



**MSE 5075 Nanoscale Probing and Imaging
Fall 2024**

Department of Materials Science and Engineering

Instructor: Ling Zang

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Pre-requisites: CHEM1210, or equivalent knowledge of general chemistry

Lecture: M&F 3:00 – 4:20 pm; Classroom: WEB 1248

Lab: Click or tap here to enter text.

Credit Hours: 3

Text(s): **No primary textbook required.**

Lecture Notes & other course materials can be downloaded from the course website:

<http://www.eng.utah.edu/~lzang/mse6075&5075-lecture-notes.html>

The Lectures notes, together with the additional readings provided, are expected to be sufficient for well-round understanding of nanoscale probing and imaging, as well as the applications in materials research.

Class communication based on Canvas

Course Description: This course is designed to teach students the basic principles of electronic microscopy, scanning probe microscopy and spectroscopy, and their applications in nanoscale probing and imaging, as well as single molecule detection. It is designed for improving the understanding and knowledge in nanoscience and nanotechnology.

Course Outcomes: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

Content Overview: The instructor, Prof. Ling Zang, will be lecturing the class and supervising the paper and proposal presentations (as scheduled) throughout the semester. The students are expected to keep regular class attendance if ever possible to keep up with the lecture materials, and finish up the paper and proposal presentations and turn in the written proposal in time. The presentations are encouraged to be made as a group of 2-3 people (when class is enrolled with more than 6 people), and in the format of PowerPoint. Working together, the instructor and students are expected to build up an interactive, dynamic classroom, where all students are involved in active discussion and challenging with questions --- *learning through questioning*.

Course Objectives for students:

- To gain an understanding of the basic principles of electronic microscopies, scanning probe microscopies (AFM, STM, NSOM) and confocal microscopies;
- To learn the broad application of the microscopy techniques in various research fields, crossing nanomaterials, nanotechnology and nanodevices;
- To understand the principles and advantages of nanoscopic imaging, probing and spectroscopy, including single-molecule imaging;
- To develop critical and creative thinking skills of using the microscopy techniques to solve problems in 'real-world' materials science and engineering.

Grading & Evaluation Methods:

There is no exam in this course. The final grade will be based on paper presentation, final proposal writing and presentation, and class performance (including questioning, discussion, etc., to be adjusted for online class). Full grading distribution is shown in the table below.

Throughout the semester, each student will be required to present (as a group) one published paper before the class (20 min, plus 5 min for discussion) as if it were your work and be prepared for answering or defending related questions. The paper to be presented will be provided one week before the presentation. The guideline for paper presentation is provided below. Each student will also be required to write (as a group) a research proposal in "professional" format (~ 1500 words) and present it (as a group) before the class in 20 min (plus 5 min for discussion). The guideline for writing the proposal is provided below. The deadline for turning in the written proposal is the last lecture before the

proposal presentation week. Grading of the written proposal will be based on 100 points scale. Turning in after the deadline will be considered as late work and points will be deducted for the late work: 5 points deducted for turning in one day late; 10 points deducted for two days late, and continue with 5 points deducted for each additional day late.

The paper and proposal presentation will be given during the lecture times as scheduled. No makeup will be given for a missed presentation. If you have an unavoidable excuse for missing a presentation, the grading weight of that presentation will be transferred to the other grading categories as illustrated below in the grading distribution table. Valid excuse for missing a presentation includes critical health problems, critical family related issues or any other unexpected critical situations that make it unable to attend the class and finish up the presentation on time.

Grading Distribution	class performance 15%	paper presentation 20%	proposal writing 40%	proposal presentation 25%				
Grading Scale (based on 100 points)	A 93-100	A- 90-93	B+ 85-90	B 80-85	C+ 75-80	C 70-75	D 60-70	F <60

Guideline for paper presentation:

1. Present it as if it were your work.
2. Presentation (in format of PowerPoint) should be within 20 min, plus 5 min for discussion and answering questions from the audience.
3. Presentation should cover not only the data and materials described in the paper, but also the related background and current stage of the specific research topic or field, aiming to provide the audience clear insight into the merit and significance of the reported work.
4. Don't accept by default that the reported experimental approach is the best to solve the raised problems. If necessary, you may try to propose some new technical or specific microscopy improvement that may bring new or better results to the research, helping clarify the scientific argument. Particularly some new technical improvements, regarding the microscopy imaging, are always available after the paper was published.
5. The grading of the presentation will be a combined evaluation of the following aspects: presentation of novelty/significance/background of the topic subject, description and justification of the major experimental design,

presentation of the important results and the discussion related to the main topics, the content of the presentation (organization, completeness, references, etc.), presenter's overall understanding of the research, and clearness of the presentation, and response to the questions.

Guideline for proposal writing:

1. Totally about ~ 1500 words, excluding the abstract (200-250 words) and the references.
2. The proposal should be focused on a research topic, which is **tightly associated** with one or more scanning probe microscopy techniques; a good justification of why that specific microscopy technique is critical for solving the proposed problems.
3. Pick a topic by yourself, but you are welcome to ask for suggestions.
4. The proposal should consist of title, abstract, overview (background and significance), experimental designs and methods, major facilities (mainly the proposed microscopy technique along with other conventional instrumentations as needed), and references.
5. You should present clearly the objectives and scientific significance of the proposed work, the rationale for selecting the proposed experimental approach (particularly the microscopy imaging or probing techniques) to achieve the objectives.

Guideline for proposal presentation:

1. Present it as described in the proposal, covering the major parts, including overview (background and significance), objectives or problems to be solved, experimental designs and methods, major facilities, and references.
2. Presentation (in format of PowerPoint) should be within 20 min, plus 5 min for discussion and answering questions from the audience.
3. The grading of the presentation will be a combined evaluation of the following aspects: presentation of novelty/significance/background of the proposed topic, description and justification of the major experimental design and methods, presentation and discussion of the major outcomes and/or potential observations, the overall quality of the presentation regarding organization, clearness, completeness, as well as the response to the questions.

Key Dates:

- Friday, Aug. 30 - Last day to add or drop classes
- Monday, September 2 - Labor Day

- Sun.-Sun., Oct. 6-13 - Fall Break
- Friday, Oct 18 - Last day to withdraw from classes
- Thurs.-Sun., Nov. 28 – Dec. 1 - Thanksgiving Break
- Thursday, Dec. 5 – University classes end
- Sat., Dec. 14 - Sun., Jan. 5 – Holiday Recess
- **There is no Final Exam for this course.**

Americans with Disabilities Act Statement: “The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodation in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations.”

Faculty and Students' Responsibilities: “All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, and I will do so, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.”