Chemistry/Physics 538: POLYMER SCIENCE
Mechanics of plastics, gels, and cells

TEXTBOOKS:
Mechanics of the Cell, D. Boal (Cambridge University Press) (optional)
Physical Biology of the Cell, Rob Phillips, Jane Kondev, and Julie Theriot (Taylor and Francis, inc) (optional)

TIME AND PLACE:
Spring 2014, TTh 17.30-18.45  room 147 (Physics building)

PREREQUISITES (concurrent enrollment allowed):
(Chemistry 200 or 202) and (Physics 360 or Chemistry 400B or Mechanical Eng. 350 or Mechanical Eng. 352) or consent of instructor.

INSTRUCTOR:
Prof. Arlette Baljon, room 136 (Physics building) abaljon@mail.sdsu.edu.
Office hours: TTh 15.00- 16.00 or by appointment.

GRADING:
Problem sessions (10%), Tests (60%), Final presentation (30%).
Scale: A: 85%  B: 75%  C: 65%  D: 55%  partial grades given.

COURSE OUTLINE:

Introduction and polymer synthesis
-  What is polymer science?
-  Basic definitions
-  Step-growth and chain polymerization
-  Kinetics of polymerization
-  Statistics of polymerization

Microstructure
-  Conformations and configurations of polymer chains
-  Random walks and random flights
-  Polymer morphology
-  Gelation and percolation

Crystallization, melting and the glass transition
- Review of basic thermodynamics
- Some statistical mechanics
- The crystalline melting temperature
- Kinetics of polymer crystallization: nucleation
- The glass transition.

**Thermodynamics of polymer solutions and blends**
- Polymer excluded volume
- The free energy of mixing
- Flory-Huggins theory
- Phase separation
- Theta solvents

**Mechanical and rheological properties**
- Stress-strain behavior
- Viscosity of polymer melts
- Viscoelasticity: some simple models
- Relaxation in polymers
- Time-temperature superposition principle

**Physical properties of Biopolymers**
- Elasticity, entropy, and bending energy of biopolymer
- Helix and coil formation
- DNA and RNA
- PRC and electrophoresis

**Molecular motors**
- The cytoskeleton
- Molecular motor proteins: myosin and kinesin
- Thermal ratchets
- Growth through dynamic instability
- Treadmilling

<table>
<thead>
<tr>
<th>Week of:</th>
<th>Tuesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 23</td>
<td>Lecture Chap 2 Painter</td>
<td>Lecture Chap 1 Painter</td>
</tr>
<tr>
<td>Jan 28/30</td>
<td>Lecture Chap 4 (E) Painter</td>
<td>Lecture Chap 3 (A-B), Chap 4 (A-C) Painter</td>
</tr>
<tr>
<td>Febr 4/6</td>
<td>Problem session 1: read</td>
<td>Problem session 1: read Painter Chap 1 and</td>
</tr>
<tr>
<td></td>
<td>Painter Chap 1 and</td>
<td>Chap 2 (till page 47), 3 (A-B), Chap 4 (A-C).</td>
</tr>
<tr>
<td>Febr 11/13</td>
<td>Lecture Chap 7 Painter</td>
<td>Problem session 2: read Painter Chap 4 (E), 7</td>
</tr>
<tr>
<td></td>
<td>(online)</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Activity</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Febr 25/27</td>
<td>Lecture Chap 8 Painter</td>
<td></td>
</tr>
<tr>
<td>March 4/6</td>
<td>Lecture Chap 9 Painter</td>
<td></td>
</tr>
<tr>
<td>March 11/13</td>
<td>Test I: Painter Chaps. 1, 2, 3(A-B), 4 (A,B,C,E), 7 and material from problem sessions 1-2</td>
<td></td>
</tr>
<tr>
<td>March 18/20</td>
<td>Lecture Chap 11 Painter</td>
<td></td>
</tr>
<tr>
<td>March 25/27</td>
<td>Lecture Chap 11 Painter</td>
<td></td>
</tr>
<tr>
<td>April 8/10</td>
<td>Problem session 3: read Painter Chap 8 and 9</td>
<td></td>
</tr>
<tr>
<td>April 15/17</td>
<td>Lect Biopolymers</td>
<td></td>
</tr>
<tr>
<td>April 22/24</td>
<td>Test II: Painter Chaps. 9,10 (A-B),11 (A-F) and material from problem sessions 3-4</td>
<td></td>
</tr>
<tr>
<td>April 29/May 1</td>
<td>Lect Biopolymers</td>
<td></td>
</tr>
<tr>
<td>May 6/8</td>
<td>Presentations</td>
<td></td>
</tr>
<tr>
<td>May 13  6-8</td>
<td>Presentations (instead of final)</td>
<td></td>
</tr>
<tr>
<td>May 19</td>
<td>Test III Biopolymers (take home) and write-up on presentation due…..submission by email allowed.</td>
<td></td>
</tr>
</tbody>
</table>

Note: there will be no class the week of Feb 17. Instead individual session with student will be scheduled to consult on final presentations.

**Presentations:**

Each student has to give a 10 min presentation on a topic related to the class material. A 3-page write-up on this presentation is due on May 20. This write up should contain a title, an abstract of 150-250 words, and at least 3 references (references to our textbook are allowed). The take-home final is due that day as well.

**Student learning outcomes:**

Polymer Science is an interdisciplinary field in which chemists, physicists, engineers, and biologists closely collaborate. It is a relative young field, actively explored in cutting edge 21th century research. In this course students will familiarize themselves with the most important concepts in this area. They will learn about the fundamental mechanical and rheological properties of polymeric materials and cellular polymeric filaments. They will work with students of other disciplines in the problem sessions. They will also acquire presentation skills.