MSE 4330: Fundamentals of Nanomaterials and Nanostructures (required)

Catalog Description: (3-0-3)
Prerequisites: MSE 2001 Introduction to Engineering Materials
Introduction to nanotechnology. Description of various nanomaterials, their applications and synthesis methods.

Textbook: "No Small Matter: Science on the Nanoscale": Felice C. Frankel and George M. Whitesides, The Belknap Press of Harvard University Press, 2009
"Introductory Nanoscience: Physical and Chemical Concepts": Masaru Kuno, Garland Science; 1 edition (August 19, 2011)

Prepared by: Dong Qin

Topics Covered:

1. Structure and property – 2D and 3D system.
2. Specific surface to volume ratio and surface energy.
3. Length of nanoscales: metal, semiconductor and magnetic nanoparticles.
4. Light and electrons: optical and electron microscopy.
5. Near field imaging: near field optical microscopy and scanning probe microscopy.
6. Top-down approach: photolithography, e-beam lithography and soft lithography
7. Bottom-up approach: shape controlled synthesis of nanomaterials.
8. Self-assembly of colloidal particles for photonics.
9. Lab demos: "feel" and "see" nanomaterials.
10. Recent development of nanomaterials and safe nanotechnolgy

Course Outcomes:

Outcome 1: The student will develop a fundamental knowledge of nanomaterials.

1.1 The student will demonstrate a basic understanding of the length scale that defines nano for metal and semiconductor materials.
1.2 The student will demonstrate an understanding of the properties of materials with strong dependence on size.
1.3 The student will demonstrate an understanding of approaches to nanomaterials characterization.
1.4 The student will demonstrate an understanding of approaches to engineering nanomaterials and nanostructures.
1.5 The student will demonstrate an understanding of the challenges on safe nanotechnology.

Outcome 2: The student will gain experience in applying unique properties of nanomaterials to solve problems and challenges in our life.

2.1 The student will demonstrate the ability to develop case studies of nanomaterials with a focus on fundamentals, fabrication, characterization, and applications.

2.2 The student will demonstrate the ability to write final project report to reflect his/her learning on fundamentals through the course.
2.3 The student will demonstrate an ability to present final project and share his/her learning.

Correlation between Course Outcomes and Student Outcomes:

Course Outcomes	Student Outcomes										
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Course Outcome 1.1	x	x							x		
Course Outcome 1.2	x	x			x				x		x
Course Outcome 1.3	x	x			x				x		x
Course Outcome 1.4	x	x			x				x		x
Course Outcome 1.5		x	x	x	x	x		x	x		x
Course Outcome 2.1	x	x		x	x		x	x	x		x
Course Outcome 2.2	x		x	x	x	x					x
Course Outcome 2.3	x		x	x	x	x	x		x		x
Entire Course	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**0**	**3**
0 = None or insignificant; 1 = Some; 2 = Moderate; 3 = Strong											

School of Materials Science and Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.