

MSE 512/ChE 512/Macro 512 Polymer Physics

Semester: Winter 2023

Days/Times: Monday/Wednesday 4:30 – 6:00 PM

Place: H. H. Dow 1018

Professor: Jinsang Kim, Ph.D.

Director and Professor of Macromolecular Science and Engineering,
Professor of Materials Science and Engineering, Chemical Engineering, Chemistry,
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Suggested Prerequisite: MSE412

As they have throughout the past years, policies around academic and public health are subject to change as this pandemic evolves. This course will follow all policies issued by the University, which are documented on the [Campus Blueprint's FAQ](#). These policies may change over the course of the term, so please review the [Campus Blueprint's FAQ](#) for the most up to date information.

Useful Websites • The Web of Science Citation Index: <http://isi10.newisiknowledge.com/portal.cgi>
(*journal search*): (need to use from on campus or through library with library password)
• SciFinder Scholar is one of the most powerful search programs.

I. Textbook

Polymer Chemistry, Paul C. Hiemenz, Timothy P. Lodge, 2nd Edition, CRC Press

II. Reference Text

- Principles of Polymer Chemistry, Paul J. Flory (1953)
- Polymer Physics, Michael Rubinstein, Ralph H. Colby
- The Physics of Polymers: Concepts for Understanding Their Structures and Behavior, 3rd Ed. Gert Strobl.
- Introduction to Polymers, Young & Lovell, 3rd Ed. CRC Press

III. Grading

- A. Two Exams (35% each) There will be no make-up exam!!
- B. Homework (30%) 6-7 problem sets

VI. Journals

- You should browse through

*Nature, Science, Nature Biotech, Nature Chemistry, Nature Materials, Nature Commun, Science Advances, Proceedings of the National Academy of Science USA (PNAS)
Journal of the American Chemical Society (JACS), Biomaterials, Biomacromolecules
Advanced Materials, Analytical Chemistry, Annual Review of Biomedical Engineering
Advanced Functional Materials, Angew. Chem. Inter. Ed., Applied Physics Letters
Macromolecules, Chemistry of Materials, Journal of Materials Chemistry*

V. Course Outline

12 Lectures

Chapter 1: Introduction to Chain Molecules

Chapters 2 – 5: Summary Only

Chapter 6: Polymer Conformations

Chapter 7: Thermodynamics of Polymer Solutions

Exam I (Feb 22, 2022)

11 Lectures

Chapter 8: Light Scattering and Zimm Plot

Chapter 9: Dynamics of Dilute Polymer Solutions

Chapter 10: Networks, Gels, and Rubber Elasticity

Chapter 12: Glass Transition

Chapter 13: Crystalline Polymers

Exam II (April 17, 2022)

V. Course Outline

	Topics	Dates
1	- Orientation and Introduction, Chapter 1.1 – 1.3	January 4
2	- Chapter 1.4 – 1.10	January 9
3	- Chapters 2 – 5 Summary	January 11
	MLK No Class	January 16
4	- Chapter 6.1 – 6.3 End-to-end Distance	January 18
5	- Chapter 6.1 – 6.3 End-to-end Distance, Characteristic Ratio	January 23
6	- Chapter 6.4 Persistence Length, Kuhn Length	January 25
7	- Chapter 6.5 – 6.8 Radius of Gyration	January 30
8	- Chapter 7.1 – 7.2 Regular Solution	February 1
9	- Chapter 7.3 Flory-Huggins Theory	February 6
10	- Chapter 7.4 Osmotic Pressure	February 8
11	- Chapter 7.5 Phase Behavior of Polymer Solutions, Binodal, Spinodal, and Critical Point	February 13
12	- Chapter 7.6 χ parameter, Excluded Volume	February 15
13	- Chapter 8 Light Scattering and Zimm Plot	February 20
	Exam I (Lectures 1 – 12) Exam room TBA	February 22
	Spring Break No Class	02/27–03/03
14	- Chapter 8 Light Scattering and Zimm Plot	March 6
15	- Chapter 9.1 – 9.2 Friction, Viscosity, Stokes' Law, and Einstein's Law	March 8
16	- Chapter 9.3 Intrinsic Viscosity	March 13
17	- Chapter 9.4 – 9.5 Viscosity Measurement, Diffusion Coefficient, and Friction Factor	March 15
18	- Chapter 10.1 – 10.4 Gel Points and Thermodynamics of Elasticity	March 20
19	- Chapter 10.5 – 10.8 Statistical Mechanics Theory of Rubber Elasticity, Swollen Gels	March 22
20	- Chapter 10.5 – 10.8 Rubber Elasticity, Swollen Gels	March 27
21	- Chapter 12.1 – 12.6 Glass Transition, free volume, factors affecting T_g	March 29
22	- Chapter 12.7 Mechanical Properties	April 3
23	- Chapter 13.1 – 13.4 Structure of Crystalline Polymers, Thermodynamics of Crystallization	April 5
24	- Chapter 13.5 – 13.7 Kinetics of Nucleation and Growth	April 10
25	- Course Review	April 12
	Exam II (Lectures 13 – 24) Exam room TBA	April 17