APHY 510 Introduction to Nanoscience and Technology

Course Description

Explores science and technology at the nanoscale. Studies the physical properties of nanomaterials, the tools and techniques for nanosystem fabrication and investigation; principles of mechanical, optical, electrical, and magnetic nanosystems; current state of nanotechnology in physics, chemistry, biology, engineering, and information systems; and future applications. (3 credit hours)

Prerequisite: PHYC 260.

Course Objectives

The introduction of ultra-modern topics in nanoscience and nanotechnology to undergraduate students is a course objective. Through this course we seek to motivate undergraduates about science, intensify their science studies, and expand their science horizons. Teaching and learning the physics fundamentals of physical phenomena at the nanoscale is a course objective. The course seeks to prepare students for the expected revolutionary expansion of our technology originating in nanoscience. The course will illustrate the graying of disciplinary boundaries at the nanoscale and promote interdisciplinary studies.

Course Rationale

Nanoscience is arguably the most exciting area of scientific research in the new millennium. With a foundation built primarily in the twentieth century, the promises of nanoscience stretch from the fundamental understanding of organisms and materials to astounding new technologies in medicine, information science, and space science. This course offers science students the opportunity to learn the basic concepts and physical principles governing the nanoscale, to study the many types of nanosystems, and to investigate the new technologies that have been developed or are on the horizon.

Course Content, Format, and Bibliography

Content

The course content will naturally change from year to year to reflect the latest scientific breakthroughs and technologies in this rapidly changing field. The course structure represents general topic areas from which specific examples for discussion will be selected.

Introduction

- Vocabulary and definitions
- Physics of scale
- What is nanoscience?
- Origins of nanoscience

- Promise of nanoscience

Production of nanomaterials

- Nanosystem types: nanotubes, nanostructures, nanopowders, nanocomposites, etc.
- Fabrication techniques and growth processes
- Tools and instruments

Properties of nanomaterials

- Characterization
- Measurement techniques
- Investigative tools

Quantum effects in nanosystems

- Principles of quantum mechanics
- Quantum confinement
- Quantum transport
- Quantum polarization
- Optical emission and absorption

Nanoelectronics

- Physics of nanoscale devices
- Quantum wires, cells, dots and other structures.
- Molecular dots, wires, and devices
- Molecular electronic logic and architectures
- Quantum cellular automata dots, binary wires, digital devices, and integrated circuits

Nanotechnology

- Nanosensors
- Molecular machinery, manufacturing, and computation
- Space applications
- Biological nanosystems

Nanomedicine

Chemical applications

Future prospects for nanotechnology

Format

This course will include multimedia lectures with demonstrations in the traditional classroom, computer modeling and simulation sessions in a departmental laboratory, on-site and videoconference seminars by guests, electronic field trips, and student presentations on selected topics. Student activities will also include web-based topical studies, solving homework problems, and writing course papers.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

Bibliography

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