**CHEN 415/ CHGN 430 / MLGN 530**
**Introduction to Polymer Science (Polymer Science and Technology)**
**Fall Semester 2008, CO 131**

Professor: Stephen G. Boyes 254 Coolbaugh Hall 273-3633 sboyes@mines.edu

Website: http://www.mines.edu/fs_home/sboyes/courses.html

Text: Polymer Chemistry, 2nd edition (2007) by Paul Hiemenz and Tim Lodge, Publisher: CRC Press

Recommended References:

Contemporary Polymer Chemistry, 3rd edition (2003) by H.R. Allcock, F.W. Lampe, and J.E. Mark, Publisher: Pearson

Principles of Polymer Systems, 5th edition (2003) by F. Rodriguez, C. Cohen, C.K. Ober, and L.A. Archer, Publisher: Taylor and Francis

Principles of Polymerization, 4th edition (2004) by George Odian, Publisher: Wiley-Interscience

Fundamental Principles of Polymeric Materials, 2nd edition (1993) by S.L. Rosen, Publisher: Wiley-Interscience

The Elements of Polymer Science and Technology, 2nd edition (1999) by Alfred Rudin, Publisher: Academic Press

**Catalog Description:**

Over the last 60 years, polymer chemistry has had a striking and direct impact on the lives of almost every person. The products made from polymers influence virtually every aspect of our present way of life. As such, more than 50% of all chemists and chemical engineers are involved with research or development work with polymers. While polymer chemistry broadly encompasses different areas of organic, inorganic, and physical chemistry; the synthesis of polymers is very different from the synthesis of small molecules. Indeed, probably the main challenge in polymer chemistry is the application of fundamental chemical and physical techniques and ideas to large and complex molecules.

Due to the inherently interdisciplinary nature of polymer science, this course will draw on the knowledge of several fields of study. Starting with a discussion on the basic concepts and definitions of polymeric materials as well as structure and molecular weight determination, the course will then move to discuss the organic chemistry of polymers and the reaction engineering of various polymerization techniques. Next, the materials science of polymers in the varying physical states of semi-crystalline, glassy, rubbery, and liquid will be discussed, along with various characterization techniques based upon solution properties. Processing operations for polymeric materials will be briefly discussed and time permitting, a short discussion on recent advances in polymers will be included.

**Course Learning Objectives:**

The class will provide the needed background to familiarize chemists and engineers with polymer production techniques, polymer characterization and materials selection problems. Upon completion of this class, all students should be able to:

1. Draw chemical structures of some representative polymers; define and understand basic polymer concepts; derive and apply the basic principles behind polymer molecular weights and molecular weight determination; and identify the different types of polymer isomerism and conformational changes and what effect these changes have on polymer properties.
2. Outline synthetic procedures and mechanisms for polymer formation, derive and manipulate chemical kinetic equations describing polymer formation in order to specify reaction conditions to achieve target molecular weights and polymer or copolymer architectures.
3. Describe different methods for the production of polymeric materials such as solution, bulk, suspension and emulsion polymerizations.
4. Give examples of the structural considerations at the molecular level that give rise to crystallinity in polymer materials and describe the morphology of semi-crystalline materials.
5. Define and describe the theory behind the glass transition, free volume, and polymer solutions.
6. Work phase equilibria problems using Flory-Huggins theory.
7. Summarize the principles behind and the operation of various techniques used to characterize polymeric materials including gel permeation chromatography, dilute solution viscometry, differential scanning calorimetry, thermal gravimetric analysis, and x-ray diffraction.
8. Interview successfully for a job in the polymer industry by conversing intelligently with the interviewer about technical aspects of polymer science and engineering.

**Course Grading:**

Your grade in this course will be determined as follows:

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| All Homework | 10% |
| Presentation | 15% |
| Exam 1 | 25% |
| Exam 2 | 25% |
| Exam 3 | 25% |
| | |
| Total | 100% |

- Periodic homework will be assigned and graded, with the average of all homework grades making up the 10%
- A 15 minute presentation will be given in groups of three on a topic/paper relevant to the course. Topics/papers must be chosen in consultation with me before the last week in September. Presentations will be given in November.
- Exams 1 and 2 will be held during the semester and cover the material presented before each exam. Exam 3 will be the final and will be comprehensive.

**Office Hours:**

Office hours will be Monday and Wednesday from 10:00 – 12:00. You may always schedule an appointment by **e-mailing** me ahead of time. If my office hours do not fit in with your schedule, I am more than happy to meet you outside of office hours but please **e-mail first**. There are many demands on a professor's time and I am not always available or in my office. As such, setting up an appointment by e-mail will make sure that I am in my office and have time to help with any questions you may have.

**Academic Dishonesty:**

All students at the Colorado School of Mines are subject to the Student Honor Code, as outlined in both the undergraduate and graduate student bulletins (http://www.mines.edu/stu_life/activities/Brunton/campusrulesandregs.pdf ), and I expect all students within this course to follow that code. Academic integrity is a founding principle of not only the Colorado School of Mines but of the entire academic community. Any student violating the principles of academic integrity is guilty of academic dishonesty. Academic dishonesty includes, but is not limited to, dishonest conduct, plagiarism, cheating, enabling others to cheat, falsification or fabrication, tampering and impeding. Any student found committing academic dishonesty at any stage during the course will be penalized by receiving, at a minimum, a grade of F for the entire course and potentially expelled from the University in accordance with the University's general regulations on ethics and honesty.

I am sure all students in this class have both honesty and integrity and will follow the Student Honor Code. If at any stage you have questions about, or are unclear as to what constitutes, academic dishonesty, please come and see me *before* proceeding.