PHZ3462-0001
Nanoscience I: The Science and Societal Impacts

Fall 2016 - TuTh 1:30 PM to 2:45 PM MSB 0306

Instructor: Aniket Bhattacharya **Office:** PSB 452
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(Or by appointment)

Description: The course offers a broad perspective and introduction to the basic concepts, applications, and importance of Nanoscience and Technology in our society. The course is the first of a three-course series on fundamental sciences and applications of Nanoscience and Nanotechnology which forms the core of a Minor in Nanoscience and Technology offered by the UCF physics department. However any interested student can enroll provided prerequisites are satisfied. The course will begin with introduction to the "nano" scale; introduce important already existing and known, as well as new and emerging phenomena occurring around nanometer length scale. Examples will be drawn from all areas of Physical and Biological sciences and underlying physical principles will be taught using math as permitted by the prerequisites. The course will use ideas of quantum mechanics keeping the math at a minimum (but not) zero.

The main objective of this course, - following Richard Feynman's famous quote on Nano Science and Technology that "*There's plenty of room at the bottom*", - is to expose students the extreme importance of this new and emerging field which has already begun to change our every-day-life, industry, technology, and health and will continue to lead to a new and exciting world hitherto unknown.

Textbook: Introduction Nanoscience
Author: S. M. Lindsay, **Oxford University Press**.
ISBN 978-019-954421-9 (Pbk)

Service-Learning (20%): PHY3462SL is a UCF Service-Learning*(SL) approved course. Students choosing this option, and in an effort to enhance the understanding of the topics covered in this course and to prepare students for an effective dissemination of scientific knowledge and research to society, will be engaged in several activities involving high/middle schools in the Orange/Seminole/Osceola counties. A selection of exciting topics with a direct relation to the topics covered in the course will be presented to the class. Students, forming groups of 2-3 people (TBD), will develop a dissemination product (video, PowerPoint, poster…) to be delivered to the high/middle schools, where students will present in a language/level accessible to their level. Students will work directly with high school teachers to accommodate the product to their specific needs. Successful completion and delivery of the project will be used to calculate the Service-Learning grade portion (20%), which will be evaluated in conjunction with the K-12 teacher. The final products will be permanently displayed and accessible to other high schools in the area through the existing UCF - High Schools blog www.highschoolscience.ucf.edu

** Students seeking a Service-Learning Certificate need to obtain a minimum GPA of 2.5 in four SL coursesand 60 hours of community service. Both PHY6426SL and PHY6428SL are SL courses and can be employed for this purpose. For more information visit: http://www.catalog.sdes.ucf.edu/academic_programs/pdf/Service_Learning_Certificate.pdf*

Exams (50%): 50% of your grade will be determined on the basis of **2 mid-term exams (15% each) and a comprehensive Final (20%) exam**. For exceptional situations (such as Religious holiday,

medical emergency, etc.) you may take a makeup exam in a different day if personally talk to the instructor well ahead of time with the appropriate documentation to justify the absence. A non-graphic, non-programmable calculator may be used during exams.

Homework (30%): A set of homework assignments will be provided to students in an individual basis. Each student is expected to complete one comprehensive homework assignment on each of the four main sections covered by this course. Homework will weight 20% of the total course grade.

Please note that for some homework and test students will be required to make a literature search and make powerpoint presentation during the lecture period.

Project (20%): For student opting for taking the course without the SL-component need to do a project. The project will require preparing a report on a topic chosen at the beginning of the course and making a presentation during the lecture period. Each student will be required to meet the instructor to update the status of the project.

Grades: Your grade for this course will be calculated as follows:
G = **20%** (SL/Project) + **30%** (HW) + **50%** (exams + final)
Grading scale: **A** 85-100%; **B** 75-84%; **C** 60-74%; **D** 50-59%; **F** 0-49%

Course information: Course information (i.e. updated tentative coverage, syllabus, class-notes, etc…) will be available at UCF Webcourses (visit www.webcourses.ucf.edu and then click on PHZ3462-16Fall001)) for this class. Content in this webpage will be frequently updated as the course advances. A tentative course outline is provided. A more detail outline will be available later.

Course Outline:

We will follow the textbook. Supplementary materials will be supplied as appropriate

1. Introduction to Nanoscience
2. Atomic spectra and Bohr's theory of Hydrogen atom
3. Wave nature of electrons, wave particle duality, Hitachi experiment, uncertainty principle, examples
4. Introduction to quantum mechanics; probability amplitude, Schrödinger equation, wave functions, simple examples: particle in a box, energy levels, density of states, molecular orbitals
5. Spins, spin-statistics theorem, Identical particles, Bosons and Fermions, Pauli exclusion principle
6. Some other solution of Schrödinger equation; tunneling, wave function for Hitachi experiment
7. The Hydrogen atom, solution of Schrödinger equation; multi electron atoms and wave functions
8. Statistical mechanics and chemical kinetics; macroscopic description of many particle systems, Boltzmann distribution and partition function, entropy and free energy, partition function for an ideal gas, the equipartition theorem, energy fluctuation, a two level system.
9. Measuring Tools: Physics behind the experimental methods, scanning tunneling microscopy, The atomic force microscope, surface force apparatus, electron microscopy, Tweezers for grabbing molecules,…..
10. Application of nanotechnology to probe biological molecules: Nano-biology.
11. Ethical aspects of the emerging nanoscale.