Polymer Physics
EMA 4161/EMA6165
MWF Period 3 (9:35–10:25 am), EDGE
MAE B, Room 0229
Fall 2025

Instructor: Prof. Angelika Neitzel, aneitzel@ufl.edu, 352-294-6609, Rhines 216.
Office hours: T & R from 2–3p in Rhines 216 and/or on zoom. Please turn your camera on.
Communication: Please communicate with me via email.

Course Description: This class covers 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). The book is available through the UF bookstore but is cheaper if you purchase it from Amazon. A copy of the book is in course reserve at Marston library.

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, and blends 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

Lecture Format: I will lecture on the board. Students are expected to take their own lecture notes. Video recordings of all lectures will be shared via Canvas.

Attendance: Students registered for EMA4161 CAMP/EMA6165 CAMP are required to attend lectures in person.

Assessment: Students enrolled in EMA 6561 will have the following requirements imposed on them in addition to those present for EMA 4161:
- Undergraduate homework assignments and exams will differ from those for graduate level, in terms of workload and difficulty level.
- Undergraduate homework and exams will include more basic problems, while the graduate version will focus on more complex concepts and applications.
- Graduate students will have additional problems and/or more challenging problems on assigned homework and exams.
- All students in the co-listed courses will be held to the same standards regarding attendance, academic honesty, and general class expectations.

Exams: There will be a total of six 1h exams of which the lowest score will be dropped (5 x 15% = 75%). Five of these exams will be held outside of scheduled class time to allow you 2h to complete 1h exams. Exams 1–5 will take place in **Rhines 125 from 5–7 pm** on the dates indicated in the course schedule. Exam 6 will be held during the final exam period. Exams will be taken on paper. The concepts covered build on each other; therefore, exams will frequently require you to recall and apply previously covered concepts. **Regrades:** Exams completed in pencil are not eligible for a regrade. If an exam is submitted for a regrade, the entire exam will be regraded. **Conflicts:** Students that have a conflict during the scheduled exam time must contact the instructor during the first week of class to coordinate

alternate exam times. **Make-up policy:** Only exams that are missed due to an *acceptable reason*, as defined under Academic Policies & Resources, are eligible for make-up. Documentation is required. Unexcused absences count as zero and cannot be dropped.

EDGE student exam policy: EDGE students must take exams in the presence of an *in-person proctor* within 3 business days of the in-class exam. The instructor will provide instructions and documentation to complete the proctor selection process. Proctors will receive exams and instructions 12h prior to the in-class exam as a PDF attachment via email from the instructor. The proctor must email a scanned PDF copy of the completed exam to the instructor by the time the examination window closes.

Problem Sets: Ungraded problem sets will be provided on Canvas for students to apply the concepts and models covered in class. Working problems is essential to learn the material.

Quizzes: There will be a short quiz on key concepts each class period. **EDGE students** must submit quiz answers online using Honorlock within 2 days of the in-class quiz. For help with technical issues, visit the help desk website, https://elearning.ufl.edu/student-help/, or call 352-392-4357. Students are allowed to drop 5 quizzes which they missed due to absence from class for any reason and/or the lowest scoring quiz grades achieved. There will be no make-up quizzes unless the student has contacted the instructor at the beginning of the semester to inform them of valid circumstances that will cause the student to miss lectures semi-frequently.

Grading:	30 quizzes, drop 5	25%
	6 exams, drop 1	75%

The class will be graded on a curve (graduate and undergraduate students will be curved separately): Average = B, each standard deviation above/below raises/lowers your grade by a letter, respectively.

Academic policy and resources: Please refer to the Academic Policies & Resources and Graduate Level Academic Policies and Regulations (Attendance and Grading policy): https://gradcatalog.ufl.edu/graduate/regulations/ for official UF policy regarding class attendance, academic accommodations, student code of conduct, grading, in-class recording, course evaluation, academic, campus health, and wellness resources.

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	L	Day	Date	Topic	Reading
1	1	F	8/22	Macromolecular characteristics	1.1–1.6
2	2	M	8/25	Molar mass averages and distributions, Q1	1.7
	3	W	8/27	Characterization of macromolecular characteristics, Q2	1.8
	R	**F**	**8/30**	**Chapter 1 Review**	**Ch 1**
3	**–**		**9/1**	**Holiday, no class**	**–**
	E1	**T**	**9/2**	**Exam 1: Rhines 125 from 5–7 pm**	**Ch 1**
	4	W	9/3	Chain conformations: random walk, Q3	6.1–6.3
	5	F	9/5	Semi-flexible chains; radius of gyration, Q4	6.4–6.5
4	6	M	9/8	Gaussian distribution; excluded volume, Q5	6.6–6.8
	R	**W**	**9/10**	**Chapter 6 Review**	**Ch 6**
	7	F	9/12	Thermodynamics of mixing: Flory-Huggins theory, Q6	7.1–7.3
5	8	M	9/15	Osmotic pressure, Q7	7.4
	E2	**T**	**9/16**	**Exam 2: Rhines 125 from 5–7 pm**	**Ch 6**
	9	W	9/17	Phase diagrams, Q8	7.5
	10	F	9/19	Phase diagrams, Flory-Huggins theory, Q9	7.6
6	11	M	9/22	What is in χ and excluded volume, Q10	7.7–7.8
	R	**W**	**9/24**	**Chapter 7 Review**	**Ch 7**
	12	F	9/26	Basics of scattering, Rayleigh scattering, Q11	8.1–8.3
7	13	M	9/29	Scattering from dilute polymer solutions, Q12	8.4
	E3	**T**	**9/30**	**Exam 3: Rhines 125 from 5–7 pm**	**Ch 7**
	14	W	10/01	Form factor, Zimm equation, Q13	8.5–8.6
	15	F	10/03	Small angle scattering with X-rays/neutrons, Q14	8.8, extra
8	16	M	10/06	Small angle scattering with X-rays/neutrons, Q15	8.8, extra
	R	**W**	**10/08**	**Chapter 8 Review**	**Ch 8**
	17	F	10/10	Viscosity of dilute polymer solutions; MH EQN, Q16	9.1–9.3
9	18	M	10/13	Size-exclusion chromatography and detectors, Q17	9.8
	19	W	10/15	Size-exclusion chromatography and detectors, Q18	9.8
	–		**10/17**	**Homecoming, no class**	**–**
10	**R**	**M**	**10/20**	**Chapter 9 Review**	**Ch 9**
	20	W	10/22	Gel point, Carothers equation, Elastic deformation, Q19	10.1–10.3
	E4	**R**	**10/23**	**Exam 4: Rhines 125 from 5–7 pm**	**Ch 8, 9**
	21	F	10/24	Rubber elasticity: classical and statistical theories, Q20	10.4–10.5
11	22	M	10/27	Models for networks, Swelling of gels, Q21	10.7
	R	**W**	**10/29**	**Chapter 10 Review**	**Ch 10**
	23	F	10/31	Viscoelasticity: Maxwell model & material functions, Q22	11.1–11.2
12	24	M	11/3	Rouse model and mode spectrum; entanglement, Q23	11.4–11.5
	25	W	11/5	Reptation model, Q24	11.6–11.7
	R	**F**	**11/7**	**Chapter 11 Review**	**Ch 11**
13	26	M	11/10	Glass transition I, Q25	12.1, 12.3
	27	W	11/12	Glass transition II, free volume, Q26	12.4, 12.6
	E5	**R**	**11/13**	**Exam 5: Rhines 125 from 5–7 pm**	**Ch 10,11**
	28	F	11/14	Time-temperature superposition, Q27	12.5
14	**R**	**M**	**11/17**	**Chapter 12 Review**	**Ch 12**
	29	W	11/19	Crystallization, Q28	13.1–13.3
	30	F	11/21	Crystalline lamellae; thermodynamics of melting, Q29	13.4–13.6
15	**Thanksgiving 11/24–11/28**				
16	31	M	12/1	Crystallization kinetics, Q30	13.7
	R	**W**	**12/3**	**Chapter 13 Review**	**Ch 13**
	E6		**12/10**	**Exam 6 during final exam period**	**Ch 12,13**

The instructor reserves the right to make changes to the syllabus. Any changes will be announced on Canvas.