

Properties of Functional Materials

EMA 6114

Section 12611 (Camp), 12613 (1FE2), 12614 (2FED)

Class Periods: MWF, period 3 (9:35-10:25am)

Location: Weil 238

Academic Term: Spring 2024

This course is one of the four key technical courses foundational to the MSE graduate programs: Materials Thermodynamics (EMA 6316), Diffusion, Kinetics and Transport in Materials (EMA 6136), Structure and Mechanical Properties of Materials (EMA 6313), and Properties of Functional Materials (EMA 6114). As a core course, this class covers a significant amount of graduate-level material and it is designed to challenge you to advance your knowledge and skills. Success will require a considerable investment in preparing for lectures by using textbooks and other sources that you seek out, solving problems, and studying for exams. It is expected that you will have to exhibit significantly more independence, initiative, and ownership of the learning process than was required for success at the undergraduate level.

Instructor:

Prof. Jiangeng Xue

Email: jxue@mse.ufl.edu

Phone: (352) 846-3775

Office Hours: TBD

Teaching Assistant:

- TBD.

Course Description

To gain an understanding of the principles underlying the properties of functional materials. The specific objectives for the course include understanding the electrical, thermal, magnetic, and optical properties of materials.

Course Pre-Requisites / Co-Requisites

EMA 6313 or EMA 6001 or an undergraduate class in electronic materials, solid state physics, quantum mechanics or a related topic

Course Objectives

Upon completion of this course, students should be able to:

- Describe the characteristics of electrons and other (quasi-)particles using classical and/or quantum theories
- Relate the (microscopic) behavior of electrons and other (quasi-)particles to the (macroscopic) functional properties of solids
- Compare the electrical, optical, thermal, and magnetic properties of different types of solid materials
- Design suitable functional materials for specific electrical/optical/magnetic applications

Materials and Supply Fees

N/A

Required Textbooks and Software

- Principles of Electronic Materials and Devices, S.O. Kasap, 4th Edition, McGraw-Hill 2018, ISBN: 0072957913

The 3rd edition is also OK, but the student is responsible for any differences between the editions. First and second editions are not acceptable substitutes.

Recommended Materials

- The Physics and Chemistry of Materials, by Joel I. Gersten and Frederick W. Smith, Wiley, 2001
- Introduction to Solid State Physics, C. Kittel, Wiley (classical solid-state physics book; now in 9th ed.)
- Electronic, Magnetic, and Optical Materials, by Pradeep Fulay, CRC Press, 2010
- For basics of quantum physics, consult a standard introductory physics book. An open source text is available at <https://openstax.org/details/books/college-physics>

Course Schedule

The following is an approximate outline of the 42-class schedule breaking down to 10 modules in addition to an introduction class. This schedule may be subject to change:

0. Introduction (1 class)
1. Classical Electronic and Thermal Properties: Successes and Failures (3 classes)
2. Quantum Theory of Electrons in Solids (6 classes)
3. Lattice Vibrations, Phonons and Thermal Conductivity (4 classes)
4. Electronic Properties of Semiconductors: Basics (4 classes)
5. Electronic Properties of Semiconductors: Devices (4 classes)
6. Dielectric Properties (3 classes)
7. Optical Properties and Applications of Optical Materials (6 classes)
8. Electrical and Optical Properties of Organic Systems (2 classes)
9. Magnetic Properties, Magnetic Materials and Superconductors (4 classes)
10. Surfaces, Interfaces, and Nanostructures (5 classes)

Attendance Policy, Class Expectations, and Make-Up Policy

- For on-campus students (Camp section), class attendance is strongly encouraged to enhance classroom learning and interaction. Students are encouraged to actively participate in various in-class interactive activities. Questions from students are also encouraged. Cell phones should be turned off or put to silent in class. **Classroom Participation** points will be awarded to on-campus students who participate in in-class polling via iClicker and will be worth 10% of the course grade. Multiple (typically 3-5) polls will be conducted for each lecture. An on-campus student needs to participate in at least 75% of all polls to receive the full 10% course grade.
- Two sections (1FE2 and 2FED) of this course are offered online via UF EDGE **using recorded lectures from Spring 2023 offering of this course**. There will be minimal content change from Spring 2023. Relevant changes will be pointed out, and short videos may be recorded and posted in Canvas to supplement the videos from Spring 2023. EDGE students will complete watching these videos in PlayPosit and answer interactive questions embedded (typically 3-5 per lecture). An EDGE student needs to earn at least 75% of points to receive the full 10% course grade.
- E-mail communications with the Instructor should originate through Canvas (preferred) or via direct email from your authenticated UF email account. For direct emails, make sure you include “EMA 6114” in the subject line of your email to ensure timely response.
- 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/>. Other than in emergency situations, you must notify the instructor of your scheduled absence for exams and discuss make-up options **at least one week prior to your absence**; failure to do so may not allow you to make up for the missed exam.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade	
		Camp	1FE2/2FED
Homeworks (~weekly)*	100	10%	10%
Classroom Participation (iClicker)&	100	10%	N/A
Lecture Video Assignment (PlayPosit)&	100	N/A	10%
Exams (4)§	100 each	65%	65%
Review Paper	100	15%	15%
Total		100%	100%

* A total of 12 homework sets will be assigned (approximately on a weekly basis), following the conclusion of each module (two sets for modules covering more than 5 lectures). 80% or better accuracy on each homework will earn you the full 5 points for that assignment. Only the 10 highest scores for all homeworks will be used for final grade assignment.

& Participation in at least 75% iClicker polls (on-campus students) or earning at least 75% of PlayPosit points (EDGE students) to receive full credits for this category.

§ There will be four in-semester exams. The dates for these exams are listed below. Any change to these dates will be announced at least one week ahead of the actual exam dates. Exams for on-campus students will be taken ~6 – 8pm in locations to be determined. EDGE students should schedule the exams with your approved proctor or take Honorlock computer-based exams anytime during the day as your schedule fits. Extension of the exam window for EDGE students will need to be approved by the instructor at least one week ahead of the exam dates. The highest scoring exam will be weighted at 20% while the other three exams will be weighted at 15% each.

Exam #	Modules Covered	Total Points	Date
I	1-2	100	Wednesday, February 7 th
II	3-5	100	Wednesday, March 6 th
III	6-8	100	Wednesday, April 10 th
IV	9-10	100	Wednesday, April 24 th

Grading Policy

Final letter grade will be assigned based on a student's overall performance during the semester. The following scale will be used as a guideline.

Percent	Grade	Grade Points
90.0 - 100	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
80.0 - 83.9	B	3.00
77.0 - 79.9	B-	2.67
74.0 - 76.9	C+	2.33
70.0 - 73.9	C	2.00
67.0 - 69.9	C-	1.67
64.0 - 66.9	D+	1.33
60.0 - 63.9	D	1.00
55.0 - 59.9	D-	0.67
0 - 54.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

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 Conduct 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. 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 broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

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
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@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](mailto:title-ix@ufl.edu), 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/>.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.

- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

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

Career Resource 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: <http://www.distance.ufl.edu/student-complaint-process>.