UNIVERSITY OF ILLINOIS
College of Engineering
Department of Materials Science and Engineering

MSE 487: MATERIALS FOR NANOTECHNOLOGY

Spring 2024

Instructor:	Prof. Chris Anderson, 212 MRL, 217-300-6482, cpand@illinois.edu
Lecture:	Tu-Th 9:30-10:50 am, 158 Loomis. (Secondary room MRL 208 as needed)
Office Hours:	By appointment
Teaching Assistant:	Saeed Moradi, 140 ESB, moradi3@illinois.edu
Office Hours:	Wed., 5-6 pm or by appointment
Website:	https://canvas.illinois.edu/

Extensive readings from the current literature will be assigned over the semester.

Course Outline: (may revise as the course progresses)

Part I. Introduction to Nanoscience and Nanotechnology

Part II. Physical and Chemical Properties at the Nanoscale

- Bonding and crystal structure
- Thermodynamics at the nanoscale
- Electronic properties
- Magnetic properties
- Optical properties
- Mechanical properties

Part III. Synthesis and Characterization Methods

- Thin film growth
- Self-assembly and self-organization
- Photolithography
- Examples of applications of characterization methods

Part IV. Selected Applications of Materials for Nanotechnology (tentative)

- Carbon nanotubes
- Metallic and semiconductor nanocrystals
- Ferroelectrics and multiferroics
- Nanostructuring by severe plastic deformation
- Nanomechanics of biological systems

Grading: **1000 points total (subject to revision if number of assignments changes).**

420 points: 2 homeworks (60 pts. each) and 5 critical paper reviews (60 pts. each).
200 points: breakout group presentations (20 pts. each).
50 points: Final presentation attendance.
50 points: Class participation.
3 Credit Option: Term paper (**280 pts.**)
4 Credit Option: In-class research proposal presentation (**150 pts.**) & written proposal (**130 pts.**)

- Students are expected to participate in guest lectures, breakout group discussions/presentations, and final presentations. Attendance is mandatory on those days. Attendance at final presentations worth *50 pts.* spread over the presentation day(s).
- Participation in lecture will be determined by the instructor by tracking engagement with digital and in-person activities and is worth *50 pts* spread over the semester.
- All assignments are due at the beginning of class. Late assignments will be accepted at half credit for up to one week and need to be discussed with the instructor.

COURSE GOALS

Our goal is to develop broad literacy in the fields of nanotechnology, nanoscience, and nanomaterials. Summarization, reading, and presenting skills will be honed with respect to reviewing journal articles. The evaluation of literature articles and the referee process will be introduced and practiced. Students will explore the societal and ethical implications of nanotechnology. Students will develop new research proposals in written form. The combination of these goals and skills prepares students for successful careers in industry and graduate work.

COURSE ASSIGNMENTS

1. **Homework assignments (first two weeks).**
2. **Critical reviews (starting week 3).**

- A list of published papers will be assigned every other week for review. You will select one paper from the list provided and submit a written critical review of the paper, adding personal comment(s) prompted by your reading, and supported by some additional source (e.g., papers cited by the article you summarized, papers you found by searching the literature…). A template to review the paper will be provided.
    - This assessment mirrors the skillset needed to referee papers and synthesize scientific literature.

3. **Review assessments (starting week 4).**

- You will submit a written critical assessment of your classmate's reviews, including an overall grade, and personal comment(s) prompted by your reading supported by literature sources. Failure to complete this will result in you being assigned a grade of "0" for your review. Should your assessment be superficial or low quality, I reserve the right to significantly reduce your grade on your review.
    - This assessment simulates the role of a journal editor and encourages further reading of literature.

4. **Group discussion and in-class reports (Starting week 3).**

- You will be divided into fixed groups of 3-6 students to critically analyze specific components of scientific research throughout the semester. Content for each round will be drawn from a recent guest lecture or an assigned paper important to nanotechnology (separate from the review process).
- Following the breakout time (first ~30 min of lecture on the indicated dates) your team will be responsible for leading in-class discussion on a different element of the assigned work (prior work, background and motivation, methods, results, or discussion) and you will create a short presentation to report in class. Rotating delegates will be chosen from each group for each presentation, ensuring every student will lead at least once.

- Teams will be asked to perform peer evaluation several times during the semester; if individuals on a team are not participating fully, points will be deducted from their scores (hopefully this will not need to happen).
    - These activities develop teamwork and presentation skills.

5. Term paper (3-credit option) or Research proposal (4-credit option).

- Each student will prepare and submit either a term paper (3-credit option) or a research proposal (4-credit option). The paper/proposal should consist of 10 to 15 pages of text plus figures and references on a topic of your choice. Note, "science" focused papers/proposals are generally better than "technology" focused proposals.
    - This proposal and paper develops scientific writing skills.
- All thesis MS and PhD students must list their research advisor's name on their research proposal. The proposal must be different than your or your group's current research.
- Pre-proposal (graduate students) or term paper abstract (undergraduate students) will be due by **Tuesday March 5th.**
- Term papers will be due on Canvas by the start of class on **Tuesday April 30** (last day of class), but will be accepted without penalty until noon on the day scheduled for the course final, **Tuesday May 7th.**
- Research proposals will be due by noon on Canvas on the day scheduled for the course final, **Tuesday May 7th.**
- **Presentations on the research proposal for 4 Credit students will occur during the last two days of class.**
    - Develops presentation skills and defending/explaining scientific ideas.
- There will be no final exam.

MSE 487 Course Schedule (Guest Lecture Dates subject to revision)

Week 1
January 16: Lecture
January 18: Lecture *(Homework 1 assigned)*

Week 2
January 23: Lecture
January 25: Lecture, **Homework 1 due** *(Homework 2 & Breakout paper 1 assigned)*

Week 3
January 30: Breakout groups Paper 1
February 1: Lecture, **Homework 2 due** *(Breakout paper 2 assigned)*

Week 4
February 6: Breakout groups Paper 2
February 8: Lecture, **Critical Review 1 due** *(Breakout paper 3 assigned)*

Week 5
February 13: Breakout groups Paper 3
February 15: Lecture, **Critical Review 1 Assessments due** *(Breakout paper 4 assigned)*

Week 6
February 20: Breakout groups Paper 4
February 22: Lecture, **Critical Review 2 due** *(Breakout paper 5 assigned)*

Week 7
February 27: Breakout groups Paper 5
February 29: Lecture, **Critical Review 2 Assessments due**

Week 8
March 5: Guest Lecture, **Pre-proposal or abstract due**
March 7: Guest Lecture, **Critical Review 3 due** *(Breakout paper 6 assigned)*

March 9-17: SPRING BREAK

Week 9
March 19: Breakout groups Paper 6
March 21: Lecture, **Critical Review 3 Assessments due** *(Breakout paper 7 assigned)*

Week 10
March 26: Breakout groups Paper 7
March 28: Lecture, **Critical Review 4 due** *(Breakout paper 8 assigned)*

Week 11
April 2: Breakout groups Paper 8
April 4: Lecture, **Critical Review 4 Assessments due** *(Breakout paper 9 assigned)*

Week 12
April 9: Breakout groups Paper 9 *(Breakout paper 10 assigned)*
April 11: Lecture, **Critical Review 5 due**

Week 13

April 16: Breakout groups Paper 10

April 18: Lecture, **Critical Review 5 Assessments due**

Week 14

April 23: Student research proposal presentations

April 25: Student research proposal presentations

Week 15

April 30: Guest Lecture, **last day of class**

Week 16

May 7: **Research proposals due, term papers accepted without penalty.**

GRADING POLICY

All assignments due on Canvas no later than 5 min. after the start of class. Assignments uploaded after this until noon the following day will receive 25 pts off. Assignments will not be accepted after that. If you have professional engagements (e.g. interviews) or significant personal issues (e.g. illness), contact Saeed and me via email for accommodations.

You are expected to have read the Student Code section related to Academic Integrity (http://admin.illinois.edu/policy/code/article1_part4_1-401.html). All infractions listed in the Student Code, including cheating and plagiarism, will result in penalties in accordance with the Student Code. If you have any question regarding what constitutes an infraction, contact me.

Plagiarism will be treated very seriously. If you do not understand what constitutes plagiarism, talk with me. For example, you cannot copy text from published papers without marking it as "copied from" or equivalent.

PAPER SELECTION FOR CRITICAL REVIEWS

Each week a critical review is due, I will post in advance a list of papers published in Nature Nanotechnology, Nano Letters, and other journals to Canvas. Each student will be assigned a number. You will pick one paper from the nine papers you are assigned, using the following formula:

Assigned paper #s = student number + 50n (n = integer from 0 to 8)
(e.g., if you are assigned student number #18, you pick one paper from paper #18, 68, 118, 168…)

Student numbers will be assigned.

Important: You should only pick original scientific articles, not commentaries or review articles. If in doubt, send me the pdf of the paper you select, and I will inform you if it is suitable.

Your review must be substantive. Follow the procedures indicated.