

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

Instructor: T. Serkan Kasirga

Contact: Office: UNAM Director's Office, Phone: 8026, E-mail: kasirga@unam.bilkent.edu.tr

Course website: <http://serkankasirga.com/teaching/msn517>

Office hours: Thursdays, after the class, by appointment

Lectures: 1:40-12:30 Monday, 9:40-10:30 Thursday

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&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. Physics at Nanoscales- Quantum mechanics**
Working with waves/particles: Quantum mechanics, concepts in quantum mechanics
- 3. Statistical behavior of matter**
Basic concepts in thermodynamics
- 4. Remembering the basics- Electromagnetic theory**
A quick reminder for basics of electromagnetic theory
- 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