

## Electronic Properties of Materials

EMA 3413

**Class Periods:** Tue, 10:40 AM- 11:30 AM; Thu, 10:40 AM – 12:35 PM

**Location:** BAR 0211 (T) & WEIM 1084 (TH)

**Academic Term:** Spring 2024

### ***Instructor:***

Honggyu Kim

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Office Phone Number: (352) 846-3766

Office Hours: Wed 8:00 PM – 9:00 AM or by appointment

Class Website: Login to e-learning at [elearning.ufl.edu](http://elearning.ufl.edu)

### ***Teaching Assistants:***

TBD

Email Address: (Note: Please contact through the Canvas website)

Office Hours: TBD

### ***Course Description***

This 3-credit course introduces the electrical, optical, magnetic, and thermal properties of materials (in particular solids) and their applications in technologically important devices. Students will be exposed to the following contents: atomic/electronic structure and bonding of materials; fundamentals of quantum mechanics; quantum-mechanical and classical descriptions of materials properties; electrical conduction in metals and semiconductors; dielectric, magnetic and thermal properties of solids; design principles of devices.

### ***Course Pre-Requisites / Co-Requisites***

EMA3011 or equivalent. Basic knowledge of undergraduate-level general physics, chemistry, calculus, and differential equations.

### ***Course Objectives***

After taking this course, students will be able to

1. Describe how the electrical, optical, magnetic and thermal properties of (solid) materials originate from their atomic and electronic structures;
2. Understand aforementioned materials properties of different kinds of solid materials;
3. Understand how aforementioned materials properties are utilized to design specific electrical, optical and magnetic applications.

### ***Professional Component (ABET):***

This is a 3-credit course. It provides 3 credits towards engineering sciences.

### ***Relation to Program Outcomes (ABET):***

The following outcome and coverage table applies to students in the Materials Sciences and Engineering undergraduate program:

Outcome	Coverage*
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. an ability to apply engineering design to produce solutions that meet specified needs with	

consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. an ability to communicate effectively with a range of audiences	
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	

\*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

### ***Materials and Supply Fees***

Not applicable

### ***Required Textbooks and Software***

- *Principles of Electronic Materials and Devices*, S. O. Kasap, 4<sup>th</sup> edition, 2018, McGraw Hill, ISBN 978-0-078-02818-2

### ***Recommended Materials***

- *Electronic Properties of Materials*, R. E. Hummel, 4<sup>th</sup> edition, 2011, Springer, ISBN 978-1-4419-8164-6  
([Available as an e-book through UF library](#))

### ***Course Outline: Contents and schedule are subject to change as necessary***

Subject	Hours
<b>Basics</b>	
1. Elementary Materials Science Concepts	4
2. Electrical and Thermal Conduction in Solids	4
3. Elementary Quantum Physics & Modern Theory of Solids	12
<b>Materials and Devices</b>	
4. Semiconductors and Relevant Devices	10
5. Dielectric Materials	3
6. Magnetic Properties	3
7. Optical Properties	3
Total	39

### ***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.

### ***Attendance Policy and Class Expectations***

**Attendance** is not required, but **highly recommended**. Prompt and regular attendance at each lecture is essential to student’s success in the class. Students are expected to **be punctual** on every online lecture and **behave respectfully** to their peers and the instructor.

### ***Make-Up Policy***

Makeup exams will be provided only if students have a valid reason (e.g., medical absences, family emergency, etc.). Excused absences for exams must be in compliance with university policies in the Undergraduate Catalog (<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>) and require appropriate documentations. 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	40%
Midterm Exam (3)	100 each	60%
Total		100%

**Midterm 1: Feb.9.2023 (Thursday, TBD) – tentative**

**Minterm 2: Mar.7.2023 (Thursday, TBD) – tentative**

**Midterm 3: Apr.19.2023 (Thursday, TBD) – tentative**

**Exam schedule is subject to change as necessary.**

**Late assignments:** Late submission of problem sets is **not allowed**. Late assignments will be counted as **ZERO**.

### ***Grading Policy***

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
≥ 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 exams is low, grades for exams (not for homework assignments) can be curved up at the discretion of the instructor. More information on UF grading policy may be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

### ***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.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### ***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/policies/student-honor-code-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 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](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](mailto: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:** <http://www.counseling.ufl.edu/cwc>, 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](mailto: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 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://www.crc.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://care.dso.ufl.edu>.

**On-Line Students Complaints**: <http://www.distance.ufl.edu/student-complaint-process>.