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Fall 2024

MTEN 305-001: Materials Characterization Methods

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MTEN 305. Materials Characterization Methods

Fall 2024

Course details:

4 credits

Course code:	MTEN 305
Course title:	Materials Characterization Methods
Course location:	TIER 114/TIER 007A
Course time:	Tuesdays, Thursdays 1 PM – 2:20 pm; Friday 9:15 – 11:20 am
Pre-requisite:	MATH 211 or MATH 213, MTEN 201

Course Instructor and Office Hours:

Instructor: Dr. Edward L. Dreizin, York 120
Email address: dreizin@njit.edu
Office number: 973-596-5751
Office hours: by appointment (in person or virtual)

Laboratory Instructor: Dr. Rees Rankin, Tiernan Hall B007D
Email address: rees.rankin@njit.edu
Office number: 973-596-3616

Course Description:

This course gives an introduction to instrumentation for characterization of material structures and compositions and methods for measuring a wide range of material properties including optical, morphological, structural, compositional, and thermal. Principles of microscopic imaging and the major branches of microscopy: optical, electron, and scanning probe will be discussed. Certain methods of image analysis will be discussed. Principles of X-ray diffraction and X-ray, IR, UV, and electron spectroscopies will be introduced by considering interaction of materials with electromagnetic radiation and electrons. Principles of thermal analysis in which the properties of materials are studied as they change with temperature will be introduced. Students will learn hands-on operation of analytical instrumentation, organization and interpretation of experimental data.

Course organization:

The course includes 3 hours of lecture time weekly with in-class discussion and problem solving and laboratory work 2 hours per week. Lecture notes will be available in CANVAS. The lecture notes are set up as problems engaging students to interact with the material and actively test the concepts covered in the course.

Required software:

Microsoft Word, Excel and PowerPoint.

Recommended textbook:

Yang Leng. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition ISBN: 978-3-527-33463-6

Suggested resources:

NSF Virtual Lab

Myscope microscopy training

Nanoscience technique pages

6. Specific goals for the course

a. Students will be able to

1. Prepare material samples for microscopic examination.
2. Collect and analyze images using optical and electron microscopes.
3. Identify and characterize quantitatively spatial scales in the material samples.
4. Develop and interpret 2-dimensional maps of material composition.
5. Prepare materials for x-ray powder examination.
6. Collect and interpret x-ray diffraction patterns.
7. Process the x-ray diffraction patterns to determine the material composition and characteristics of its crystal structure.
8. Prepare materials for thermoanalytical measurements.
9. Develop heating program suitable for measuring reaction kinetic and heats of reaction for a diverse range of materials.
10. Perform isoconversional analysis of thermoanalytical measurements.
11. Connect the main concepts of materials science with the operational principals of multiple material characterization techniques, including imaging, diffraction, and spectroscopic methods.

b. Students will calibrate and use diverse material characterization instruments.

c. Students will analyze x-ray diffraction patterns to obtain crystallite sizes and grain sizes in crystalline solids.

d. Students will process images to determine mixing scales in composite materials.

e. Students will measure the temperatures, heat effects, and mass changes associated with reactions in phase changes in material samples.

f. Students will process the thermo-analytical measurements to obtain activation energies for the thermally activated reactions, such as oxidation, for selected material samples.

g. Students will identify the type of material characterization necessary to answer specific application-driven questions about the material properties.

h. Students will compile the measurements of material properties into laboratory reports including methods, results, interpretations, and conclusions.

i. Students will work in teams to create collaborative environment.

j. This course explicitly addresses the following student outcomes: 1, 3, 5, 6, 7.

7. Topics

1. Introduction and basic concepts (week 1)

2. Optical microscopy (week 2, 3)

3. X-ray fluorescence (week 3, 4)

4. X-ray diffraction (week 4 – 6)

5. Transmission electron microscopy (week 7)

6. Scanning electron microscopy (week 8, 9)

7. Scanning probe and atomic force microscopy (week 10)

8. Optical spectroscopy (week 11)

9. Thermal analysis (week 12 – 14)

8. Grading

In class assignments (submitted in Canvas): 20%

Written laboratory project reports:

Lab 1: Optical imaging: 20%

Lab 2: X-ray diffraction analysis: 20%

Lab 3: Electron microscopy: 20%

Lab 4: Thermal analysis: 20%

For the laboratory reports the grades will be split as follows:

1. Writing style: 25 %
2. Results of experiments: 30%
3. Interpretation of results: 25%
4. Oral presentation of the report: 20 %

University Policies:

Accommodation

If you need accommodations due to a disability or challenge please contact Scott Janz, Associate Director of Office of Accessibility Resources & Services (OARS), Kupfrian Hall 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the OARS authorizing your accommodations will be required. Other resources for special support services can be found here: https://www.njit.edu/studentsuccess/support-services-and-accommodations

Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. **Cheating is strictly prohibited and devalues the degree that you are working on**. As a member of the NJIT community, it is **your responsibility** to protect your educational investment by knowing and following the **academic code of integrity policy.** More details on this is provided at the following link: https://www5.njit.edu/policies/sites/policies/files/NJIT-University-Policy-on-Academic-Integrity.pdf

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

COVID policy:

Based on the NJIT memo regarding Course Requirements and Expectations for Spring 2023, dated January 11, 2023 from the Interim Provost and Senior Executive Vice President: "Although not mandated, both students and instructors are free to wear facemasks in the classroom, if they so desire. Instructors are not allowed to set their own rules on this issue. The university will be actively monitoring the situation and if the conditions call for it, the policy may be changed."
If you are feeling unwell and experiencing any of the COVID- like symptoms, please follow University guidelines as stipulated at the following website: https://www.njit.edu/healthservices/. Any student who has tested positive, should inform the relevant University authorities at **covid.notify@njit.edu** so that proper contact tracing and COVID recovery measures can be completed. If he/she is unable to attend class sessions, measures for making up or conducting the presentations at a later date will be discussed on a case-by-case basis. This should be reported to the Dean of Students. More resources: https://www.njit.edu/counseling/c-caps-covid-19-bulletin

Attendance Policy

All students are required to attend all classes. If a student is unable to attend a class session, the instructor should be informed via email of your absence prior to the start of the class. Class attendance will also be recorded by instructor and/or TA.

Withdrawal

Student requests for withdrawals after the deadline *(end of the 10th week of classes)* will not be permitted

unless extenuating circumstances are documented **through the Office of the Dean of Students**. If you are considering withdrawing, please contact the course instructor and the Dean of Students