

# EMA 3011 Fundamental Principles of Materials, Section 9765

## Spring, 2014

### 1. Catalog Description:

The fundamental principles of structure, reactivity and energies describing materials systems will be covered, directly relating individual principles to specific materials properties or functions. (3 credit hours)

### 2. Prerequisites and Co-requisites:

The prerequisites for this course are CHM 2046 or CHM 2096.

### 3. Course Objectives:

In this course the student is introduced to the way in which the fundamentals of organic materials and the physical laws of quantum mechanics influence materials properties and reactions. The specific objectives are to:

- Become familiar with the fundamentals of organic chemistry and be able to apply them to the chemical and physical properties and processing of polymer materials
- Learn the laws of quantum mechanics and understand the way in which they influence materials properties

### 4. Contribution of course to meeting the professional component:

This course provides 3 credits towards Engineering Sciences.

### 5. Relationship of course to program outcomes:

This course addresses the following MSE Program outcome:

- Ability to apply knowledge of mathematics, science, and engineering to materials systems (High coverage). Students demonstrate this knowledge on homework problems and exams.

### 6. Instructor:

Prof. Susan B. Sinnott

- Office: 154 Rhines Hall
- Telephone: 352-846-3778 (office)
- E-mail address: [ssinn@mse.ufl.edu](mailto:ssinn@mse.ufl.edu)
- Web site: [sinnott.mse.ufl.edu](http://sinnott.mse.ufl.edu)
- Office hours: MWF 11:30-12:00, T 2:30-3:30, Th 1:30-2:30

### 7. Teaching Assistant:

TBD

- Office:
- Telephone:
- E-mail address:
- Office hours:

**8. Meeting Times:**

Monday, Wednesday, Friday 4<sup>th</sup> period

**9. Meeting Location:**

1094 WEIM

**10. Textbooks Required:**

- Title: Introduction to Organic Chemistry  
Authors: William Brown and Thomas Poon  
Publisher: Wiley  
Publication date and edition: 2014, 5<sup>th</sup>  
ISBN number: 978-1-118-08338-3
- Title: Physical Chemistry: A Molecular Approach  
Authors: Donald A. McQuarrie and John D. Simon  
Publisher: University Science Books  
Publication date and edition: 1997, 1st  
ISBN number: 978-0-935-70299-6

**11. Attendance and Expectations:**

Attendance in class is not mandatory but is strongly encouraged as the material covered and for which students are responsible will follow the books closely in some areas and will deviate from them in others.

**12. Grading:**

The course grade is based on numerical scores from three exams using the following weighting system:

Uploaded photo to e-Learning site	4%
Quizzes	8%
Exam #1	22%
Exam #2	22%
Exam #3	22%
Exam #4	22%

**13. Grading Scale:**

Letter grades will be assigned as follows:

92-100= A; 91-88 = A-; 87-84 = B+; 83-80 = B; 79-76= B-; 75-72 = C+; 71-68 = C; 67-65 = C-; 64-62 = D+; 61-59 = D; 58-56 = D-; Less than 56 = E. Grades may be curved up at the end of the course at the discretion of the instructor.

**14. Make-up Exam Policy:**

Makeup exams will not be given without an excused absence supported by written documentation.

**15. Assignments:**

- An uploaded head and shoulders photo to the e-Learning site by the stated deadline.
- Homework problems are given in the course outline below and solutions will be posted to the e-Learning site.
- Quizzes will be posted to the e-Learning site and will be due on the days indicated in the course outline. They will be similar in scope and tone to the homework problems. The lowest quiz grade will be dropped at the end of the semester.
- Exams will closely follow the material covered in class and will be closed book; however, students may bring one 3"x5" index card of material (front and back, hand-written or printed electronically) for use on the exam (index cards must be turned in with exams). Some of the questions on the exams will be taken directly from relevant homework sets. No cell phones or programmable calculators may be used or be with students during exams. Use of these items will be considered to be violation of exam rules and will result in an E on the exam. Requests for re-grading must be made within one week after an assignment has been returned if the exam is taken in ink. If pencils are used on the exams, no regarding requests will be considered.

**16. 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.

**17. 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.

**18. UF Counseling Services:**

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
- SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
- Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
- Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

**19. 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.

## 20. Course Outline:

Class #	Class Date	Topic	Relevant Information or Reading Assignment	Homework Problems
1	M, 1/6	Introduction + review of bonding, polarity, resonance, functional groups, free radicals	B&P: 1.2-1.7	1.37 (a),(c); 1.38 (b),(d),(e); 1.41 (a),(d); 1.44 (a),(d),(g),(i); 1.47; 1.52 (a),(c),(e); 1.53; 1.57
2	W, 1/8	Alkane isomers, IUPAC naming, cycloalkanes	B&P: 3.1-3.5	3.13 (b), (d), (f); 3.14 (a), (b); 3.17; 3.19; 3.25 (b), (d), (f); 3.24 (b), (d), (f); 3.25 (a), (c), (e), (g); 3.29 (a), (c), (d), (g), (k), (f), (j); 3.30 (a), (c), (d)
3	F, 1/10	Alkane and cycloalkane conformations, <i>cis</i> and <i>trans</i> isomerization, reactions	B&P: 3.6, 3.7, 3.9	3.36 (a), (b); 3.46; 3.55 (b), (c)
	M, 1/13	<b>Sinnott travel</b> - Stereoisomers and molecular chirality, Newman projections	B&P: 6.1-6.5, 6.7	6.15; 6.19 (b), (d), (f), (h), (j), (l); 6.24 (a), (b); 6.25 (b), (d); 6.36 (a), (b), (c); 6.37
4	W, 1/15	Alkenes, alkynes and their reactions	B&P: 4.1, 4.2, 5.3	4.15 (b), (d), (f); 4.17 (b), (d); 4.21; 4.27 (a), (b); 4.28 (a), (c)
5	F, 1/17	Alkenes, alkynes and their reactions	B&P: 5.4-5.6	5.15(a); 5.16(a); 5.21; 5.23; 5.25; 5.28 (a), (c), (e); 5.30; 5.33 <b>Quiz #1 due</b>
	<b>M, 1/20</b>	<b>UF Holiday – No class</b>		
6	W, 1/22	Alkenes, alkynes and their reactions	B&P: 5.7, 5.9-5.11	5.39; 5.41; 5.43 (a), (c); 5.45; 5.47; 5.49; 5.51
7	F, 1/24	Haloalkanes, characteristic reactions, and nucleophilic aliphatic substitution reactions <b>Review for Exam</b>	B&P: 7.1-7.3  <b>5-6 PM, Location TBD</b>	7.9; 7.11; 7.17; 7.19
<b>8</b>	<b>M, 1/27</b>	<b>Exam 1</b> <b>Photos due on e-Learning site</b>		
9	W, 1/29	S <sub>N</sub> 2 and S <sub>N</sub> 1 mechanisms and determining when each predominates	B&P: 7.4-7.5	7.21; 7.22; 7.24; 7.26; 7.28; 7.33; 7.35
11	F, 1/31	β-elimination, E1 and E2 mechanisms, and knowing when substitution and elimination occur	B&P: 7.7-7.9	7.36; 7.40; 7.42; 7.43 (b), (d), (f)
12	M, 2/3	Alcohols and their reactions, hydrogen bonding, ethers	B&P: 8.1-8.3	8.13 (b), (d), (f); 8.15 (b), (d), (f), (j); 8.16 (b), (d); 8.18 <b>Quiz #2 due</b>
13	W, 2/5	Epoxides, thiols and their reactions	B&P: 8.4-8.6	8.23 (b), (d); 8.25 (b), (d); 8.26; 8.28; 8.30; 8.34; 8.38 (b), (d), (f); 8.41 (b), (d); 8.45
14	F, 2/7	Benzene, aromaticity, and naming benzene compounds	B&P: 9.1-9.3	9.11 (b), (d), (f); 9.13 (b), (d), (f); 9.14 (b), (d), (f), (h), (j), (l), (n), (p)
15	M, 2/10	Electrophilic aromatic substitution and phenols	B&P: 9.5-9.8	9.26; 9.28 (b), (d); 9.31 (b), (d); 9.37 (a), (c); 9.38 (b), (d); 9.42; 9.48 (a), (d), (e), (g), (h), (n)
16	W, 2/12	Amines, naming and acid-base properties	B&P: 10.1, 10.2, 10.4	10.11 (b), (d), (f); 10.12 (a), (c), (e); 10.22 (b), (d); 10.23; 10.31
17	F, 2/14	Amines reacting with acids,	B&P: 10.5-10.7	10.44

		arylamines, amines as nucleophiles <b>Review for Exam</b>	<b>5-6 PM, Location TBD</b>	
<b>18</b>	<b>M, 2/17</b>	<b>Sinnott travel - Exam 2</b>		
19	W, 2/19	Sinnott travel – Aldehydes and ketones, naming and reactions, Grignard reagents	B&P: 12.1, 12.2, 12.4, 12.5	12.13 (b), (d); 12.14 (b), (d), (f), (h); 12.15; 12.17 (b), (d), (f); 12.18 (b), (d), (f); 12.20
20	F, 2/21	Hemiacetals and acetals, aldehydes and ketones reacting with ammonia and amines, keto-enol tautomerism, oxidation and reduction of aldehydes and ketones	B&P: 12.6-12.9	12.23; 12.25; 12.29; 12.30; 12.36; 12.40; 12.46
21	M, 2/24	Carboxylic acids	B&P: 13.1, 13.2, 13.4-13.8	13.9 (b), (d), (f); 13.10 (b), (d), (f); 13.10 (a), (c), (e), (g); 13.18 (b); 13.19 (b); 13.21; 13.23 (b), (d); 13.30; 13.39 (b), (d), 13.47 <b>Quiz #3 due</b>
22	W, 2/26	Derivatives of carboxylic acids, naming and reactions, hydrolysis, reactions with alcohols	B&P: 14.1-14.4	14.9 (a), (c), (e); 14.10 (b), (d), (f); 14.15; 14.16
23	F, 2/28	Carboxylic acid derivative reactions with ammonia and amines, interconverted, reduction, Grignard reagents	B&P: 14.5-14.8	14.18, 14.21, 14.26, 14.29, , 14.34, 14.39, 14.46
	<b>M, 3/3</b>	<b>Spring Break – No class</b>		
	<b>W, 3/5</b>	<b>Spring Break – No class</b>		
	<b>F, 3/7</b>	<b>Spring Break – No class</b>		
24	M, 3/10	Introduction to quantum mechanics	M&S: 1.1-1.8	1.2, 1.6, 1.8, 1.10, 1.11, 1.13, 1.15, 1.16, 1.18, 1.22, 1.25, 1.26, 1.33
25	W, 3/12	Heisenberg Uncertainty Principle, Schrodinger equation, operators and eigenvalues	M&S: 1.9, 3.1-3.3	1.35, 1.37, 1.39
26	F, 3/14	Particle in a box, normalization, momentum, uncertainty	M&S: 3.4-3.8	3.6, 3.9, 3.12, 3.21, 3.22
27	M, 3/17	Particle in a box: 3D versus 1D and quantum dots	3.9	3.23, 3.24, 3.25, 3.26, 3.27 <b>Quiz #4 due</b>
28	W, 3/19	Postulates of quantum mechanics <b>Review for Exam</b>	M&S: 4.1-4.6 <b>5-6 PM, Location TBD</b>	4.3, 4.5, 4.21, 4.22, 4.23
<b>29</b>	<b>F, 3/21</b>	<b>Exam 3</b>		
30	M, 3/24	Harmonic oscillator and molecules	M&S: 5.1-5.7	5.3, 5.7, 5.9, 5.12, 5.13, 5.22
31	W, 3/26	Rigid rotator and molecules	M&S: 5.8-5.9	5.29, 5.35
32	F, 3/28	Putting it all together: the H atom	M&S: 6.1-6.3	6.15
33	M, 3/31	Properties of H atom orbitals and the He atom	M&S: 6.4-6.7	6.20, 6.21, 6.29, 6.33, 6.36 <b>Quiz #5 due</b>
34	W, 4/2	Introduction of approximations	M&S: 7.1-7.4	7.4, 7.6
35	F, 4/4	Application to multi-electron atoms	M&S: 8.2, 8.3	8.7, 8.9

36	M, 4/7	Spins and electron exchange	M&S: 8.4, 8.5, 8.7	8.16, 18.17, 18.18
37	W, 4/9	Born-Oppenheimer and molecular orbital theory	M&S: 9.1-9.2	9.41
38	F, 4/11	Born-Oppenheimer and molecular orbital theory	M&S: 9.5, 9.6	9.12, 9.17
39	M, 4/14	Implications for polyatomic systems and solid-state materials	M&S: 10.1, 10.3	10.15, 10.16, 10.17
40	W, 4/16	Modern computational quantum chemistry: implications for materials science	M&S: 11.1-11.5	Supplemental <b>Quiz #6 due</b>
41	F, 4/18	Modern computational density functional theory: implications for materials science <b>Review for Exam</b>	Supplemental material <b>5-6 PM, Location TBD</b>	Supplemental
<b>42</b>	<b>M, 4/21</b>	<b>Exam 4</b>		
43	W, 4/23	Class wrap-up, instructor evaluations, preview of junior year MSE classes		