

***Advanced Nano-electronic Devices:*** miniaturization of transistors and the resulting impact on their performance.

The course is devised into three main sections. The first section comprised of topics in semiconductor physics and is providing a definition of terms that are in frequent use throughout the course.

The second section deals with the effects of miniaturization of transistors and the resulting impact on their performance.

The last section deals with solutions to the problems presented in the second section and describe the state of the art of nano-electronics.

1. Semiconductors properties and their relation to energy bands and phonon bands
  - Current drivability
  - Thermal velocity of electrons
  - Mean free path and scattering times
2. The effects of short channel:
  - Punch through
  - Tunneling in field effect transistors
  - Drain induced barrier lowering
  - Velocity saturation
  - Threshold voltage roll-off
  - Body Effect
3. Advanced Nanoelectronic Devices
  - High Electron Mobility Transistors
  - Multi-gate transistors and Fin-FETs
  - Nanowire field effect transistors

***Sensing at the nanoscale***

The course overviews methods for probing physics and materials at the nano-scale. The course will combine lectures from experts in the field of scanning microscopy and involve discussions of the technique and representative applications. We will describe scanning microscopy for various properties such as surface, energy, magnetism and more. Topics include atomic force microscopy, scanning tunneling microscopy, scanning squid microscopy, scanning hall probe, magnetic force microscopy and scanning near field optical microscopy.

Part I

- Imaging surface in solids
  - Atomic force microscope (AFM)
  - Scanning electron microscope (SEM)
  - Scanning tunnelling microscope (STM)

- Techniques for nanoelectronics
- Magnetic measurements of nanoparticles
  - Bulk SQUID – MPMS
  - VSM
- Imaging magnetism at the nanoscale
  - Scanning Hall probe
  - Scanning SQUID microscopy
  - Magnetic Force Microscope

## Part II

- Imaging biological systems
  - Contrast agents assisted optical microscopy
  - Contrast agents assisted fluorescence microscopy
  - Contrast agents assisted computed tomography
  - Contrast agents assisted magnetic resonance imaging
  - Contrast agents assisted photoacoustic imaging
- Chips for sensing biological systems
  - Mechanical detection methods
  - Optical detection methods
  - Electronic detection methods
  - Electro-chemical detection methods