EMA 6461

POLYMER CHARACTERIZATION

Syllabus for Spring Semester 2017

1. Catalog Description – Credits: 3 Grading Scheme: Letter
   -Use of a broad variety of spectroscopic and other scattering phenomena in polymer research.
2. Pre-requisites and Co-requisites: EMA3066 or equivalent
3. Course Objectives:

   This course will provide an overview of the common techniques for determining the structure and characteristics of polymeric materials. The goals of the course are as follows: 1) to equip the student with the knowledge necessary for deciding which characterization technique(s) would be appropriate for determining properties of interest; 2) to impart the student with sufficient background to enable the proper judgment of the quality of data obtained, and the significant variables effecting the results; 3) to enable the student to comprehend the polymer literature and make their own judgment regarding the interpretation of data. This course will not delve into techniques of general materials characterization except where the method differs when applied to polymers. Instead, the methods studied will typically be aimed at determining the polymer's size and molecular weight/distribution, primary structure of the backbone, nature of the chemical bonding environments, crystallinity, thermo/mechanical behavior, secondary conformations, tertiary morphology, surface or interfacial characteristics, etc..
4. Contribution of course to meeting the professional component.

   - This is a 3 credit course. It provided 3 credits towards engineering sciences.
5. Relationship of course to program outcomes: This course addresses the following MSE Program outcomes (note: Numbers refer to the list of MSE Program outcomes):

   1. Ability to apply knowledge of mathematics, science, and engineering to materials systems. This course requires for the students to assess and calculate material parameters from experimental data and plots. (HIGH)
   2. Ability to conduct experiments, analyze and interpret data. Students will collect and/or interpret data, and discover any sources of error. (HIGH)
   3. Ability to conduct and analyze design of experiments (DOE). Students will be exposed to a variety of types of analytical techniques, where they will learn to identify which techniques are best suited for the type of information that is desired, what the strengths and limitations are for the various techniques, and how to avoid or overcome those limitations. (MED)
   4. Ability to apply and integrate knowledge of structure, properties, processing, and performance to solve materials selection and design problems within realistic constraints. The students will be asked to analyze literature that utilizes

a variety of characterization techniques, and determine if they were most suitable or if alternative methods could be utilized. (MEDIUM)

6. Ability to identify, formulate, and solve engineering problems. The students will be asked to provide realistic solutions to issues associated with the material characterization and the associated experimental data sets. (MEDIUM)

7. Understanding of professional and ethical responsibility. The students will discuss how data can be manipulated, both appropriately and inappropriately. (LOW)

8. Ability to communicate effectively in both oral and written form. The students will provide written essay and short answers to homework and exam problems. These will be graded on both technical content, organization and clarity. The students who do the literature review project will also be assessed on their presentation skills, as described above. (MEDIUM)

11. Ability to engage in lifelong learning. The students will practice literature searches and analysis of data from other groups in the literature. (LOW)

13. Ability to use the techniques, skills, and tools needed for practice as a materials engineer. The course is focused on basic knowledge and practical application of a variety of polymer characterization techniques that are commonly used in both the academic and industrial arenas. (HIGH)

6. Instructor: Laurie Gower, Professor of Materials Science & Engineering
   a. Office location: 210A Rhines Hall (ring doorbell for inner office)
   b. Telephone: 846-3336
   c. E-mail address: lgower@mse.ufl.edu
   d. Class Web site: Canvas (http://elearning.ufl.edu)
   e. Office hours: TBD
7. Teaching Assistant: Not applicable
8. Meeting Times: M,W,F: 5th period (11:45am to 12:35am)
9. Class/laboratory schedule: not applicable
10. Meeting Location: Tur 2305
11. Material and Supply Fees: Not applicable
12. Textbooks and Software Required (recommended)
    a. Title: Polymer Characterization- Physical Techniques
    b. Author: D. Campbell, R.A. Pethrick, J.R. White
    c. Publication date and edition: 2000, 2nd Edition
    d. ISBN number: 0-748740058
13. Recommended Reading (see 12 above): In addition, supplementary reading from various sources will be posted on Canvas website
14. Course Outline:

Tentative Schedule

Lecture	Month	Date	Lecture Topic	Book Chapter
1	Jan.	W 4	Class overview and polymer review	Chapter 1
2		F 6	MW- primary methods (EGA;Colligative)	Chapter 2
3		M 9	Secondary methods: Viscometry	
4		W 11	Light scattering	
5		F 13	GPC/SEC	
		M 16	***Martin Luther King Holiday***	
6		W 18	Other Methods (PAGE; M.S.)	
7		F 20	Spectroscopy overview	Chapter 3
8		M 23	UV-Vis spectroscopy	Chapter 4
		W 25	*Catchup day*	
9		F 27	Vibrational spectroscopy	Chapter 5
10		M 30	ATR-FTIR	
		T 31	***Evening Exam 1: Covers MW characterization***	
11	Feb.	W 1	IR Dichroism	
12		F 3	Raman	
13		M 6	IR/Raman application to polymers	
14		W 8	Nuclear Magnetic Resonance Spectr.	Chapter 6
15		F 10	NMR: Shielding & Splitting	
16		M 13	Coupling, Double resonance techniques	
17		W 15	^{13}C and other nuclei; decoupling	
18		F 17	Relaxation times; pulse sequences	
20		M 20	Solid-state NMR	
21		W 22	2D NMR	
22		F 24	NMR applications with polymers	
23		M 27	*Catchup day*	
		T 28	***Evening Exam 2: Covers spectroscopy***	

	March	W 1	Thermal Analysis- DTA/DSC	Chapter 12
24		F 3	Thermogravimetric analysis (TGA)	
		6 - 10	***Spring Break***	
25		M 13	Dynamic mechanical thermal analysis (DMTA)	
26		W 15	Surface properties: contact angle	
27		F 17	Surface chemical analysis (XPS/ESCA/SIMA)	Chapter 13
28		M 20	Microscopy- Light (contrast)	Chapter 11
29		W 22	Fluorescence Microscopy	Supplement
30		F 24	Polarized Light Microscopy	
31		M 27	Electron microscopy: TEM	Chapter 9
32		W 29	Electron microscopy: SEM	Chapter 10
33		F 31	Scanning probe microscopies (SPM)	Chapter 13.4
34	April	M 3	Microscopy of polymers	
35		W 5	Scattering	Chapter 8, 11.5, 13.5
36		F 7	Scattering	
37		M 10	*Catchup day*	
		T 11	***Evening Exam 3: Covers Thermal Analysis, Surface Analysis, Micr.***	
		W 12	***Final Project Preparation***	
		F 14	***Project- student presentations***	
		M 17	***Project- student presentations***	
		W 19	***Project- student presentations***	
			Reading days	

15. Attendance and Expectations: Attendance will not be formally monitored, but classroom contribution to discussions will be noted and taken into consideration for borderline grades. Therefore, you may want to notify me of any necessary absences. Plus, for excused absences, I will provide you with my annotated lecture notes, which highlight important concepts of that topic.
    - Homework: Homework should be turned in at the beginning of class. No late submissions will be accepted in order that solutions can be posted after class.
    - Grade changes: Requests for adjustment to any grade should occur within the 2 week period following the posted grade in question, and must be approved by the course instructor (you can discuss your concerns with the TA, but the TA cannot change grades without final approval from me).
    - Policy on Cell Phones: Cell phones should be turned off or on vibrate mode during class, with the exception of a primary care giver. If/when receiving a call, promptly move to outside the classroom.

16. Grading – methods of evaluation

First exam-	20%
Second exam-	20%
Third Exam-	20%
Homework-	10%
Final Project-	30%

17. Grading Scale: (rounded up for ≥ 0.5)

A	= 90 or above	C	= 70-73
A-	= 87-89	C-	= 67-69
B+	= 84-86	D+	= 64-66
B	= 80-83	D	= 60-63
B-	= 77-79	D-	= 57-59
C+	= 74-76	E	= 56 or below

"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

18. Make-up Exam Policy: Make-up exams will be provided only with the prior approval of the instructor for excused absences. In general, acceptable reasons for excused absence include illness, serious family emergencies, special curricular requirements, military obligation, court-imposed legal obligations, religious holidays and participation in official university activities such as music performances, athletic competition or debate.

19. 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

20. 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.

21. 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, http://www.counseling.ufl.edu/cwc/Default.aspx, counseling services and mental health services.
    - Career Resource Center, Reitz Union, 392-1601, career and job search services.

      University Police Department 392-1111

22. 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.

23. Students are expected to provide feedback on the quality of instruction in this course based on 10 criteria. These evaluations are conducted online 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. "