PHYS 576: Advanced Topics in Theory: Spring 2012
Simple to Complex Fluids

I. Course Information

Course Summary: This course will be a survey of important features of the liquid state. The physics of liquids is important from everything from "garden variety" liquids that are relatively well understood, to complex systems like polymer composites, films, biological membranes and gels. There is not enough time for a comprehensive discussion of all these topics, so we will consider a more select choice of discussion. Classes should be highly interactive – not simply lecture. I will expect you to take initiative to question and analyze the material in class.

Background: I assume knowledge of undergraduate statistical and thermal physics. You may also be required to indepedently review some material from graduate statistical physics.

Instructor: Francis Starr (fstarr@wesleyan.edu), Science Tower #227, x2044

Office Hours: Since the class is small, we do not need to fix specific hours. If my door is open, I am usually happy to answer your questions. If you have any concern about finding me, please email and we can fix a meeting time.

Lectures: T 10:30 – 11:50 AM, R 1:10 – 2:30 PM; yes, this is a slightly weird schedule.

Course Text: As this course is an overview of a broad set of material, there is no single required course text. I will provide handouts or electronic copies of some material. Below is a list of texts that offer helpful backgroud.

Statistical mechanics and thermodynamics

1. K. Huang, *Statistical Mechanics*, Second edition, graduate level.
2. R. K. Pathria, *Statistical Mechanics*, Second Edition, graduate level.
3. F. Reif, *Statistical and Thermal Physics*, grad/undergraduate level.
4. B. Widom, *Statisical Mechanics: A concise introduction for chemists*, undergraduate level.
5. C. Kittel and H. Kroemer, *Thermal Physics*, undergraduate level.

Liquids, Phase Transitions, Soft Matter, Biology

1. H. E. Stanley, *Phase Transitions and Critical Phenomena*
2. P. G. Debenedetti, *Metastable Liquids*
3. J.-L. Barrat and J.-P. Hansen, *Basic Concepts for Simple and Complex Liquds*
4. J.-P. Hansen and I. R. McDonald, *Theory of Simple Liquds*
5. R. A. L. Jones, *Soft Condensed Matter*
6. P.-G. de Gennes, *Scaling Concepts in Polymer Physics*

7. P. Nelson, *Biological Physics*

Homework: There will be a few modest assignments during the course. Assignment will be modest since there are few problems that are tractable in the context of a traditional homework. Homeworks will constitute 30% of your grade. Late homework is not accepted.

Final Evaluation: The main means of evaluation will be either a final presentation, or a final oral exam; the student may choose which means of evaluation is used. Details of evaluation will be discussed around the mid-point of the course. The final evaluation will be 60% of your grade. The remaining 10% will be based on participation throughout the semester.

II. Tentative Syllabus

The quarter is very short, and we may be pressed to cover all topics. Based on your feedback – and since I have never taught this previously – we may deviate from this original plan.

Week 1: Fluid Phase Behavior and Thermodynamics

Week 2: Stucture of Liquids

Week 3: Dynamics of Liquids

Week 4: Glass Formation and Gelation

Week 5: Polymeric and Biological Liquids

Week 6: Presentations and oral exam preparation