Schedule: TuTh 2:00-3:20 1047 Sidney Lu Mechanical Engr Bldg

Course websites:

- Class schedule, announcements, lecture videos, lecture notes, worksheets, gradebook, and homework deposit: canvas.illinois.edu

Scope: This course provides an advanced treatment of the theory and techniques of diffraction and their applications to materials characterization, drawing from classical and quantum physics, solid-state physics, thermodynamics, and optic principals. Fundamentals of elastic and inelastic scattering; periodic and nonperiodic structures are reviewed in order provide a basis for more advanced topics including; X-ray, neutron and electron instrumentation; powder, thin film, surface scattering and backscattering diffraction. These physics and applications are connected to modern materials characterization approaches in the context of engineering design and scientific discovery.

Objectives: Students will be able explain basic principles of crystallography and the interactions of light with matter and then to apply diffraction theory to interpret experimental diffraction data. Students will be able to develop quantitative and qualitative understanding of advanced diffraction techniques for material characterization, specifically, the principle of these techniques, their applications and limitations.

Instructor: Jessica Krogstad (jakrogst@illinois.edu; 206 MRL)
Office hours: Immediately following lecture until 4PM on TuTh; Office hours will be held in MRL206; Hours/location may be adjusted as needed.

Reference Texts:

- Elements of Modern X-ray Physics, Jens Als-Nielsen and Des McMorrow, 2nd ed. (Wiley, 2011) *available electronically through the University Library*;
- X-ray diffraction, B.E. Warren. (Dover) *available from Amazon or Dover for as little as $14*;
- The Basics of Crystallography and Diffraction, Christopher Hammond, 3rd ed. (Oxford, 2009);
- Advanced Transmission Electron Microscopy, J.M. Zuo & J.C.H Spence, (Springer, 2017);
- Introduction to Conventional Transmission Electron Microscopy, Marc De Graef. (Cambridge, 2003);
- International Tables for Crystallography, Authier A. ed. (Wiley, 2010);

Course structure and expectations:: While this course involves a traditional lecture format, it will require student investment in supplemental reading to develop a greater depth of understanding of topics and connection to their respective research areas. In lieu of regular homework assessments, students will submit weekly reading summaries. Oral assessments of course material will occur frequently (approximately every 3-4 weeks). These assessments will be accompanied by several short "lab" activities that will be initiated during class time and completed independently and a final project the connects the topics of the course the student's research topic.

Special accommodations: To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact their lecturer and the Disability Resources and Educational Services (DRES, disability.illinois.edu) as soon as possible, and no later than Feb. 2.

Course evaluation:

$$50\%\times(\text{Oral Assessments}) + 10\%\times(\text{Weekly Summaries}) + 16\%\times(\text{Lab Reports}) + 24\%\times(\text{Final Project}) = \text{Total}$$

Oral Assessments (50%): Oral Assessments (quizzes) will be conducted through one-on-one discussions with the instructor, approximately 15 minutes in length every 3-4 weeks. Students will

have an opportunity to sign up for a time slot that best fits in their schedule. Sign up will be on a first come-first serve basis and will be available at least one week in advance of the assessment. In the case of illness or other emergency, assessments may be rescheduled at the instructors discretion. See the excused absences section below for more details.

Each assessment will center around a predefined scenario or case study that will be provided at least one week in advance. This scenario will also include targeted study topics and relevant formulas. Students will be asked a short series of questions related to the scenario. This type of exam structure leverages your knowledge of the targeted scientific fundamentals with problem solving. You are welcome to have notes available but the time will be very short and you may not have sufficient time to reference your notes extensively.

Perhaps you've never taken an exam like this. Perhaps it makes you a little bit nervous. There are a few things you can do to prepare for this type of exam.

- Make use of office hours and the assessments will feel familiar.
- Reviewing in lecture concept checks and self-study questions. Are there points that you didn't understand?
- Can you turn your own notes in to quiz questions?
- Study with a partner so you can practice talking through problems.
- Practice connecting the study topics through logical arguments. Make a concept map!
- Practice!

Each quiz will be worth 10 points and you will be provided will immediate feedback following the quiz.

Weekly Summaries (10%): Depending on your own familiarity with the foundational material for this course (Classical electromagnetic theory, quantum physics, vector calculus, crystallography, etc) you may find that some additional reading is helpful to fully grasp the lecture material. Or you may understand the material when presented in a slightly different way (through a different derivation or a different narrative). Or you may benefit from additional examples that we don't have time to cover in class. Or you may want to spend some time understanding how lecture topics connect to your own research. There are the types of brief notes that you should include in your weekly reading/notes summaries. These should handwritten, scanned and uploaded to Canvas by the start of lecture each Tuesday.

Lab Reports (16%): Over the course of the term we will conduct at least two laboratory exercises, which will involve the collection of diffraction data during the lecture period. Students will then be expects to analyze the collected data using methods learned in class and submit a written report showing their results and methodology. More details will be provided about specific requirements of these lab reports as they approach.

Final Project (24%): Over the course of the semester, students will connect concepts and topics learned in this course to their own research. A list of approved topics will be provided by the instructor, although students may propose their own topic with approval. This will culminate in a final presentation held during the class period on either April 30 or May 5.

Grade Reporting: All assessment scores are stored on the Canvas website. Any errors in grade reporting appearing on Canvas must be reported within 2 weeks of the due date of the assessment item or by the last day of class, whichever is earlier.

Academic Integrity, Harassment, and Discrimination: You are bound by the University Honor Code in this course. Any violation of the Honor Code will result in disciplinary action. In

addition, harassment or discrimination of any kind will not be tolerated. Please report any concerns immediately to your professor.

Community of Care: As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (217-333-0050). Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe.

Further, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at the Counseling Center or McKinley Health Center. For mental health emergencies, you can call 911 or walk in to the Counseling Center, no appointment needed.

Changes to syllabus: may occur as deemed necessary by the professor; they will be announced.