**PH 544: Nanoscience and Technology (3-0-0: 3)**

**Background to Nanotechnology**

Scientific revolution, physics of low-dimensional materials, atomic structures, 1D, 2D and 3D confinement, density of states, excitons, emergence of nanotechnology, challenges in nanotechnology. Carbon age: new form of carbon (from graphene sheet to CNT). Risks and benefits of nanomaterials.

**[6L]**

**Different Classes of Nanomaterials**

Carbon nanotubes (CNT), metals (Au, Ag), metal oxides (TiO2, CeO2, ZnO), semiconductors (Si, Ge, CdS, ZnSe), ceramics and composites, dilute magnetic semiconductor, size dependent properties, mechanical, physical and chemical properties. **[6L]**

**Nanostructure Fabrication**

Top-down approach: Lithography. Bottom-up approach: PVD & CVD. **[8L]**

**Nanoelectronics**

Tunnel junction, Coulomb blockade and single electron transistor: operating principle, technology and application, carbon based devices. **[8L]**

**Nanobiotechnology**

Protein-based nanostructures, engineered nanopores, DNA-based nanostructures, Nanoparticle–biomaterial hybrid systems for bioelectronic devices, DNA-gold nanoparticle conjugates. **[8L]**

**Text Books and References**

# M. Kuno, “Introductory Nanoscience: Physical and Chemical Concepts”, Garland Science.

1. H. H. Gatzen, V. Saile and J. Leuthold, “Micro and Nano Fabrication: Tools and Processes”, Springer.
2. G. W. Hanson, “Fundamentals of Nanoelectronics”, Pearson.
3. C. M. Niemeyer and C. A. Mirkin, “Nanobiotechnology Concepts, Applications and Perspectives”, Wiley-VCH.