

# NANOSCIENCE AND NANOTECHNOLOGY (NANO)

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## **NANO 530. Nanomaterials Characterization Techniques. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. This course will explore a select number of fundamental topics that are essential to nanoscience and nanotechnology. Topics will be developed to a basic understanding of the scientific principles and technological methods that are employed in research in experimental nanoscience. Theoretical concepts are only briefly introduced when they are needed. The following topics will be examined: ultra-high vacuum system and techniques, surface structure and characterization techniques, surface electronic properties, elements of crystallography, theory of electronic lenses, interactions of electrons with solids, elements of image processing techniques.

## **NANO 570. Nanoscale Physics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. This course builds a fundamental understanding of the unique properties of materials with nanoscale dimensions and emphasizes the physics and thermodynamics underlying several phenomena encountered in nanotechnology. The course starts from a general description of size effects and then moves to describe the fundamental aspects of nanocluster physics such as magic numbers, and concludes with a description of the theory and fabrication of nanoscale devices. Suggested background: PHYS 380.

## **NANO 571. Nanoscale Chemistry. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. This course builds a fundamental understanding of the unique chemical properties of materials with nanoscale dimensions and emphasizes the synthetic chemistry encountered in nanotechnology. The course starts from a description of crystallization and growth models and concludes with discussion of several different synthetic approaches of nanoscale systems. Suggested background: PHYS 380.

## **NANO 630. Experimental Techniques in Nanoscience. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. This course will explore a select number of fundamental topics that are essential to nanoscience and nanotechnology. Topics will be developed to a basic understanding of the scientific principles and technological methods that are employed in research in experimental nanoscience. Theoretical concepts are only briefly introduced when they are needed. The following topics will be examined: ultra-high vacuum system and techniques, surface structure and characterization techniques, surface electronic properties, atomic motion and vibration on solid surface, semiconductor surfaces and interfaces, nanofabrication techniques.

## **NANO 650. Experimental Techniques in Nanoscience I. 1.5 Hour.**

Semester course; 1.5 lecture hours. 1.5 credits. The course will focus on a variety of instrumental methods and techniques commonly applied to the characterization of nanomaterials. Particular attention will be placed on the theory behind the measurements, instrument safety, sample preparation and data analysis/interpretation. Topics will focus on X-ray, optical and electron characterization techniques. Suggested background: CHEM 409 or PHYS 450.

## **NANO 651. Experimental Techniques in Nanoscience II. 1.5 Hour.**

Semester course; 1.5 lecture hours. 1.5 credits. The course will focus on a variety of instrumental methods and techniques commonly applied to the characterization of nanomaterials. Particular attention will be placed on the theory behind the measurements, instrument safety, sample preparation and data analysis/interpretation. Topics will cover morphological and physical properties characterization tools. Suggested background: CHEM 409 or PHYS 450.

## **NANO 660. Theoretical Studies of Nanostructures. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: CHEM 660 or PHYS 580. Introduction to theoretical techniques needed to study electronic and magnetic properties of nanostructures. Covers theoretical first-principles approaches to study electronic structure of molecules, clusters, nanostructure materials and condensed matter, including determination of geometry and electronic states. Will also cover magnetic properties in reduced sizes, including quantum effects and the model Hamiltonians. A brief discussion of effective interatomic molecular potentials and their application in monte-carlo and molecular dynamics methods will be included, as well as a discussion of application of nanomaterials to medical areas. Suggested background: CHEM 660 or PHYS 580.

## **NANO 661. Computational Nanoscience. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: CHEM 511, CHEM 512 or CHEM 612. Open only to students admitted to the Nanoscience and Nanotechnology Ph.D. program. Introduction to computational methods used to model true nanostructures containing more than  $10^5$  atoms and whose assembly, morphology and properties are governed by noncovalent interactions. Structural and dynamic aspects of the computational methods will be covered throughout the course. Applications to nanotechnology and environmental cleanup will be covered through special topics assignments during the semester and discussed by the end of the course.

## **NANO 690. Research Seminar in Nanoscience and Nanotechnology. 1 Hour.**

Semester course; 2 lecture hours. 1 credit. May be repeated for credit. In addition to reports presented by staff and visiting lecturers, current problems and developments in nanoscience and nanotechnology are discussed. Graded S/U/F.

## **NANO 692. Nanoscience Seminar Presentation. 1 Hour.**

Semester course; 2 lecture hours. 1 credit. May be repeated for credit. In addition to reports presented by students, staff and visiting lecturers, current problems and developments in chemistry are discussed.