CHEN 4836/5836 – Nanomaterials
Course Syllabus – Spring 2025

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CLASS HOURS: MW 11:05-12:20am, JSCBB B231

OFFICE HOURS: ATA Noah: Thursdays 4:30-6:30pm JSCBB E1B25
Prof. Shields: Fridays 1:00-2:00pm JSCBB D218

TEXT: Introduction to Nanoscience (1st Edition) – CRC Press (Optional)
Required reading will be uploaded prior to class

COURSE MATERIALS: Canvas will contain announcements, supplementary material, lecture material, homework assignments, grades, solutions, corrections, etc.

COURSE REQUIREMENTS: There are no mandatory prerequisites, but the class is geared toward first-year graduate and senior/junior-level chemical and biological engineering undergraduate students. Basic knowledge of chemistry, biochemistry, physics, math and thermodynamics is helpful. See me in advance if you have questions regarding these prerequisites.

COURSE GRADES:	**CHEN 4836 (Undergrad)**	**CHEN 5836 (Grad)**
• Homework	20%	20%
• Journal Club	10%	15%
• Research Proposal	20%	25%
• Midterm I	20%	15%
• Midterm II	20%	15%
• Video Responses	5%	5%
• Class Participation	5%	5%

ASSIGNMENTS AND DEADLINES:

- Unless otherwise noted, all assignments are due on Fridays at 11:59pm by Gradescope.
- Assignments turned in after 11:59pm will be counted for 50% of possible points for 24 hours after the due date/time.
- *No credit* will be given for assignments turned in more than 24 hours after the due date/time.
- All grade contesting must occur via email to the ATA within one week of their return date/time to the class; any contesting after this window will not be considered.

IMPORTANCE OF THE COURSE: Nanomaterials are poised to transform many aspects of our daily lives. Examples include nanoelectronics, surface probes and injectable "robots" that can detect disease. As engineers, it is essential to gain an understanding of the laws that drive interactions at the nanoscale to develop useful, next-generation nanomaterials. In this course, we will survey key topics at the heart of

nanomaterials, including scaling laws, intermolecular forces, synthesis paradigms and characterization techniques. After we study these fundamental principles, we will turn our attention to applied themes in nanomaterials such as colloidal assembly, drug delivery and nanodevices that are at the cutting-edge of ongoing research efforts worldwide. Together, these topics will highlight the importance and impact of nanomaterials in society.

LEARNING OBJECTIVES:
By engaging in class, this course will help you:

- Develop an understanding of the laws governing nanoscale systems;
- Apply principles of nanoscience to design and engineer useful materials;
- Identify contemporary problems and apply nanoscale principles to address those problems;
- Learn the art of persuasive scientific writing;
- Sharpen problem-solving abilities; and
- Improve ability to work in teams.

COURSE EXPECTATIONS:

- Attend all classes and be on time.
- Cell phones are powered off during class; computers and tablets are allowed for notetaking.
- Participate in class by answering—and asking—questions.
- Complete reading assignments prior to class and complete assignments on time.
- Think critically about applying learned topics to current and emerging issues in society.

JOURNAL CLUBS: Graduate students will organize themselves into pairs and take turns leading the class in a journal club on an article of their choosing. Journal clubs will consist of a brief quiz prior to the respective journal club to ensure the class read the article beforehand, a 10-minute presentation on main findings in the paper, and 15-minute class discussion that includes a breakout discussion for the class. Undergraduate students will organize themselves into groups of 3-4 based on their research interests and prepare a written report only that thoroughly analyzes an article of their choosing. All students will be evaluated on their ability to identify the central hypothesis, summarize research methods and design and assess the findings and interpretations of the authors. Students will also be evaluated on their critical evaluation of the strengths and weaknesses of the article as well as their ability to guide class discussion.

VIDEO ASSIGNMENTS: Throughout the semester, we will post videos to Canvas to introduce new content before a lecture or demonstrate an example of content discussed in lecture. For each video posted, students will be required to comment on the video or respond to a classmate's comment. The grading for this assignment is participation only; however, we will look for engagement and insightful discussion as a part of participation grades. Each student is allowed to miss one video assignment without penalty.

MIDTERM EXAMS: Two exams will be held during the semester. Exams are not cumulative. Students requiring special accommodations should contact me directly at least one week prior to the exam to coordinate arrangements.

RESEARCH PROPOSALS: In lieu of a final exam, this course will culminate in a proposal to provide students with an opportunity to apply principles from the course to address real-world problems. The proposal must relate to nanomaterials, but students have autonomy in deciding the problem and the technology proposed to address that problem. Undergraduate students will organize into groups of three to four to write a specific aims page and make an oral pitch to the class to highlight their problem and unique solution. Graduate students will complete the assignment individually. Graduate students will not give an oral presentation of their proposal; however, they must write a 4-to-6-page proposal using technical and persuasive writing. At the end of the semester, aims pages and proposals will be reviewed by your peers and scored in a manner similar to scientific review panels. Grades will be determined by the quality of the initial proposal and the criticisms provided. Criticisms received by peers (good or bad) will *not* be a part of the final grade.

ABET STUDENT OUTCOMES: This course will provide students with:

- An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental and economic factors;
- An ability to communicate effectively with a range of audiences;
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives;
- An ability to acquire and apply new knowledge, using appropriate learning strategies; and
- A working knowledge of advanced biological sciences.

CLASSROOM BEHAVIOR: Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

REQUIREMENTS FOR COVID-19: As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. CU Boulder currently requires COVID-19 vaccination and boosters for all faculty, staff and students. Students, faculty and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the MyCUHealth portal.

The CU Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). If you miss a class due to illness or quarantine, please contact me in advance to receive a recording of the missed lecture.

ACCOMMODATION FOR DISABILITIES: If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

PREFERRED STUDENT NAMES AND PRONOUNS: CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

HONOR CODE: All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION: CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and the support resources can be found on the OIEC website.

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

RELIGIOUS HOLIDAYS: Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.

See the campus policy regarding religious observances for full details.

Updated January 26, 2025

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COURSE SCHEDULE 2025 SPRING

WEEK	DATES	Monday	Wednesday
1	Jan. 13 – 17	**1. Introduction to Nanomaterials**	**2. Natural Nanomaterials** VA#1
2	Jan. 20 – 24	**MLK Jr. Day** *No class*	**3. Scaling Arguments** VA#2, UJC#1, HW#1
3	Jan. 27 – 31	**4. Intramolecular Interactions** VA#3	**5. Intermolecular Interactions** VA#4
4	Feb. 3 – 7	**6. Particle Interactions**	**7. Colloids and Surfaces** JQ#1, HW#2
5	Feb. 10 – 14	**8. DLVO Theory** VA#5	**9. Electrical Double Layers** JQ#2, FP#1
6	Feb. 17 – 21	**10. Nanofabrication** VA#6	**11. Midterm Review I** JQ#3, HW#3 (Wed at 11am)
7	Feb. 24 – 28	**Midterm I**	**12. Molecular Self-Assembly** JQ#4, VA#7, UJC#2
8	Mar. 3 – 7	**13. Particle Self-Assembly**	**14. Suspension Characterization** FP#2
9	Mar. 10 – 14	**15. Solid Nanomaterials Characterization** VA#8	**Wellness Day** *No class* HW#4
10	Mar. 17 – 21	**16. Nanoelectronics for Storage**	**17. Nanoelectronics for Computing** JQ#5, VA#9
11	Mar. 24 – 28	**Spring Break** *No class*	**Spring Break** *No class*
12	Mar. 31 – Apr. 4	**18. Catalysis**	**19. Active Nanoparticle Systems** JQ#6, VA#10, UJC#3, HW#5
13	Apr. 7 – 11	**20. Nanomedicine** VA#11	**21. Nanomedicine II** JQ#7, FP#3
14	Apr. 14 – 18	**22. Undergrad Pitches**	**23. Midterm II Review** JQ#8, HW#6 (Wed at 11am)
15	Apr. 21 – 25	**Midterm II**	**24. Panel Discussion** JQ#9, FP#4
16	Apr. 28 – May 2	**25. Nanoscale Interactions with Light**	**26. Class Jeopardy** *Last Day of Class* FP#5

JQ (Journal Quiz): Due **before** class on Canvas
UJC (UG JC Assignment): Due Fridays at 11:59pm on Canvas or by email
HW (Homework): Due Fridays at 11:59pm on Gradescope (unless otherwise noted)
VA (Video Assignment): Due **before** class on Canvas
FP (Final Project): Due Fridays at 11:59pm on Canvas