

**Spec Prob in Chem Eng:  
Introduction to Polymer Science and Engineering**

ECH4905 Section UGE1

**Class Periods:** M, W, F | Period 8 (3:00 – 3:50 pm)

**Location:** CSE E221

**Academic Term:** Fall 2022

**Instructor:**

Prof. Yeongseon Jang

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(352) 294 - 1289

Office Hours: Wednesday 4-6 pm, ChE 215

**Teaching Assistant/Peer Mentor/Supervised Teaching Student:**

N/A

**Course Description**

This course offers an overview of polymer science and engineering for chemical engineers. This course aims to provide a general understanding of structure-property relationships of polymers at microscopic and macroscopic levels.

**Course Pre-Requisites / Co-Requisites**

N/A

**Course Objectives**

This course will introduce students to understand structural, chemical, and physical properties of polymers from molecular level to bulk. Topics will include 1) polymer structure and nomenclature, 2) polymerization synthesis and growth kinetics of polymer chains, 3) thermodynamics and phase behavior of polymer solution, polymer blends, and multicomponent systems, and 4) thermal transition, mechanical properties, and viscoelastic properties. Examples of recent research publications in each subject will be discussed. The goal is to provide students with the knowledge of nomenclature, synthesis methods and reaction kinetics in polymerization, phase behavior of polymer solutions and blends, and mechanical, thermal, and viscoelastic properties of semicrystalline polymers, which is useful to design a new polymer material for sustainability and human health.

By the end of this course, students will be able to:

- Know chemical structure and formulas of common polymeric materials
- Characterize molecular weight (MW) and MW distribution
- Distinguish different polymerization reactions and mechanisms
- Predict conversion kinetics and MW resulting from polymerization reactions
- Estimate the thermodynamic interaction and miscibility of polymer solutions and blends
- Identify the physical states and transition temperatures of polymers
- Describe the methods to characterize properties of polymers
- Apply the knowledge to critically analyze polymer engineering results in the current literature

**Materials and Supply Fees**

N/A

**Required Textbooks and Software**

Course notes will be developed and provided by the instructor though combination of the chapters in part from the textbooks below.

**Recommended Materials**

- Introduction to Polymers, 3rd Edition, Robert J. Young and Peter A. Lovell, ISBN: 978-14-398-9195-7

- Contemporary Polymer Chemistry, Harry Allcock, Fred Lampe Deceased, James Mark, Prentice Hall, 2003 (3rd edition), ISBN-13: 978-0130650566
- Polymer Physics, Michael Rubinstein, Ralph H. Colby, Oxford University Press, 2003, ISBN: 978-0-19-852059-7
- Other recommended reading materials and research articles will be suggested during classes.

### Course Schedule

Week 1: A brief Introduction to Polymer Science, HW

Week 2-3: Characteristics of Polymers: Molecular Weight, Configuration, Conformation, HW

Week 4-7: Synthesis and Reactions of Polymers: Polymerization, HW, **Midterm**

Week 8-10: Polymer Solution and Blends: Phase Diagram, Flory-Huggins Theory, HW

Week 11-12: Transitions in Polymers: Thermal, Mechanical, Viscoelastic Properties, HW

Week 13-14: Fabrication & Processing of Polymers, HW

Week 15-16: Recent Development of Functional Polymers & Biodegradable Polymers – **Term Papers**

Topic	Textbook Ref.
Course Introduction: A Brief Introduction to Polymer	Ch. 1.1
<b>PART 1. Concepts &amp; Nomenclature of Polymers</b>	Ch. 1.2
Classification of Polymers	
Average Molecular Weight (Degree of Polymerization), PDI	Ch. 1.3
MW Determination Techniques	Ch. 11, 12, 14
Polymer Configuration	
Polymer Conformation	Ch. 10.1
Chain Dimension – End-to-end distance, radius of gyration	Ch. 10.3.
<b>PART 2. Synthesis of Polymers: Principles of Polymerization</b>	Ch. 2-3
Condensation Polymers	
Addition Polymers	Ch. 4, 5
Ring-opening Polymers	Ch.7
Step-growth Polymerization – p and DP at stoichiometry	Ch. 3
Step-growth Polymerization – p and DP at non-stoichiometry	
Step-growth polymerization - rate	
Chain-growth Polymerization	Ch. 4
Free-radical polymerization kinetics	
Living polymerization	
<b>PART 3. Theoretical Description of Polymers in Solution</b>	Ch. 10
Thermodynamics of Ideal Solutions	
Thermodynamics of Real Solutions	
Thermodynamics of Polymer Solution	

Topic	Textbook Ref.
Thermodynamics of Polymer Blends	
Applications of Polymer Solution and Blend	
BCP Phase Separation in Bulk and Thin Films	
Charged Polymers	
Phase Structure and Morphology of Bulk Polymers	Ch. 16-17
Crystallinity of Polymers	
Glass Transition Temperature of Polymers	
Mechanical Properties of Polymers	Ch. 19, 22, 23
<b>PART 4. Applications of Polymers</b>	Ch. 20
Understanding Viscoelastic Properties of Polymers	
Understanding Viscoelastic Properties of Polymers	
Polymer Processing & Fabrication in Industry	
Polymer Characterization at Microscopic and Macroscopic Level	
Biomedical Polymers	
Biodegradable Polymers & Recycling	
Conducting Polymers	
<b>Term Project &amp; Final Review</b>	

### ***Attendance Policy, Class Expectations, and Make-Up Policy***

**Attendance of all lectures is highly recommended. Lecture will not be recorded. Lecture notes will be shared only during the class time.**

Excused absences must be in compliance with university policies in the Graduate Catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.

**Dates and format for Midterm will be announced at least 2 weeks in advance.** Students who do not attend an exam at the scheduled time will receive a score of zero for that exam. Requests for make-up exams will be considered only for those students who missed due to an acceptable reason. It is required that, whenever possible, the student notifies the instructor about the situation prior to the exam, preferably at least two weeks in advance.

### ***Evaluation of Grades***

Assignment	Total Points	Percentage of Final Grade
Homework Sets (10)	100 each	20%
Midterm Exam	150	30%
Final Exam	150	30%
Review Paper	100	20%
<b>Total</b>	<b>500</b>	<b>100%</b>

- **Homework assignments** will be given no more than once per week, generally due the following week. Students should be turned in scanned copies of homework to Canvas by the due dates. Late homework will not be accepted.
- **Midterm & Final:** Students will be allowed to have their notes for formulas during exams. Calculator is required. Partial credit will be assigned to the right solving process, but no credit will be given for problems that have a solution only with no work leading to this solution.
- **Term Paper:** The term project aims to assist students in gaining better insights into state-of-the-art polymer science and engineering. The peer-reviewed research articles that introduce recent developments on biodegradable polymers and recycling will be provided during the class. Students must submit the term paper that summarizes the background and fundamental applied for the topic and provides a summary including perspectives in the fields. **The report will be limited to 3,000 words.** Detailed writing guidelines will be taught during class also posted to Canvas. The report grading rubric includes both technical and writing merits.

### **Grading Policy**

<i>Percent</i>	<i>Grade</i>	<i>Grade Points</i>
93.4 - 100.0	A	4.00
88.0 - 93.3	A-	3.67
80.0 - 87.99	B+	3.33
75.0 - 79.99	B	3.00
70.0 - 74.99	B-	2.67
65.0 - 69.99	C+	2.33
60.0 - 64.99	C	2.00
55.0 - 59.99	C-	1.67
50.0 - 54.99	D+	1.33
45 - 49.99	D	1.00
40 - 44.99	D-	0.67
0 - 39.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### **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.

### **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.ua.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.ua.ufl.edu/public-results/>.

### **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.

### ***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 Honor 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. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***Commitment to a Safe and Inclusive Learning Environment***

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

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 Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, [jpennacc@ufl.edu](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](mailto: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](mailto: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](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**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/state-authorization-status/#student-complaint>.