

## **MSE 4335: Soft Nano/Bio Materials**

**Credit hours and contact hours:** 3-0-0-3

**Instructor:** Vladimir Tsukruk

**Textbook:** Textbook not used. Lecture notes used.

### **Specific course information**

**Catalog description:** Introduction soft nanomaterials and nanostructures that have been discovered and synthesized for prospective applications in nanotechnology.

**Prerequisites:** MSE 2001 – Principles & Applications of Engineering Materials

**Course:** Selected Elective

### **Specific goals for the course**

#### **Outcomes of instruction:**

1. General principles of chemical and physical basis for soft nanomaterials
2. Thermodynamics of flexible long-chain molecules
3. Principles of surface and interface formation in soft nanomaterials
4. Assembly approaches to formation of organized soft nanomaterials
5. Major classes of soft nanomaterials and their fundamental properties
6. Current, emerging, and prospective applications of soft nanomaterials

#### **Student Outcomes:**

- (1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- (2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- (3) An ability to communicate effectively with a range of audiences.
- (4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- (5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- (6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

**Topics covered:**

**Module I: Soft Matter Fundamentals**

Introduction in soft nanomaterials-general principles  
 Introduction -general principles and chemical structures  
 Configuration, conformation, local/global flexibilities  
 Entropy, enthalpy, & multi-length scale dynamics  
 Solutions and solid states of soft matters  
 Thermal and mechanical properties  
 Surfaces and interfaces at confined states 1

**Module II: Organization and Assembly of Soft Nanomaterials**

Surface and interfacial organization 2  
 Colloidal assemblies  
 Nanoparticles and organic ligands 1  
 Nanoparticles and organic ligands 2  
 Molecular films  
 Layer-by-layer assemblies  
 Polymer Brushes

**Module III: Properties and Application of Soft Nanomaterials**

Responsive soft nanomaterials  
 Hybrid nanoparticles applications  
 Microcapsules and bio/synthetic membranes  
 Block-copolymers and reinforced nanomaterials  
 Soft membranes  
 Soft lithography  
 SPM Lithography  
 Controlled delivery  
 Flexible electronics  
 Organic photonics/electronics 1  
 Organic photonics/electronics 2

**Correlation between Outcomes of Instruction and Student Outcomes:**

Outcomes of Instruction	Student Outcomes						
	1	2	3	4	5	6	7
1. General principles of chemical and physical basis for soft nanomaterials	X					X	
2. Thermodynamics of flexible long-chain molecules	X	X					

3. Principles of surface and interface formation in soft nanomaterials		X		X			
4. Assembly approaches to formation of organized soft nanomaterials	X					X	
5. Major classes of soft nanomaterials and their fundamental properties				X	X	X	
6. Current, emerging, and prospective applications of soft nanomaterials	X	X	X	X	X		X

**School of Materials Science and Engineering Student Outcomes:**

- (1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- (2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- (3) An ability to communicate effectively with a range of audiences.
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