

PHYS 782

# Condensed Matter Physics

Spring 2007

# 10303 (3 credits)

**Instructor:** Dr. Alan Denton  
South Engineering 214B  
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**Meetings:** TF 10:00-11:15 a.m.  
South Engineering 212C

**Office Hours:** To be arranged  
South Engineering 214B

**Bulletin Description:** An introduction to the field of soft condensed matter, focusing on colloids, polymers, liquid crystals, surfactants, membranes, and other biological systems. Topics will include characterization of soft materials, interparticle interactions, structure, equilibrium phase behavior, nonequilibrium properties, and practical applications.

**Preparation:** Advanced knowledge of mechanics, electrostatics, thermodynamics, and statistical mechanics. Experience with numerical methods and computer programming.

**Student Responsibilities:** Attend all lectures. Read assigned material in advance. Come prepared for discussion. Be curious; ask questions. Complete assignments on time.

**Objectives:**

- Develop conceptual understanding and practical expertise in modern theoretical and computational methods applied to soft matter systems.
- Gain an appreciation for the remarkable physical properties and industrial applications of soft materials.

**Topics:** See attached course outline for a tentative list of topics.

**References:** R. A. L. Jones, *Soft Condensed Matter* (Oxford, 2002).  
See also the list of books on reserve in the library for short-term loan.

**Evaluation:**

Homework	30%	All assignments and the research project must be completed to pass the course.
Research Project	20%	
Exams (2)	40%	
Participation	10%	

**Lateness:** Late homework will be accepted with a 20% penalty/day until next class.

**Grading:** A:  $\geq 85\%$ , B: 70-84.9%, C: 60-69.9%, F:  $< 60\%$

*All work in this course must be completed in a manner consistent with NDSU University Senate Policy, section 335: Code of Academic Responsibility and Conduct (<http://www.ndsu.nodak.edu/policy/335.htm>).*

*Any students with special needs are encouraged to contact the instructor promptly to make appropriate arrangements.*

## Course Outline

### I. INTRODUCTION

- Defining characteristics of soft condensed matter
- States of matter and phase transitions
- Applications of soft materials
- Scope of the course

### II. COLLOIDS

- Interparticle Interactions and Stabilization
- Effective Interactions and DLVO Theory
- Structure and Phase Behavior
- Dynamics: Aggregation, Rheology

#### Applications

paints and inks  
food colloids (*e.g.*, milk)  
sedimentation and flotation  
photonic materials

### III. POLYMERS

- Fractal Nature of Polymers
- Statistical Mechanics of Chain Molecules
- Polymer Solutions and Melts
- Block Copolymers
- Phase Separation

rubbers and plastics  
food polymers  
biopolymers (proteins, DNA, actin)  
viscoelastic fluids  
synthetic materials

### IV. LIQUID CRYSTALS

- Classification by Symmetry
- Nematics and Cholesterics
- Smectics and Columnar Phases
- Phase Transitions

display devices (LCD)  
heat sensors

### V. AMPHIPHILES

- Micelles, Bilayers and Vesicles
- Langmuir Monolayers
- Microemulsions
- Membranes

soaps and detergents  
thin films  
foams  
biological cells