Electronic Properties of Materials

EMA 3413 Section 9766
Class Periods: MWF 4th period, 10:40am – 11:30am
Location: FLG 220
Academic Term: Spring 2017

Instructor:
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Office Hours: Thursdays 2-3pm, 100C RHN, or by appointments

Teaching Assistants:
S. Jana Sadovy, sjsadovy@ufl.edu, 200 RHN, Tuesdays 1-2pm

Course Description
Atomistic and quantum-mechanical description of the electrical, optical, magnetic and thermal properties of materials. This course deals with metals, alloys, semiconductors, polymers, dielectrics and amorphous materials. Special emphasis is given to technology applications of electronic materials.

Course Pre-Requisites / Co-Requisites
EMA 3010. Students are also expected to have taken calculus and college physics courses.

Course Objectives
Understanding the fundamental electronic properties of solid materials

Materials and Supply Fees
N/A

Professional Component (ABET):
This is a 3 credit course. It provides 3 credits towards engineering sciences.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
a. Apply knowledge	High
b1. Conduct experiments	
b2. Statistical design of experiments	
c. Design	
d. Function on teams	
e. Solve problems	
f. Professional and ethical responsibility	
g. Communicate	
h1. Economic impact	
h2. Global, societal, and environmental impact	
i. Lifelong learning	
j. Contemporary issues	Medium
k. Techniques, skills, and tools for degree program	

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

Required Textbooks and Software

- Principles of Electronic Materials and Devices
- S. O. Kasap
- 3rd Ed.
- ISBN: 0-07-295791-3

Recommended Materials

- Electronic Properties of Materials
- R. E. Hummel
- 4th Ed.
- ISBN: 978-1441981639

Course Schedule

Table below is a list of topics to be covered in the lectures along with the corresponding reading assignment in the textbook. This list is subject to change. Actual dates for quizzes and exams will be announced ahead of time.

Section Subject	Lecture	Date	Lecture Topic	Reading Assignment
Overview	1	1/4	Syllabus and course overview	3-76
Elementary Materials Science Concepts	2	1/6	Atomic structure and bonding	3-25
	3	1/9	Thermal expansion and thermally activated processes	25-49
	4	1/11	Crystals and defects	49-76
Conduction in Solids	5	1/13	Drude model	114-125
		1/16	MLK Holiday/No Class	
	6	1/18	Matthiessen's and Nordheim's Rules	125-139
	7	1/20	Hall effect/**Quiz 1**	145-148
Quantum Physics	8	1/23	Wave-particle duality	191-207
	9	1/25	Schrodinger equation and infinite potential well	208-217
	10	1/27	Uncertainty principles and tunneling	217-230
	11	1/30	Review (instructor travel)	
	12	2/1	Hydrogen atom	231-253
	13	2/3	Helium and periodic table	254-258
Modern Theory of Solids	14	2/6	Band structures of metals and semiconductors	285-303
	15	2/8	Effective mass and density of states	303-311
	16	2/10	Fermi-Dirac statistics/**Quiz 2**	312-315
	17	2/13	Quantum theory of metals	315-320
	18	2/15	Phonons	337-342
Semiconductors	19	2/17	Intrinsic semiconductors	374-387
	20	2/20	Extrinsic semiconductors	388-396
	21	2/22	Temperature dependence	396-407
	22	2/24	Carrier recombination and diffusion	407-422
	23	2/27	**Mid-term Exam**	
	24	3/1	Optical absorption/direct and indirect bandgap semiconductors	427-431, 448-452
	25	3/3	Schottky junction and Ohmic contacts	435-440, 443-445
		3/4-11	Spring Break/No Class	
Semiconductor Devices	26	3/13	pn junction and diode	476-498
	27	3/15	pn junction and diode	476-498

	28	3/17	MOSFET	532-541
	29	3/20	Light emitting diode	543-551
	30	3/22	Solar cells/**Quiz 3**	551-563
Dielectric Properties	31	3/24	Permittivity	583-594
	31	3/27	Polarization mechanisms	595-603
	33	3/29	Dielectric constant, dielectric loss, and dielectric strength	603-614, 620-631
	34	3/31	Piezoelectricity, ferroelectricity, and pyroelectricity/**Quiz 4**	638-653
Magnetic Properties	35	4/3	Magnetization	685-696
	36	4/5	Magnetic material classes	696-704, 740-744
	37	4/7	Superconductivity	729-740
Optical Properties	38	4/10	Light wave and optical constants	773-787, 804-811
	39	4/12	Refraction, reflection, absorption	789-803, 811-816
	40	4/14	Scattering, luminescence/**Quiz 5**	816-825
	41	4/17	Review (instructor travel)	
	42	4/19	Review (instructor travel)	
		4/27	**Final Exam** (3-5pm)	

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is not required, but expected and strongly recommended. Cell phones should be turned off or set to vibrate. Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Evaluation of Grades

Assignment	Points	Percentage of Final Grade
Homework Sets (~10)*	10 each	10%
Quizzes (5, 15 min each)	25 each	25%
Midterm Exam (50 min)	100	25%
Final Exam (comprehensive)	100	40%
Total*		***100%***

* Homework sets will be assigned on a weekly basis in general; two lowest scores (including non-submissions) will be discarded when computing the total points.

** A half bonus percentage point will be given to students who complete the profile picture in e-Learning as instructed by Jan. 13.

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:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation
Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

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: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

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 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 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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

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