

Course Motivation: The focus of this course will be the analysis and characterization of engineered materials, in order to develop an intuitive understanding of their structure-properties-processing-performance relationships. To this end, a broad selection of commonly used characterization tools will be the subject of discussions and demonstration. We will use heat, light, electrons, and x-rays to probe the material structure. For each technique, we will address the structural features of the material are being investigated, the interpretation of the results of analysis to deduce information about the structure-property relationship in the material, and how the instruments work.

Stories that we analyze, that we dissect, in this class will enable us to

- 1) relate material properties to their structure and processing history
- 2) develop new materials based on our understanding of structure-properties relationships
- 3) understand how to extract material information by choosing the best analysis method

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Lecture hours: Mondays, 12:40-14:30 on Zoom
Tuesdays, 09:40-10:30 on Zoom

Lab Sections: Mondays, 14:40-18:30 on Zoom
Wednesdays, 16:40-20:30 on Zoom

Office hours: during the scheduled lab hours, by appointment; please email us the teaching staff at least 24 hours in advance; because we are conducting the course online, do please contact the teaching staff frequently so you don't feel lost! We'd be glad to do 1-on-1 or small group tutorials ☺

1. **Lecture notes:** *Some* of the lecture notes will be posted to SUCourse+ to help you follow along in lecture. **Recopying** your lecture notes within 24 hours of lecture is strongly recommended to aid your digestion of the concepts covered. Identify your questions or conceptual difficulties and ASK IMMEDIATELY.

2. **Textbook:** There will not be an official course textbook. *You will need your ENS 202, ENS 205, and MAT 204 course notes and textbooks.* Supplementary learning media will be recommended for each topic, posted in a folder in SUCourse+. Additional (optional) reference material will be posted to SUCourse+—see below for more information.
3. **Attendance:** *You may not miss more than 2 lectures as a minimum condition for passing the course.* There will be a quiz in every lecture, and the quiz paper serves as your attendance record.
4. **Supplementary Learning Media:** We will down-select a reasonable amount of reading material and multimedia on-line to help you get an overview of the technique and its application to material analysis. This material is intended to supplement the lecture discussions, both of which is fair game for quiz material.
5. **Quizzes:** There will be a quiz in each lecture. The questions will cover material from previous lectures—in fact, the answer is usually in your lecture notes, so please take good notes. The quizzes will be open notes, open book, but NOT “open friend”. There will be a time limit, so start uploading your solution at least 1 minute before the deadline. If you know the answer, you should be able to complete your solution within the generous amount of time allotted.

Plagiarism will not be tolerated, so do not copy from other sources (books, websites, anywhere), including your friends. In Spring 2020, 3 students from MAT 204 were sent to the Disciplinary Court. Don’t join this ignominious cohort. If you didn’t bother learning the material, be honest about it. *If you are struggling, ask the teaching staff for help.* We enjoy teaching and being helpful, so don’t waste our time documenting your cheating. If you don’t want to learn, please do something better with your life—you’re only in your early 20’s once in your life!
6. **Lab write-up:** The lab exercises should be written up in a 2-page memo, submitted via Turnitin within one week of each lab. ***There will be 7 lab exercises total this semester, and your lab memo grade will come from 3 memos.*** This opportunity will be one of few in your undergrad education for learning to write technical communication. Please address concisely the following:
 - a. Indicate what you would like to learn about the specimen and why the specific technique would help you learn that information
 - b. Relate the measured properties to the structure of the material
 - c. Extrapolate to how this information would be useful in a commercial product (this is your chance to be creative; whatever you come up with will be your ammunition when interviewing for a job!)

Plagiarism will not be tolerated, which is why you will need to submit via Turnitin. Your writing will only be evaluated, if the automatically generated originality report shows that < 7% is common with other sources. ***Do not submit at the last minute*** and come begging for sympathy, because the system crashed. Expect that computers/servers/networks do crash and never do important things at the last minute!
7. **Failure Analysis Term Project:** This opportunity will be one of few in your undergrad education for learning to communicate technical work in written and oral formats. Everyone will choose a unique failure analysis problem *from a list that Cleve Hoca will provide*. Your task is to define the *methodology* for determining the failure mode by using the 2 most appropriate materials characterization techniques covered in the course. Please re-read the previous sentence and make sure that you understand every single word.

You are encouraged to work together, even though your problems will be unique to you.

Milestones will be collected at specific dates to ensure that you are on-track.

Address concisely the following:

- a. Indicate what you would like to learn about the specimen and why the specific technique would help you learn that information
- b. Relate the measured properties to the structure of the material
- c. Explain how the failure mode can be determined from the characterization methods applied

Note that you will not perform the failure analysis. You will determine which 2 characterization methods will be the most useful and explain why and how. ***Plagiarism will not be tolerated.***

8. **Grading:** the course grade will be calculated according to the following: 20% from the lecture quizzes; 30% from the Failure Analysis term project, an oral presentation in which you describe how you would apply the tools we discuss to solving a failure analysis problem; and 50% from the average grade of 3 lab memos. Please have some dignity and do not negotiate your grade. If it's really critical for you to pass this course, you would take every aspect of the course seriously, which would be reflected in your actions and output.
9. This document defines the expectations for the course, and these rules are applied equally to all students. Therefore, please do not try to negotiate for special privileges or special projects to boost your grade. The grade that you earn for the course only reflects your degree of mastery of the course material **during** the 14 weeks of the semester. ***Your attendance in this course beyond the Add/Drop date automatically implies that you have read and accepted these guidelines.***

Learning Outcomes:

- Ability to choose an appropriate materials characterization tool to determine desired material information
- Ability to design experiments, collect data, analyze, interpret the data
- Ability to communicate effectively theoretical and practical concepts, findings, and results

Calendar Week #	Semester Week #	Lectures (M 12:40-14:30; T 09:40-10:30)			
		Date	Topic	Lecturer	Lab
41	1	05-09/10	Spectrophotometry (UV-Visible Spectrophotometry)	CO	
42	2	12-16/10	Spectrophotometry (UV-Visible Spectrophotometry)	CO	Spectrophotome
43	3	19-23/10	Spectrophotometry (FTIR & Raman)	CO	
44	4	26/10-30/10	Spectrophotometry (FTIR & Raman)	CO	
45	5	02-06/11	thermal analysis (TG-DTA & DSC)	CO	FTIR-Raman
46	6	09-13/11	thermal analysis (TG-DTA & DSC)	CO	TG-DTA
47	7	16-20/11	Visible Light Microscopy (VLM)	CO	DSC
48	8	23-27/11	Scanning electron microscopy (SEM)	CO	VLM
49	9	30/11-04/12	Scanning electron microscopy (SEM)	CO	SEM
50	10	07-11/12	Energy-dispersive x-ray spectroscopy (SEM-EDX)	CO	
51	11	14-18/12	X-ray diffraction (XRD)	CO	
52	12	21-25/12	X-ray diffraction (XRD)	CO	XRD
1	13	28/12-01/01	Crystallography & X-ray diffraction (XRD)	CO	
2	14	04-08/01	Crystallography & X-ray diffraction (XRD)	CO	Term project presentations

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