Transmission Electron Microscopy
EMA 6518
Class Periods: M, W, F (12:50PM- 1:40 PM)
Location: NEB 0201
Academic Term: Fall 2023

Instructor:
Honggyu Kim
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Office Phone Number: (352) 846-3766
Office Hours: 9 am Wednesday or by appointment via Zoom (link will be accessed through Canvas)
Class Website: Login to e-learning at elearning.ufl.edu

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Not applicable

Course Description
This 3-credit course presents an introduction of transmission electron microscopy (TEM) and its applications to materials research. This course covers the following contents: introduction of TEM instrumentation; operating principles of TEM; fundamentals of electron optics; theory of electron diffraction and image formation; analytical TEM (EDS and EELS).

Course Pre-Requisites / Co-Requisites
EMA3010 or equivalent. Basic knowledge of crystallography, diffraction and quantum mechanics.

Course Objectives
After taking this course, students will be able to
1. Describe key components in TEM and explain their roles.
2. Understand theory leading to various types of TEM data (diffraction, BF-, DF-, HR-TEM images and etc.).
3. Interpret and analyze experimental TEM data (in particular solid materials such as semiconductors, ceramics, and metals)
4. Apply the above knowledge to design TEM experiments for materials research
5. Understand and evaluate TEM data presented in peer review journals or conference talks

Note: ***This course is not designed for instrument training purpose***, although it will cover practical aspects of TEM. In order to become a TEM user, students need to take an official training procedure through RSC staff, Dr. Nichola Rudawski.

Materials and Supply Fees
Not applicable

Required Textbooks and Software
- *Transmission Electron Microscopy: A Textbook for Materials Science*, D.B. Williams and C.B. Carter, 2nd edition, 2009, Springer, ISBN 978-0-387-76501-3 (Available as an e-book through UF library)

Recommended Materials
- *Transmission Electron Microscopy and Diffractometry of Materials*, B. Fultz and J.M. Howe, 4th edition, 2013, Springer, ISBN 987-3-642-29761-8 (Available as an e-book through UF library)
- *Introduction to Conventional Transmission Electron Microscopy*, Marc De Graef, 2003, Cambridge, ISBN 9870511615092
- *Advanced Transmission Electron Microscopy: Imaging and Diffraction in Nanoscience*, J.M. Zuo and J.C.H. Spence, 1st edition, 2017, Springer, ISBN 978-1-4939-6607-3 (Available as an e-book through UF library)
- *Transmission Electron Microscopy: Physics of Image Formation*, L. Reimer and H. Kohl, 5th edition, 2008, Springer, ISBN 978-0-387-34758-5 (Available as an e-book through UF library)

Course Schedule

Subject	Hours
Basics	
1. Overview and electron optics	5
2. TEM instrument and practical operation	5
Diffraction	
3. Electron scattering and diffraction	5
4. Electron dynamical diffraction	5
5. Practical uses of electron diffraction	4
Imaging	
6. Imaging modes and image contrast	5
7. High-resolution TEM and Scanning TEM	6
Spectroscopy and advanced techniques	
8. Analytical TEM: EDS and EELS	3
9. Emerging area in TEM	if time permitted
Final project: Presentations	2
TEM Lab tour and demonstration	if time permitted
Total	40

Class Format and Notification for Recording Online Lecture Video

This course is offered as part of UF's Electronic Delivery of Gator Engineering (EDGE) curriculum for distance students, thus all lectures will be recorded. *The lectures will be delivered during the listed course times (i.e., synchronous); the lecture video will be uploaded in Canvas after each lecture.* The lecture note (pdf version) will be posted on the Canvas course page at least one day before the lecture. A detailed information regarding online course recording is listed in the following section.

Final project

The final project consists of **ONE written report** (~1000 words) and **ONE presentation** (10-12min talk and 2-3min Q&A) near the end of the semester. The report should be submitted a week before the scheduled presentation date, so that peers can read it before the presentation. Students will decide a TEM-related topic and notify it to the instructor before the first exam (10.13.2023, Fri – tentative). Students are encouraged to select a topic that is relevant to their research or meets their research interests in general. Topics can be focused on novel TEM techniques (*e.g.*, Quantitative TEM, 4D TEM, in-situ TEM, tomography, holography) or emerging materials that require high-end TEM works (*e.g.*, metal alloys, topological insulator, epitaxial thin films, nanoscale materials, and soft materials). Students are welcome to discuss with the instructor about the choice of topics. ***The grade for the final project will be given by BOTH peers and the instructor.*** **NOTE:** The final project is basically an individual project. However, in case that the number of registered students is large, the final project can become a team project.

Attendance Policy and Class Expectations

Experience has shown that discussions and Q/A during the live lecture improve the student's understanding of the course materials. Therefore, lecture attendance is highly recommended. Attendance will not be required except for the final presentation in which students will ask questions and grade their peers. Students are expected to **be punctual** on every lecture and **behave respectively** to their peers and the instructor. All the electronic devices should be in silence mode and especially **the use of cell phones is prohibited**.

Make-Up Policy

Makeup exams will be provided only if students have a valid reason (e.g., medical absences, family emergency, etc.). Excused absences must be consistent with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations) and require appropriate documentation. Additional information can be found here: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/. If students are not able to take exams, students must inform the instructor at the earliest opportunity.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Problem Sets (~8)	10 each	15 %
Midterm Exam (2)	100	70 %
Final project	100	15 %
Total		100 %

Midterm 1: 10.13.2022 (Friday, TBD) - tentative
Midterm 2: 12.06.2023 (Wednesday, TBD) - tentative

Late assignments: ONLY one late homework assignment will be allowed. Any further late homework assignments will be considered as ZERO.

Grading Policy

Percent	Grade	Grade Points
≥ 92	A	4.00
≥ 88	A-	3.67
≥ 84	B+	3.33
≥ 80	B	3.00
≥ 76	B-	2.67
≥ 72	C+	2.33
≥ 68	C	2.00
≥ 65	C-	1.67
≥ 62	D+	1.33
≥ 59	D	1.00
≥ 56	D-	0.67
< 56	E	0.00

Note: In case that the class average for midterm and final exams are low, grades for exams (not for homework assignments and final project) can be curved up at the discretion of the instructor.

More information on UF grading policy may be found at:
UF Graduate Catalog
Grades and Grading Policies

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment
The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:
Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*: https://distance.ufl.edu/getting-help/; https://distance.ufl.edu/state-authorization-status/#student-complaint.*