

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 Nayeypashaei (pnayeypashaei@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)

Required Computer

UF student computing requirement: <https://news.it.ufl.edu/education/student-computing-requirements-for-uf/>

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/), <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	8/26	Molar mass averages and distributions		1.7
2	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.

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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. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect

regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://elearning.ufl.edu/>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.

