

## **Electronic Properties of Materials EMA 3413**

1. Catalog Description (3 credits): 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.

2. Pre-requisites and Co-requisites - EMA 3010 or equivalent  
Students are also expected to have taken calculus and college physics courses.

3. Course Objectives – Understanding the fundamental electronic properties of solid materials

4. Contribution of course to meeting the professional component - This is a 3 credit course. It provides 3 credits towards engineering sciences.

5. Relationship of course to program outcomes - This course addresses the following MSE Program outcomes:

Outcome 1: Ability to apply knowledge of mathematics, science, and engineering to materials systems. (High coverage) This course builds on the students' knowledge of physics and chemistry to develop an understanding of electronic properties of materials. Students are assigned homework and exam problems that examine the students understanding of semiconducting, metallic, and insulating electronic systems.

Outcome 2: Knowledge of contemporary issues. (Medium coverage) This course helps students to understand certain contemporary issues related to electronic and optical properties of materials. Students are assigned homework and exam problems that examine the students' understanding of these contemporary issues.

6. Instructor: Prof. S.J. Pearton

a. Office location: NSC 343

b. Telephone: 846-1086

c. E-mail address: [spear@mse.ufl.edu](mailto:spear@mse.ufl.edu)

d. Office hours: Monday 8:00 to 9:00 am and Tuesday 10.30- 11.30 am

7. Teaching Assistants: not normally used for this course

8. Meeting Times: Monday, Wednesday and Friday, 4<sup>th</sup> period, 10.40-11.30 am

9. Meeting Location: Weil 273

10. Materials and Supply Fees - none

11. Textbooks and Software Required – *Principles of Electronic Materials and Devices*, by S. O. Kasap, McGraw-Hill, 3<sup>rd</sup> Edition (ISBN: 0-07-295791-3). Slides from the book are posted at the class page (Canvas) on the E-Learning website, <http://lss.at.ufl.edu>

12. Recommended Reading – Assigned in class; the following may be helpful to some students - *Introduction to Solid State Physics*, by C. Kittel, Wiley, 8<sup>th</sup> Edition (ISBN: 0-471-41526-X)

13. Course Outline – 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.

Section Subject	Lecture	Date	Lecture Topic	Reading assignment
Elementary Concepts	1	1/6	Atomic structure and chemical bonding	3-25
	2	1/8	Chemical bonding	
	3	1/11	Thermal expansion	31-35
	4	1/13	Thermally activated process	45-48
	5	1/15	Crystal States	49-63
		1/18	MLK Holiday	
	6	1/20	Crystal Defects	64-75
	7	1/22	Point/line defects	
Conduction in solids	8	1/25	Drude model	114-121
	9	1/27	Matthiessen and Nordheim rules	125-133
	10	1/29	Hall effect	145-148
	11	2/1	First quiz	*****
Theory of solids	12	2/3	Band structure for metals/semiconductors	291-303
	13	2/5	Density of states/effective mass	305-310
	14	2/8	Fermi energy and distribution	313-315
	15	2/10	Electron theory in metals	315-319
Semiconductors	16	2/12	Intrinsic semiconductors	374-387
	17	2/15	Extrinsic semiconductors	388-394
	18	2/17	Second quiz	*****
	19	2/19	Mobility	401-404
	20	2/22	Diffusion/absorption	416-430
	21	2/24	Direct/Indirect bandgap	448-456
	22	2/26	pn junction and diode	476-485
		2/27-3/4	Spring Break	
	23	3/7	MOSFET	532-539
	24	3/09	Light emitting diode	543-550
Dielectrics	25	3/11	Permittivity	584
	26	3/14	Polarization	597-601
	27	3/16	Capacitor dielectrics	631-635
	28	3/18	First exam	*****
Magnetic properties	29	3/21	Magnetization	685-692
	30	3/23	Magnetic materials classes	696-698
	31	3/25	Ferromagnetism	699

	32	3/28	Origin of ferromagnetism	700-702
	33	3/30	Magnetic recording materials	749-755
Optical Properties	34	4/1	Optical properties	
	35	4/4	Light waves/refractive index	774-783
	36	4/6	Reflectance/transmittance	799-803
	37	4/8	Absorption/Luminescence	811-815,820-824
	38	4/11	Phosphors/white LEDs	
	39	4/13	GaN LEDs,luminous flux	853
	40	4/15	Review lecture	
	41	4/18	Review lecture	
	42	4/20	Second exam	*****

14. Attendance and Expectations - attendance is not required, but strongly recommended. Cell phones should be turned off or set to vibrate. Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

15. Grading – Two quizzes (in-class, 50 min each): 30%  
Two exams (in class, 50 min): 70%

16. Grading Scale – Final letter grade will be assigned based on a student’s overall performance during the semester (the instructor has the discretion to grade on a curve to reflect upon the difficulty levels of the exams). The following scale will be used as a guideline:

90-100%	A	85-89%	B <sup>+</sup>
80-84%	B	75-79%	C <sup>+</sup>
65-74%	C	61-64%	D <sup>+</sup>
56-60%	D	0-55%	E

In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). For more information on grades and grading policies, please visit: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

17. Make-up Exam Policy – Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>

18. 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.

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>

19. 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.

20. 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.

21. 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.