## SYLLABUS: POLYMER PHYSICAL PROPERTIES (20 MTEN 634 001)

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#### Quarter: Spring 2004: 9:00-9:50 MWF 643 Baldwin

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540 ERC/410 Rhodes

Textbook:

- 1. "The Physics of Polymers, 2'nd Ed., Concepts for Understanding Their Structure and Behavior", G. Strobl, Springer Press 1997.
- 2. "Introduction to Polymer Physics" M. Doi, Clarendon Press 1996.
- 3. Class Notes Posted on the Web at: http://www.eng.uc.edu/~gbeaucag/BeaucageResearchGroup.html
- 4. "Scaling concepts in polymer physics" P. G. de Gennes, Cornell University Press 1979.
- 5. "The theory of polymer dynamics" Doi/Edwards, Oxford University Press, 1986.
- 6. "Principles of polymer chemistry." P. J. Flory, Cornell University Press 1953 (Available in reprint).
- 7. "Polymer Chemistry, The Basic Concepts", Paul C. Hiemenz, Marcel Dekker 1984.

Level: Graduate (Not Recommended for undergraduates)

Synopsis of Course: This course is aimed at equipping students with a basic level of knowledge of the terminology and mathematics involved in the physical understanding of polymers. Most of the topics deal with post 1970 concepts involving the statics and dynamics of polymeric materials. The course is intended for graduate students who would like to gain an understanding of modern approaches to polymer physics (statics). The course will closely follow the recent books of Strobl and Doi as well as Flory's seminal text. Doi's intent is similar to that of this course, "...to present a framework to graduate students in a concise and self-contained manner..." The prerequisite is "...a knowledge of undergraduate-level statistical mechanics..." as introduced in thermodynamics courses and polymer classes. Courses in polymers and thermodynamics are a necessary preparation for the course. The syllabus follows Strobl's Chapters 1-2 the Appendix on RPA and Scattering and Chapter 7 as well as Doi's 5 chapters.

This course is not recommended for undergraduates or for graduate students outside of Chemical and Materials Engineering, Chemistry or Physics due to the work load and prerequisites. Many students find they spend more than 20 hours per week on this course.

1. <u>Properties of an isolated polymer molecule.</u> (Chapter1.html) a. Ideal chain

- b. Segmental distribution
- c. Non-ideal chains
- d. Scaling laws
- 2. Concentrated solutions and melts

### (Chapter2.html)

- a. Thermodynamics of polymer solutions
- b. Concentration fluctuations in polymer solutions
- c. Expaned coil and osmotic pressure
- d. Blends
- e. Block copolymers
- 3. <u>Rubber elasticity</u>
  - (Chapter3.html)
    - a. Elasticity
    - b. The stress optical law
    - c. Interactions between partial chains
  - d. Swelling of gels
- 4. <u>Molecular motion of polymers in dilute solution</u>. (Chapter4.html)
  - a. Brownian motion
  - b. Bead-spring model (Rouse Model)
  - c. Dynamic light scattering
  - d. Hydrodynamic interactions
- 5. <u>Molecular motion in entangled polymer systems</u>. (Chapter5.html)
  - a. Dynamics of concentration fluctuations
  - b. Reptation
  - c. Viscoelasticity of polymers
  - d. Lodge Liquid

### **Course requirements:**

### **Quizzes (Equal Weight)**

10 Weekly Quizzes End of each Friday class, 1 problem (usually with 5 parts) 20 minutes

Comprehensive Final Exam Monday,June 7,12:00 - 2:00 p.m During Finals Week. (*3 Quizzes*)

Final Grade will be a letter grade (no + -'s used): A = 90.0 to 100; B = 80.0 to 89.9; C = 70.0 to 79.9 Final Grade is the mean of all quizzes and the comprehensive final weighted at 3 quizzes.

Students can replace their quiz grades with a critical review of a published paper dealing with one of the topics covered in the class (replace up to 3 quiz grades per review). The review must comment on the scientific validity of the work and the merit of the paper for publication, i.e. comment on what was added to the scientific

literature by the paper, problems with the data and interpretation, suggest better measurements or approaches and the like. **The review must include a copy of the paper and copies of relevant literature cited in the review.** Students are expected to search the literature for contradictory data and theories. The review will be between 1 and 4 pages single spaced using 12 point font and 1 inch margins.

### Reviews are due 2 weeks after the quiz which is to be replaced with the exception of the last two quizzes and the final. All Critical Reviews must be turned by the last Wednesday of Classes June 2 at 5pm. Senior undergraduates will be required to write a critical review for the final which is due Friday June 4 at 5 pm in 410 Rhodes.

Useful Links for Critical Reviews: <u>Citation Search for UC/Ohiolink</u> Electronic Journals (online) for Ohio Link

# There will be no "make-up" quizzes, if a quiz is missed a critical review will be needed to replace the 0 grade.

There is no limit to the number of critical reviews that can suppliment quiz grades (it is possible to submit 5 critical reviews for the entire course grade). There will be 13 quiz grades for the course.

Old Quizzes are given on the web page and these should be studied carefully prior to the quiz although topics may vary somewhat from year to year.