

Physics 782 – Condensed Matter Physics – Spring 2026

Instructor: Dr. Andrew B. Croll
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Office Hours: Tuesday and Thursday 11:00 to 2:00 (may be subject to change)

Aim: The course develops a graduate-level understanding of the properties, behaviors, and theoretical methods to describe soft matter systems.

Description: An introduction to soft condensed matter, focusing on colloids, polymers, liquid crystals, surfactants, and biological systems. Topics will include characterization of soft materials, interparticle interactions, structure, equilibrium phase behavior, non-equilibrium properties, and practical applications.

This course will 1. enable students to understand the specificities of various soft materials such as colloidal solutions, liquid crystals, polymers, surfactants, gels, and biomaterials, 2. equip students with the theoretical tools needed to carry out research in soft condensed matter physics, 3. provide extensive practice in solving soft condensed matter physics problems in different contexts and for different levels of complexity, 4. offer opportunities to read scientific articles and discuss (or reproduce) their findings. Course objectives are met by readings, lectures, in-class discussions, and homework through the development of a quantitative understanding on the level of graduate students. Students demonstrate their level of comprehension in homework, exams, and possibly projects and presentations.

Prerequisites: Phys463/663 or consent of instructor.

Class: tu/th 9:30 - 10:45, - NDSU South Engineering, room 221

Required Course Materials: (available at NDSU Bookstore)

- (1.) Doi, Soft Matter Physics.
- (2.) Many, Many, other books discussed in class (not required though).

Evaluation:

1 midterm exams	25%
1 final exam	35%
1 Project	15%
10 assignments	25%

Grading:	85%	-100%	A,
	70%	- 85%	B,
	60%	- 70%	C,
	50%	- 60%	D,
	0%	- 50%	F.

Marking Scheme: three point marking system

0	– nothing of any value is written down
1	– something useful has been written down
2	– the main idea of how to solve the problem appears
3	– mostly a correct answer (1 minor mistake permitted)

Make-up Policy: There shall be no make-up allowed for missed assignments or quizzes. If the midterm is missed and a student provides written documentation of a legitimate reason a make-up will be provided.

Assignments: Homework problem sets on current course material will be assigned in class. Assignments may be completed at any time, but are required to be submitted at the time indicated on each problem set. No late homework will be accepted. You may work together on homework sets, but do not simply copy another's answers; this will not benefit you when it comes to the exams or in real life applications (i.e. MCAT, ...).

Communication: Announcements will be made in class or through the Blackboard system. Marks will be displayed through the Blackboard system. DO NOT USE MESSAGING IN BLACKBOARD OR ANY OTHER SYSTEM. Use email to communicate, I do not check other places.

Attendance: According to [NDSU Policy 333 \(http://www.ndsu.edu/fileadmin/policy/333.pdf\)](http://www.ndsu.edu/fileadmin/policy/333.pdf), attendance in classes is expected.

Service Members: Veterans and student service members with special circumstances or who are activated are encouraged to notify the instructor as soon as possible and are encouraged to provide Activation Orders.

Special Needs: Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the [Disability Services Office \(http://www.ndsu.edu/disabilityservices/\)](http://www.ndsu.edu/disabilityservices/) as soon as possible.

Academic Honesty: The academic community is operated on the basis of honesty, integrity, and fair play. [NDSU Policy 335: Code of Academic Responsibility and Conduct](http://www.ndsu.edu/fileadmin/policy/335.pdf) applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the [Office of Registration and Records](http://www.ndsu.edu/registrationandrecords/). Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

Rough Schedule:

- 1.) Review of continuum mechanics including tensor notation, solid and fluid mechanics
- 2.) Background: Polymers, Elastomers, Surfactants, Colloids, Liquid Crystals, Granular Matter (Doi's chapter 1, but many other sources).
- 3.) Doi's Book: Chapter 2 – Soft Matter Solutions.
- 4.) Doi's Book: Chapter 3 – Elastic Soft Matter.
- 5.) Doi's Book: Chapter 4 – Surfaces and Surfactants.
- 6.) Pattern Formation and Instability.
- 7.) Doi's Book: Chapter 6 – Brownian Motion and thermal fluctuations
- 8.) Doi's Book: Chapter 7 – Variational Principal in Soft Matter Dynamics
- 9.) Doi's Book: Chapter 8 – Diffusion and permeation in soft matter.
- 10.) Doi's Book: Chapter 9 – Flow and Deformation of Soft Matter (Rheology)
- 11.) Glasses
- 12.) Doi's Book: Chapter 10 – Ionic Soft Matter.