DEPARTMENT OF PHYSICS

PHY 631A : Physics of Semiconductor Nanostructures 3-0-0-9

Instructor: Y N Mohapatra

Course Objectives :

The course introduces physics of phenomena in semiconductor nanostructures which have important technological applications, especially focusing on the application of principles of condensed matter physics and quantum processes in such structures. The course seeks to equip students with enough background in searching and following developments in this discipline in a journal such as Applied Physics Letters.

Prerequisites:

The students taking this course must have had a prior exposure to quantum mechanics and solid-state physics. The course is pitched at a higher level than any similar courses on 'Electronic Materials', especially in terms of use of tools of quantum physics. However, the techniques and ideas are briefly reviewed at the point of use to make them intuitively familiar.

Course Contents :

Review of condensed matter and semiconductor physics:
a brief introduction to quantum view of bulk solids: introduction to
key ideas in electronic properties, transport and interaction of photons with material.

Characteristic length scales for quantum phenomena;
Scaling as a heuristic tool; scientific and technological significance of nanostructures and mesoscopic structures

Graphene & Carbon Nanotubes; Illustration of Quantum and Condensed Matter Physics.

Fabrication of quantum nanostructures,
Quantum structures and bandgap engineering.
Transport in quantum structures with applications,
MBE, MOCVD, Langmuir-Blodgett films, novel processes; electronic
properties of heterostructures, quantum wells, quantum wires, quantum dots,
and superlattices, strained layer super-lattices;

Transport in mesoscopic structures:
resonant tunneling, hot electrons, conductance and transmission of nanostructures;
principles of application of electronic devices based on quantum structures:

Optical properties and applications,
Optical processes in low dimensional semiconductors : Absorption, luminescence, excitons.
application to lasers and photodetectors ;

Emergence two dimensional semiconductors such as MoS_2 , graphitic carbon nitride and related compounds;

(Time permitting and depending on the progress and interest of students: introduction to Magneto-transport in semiconductor Nanostructures : transport in magnetic field, semiclassical description, quantum approach, Aharonov-Bohm effect, Shubnikov- de Haas effect; introduction to quantum Hall effect)

(Perspective on Frontiers in current research: Nanoelectronics, Nanophotonics & Spintronics)

-ynm