# ECE 505 - *Nanostructures: Fundamentals and Applications*

***Fall 2013***

**Instructor:** Carmen Menoni – Electrical & Computer Engineering – (Carmen.Menoni@colostate.edu)
**Course objective:** This course introduces students to the physics and applications of nanoscale materials, their electronic, optical and magnetic properties and their potential technological applications. It also teaches students the basic principles of the most relevant tools to observe nanoscale phenomena.
**Course description**: Starting from very fundamental principles, the course will cover the fundamentals of quantum confinement. It will then provide students with knowledge of how to exploit quantum confinement to design tailored material structures with unique electrical, magnetics and optical properties. The growth and characterization of the nanoscale materials is also discussed. Important technological applications of the nanoscale structures are also discussed. The breath of the class will be such to attract students from Engineering, Chemistry and Physics.
**Credits:** 3
**Pre-requisites:** EE 342 (Electromagnetics) or PH 314, PH 452 (quantum mechanics) or equivalent.
**Text:** Introduction to Nanoscience, S.M. Lindsay, Oxford University Press
**Syllabus:**

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| Chapter 1 – The Basics and Electrons in Nanostructures<br>Chps 1 and 7 of textbook<br>(2 weeks) | What is nanoscience<br>The physics of quantum confinement, Quantum confined materials: quantum wells, wires, dots and rings.<br>Electrons in nanostructures<br>Quantum effects |
| Chapter 2 Statistical Mechanics and chemical kinetics (2 weeks) | Microscopic description of systems of many particles<br>Chemical Kinetics<br>Nanothermodynamics |
| Chapter 3 - Making nanostructures top down (1 weeks) | Projection lithography<br>Epitaxy<br>Nano-imprint |
| Chapter 3 – Making nanostructures: bottom up (1 weeks) | Nano-chemistry<br>Self assembled systems<br>DNA nanotechnology |
| Chapter 4 – Nanostructured molecular architectures (2 weeks) | Noncovalent interactions, Polymer nanostructures, Self-assembly, carbon nanotubes. |
| Chapter 5 – Microscopy and manipulation tools (1 week) | Optical microscopy<br>Atomic force microscopy<br>Electron Beam microscopy<br>Other microscopies |
| Chapter 6 – Nano-electronics and nanomagnetics (1 week) | Logic devices based on quantized structures, Quantum transport devices.<br>Magneto-resistive memory devices |
| Chapter 7 – Nanostructured materials (1 week) | Photonic Nanostructures<br>Magnetic Nanostructures |
| Nanobiology (1 week) | Introduction to molecular biology<br>Biology and nanostructures |
| Review (1 week) | |
| Final Exam (1 week) | |

**Grading:** Homework – 30 %; 1 Midterm: 25% ; Final: 25% ; Project: 20%

**Homework** will consist of a combination of critique of papers; calculations and conceptual problems and laboratory practices. An important component of this course will be a research project where students will investigate synthesis and characterization of nanostructures. Simple modeling will be required. At the end of the semester students will be expected to defend their work in a **10 min presentation**. Student will also be expected to give presentations during the semester on related topics to class contents.
**Other reference material**: The CSU library catalog list a number of electronic books that fit the contents of the class. For example, Introduction to Nanoscience and Nanotechnology by Chris Binns. Search by Nanoscience and nanotechnology