## Solid State Physics II (4:0 Credits)

Prerequisites: Quantum Mechanics I, Solid State Physics I and Statistical mechanics.

**Course Outline:**

1. **Bondings:** Covalent, Ionic, Metallic, van der Waals, Hydrogen bondings. Theoretical background and Experimental determinations.
2. **Magnetic Properties:** Fundamental concepts, Magnetic interactions, various exchange interactions, Spin waves, Magnons, Magnetic Resonance Phenomena.
3. **Magnetic Effects:** Spin and spin variables, spin-spin interactions and magnetic structures. Unitary operation and time evolution. Generators and matrix elements of unitary representations; Addition of angular momenta, Clebsch-Gordon and Racah series, Wigner-Eckart theorem, and Lande-g-factor; Charged particle in a magnetic field; Aharanov-Bohm effect, Spin-orbit coupling.
4. **Boltzmann Transport Equations:** General formalism and derivation from first principles, Dynamics of electrons, Electrical, Optical and Thermal Conductivities; Various Scattering processes and Mechanisms of Conductions.
5. **Semiconductors Physics:** Electrons and Phonons at absolute zero and at finite temperatures in Metals, Semiconductors and Insulators; Direct and Indirect band Semiconductors; Inter and Intra band transitions; Various competing processes.
6. S**emiconductor Devices:** Photoconductivity, Diffusion of charge carriers, p-n junctions, Various device physics, excess carriers, band inversion, defect scatterings and Carrier dynamics in device structures.
7. **Optical and Dielectric Properties:** Ferroelectrics and Piezoelectrics; Static and dynamic Polarizabilities; Electronic and Ionic Polarizabilities; Free Carrier effects.
8. **Superconductivity:** The basic phenomena, Theory of Superconductors, Second quantization, BCS theory, Josephson junctions. High-$T_c$ superconductors, Many-body effects.
9. **Physics of correlated systems**: Kondo Physics, Model Hamiltonians, Canonical transformations and Hilbert space methods-Schrieffer-Wolff transformation
10. **Topological and disordered systems**: Introduction to topology in condensed matter; Introduction to Anderson localization.

**References**:

1. Charles Kittel, “Introduction to Solid State Physics”, 8th edition, Wiley 8th Edition (November, 2011); ISBN: 0471415267.
2. N. Ashcroft and N. Mermin, “Solid State Physics” Revised Edition, Cengage Learning Asia Publication, Revised edition (June 30, 2016); ISBN: 9814369896
3. M. E. Rose, “Elementary Theory of Angular Momentum”, Dover Publications (November, 20111); ISBN: 4866848064.
4. G. D. Mahan, “Many-Particle Physics”, Springer Publication, 3rd ed. (October, 2000); ISBN: 0306463385.
5. Philip Philips, “Advanced Solid State Physics”, Cambridge University Press; 2nd edition (April 9, 2012); ISBN: 0521194903
6. Piers Coleman, “Introduction to Many-Body Physics”, Cambridge University Press