Syllabus

EMA 6110 Electron Theory in Solids Fall 2013

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. Franky So
   a. Office location: 166 Rhines Hall
   b. Telephone: 846-3790
   c. E-mail address: fso@mse.ufl.edu
   d. Class Web site: e-Learning in Sakai, https://lss.at.ufl.edu/
   e. Office hours: 8:00-9:00 am on Monday and Wednesday
5. Teaching Assistant: None
6. Meeting Times: 4:05-4:55 pm, T (9^{th} period);
   3:00-4:55 pm, Th (8^{th} and 9^{th} period)
7. Class/laboratory schedule: 3 classes (each 50 min) per week
8. Meeting Location: CSE E122
9. Material and Supply Fees: None
10. Textbooks and Software Required
    a. "Principles of Electronic Materials and Devices," by S. O. Kasap, McGraw Publishing, 3^{rd} edition, ISBN 0073104647
    b. "Electronic Properties of Materials," by Rolf Hummel, Springer Publishing, ISBN 978-1441981639
    c. "Solid State Physics for Engineering and Materials Science", by John McKelvey, Krieger Publishing Co., 978-0894644368
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. This list is subject to change.

Section subject	Lecture no.	Date	Lecture topic	Reading assign. (Hummel, 4^{th} ed)	Reading assign. (Kasap, 3rd ed.)	Reading assign. (McKelvey)
Electrons and Classical Physics	1	8/22	Review of Crystalline Properties		**1-81**	1-56
Classical electron theory	2	8/22	Free electrons in metals	79-93	**113-145**	267-285
No class						
	3	8/27	Electrons and bonding in crystalline			56-69

			solids			
	4	8/28	Quantum vs. classical mechanics		**191-205**	**106-117**
Quantum Mechanics	5	8/29	Intro to wave mechanics		**205-212**	**28-33, 63-74**
	6	9/3	The quantum mechanics formalism and Schrödinger's eqn	15-18		**117-129**
	7	9/5	Solution for free electron	19-20		**129-134**
	8	9/5	Infinite and finite potential wells	21-24	**212-231**	**134-145**
	9	9/10	Hydrogen atom		**231-254**	**164-174**
	10	9/12	Pauli exclusion principle and the periodic potential			**177-181**
	11	9/12	Maxwell-Boltzmann statistics	63-65	**303-315**	**199-214**
	12		Fermi-Dirac statistics	63-65		**214-224**
No class		9/17				
No class		9/19				
	13	10/1	Kronig-Penney Model			**321-327**
	14	10/3	Crystal momentum and effective mass		**303-305**	**328-333**
Exam 1		10/3	Chapter 3,4 of Kasap			
	15	10/8	Band structure	37-61, 63-65		**361-367**
Q.M. for crystals	16	10/10	Intrinsic semiconductors	115-117	**373-388**	**372-380**
	17	10/10	Extrinsic semiconductors	117-126	**388-396**	**381-385**
	18	10/15	Quantitative derivation of carrier density	127-129	**396-424**	**385-393**
	19	10/17	Conductivity and Hall effect	125-127		**306-308, 393-402**
Semiconductor properties	20	10/17	pn junction physics	137-139	**476-494**	**443-457**
	21	10/22	Pn junction as rectifier	**139-141**	**494-506**	**458-467**
	22	10/24	Heterojunctions	**129-131**		
	23	10/24	Dielectric materials	**181-194**	**583-593**	
	24	10/29	Clausius-Mosotti relationship		**593-595**	
	25	10/31	Dielectric properties in alternating field		**597-603**	
Exam 2		10/31	Chapters 5-6 of Kasap			
	26	11/5	Frequency and temperature dependence		**603-614**	
Dielectric materials	27	11/7	Ferroelectricity and piezoelectricity	**202-210**	**638-654**	
	28	11/7	Dielectric polarization		**583-601**	
	29	11/12	Frequency dependence, dielectric loss		**602-630**	
	30	11/14	Piezoelectricity and ferroelectricity		**638-677**	
Optical properties	31	11/14	Optical dielectric function		**804-825**	
		11/19	Absorption, transmission and reflectance	**259-275**		
	33	11/21	Electromagnetic waves and polarization		**773-804**	
	34	11/21	Fresnel equation, optical absorption		**825-841**	
	35	11/26	Optical devices, LEDs and lasers	**284-329**		
No class		12/3				
Exam 3		12/5	Chapters 7 and 9 of Kasap			

13. Attendance and Expectations: attendance strongly encouraged.

    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.

14. Grading –

    EDGE section: Three exams (equal weight)

    Non-EDGE section: Three exams (each weighted 30%)

    Four in-class short quizzes* (2.5% each)

*Quizzes will be given before the conclusion of a class for no more than 5 minutes each and will focus on materials covered in that lecture. Five quizzes will be given without prior announcements, though only the four best ones for each student will be counted toward the final grade.

Homework will be assigned biweekly, 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. Make-up Exam Policy: 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 – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.
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.