

Electron Theory in Solids

EMA 6110 Section 08EC (non-EDGE) and 11F3/11F4/2E14 (EDGE)

Class Periods: MWF, 6th period, 12:50-1:40pm

Location: NEB 102

Academic Term: Fall 2017

Instructor:

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846-3775

Office Hours: Fridays, 2-3pm, RHN 237, or by appointments

Teaching Assistants: N/A

Course Description

Wave equation and its application to free electrons, bound electrons, and electrons in crystals. Electron-band theory and its applications. Electrical properties of metals, alloys, and semiconductors, heat capacity and thermal properties. 3 credit hours

Course Pre-Requisites / Co-Requisites

EMA 3010, PHY 2049, and MAP 2302, or equivalents

Course Objectives

Understanding the fundamental electronic/electrical, dielectric, optical, and magnetic properties of solid materials

Materials and Supply Fees

N/A

Required Textbooks and Software

- "Principles of Electronic Materials and Devices," by S. O. Kasap, McGraw Publishing, 3rd edition, ISBN 0073104647
- "Solid State Physics for Engineering & Materials Science," by John McKelvey, Krieger Publishing, ISBN 0-89464-436-X

Recommended Materials

- N/A

Course Schedule

Table below is a list of topics to be covered in the lectures along with the corresponding reading assignment in the textbooks. This list is subject to change.

Section subject	Lecture no.	Lecture topic	Reading assign. (Kasap, 3rd ed.)	Reading assign. (McKelvey)
Electrons and Classical Physics	1	Review of Crystalline Properties	1-81	1-56
Classical electron theory	2	Free electrons in metals	113-145	267-285
	3	Electrons and bonding in crystalline solids		56-69
	4	Quantum vs. classical mechanics	191-205	106-117
Quantum Mechanics	5	Intro to wave mechanics	205-212	28-33, 63-74
	6	The quantum mechanics formalism and Schrödinger's eqn		117-129
	7	Solution for free electron		129-134
	8	Infinite and finite potential wells	212-231	134-145

	9	Particle incident on step barrier		145-150
	10	Quantum harmonic oscillator		150-163
	11	Hydrogen atom	231-254	164-174
	12	Pauli exclusion principle and the periodic potential		177-181
Statistical Mechanics	13	Intro to statistical mechanics	285-303	187-192
	14	Density of states for "confined" free particle		192-196
	15	Maxwell-Boltzmann statistics	303-315	199-214
	16	Fermi-Dirac statistics		214-224
Q.M. for crystals	17	Periodic crystal lattices		315-321
	18	Kronig-Penney Model		321-327
	19	Crystal momentum and effective mass	303-305	328-333
	20	Band structure		361-367
Semiconductor properties	21	Intrinsic semiconductors	373-388	372-380
	22	Extrinsic semiconductors	388-396	381-385
	23	Quantitative derivation of carrier density	396-424	385-393
	24	Conductivity and Hall effect		306-308, 393-402
	25	pn junction physics	476-494	443-457
	26	Pn junction as rectifier	494-506	458-467
	27	Junction between dissimilar materials		
Dielectric materials	28	Dielectric materials	583-593	
	29	Clausius-Mosotti relationship	593-595	
	30	Dielectric properties in alternating field	597-603	
	31	Frequency and temperature dependence	603-614	
	32	Ferroelectricity and piezoelectricity	638-654	
Magnetic properties	33	Intro. to magnetism	685-705	
	34	Paramagnetism and diamagnetism		
	35	Ferromagnetism and Antiferromagnetism		
	36	Microscopic theory and quantum models		
Optical properties	37	Electromagnetic waves and polarization	773-804	
	38	Optical dielectric function	804-825	
	39	Non-linear polarization	825-841	

Attendance Policy, Class Expectations, and Make-Up Policy

Sections of this course are offered on UF EDGE. The lecture videos are available on the UF e-Learning (Canvas) website for all students (not just those who registered for the EDGE section) to review at any time. However, attendance is strongly encouraged for all non-EDGE students to enhance classroom learning and interaction. Special conditions for absence will be accepted only with prior approval by the instructor. Electronic devices are allowed in classroom as long as they do not cause a distraction to other students. Cellular phones should be turned off or put to silent.

Excused absences are consistent with university policies in the undergraduate catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation. Except for emergencies, make-up exams are only allowed if requested at least one week before the regular exam time AND approved by the instructor. Make-up exams will differ from regularly-scheduled exams.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (~10)*	N/A	N/A

Exam 1	100	1/3
Exam 2	100	1/3
Exam 3	100	1/3
		100%

* Homework will be assigned weekly, but not graded. Students are strongly recommended to solve the homework problems to enhance learning and seek help from the instructor during office hours if needed.

Grading Policy

The final letter grade will be assigned based on student’s overall performance in the course. The following scale will be used as a guideline:

Percent	Grade	Grade Points
90.0 – 100.0	A	4.00
86.0 – 89.9	A-	3.67
82.0 – 85.9	B+	3.33
79.0 – 81.9	B	3.00
76.0 – 78.9	B-	2.67
73.0 – 75.9	C+	2.33
70.0 – 72.9	C	2.00
67.0 – 69.9	C-	1.67
64.0 – 66.9	D+	1.33
61.0 – 63.9	D	1.00
60.0 – 60.9	D-	0.67
0 – 59.9	E	0.00

In order to graduate, graduate students must have an overall GPA and a major GPA of 3.00 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. 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 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 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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

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