Introduction to Soft Matter Physics Syllabus

Department of Physics and Atmospheric Science

PHYC 3900 Fall 2023

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Laurent Kreplak	kreplak@dal.ca	Dunn 225, anytime I am in my office with the door open

Course Description

The aim of this course is to provide an introduction to some concepts used in soft condensed matter physics through the study of three systems, polymers, colloids and liquid crystals. The course will be divided in four modules: I) Brownian dynamics and diffusion II) Polymers shape, molecular mass distribution, osmotic pressure, gel, entropic elasticity III) Colloids: van der Waals and electrostatic interactions, Hamaker constant, DLVO theory, polymer layers (brushes), gel electrophoresisIV) Liquid crystals: order parameter, optical properties of nematics (birefringence), phase transitions, LCD

Course Prerequisites

MATH 2001.03 and MATH 2002.03

Course Exclusions

None

Student Resources

Brightspace page for the course.

Course Structure

Course Delivery

In-person

Lectures

MWF 10:35-11:25 Dunn 221C

Laboratories

2 Labs during regular lectures in Dunn B05 or B07

Tutorials

NA

Course Materials

Available on Brightspace.

Book: Introduction to Soft Matter, Synthetic and biological self-assembling materials by Ian W. Hamley, Wiley.
https://bookstore.dal.ca/CourseSearch/?course[]=SUB,FALL23,PHYC,PHYC3900,&

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Assessment

Assignments

3 assignments 10% each (every 3-4 weeks).

Tests/quizzes

Mid-Term (50 min in class), 10%

Final exam

Final exam (3 hours, during exam period), 40%

Other course requirements

Oral presentation (last week of term, in class), 10%

Each student is expected to present a talk lasting 15 min at the end of the semester (12 min presentation, 3 min for questions). Select a soft matter physics paper published over the past 5 years in a well-known journal (Physical reviews, Soft matter, Biophysical journal, PNAS, etc…). Topics may include, active matter, polymer dynamics, soft robotics, cell elasticity, microfluidics, artificial muscles, liquid crystalline elastomers, colloids in nematic liquid crystals, assembly of soft colloids, diblock copolymers, etc… You are encouraged to check with me for suitability.

Lab reports (2, every 5 weeks), 5% each.

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

I do not offer make-up for assignments, lab or mid-terms.

Course Policies related to Academic Integrity

*Students are encouraged to work together as a group on all 4 assignments. They can share tips and tricks, explain answers to each other. Trying to explain a concept to someone else is an excellent way to judge whether you fully understand that concept**. ***However full solutions of questions can't be copied verbatim within a group**.*

*For Labs, students will perform experiments together and willshare the raw data. ***Each student must perform its own analysis and write their own answers to the questions**.*

If you are using a generative AI and large language models (like chatGPT) to answer assignment questions, you must provide a screenshot of the question you asked and the answer you obtained. You are encouraged to think critically about the answer you have obtained by this method and modify it further to reflect your own understanding.

Learning Objectives

- Structure and dynamics of soft matter
- Critical reading of a scientific paper
- Oral presentation
- Problem solving

Course Content

- Week 1 Introduction

- Weeks 2 to 5: Polymers

We cover the ideal polymer chain, the freely rotating chain, entropic elasticity of an ideal chain, excluded volume effects, polymer solutions (Flory-Huggins formalism), Rubber elasticity, viscoelasticity, Diffusion and Brownian motion, the Rouse model, Reptation theory. Lab 1: nanoscale imaging and elasticity of a rubber surface.

- Weeks 6 to 8: Colloids and Amphiphiles

We cover Van der Waals forces, the DLVO model, stabilization and crystallization of colloids, surface tension, self-assembly of amphiphiles in water. Lab 2: colloid crystallization.

- Weeks 9 to 11: Liquid crystals

We cover liquid crystalline phases, order parameter in nematics, Distortions in nematics, Torque transmission by a nematic liquid, Fredericksz transition, optical properties of a nematic liquid and application to LCD.

- Week 12: final presentations

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:
https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.