation and growth		13.6–13.7
	36	**12/4**	**Exam 3**		**11–13**
	–	12/6	Reading day, no class		–
16	–	**12/12**	**Comprehensive final exam**		

Syllabus changes: The instructor reserves the right to make changes to the syllabus during the semester.