

Syllabus

EMA 6110 Electron Theory in Solids Fall 2015

1. Catalog Description (3 credits): 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.
2. Pre-requisites and Co-requisites: EMA 3010, PHY 2049, and MAP 2302, or equivalents
3. Course Objectives: Understanding the fundamental electronic properties of solid materials
4. Instructor: Prof. Jiangeng Xue
 - a. Office location: 180 Rhines Hall
 - b. Telephone: 846-3775
 - c. E-mail address: jxue@mse.ufl.edu
 - d. Class Web site: e-Learning in Canvas, <https://lss.at.ufl.edu/>
 - e. Office hours: N/A
5. Teaching Assistant: None
 - a. Office location
 - b. Telephone
 - c. E-mail address
 - d. Office hours
6. Meeting Times: N/A; this course is only available through UF EDGE
7. Class/laboratory schedule: 3 classes (each 50 min) per week
8. Meeting Location: N/A
9. Material and Supply Fees: See Registrar's Office
10. Textbooks and Software Required
 - a. "Principles of Electronic Materials and Devices," by S. O. Kasap, McGraw Publishing, 3rd edition, ISBN 0073104647
 - b. "Solid State Physics for Engineering & Materials Science," by John McKelvey, Krieger Publishing, ISBN 0-89464-436-X
11. Recommended Reading: None
12. Course Outline: Table below is a list of topics to be covered in the lectures along with the corresponding reading assignment in the textbooks. The actual topics in the lecture videos may differ slightly in progress.

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	

13. Attendance and Expectations: This is an EDGE-only course. The videos for the lectures were recorded when this course was offered in Fall 2012, and the videos are available on the UF e-Learning (Canvas) website. All lecture videos are released at the beginning of the semester. It is expected that students should watch three videos per week.

14. Grading –
EDGE section: Three exams (equal weight)

Homework will be assigned weekly, but not graded. Students are strongly recommended to solve the homework problems to enhance learning.

15. Grading Scale: 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: A(100-92), A-(91-88), B+(87-84), B(83-80), B-(79-77), C+(76-74), C(73-71), C-(70-68), D+(67-65), D(64-62), D-(61-60), E(59-0)

In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 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. For more information on grades and grading policies, please visit:

<http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades>

16. Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at:

<http://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

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.

17. 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 (<http://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.

Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures.

See <http://www.dso.ufl.edu/sccr/procedures/honorcode.php>.

18. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.
19. UF Counseling Services –Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
 - Career Resource Center, Reitz Union, 392-1601, career and job search

services.

20. Software Use – All faculty, staff and student 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.
21. Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu>. 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/>.