MSN 517: Introduction to Nanoscience and Nanotechnology I

This course is the first installment of a two-semester introduction to nanoscience and nanotechnology courses. The course aims to give students a perspective on the physics, physics related applications and device fabrication/characterization at nanoscales

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Course website: http://serkankasirga.com/teaching/msn517
Office hours: Wednesdays, after the class, by appointment
Lectures: 9:40-10:30 Wednesday, 10:40-12:30 Friday
Assistants: TBA

Course Contents

Introduction to Nanoscience

- History: a route to small scales
- Basics: Why small?
- Length Scales of Nature
- Wave nature of matter

Physics for Nanoscience

- Electromagnetic theory
- Quantum nature of matter
- Statistical behavior of matter
- Atoms in an order: crystalline materials

Applications of Nanoscience Rooted from Physics

- Diodes
- Transistors
- Solid state memory elements
- Photonics
- Characterization tools

New Frontiers of Physics Related Nanoscience and Nanotechnology

- Low dimensional materials
- Spintronics
- Mesoscopic physics
- Cryogenics

Course Assignments (Impacts on the Grading)

Project (20%)

Groups of 5 will do 1 project throughout the course. There will be one progress report and one final report. For the final report, there will be a peer-review and rebuttal and final submission. Every student will review other groups' papers and provide point by point comments. Total project grade will consist of:

1. Overall quality of the work
2. Individual contribution to the work
   For the final,
3. Additionally, grade you will get from the peer-review reports you wrote.

Quizzes (10%)

There will be weekly quizzes

Homework (10%)

There will be bi-weekly homework.

Midterm Tests (35%)

There will be two midterm tests.

Final Test (25%)

There will be a final test during the finals week.

Weekly Syllabus

1. **Introduction to Nanoscience-**
   History: a route to small scales, Basics: why small, length scales, what is matter?
2. **Remembering the basics- Electromagnetic theory**
   A quick reminder for basics of electromagnetic theory
3. **Physics at Nanoscales- Quantum mechanics**
   Working with waves/particles: Quantum mechanics, concepts in quantum mechanics
4. **Statistical behavior of matter**
   Basic concepts in thermodynamics
5. **Atoms in an order 1: crystalline materials [MIDTERM I]**
   Solids: basics of crystals, metals, insulators and semiconductors
6. **Atoms in an order 2: playground of modern nanotechnology**
   More of solids, newly “discovered” materials
7. **Making functional devices out of solids 1-**
   Solid state devices: various types of diodes and their significance modern technology
8. **Making functional devices out of solids 2-**
   Transistors: various types of transistors and their significance for modern technology
9. **Making functional devices out of solids 3-**
   Other solid state devices, flash memory, memristor, PCM, CCD etc.
10. **Making functional devices out of solids 4- [MIDTERM II]**
    Beyond 3D structures, nanosheets, nanowires, quantum dots
11. **Basic idea behind the characterization tools used commonly in nanoscience 1-**
    Commonly used characterization tools and the idea behind their operation principles
12. **Basic idea behind the characterization tools used commonly in nanoscience 2-**
    Commonly used characterization tools and the idea behind their operation principles
13. **New frontiers of physics related nanoscience and nanotechnology 1-**
    In depth review of low dimensional materials, spintronics
14. **New frontiers of physics related nanoscience and nanotechnology 2-**
    In depth review of mesoscopic physics and achieving the ultimate coldness