

MSE 480: Surfaces and Colloids

Fall 2026



Course Information

- Contact Hours: Tuesdays and Thursdays 12:30 – 1:50 pm
- Format: In-person
- Location: 1306 Everitt Laboratory
- Credit Hours: 3 Undergraduates Credit Hours, 4 Graduate Credit Hours

Instructor Information

Dr. Abigail Nason

Teaching Assistant Professor

Department of Materials Science and Engineering

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- Office hours for students: TBD, by appointment

Teaching Assistant (TA): Junxian Liu

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- Office hours for students: TBD

Course Description

Chemistry and physics of surfaces and interfaces, with emphasis on behavior in liquid media. Surface composition; surface and interfacial forces; colloidal stability and flocculation; amphiphilic molecules.

Learning Outcomes

In this course, students will:

- Explain the fundamental principles that govern the behavior of surfaces and interfaces.
- Apply models to predict and quantify interfacial phenomena.
- Analyze the forces and interactions between surfaces and particles and relate them to colloidal stability and dynamics.
- Connect fundamental surface and interfacial phenomena to materials behavior and applications.

Prerequisites

MSE 401 – Thermodynamics of Materials

Course Materials

Learning Management System (LMS)

This class utilizes Canvas for communications and assignments. Any graded material will be submitted via PrairieLearn, except for the 4-credit term paper. The course is divided by weeks and there are assignments and activities to be completed each week, including homework, lectures, quizzes, and discussions. The class is designed to be interactive and your active participation is required.

Course Readings

This class is mostly organized around class notes. Suggested references:

- Arthur W. Adamson and Alice P. Gast, Physical Chemistry of Surfaces, 6 edition, Wiley, New York, 1997. A good reference book, but it's hard to read an encyclopedia.
- Gabor A. Somorjai, Introduction to Surface Chemistry and Catalysis, 2 Ed, Wiley, New York, 2010. Clearly written, comprehensive.
- Andrew Zangwill, Physics at Surfaces, Cambridge University Press, Cambridge, 1988 This is the physics point of view (electronic structure, phase transitions, epitaxy ...) and complements the chemistry point of view in the book by Somorjai.
- The recommended textbook for the second half of the class is: Jacob N. Israelachvili, Intermolecular and Surface Forces, 3rd ed., Academic Press, New York, 2011.

Course Requirements and Policies

Grading Breakdown

Section B (3-credits):

Quizzes:	10%
Participation:	5%
Homework:	25%
Midterm:	30%
Final:	30%

Section A (4-credits):

Quizzes:	10%
Participation:	5%
Homework:	25%
Midterm:	20%
Final:	20%
Term paper:	20%

Course Components

Assignments

Homework assignments for this class will be issued via PrairieLearn. See PrairieLearn for due dates. Students will have one or two weeks to complete the assignment and they are to be submitted on PrairieLearn.

Late homework up to 24 hrs will generally be accepted for a maximum of 50% credit. Late homework after 24 hrs will receive 0% credit. The lowest score for homework will be dropped. *Students with valid reasons that may prevent on-time submission should contact Prof. Nason well in advance of the deadline.* Students are strongly encouraged to complete all assignments to assess their own understanding of the course material. It is acceptable to work with fellow students on homework problems, and to ask as well as answer questions pertaining to homework online on Canvas. Provision will be made for office hours during which to discuss the problems and solutions. Exam questions will be loosely based on assigned homework problems.

Quizzes

Short online multiple-choice quizzes will be issued via PrairieLearn, to gauge elementary understanding and mastery of the course material. Each quiz has a time limit of 30 minutes and can only be taken once. Late quizzes will not be accepted. For due dates see PrairieLearn. The lowest quiz score will be dropped.

Exams

There will be one (1) midterm exam, and one (1) final exam. Exams are planned to be in-person. Specific details will be made available a week before each exam. Both exams will be closed book. Efforts will be made to schedule exams to minimize scheduling conflicts, but the *responsibility lies with the student to anticipate and resolve scheduling conflicts with Prof. Nason well in advance of the exam dates.*

- This course uses the Grainger College of Engineering's [Computer-Based Testing Facility](#) for its exams.
- The policies of the CBTF are the policies of this course, and academic integrity infractions related to the CBTF are infractions in this course.
- If you have accommodations identified by the [Division of Rehabilitation-Education Services \(DRES\)](#) (<http://www.disability.illinois.edu/>) for exams, please submit your Letter of Accommodations (LOA) through the CBTF website (<https://cbtf.illinois.edu/students/dres>) as soon as possible. It can take up to five days for your LOA to be processed and if you make a reservation before your LOA has been processed, your reservation will not include your testing accommodations and you will be required to reschedule. This must be done each semester you use the CBTF.

- If you have any issue during an exam, inform the proctor immediately. Work with the proctor to resolve the issue at the time before logging off. If you do not inform a proctor of a problem during the test then you forfeit all rights to addressing the problem you experienced during your exam.
- Take the [CBTF Orientation \(https://go.illinois.edu/student-orientation\)](https://go.illinois.edu/student-orientation) (10 minutes) and review all instructions on the [CBTF website \(https://cbtf.illinois.edu/students\)](https://cbtf.illinois.edu/students) before your first exam.

Paper (4-credit option only)

Students in the 4-credit option will write a term paper on a student-selected topic in colloidal science. The term paper should be written in the style of a literature review or summary of a relevant research topic. *Students with valid reasons precluding on-time submission should contact Prof. Nason well in advance of the deadline.* The due dates are listed in the Class Schedule.

Topic: Term paper topic selections are due via Canvas. Submissions should take the form of a one-sentence topic title and short (≤ 250 word) abstract summarizing the topic and projected thrusts of the paper. Prof. Nason will be available to discuss and advise topic choice and general direction of the paper; overlap with relevant research projects of the student in the area of polymers are encouraged. Early topic identification and submission is also encouraged.

Paper: Both first draft and final version of the term papers are due via Canvas. Papers should be no more than 5 pages in length (excl. figures and bibliography; 12-pt font, 1-inch margins, single-spaced). Students will research and summarize the state of the field, reference classic texts and papers, and identify the principal challenges, important questions, and current research directions in the field. Prof. Nason will be available to discuss and advise paper research and production. Papers will be graded on: (i) topic definition and motivation (10%), (ii) summary of status of field (20%), (iii) identification and motivation of open challenges (25%), (iv) analysis of current research into identified challenge (20%), (v) clarity of report (10%), (vi) appropriate citations and formatted bibliography (5%).

Content: Give the reader something beyond what one can obtain directly from the source materials.

- Research and investigate. Seek out relevant materials and unify them into a clear presentation.
- Synthesize. Draw together diverse things to show patterns and relations.
- Organize. Give logical continuity and structure to diverse materials.
- Analyze. Provide your own critical analysis in which arguments are examined for evidence, validity, logic, and flaws.
- Examine in a broader context. Show how your topic fits into a broader context, relates to another field, or relates to historic precedents.
- Outlook. Going beyond what is known, discuss what is not known and why.

Peer review: Reviews are due via Canvas. Each submitted paper will be assigned to two other randomly selected students in the class for peer review. Each student will write

a *short* (≤ 1 page) *constructive* review on their assigned papers, summarizing the content of the paper very briefly, and giving feedback on (i) topic, (ii) summary of the field, (iii) open challenges, (iv) analysis, (v) clarity of the term paper, as well as formatting/style. The remaining 10% of the grade will be the quality of the given peer review. Each student will receive the peer reviews on their paper, will incorporate the feedback and submit a final version via Canvas.

Late submission of abstract first draft, peer review, and final draft is not permitted. *Students with valid reasons precluding on-time submission should contact Prof. Nason well in advance of the deadline. Only Verified Absences will be accepted.* The due dates are listed in the Class Schedule.

Plagiarism

Each student is responsible for submitting their own original quiz responses, homework assignments, and (if applicable) term paper. Collaborative interaction online and in-person is permissible and encouraged via Canvas, but each student must perform all calculations themselves and submit their own work. **Plagiarism will not be tolerated, and verified incidents will result in all parties receiving a zero on their project and formal academic sanctions.** Students are responsible for familiarizing themselves with the definition and penalties for plagiarism detailed in Section I-401 of the UIUC Student Code. Ignorance of these policies is not an excuse for any academic dishonesty. As a student it is your responsibility to refrain from infractions of academic integrity and from conduct that aids others in such infractions. A short guide to academic integrity issues may be found here. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity. Note that the code's definition of plagiarism includes "copying another student's paper or working with another person when both submit similar papers without authorization to satisfy an individual assignment".

Please note that all course materials are protected by copyright and are considered intellectual property. Course materials should only be used for this course and should not be shared with anyone not in the course, including uploading to a study site, social media, or other online sharing mechanism.

Late Assignment Policy

Late homework up to 24 hrs will generally be accepted for a maximum of 50% credit. Late homework after 24 hrs will receive 0% credit. *Students with valid reasons that may prevent on-time submission should contact Prof. Nason well in advance of the deadline.*

Class Attendance and Participation

Regular class attendance is expected of all students at the university. You must attend at least 80% of lectures to receive full participation credit. An attendance survey will be posted at the end of each class. Because the course is designed to be interactive, regular attendance and active participation in class discussions and activities are expected.

Grading Scale

The grade assignment is: A+: 100-97; A: 96-93.; A-: 92-90; B+: 89-87; B: 86-83. B-: 82-80; C+: 79-77; C: 76-73; C-: 72-70; D+: 69-67; D: 66-60; F: <60

Course Outline

PART I: BASICS ABOUT SURFACES

1. Introduction
2. Distinctive features of interfaces
 - a. what is an interface? – how to describe an interface? what are typical behavior patterns? real versus apparent area – surface to volume ratio - surface energy – surface structure and composition versus that of the bulk.
3. Surface energy
 - a. typical values — how to measure it? — reconstruction, relaxation, molecular orientation, melting, roughening — how to evaluate surface structure?
4. Surface thermodynamics
 - a. origin of surface energy — Gibbs dividing surface — surface excess functions Gibbs adsorption equation — other implications
5. Adsorption isotherms
 - a. physisorption versus chemisorptions — adsorption isotherms: Langmuir, BET, etc. — internal interfaces: critical micelle concentration
6. Monomolecular films
 - a. pressure-area diagrams — Langmuir-Blodgett films — self-assembled monolayers, SAMs — layer-by-layer self-assembly
7. Curved surfaces
 - a. capillary pressure: the Young-Laplace equation — vapor pressure: the Kelvin equation — implications: nanoparticles, adhesion, etc.

PART II: THE FORCES BETWEEN SURFACES

1. Introduction
 - a. Uses of colloids in technology – how to measure surface forces? Characterization of colloids.
2. Varieties of inter-particle forces
 - a. Scale-up from molecules to larger particles – van der Waals, electrostatic, "structured liquids"
3. Van der Waals interactions
 - a. origin of r^{-6}
4. Hamaker constant – competitive van der Waals attractions -implications
5. Electrostatic interactions
 - a. why all interfaces are charged or polarized – the electric double layer – the screened Coulomb potential – examples of calculations – Stern layer – typical DLVO behavior – zeta potential – examples
6. Non-equilibrium and time-dependent interactions

- a. diffusion; hydrodynamics; flocculation kinetics.

PART III: FORCES DUE TO STRUCTURE IN LIQUIDS

1. Polymers
 - a. types of polymers – general features of polymers in solution – examples
2. Structured liquids (small molecules)
 - a. liquid structure at surfaces – forces that result – examples
3. Tribology and adhesion

PART IV: OUTLOOK

1. Review of the course
2. Frontier areas selected depending on interests of the class

Campus Academic Policies & Statements

Academic Integrity

The University of Illinois Urbana-Champaign [Student Code](https://studentcode.illinois.edu/) (<https://studentcode.illinois.edu/>) can be found at the link. Students should pay particular attention to Article 1, Part 4: Academic Integrity.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the [Academic Integrity Policy](https://studentcode.illinois.edu/article1/part4) (<https://studentcode.illinois.edu/article1/part4>). Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Students with Disabilities

The University of Illinois Champaign-Urbana, is committed to ensuring that all students, including students with disabilities, do not experience barriers to learning and participating fully in class. Students who have a letter of accommodation from Disability Resources and Educational Services (DRES) are advised to share that with instructors as soon as possible to ensure accommodation needs can be discussed and met.

To obtain disability-related academic accommodations, disabled students are encouraged to contact DRES as soon as possible. To contact DRES, please visit 1207 S. Oak Street, Champaign, call (217) 333-1970, email disability@illinois.edu, or visit the [DRES website](https://dres.illinois.edu/) (<https://dres.illinois.edu/>).

Family Educational Rights and Privacy Act (FERPA)

See [FERPA – Office of the Registrar](https://registrar.illinois.edu/academic-records/ferpa/) (<https://registrar.illinois.edu/academic-records/ferpa/>) for more information on the Family Educational Rights and Privacy Act (FERPA).

Mental Health

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Health Service Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

- Counseling Center (217) 333-3704
- McKinley Health Center (217) 333-2700
- National Suicide Prevention Lifeline (800) 273-8255
- Rosecrance Crisis Line (815) 720-4953 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.

This statement is approved by the University of Illinois Counseling Center.

Community of Care

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether regarding their well-being or yours, we encourage you to refer this behavior to the Connie Frank CARE Center (formerly the Student Assistance Center) in the Office of the Dean of Students. You may do so by calling (217) 333-0050 or by submitting a CARE [online referral](https://odos.illinois.edu/community-of-care/referral) (<https://odos.illinois.edu/community-of-care/referral>). Based on your report, staff in the Connie Frank CARE Center will reach out to offer support and assistance.

Further, as a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the [Connie Frank CARE Center](https://odos.illinois.edu/community-of-care/CAREcenter) (<https://odos.illinois.edu/community-of-care/CAREcenter>) (formerly the Student Assistance Center) in the Office of the Dean of Students for support and referrals to campus and/or community resources.

Ombuds Assistance & Resources for Students (OARS)

OARS is housed in the Office of the Dean of Students and serves as a confidential, impartial, informal, and independent resource for students seeking guidance, clarity, and resolution when facing challenges or conflicts with university faculty, staff, policies, procedures, or practices. The office exists to provide a space where students can feel heard, discuss their concerns, explore potential options and pathways for resolving disputes and, when appropriate, be referred to other campus resources. The Student Ombudsperson listens without judgment, helps clarify issues, identifies possible

pathways forward, and supports students in making their own decisions. For more information, please visit [the Ombuds Assistance & Resources for Students \(OARS\)](https://oars.illinois.edu/) (<https://oars.illinois.edu/>).

Disruptive Behavior

Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported using the [Public Incident Report Form](https://go.illinois.edu/ReportMisconduct) (<https://go.illinois.edu/ReportMisconduct>), email (conflictresolution@illinois.edu), or phone (217) 333-3680 to the [Office for Student Conflict Resolution](https://conflictresolution.illinois.edu/) (<https://conflictresolution.illinois.edu/>) for disciplinary action.

Emergency Response Recommendations

For emergency response recommendations and building floor plans, review [Public Safety's Run, Hide, Fight information](https://police.illinois.edu/em/run-hide-fight/) (<https://police.illinois.edu/em/run-hide-fight/>), [Emergency Action Plans](https://eoc.illinois.edu/plans/eap/) (<https://eoc.illinois.edu/plans/eap/>), and [Facility Access Maps](https://facilityaccessmaps.fs.illinois.edu/archibus/schema/ab-products/essential/workplace/index.html) (<https://facilityaccessmaps.fs.illinois.edu/archibus/schema/ab-products/essential/workplace/index.html>). I encourage you to review these resources within the first 10 days of class.

Religious Observances

It is the policy of the University of Illinois Urbana-Champaign to reasonably accommodate its students' religious beliefs, observances, and practices that conflict with a student's class attendance or participation in a scheduled examination or work requirement, consistent with state and federal law. Students must make requests for accommodation in advance of the conflict to allow time for both consideration of the request and alternate procedures to be prepared. Requests should be directed to the instructor. An optional resource to assist students in making such requests can be found on the [Religious Observances website](https://odos.illinois.edu/resources/students/religious-observances) (<https://odos.illinois.edu/resources/students/religious-observances>) of the Office of the Dean of Students.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including supportive measures, resources, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found on [We Care Student Resources](https://wecare.illinois.edu/resources/students/#confidential) (<https://wecare.illinois.edu/resources/students/#confidential>) and on the [Illinois app](#).

Other information about resources and reporting is available on [At Illinois We Care](https://wecare.illinois.edu/) (<https://wecare.illinois.edu/>) and on the [Illinois app](#).

Veterans and Military Students

As a military-friendly institution, and per federal regulations and Illinois statutes, the University of Illinois Urbana-Champaign has established policies and procedures to accommodate military-connected students. In addition to the support available at the [Chez Veterans Center](https://chezveteranscenter.ahs.illinois.edu/) (<https://chezveteranscenter.ahs.illinois.edu/>), members of the National Guard or Reserves and active-duty military personnel with military obligations (e.g., deployments, training, drills) are encouraged to communicate these, in advance whenever possible, to the instructor. For policy details, see the Student Code on [Excused Absences and Departure from the University for U.S. Military or other U.S. National Defense Services](https://studentcode.illinois.edu/article3/part3/3-313) (<https://studentcode.illinois.edu/article3/part3/3-313>).