

Soft Materials - MTEN 410

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Class hours:

Type	Time	Days	Where	Date Range	Schedule Type	Instructors
Class	6:00 pm- 8:50 pm	Wednesday	FMH- 412	Sep 3, 2025 – Dec 22, 2025	Lecture	Xiaoyang Xu (P)

Office Hour: Wednesday 5:00 pm- 6:00 pm (Office: Tiernan Hall, 362); Please make appointments for in person meeting other than regular office hours.

TA and TA office hour: TAB

Supporting textbook: Fundamentals of Soft Matter Science, 2nd Edition, By Linda S. Hirst
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Description: This course is an introduction to soft materials such as polymers, colloids, liquid crystals, gels, and biomaterials. The course will cover the structure, properties, and applications of soft materials. Specific topics will include kinetics in material synthesis/growth, assembly, phase behavior, phase transitions, dynamics, characterization techniques, and applications.

Prerequisites: [MTEN 301](#) (or [CHE 230](#) or [ME 311](#) or [BME 352](#)) and [MTEN 311](#) (or [CHE 260](#) or [ME 304](#) or [BME 427](#)).

Course Goal: The purpose of this class is to build a fundamental understanding of the physical and chemical principles governing common soft material systems and their role in engineering technologically relevant materials and structures. Specifically, this course is designed to help students learn to

- Explain the physical and chemical basis of soft materials, including polymers, colloids, gels, foams, and liquid crystals.
- Describe molecular interactions and structures that give rise to soft material properties.
- Relate microscopic structure and dynamics of soft materials to their macroscopic mechanical, thermal, and transport behaviors.
- Apply fundamental principles to design or modify soft materials for specific engineering applications (e.g., biomedical devices, coatings, energy storage, flexible electronics).
- Use case studies to evaluate how soft materials enable new technologies.
- Solve quantitative problems involving thermodynamics, mechanics, and transport in soft material systems.
- Communicate technical concepts related to soft materials effectively in both written and oral forms.

Topics to be covered:

- Basic concepts; polymers; colloids; gels; foams; and liquid crystals;
- Intermolecular and surface forces (van der Waals, electrostatic, hydrogen bonding);
- Thermodynamics of soft materials (entropy, free energy, phase behavior);
- Kinetics and dynamics (diffusion, viscoelasticity, relaxation times);
- Rheology and mechanical properties of soft matter;
- Polymer types, step growth polymerization, MW averages, chain growth polymerization, tacticity, common polymers; gelation and crosslinking, the glass transition, crystalline polymers, amorphous polymers and random walks, models of chain dimensions, deformation of a single chain, rubber elasticity, viscoelasticity;
- Colloids and suspensions, stability, aggregation, Brownian motion;
- Liquid crystals, mesophases, alignment, applications in displays and sensors;
- Gels and hydrogels, swelling, crosslinking, biomedical uses;
- Foams and emulsions, interfacial tension, stabilization, industrial uses;
- Biological soft materials, proteins, lipids, membranes, biomaterials

Lectures

- This course is a face-to-face course and attending the class sessions in person is mandatory.
- Food and drink are expressly prohibited in the classroom.
- Cellphones should be turned off during lectures.
- Students are expected to be in the classroom by the start time of each class.

Attendance: Attendance is mandatory. You must notify the instructor in advance if possible, of any absence by sending an email stating the date and reason for the absence. If you are absent for up to two class periods because of illness or injury, an email message stating the reason for absence will be sufficient. If you are absent from more classes because of illness or injury, verification of a visit to a health care professional may be required. Two times class absence (without verification/notification) will disqualify your final exam for this course.

Special Needs: If you need accommodations due to a documented disability please contact Office of the Dean of Students to discuss your specific needs. A Letter of Accommodation Eligibility authorizing your accommodations will be required.

Homework: Problems will be assigned. You are strongly recommended to work on homework by yourself and bring questions to lecture or office hour.

Course materials, office hours and correspondence

- The course Canvas page is the main platform for delivering information about the course.

- All relevant course materials and assignments will be posted on Canvas, so a student should check it regularly.
- Students must upload a professional-looking head shot for their Canvas profile.
- Students are strongly encouraged to attend office Hours. Long questions which require derivations will be discussed only during the office Hours and will not be answered by email.
- Questions regarding grades can be discussed only during the office Hours.
- E-mail and Canvas correspondence is intended only for quick questions. Questions which require a detailed discussion should be discussed in person during the office Hours.
- All correspondence should be conducted in a professional style, using formal English, having a greeting or a signature.

Policy on exams: students must have a compelling reason to miss an exam. Documentation of the reason (e.g., doctor's note) is needed for the instructor to consider giving a make-up exam. A student who cannot make it to an exam needs to either e-mail or call and leave a voice message for the instructor **before** the exam is held. A student missing (for any reason) the first two exams has to withdraw from the course. A single (comprehensive) make-up exam will be given on the reading day (TBD) for those who have missed an exam for documented/ legitimate reasons.

(Note: Exam answer should be clear and legible. Solution process should be given for calculation problems. **You may lose points if the writing is illegible or solution process is missing**)

Academic Dishonesty: Misrepresentation of a student's involvement in any required academic work will result in the instructor invoking the academic dishonesty policies of the university. This could result in an "F" grade being assigned for the course. Collaboration is expected for group activities, but not for individual assignments (such as exams). Instructions for each assignment should be followed. If in doubt, ask the instructor.

A calculator is allowed to solve the calculation problems. Any unauthorized electronic materials will be considered as a violation of academic integrity. The proctoring is subject to slight changes.

Grading:

Course grading will be based on the following:

- Homework (4 assignments) 30%
- Participation 20%
- Midterm 25%
- Final 25%

2025 Fall Semester Class Schedule:

Sept	1	Labor Day. University Closed
Sept	2	First Day of Classes

Sept	8	Last Day to Add/Drop a Class
Sept	8	Last Day for 100% Refund, Full or Partial Withdrawal
Sept	9	W Grades Posted for Course Withdrawals
Sept	15	Last Day for 90% Refund, Full or Partial Withdrawal - No Refund for Partial Withdrawal after this date
Sept	29	Last Day for 50% Refund, Full Withdrawal
Oct	2	Wellness Day
Oct	20	Last Day for 25% Refund, Full Withdrawal
Nov	10	Last Day to Withdraw from Classes
Nov	25	Thursday Classes Meet
Nov	26	Friday Classes Meet
Nov	27	Thanksgiving Recess Begins. No Classes
Nov	30	Thanksgiving Recess Ends
Dec	11	Last Day of Classes
Dec	12	Reading Day
Dec	13	Saturday Classes Meet
Dec	14	Final Exams Begin
Dec	20	Final Exams End
Dec	22	Final Grades Due