CEBS

Condensed Matter Physics II P703

For 2024-25 (Aug - Dec 2024) VII Semester

Vijay A. Singh

1. Introduction. Why study theoretical condensed matter physics (TCMP)? Some aspects of Many Body Physics. Attendance and Evaluation Policy.
2. Bottoms Up Approach. From Atoms to Molecules to Solids. The Linear Combination of Atomic Orbitals (LCAO) Approximation. Diatomic Molecules.
3. The Top Down Approach. Bloch's Theorem. Model Hamiltonians. Tight-Binding Approximation. Introduction to Single Particle (non-interacting) Green's Function.
4. *Application* : The Koster-Slater Equation and evaluation of defect levels in the technologically important semiconductors.
5. *Applications*
   – The Hofstadter Hamiltonian
   – Electronic structure of Graphene.
   – Topological Hamiltonian (Haldane)
6. Many Particle (Interacting Electron) Physics. The Hartree and Hartree Fock Approximation. The Interacting Electron Gas. Time Permitting: The Density Functional Theory of Hohenberg and Kohn. The Local Density Apprximation of Kohn and Sham.
7. Second Quantization. Free (Non-interacting) electron and phonons.
8. Many Particle (Interacting Electron) Green's Function. Simple applications (e.g. free fermions and bosons).
9. Many body physics: The Landau theory of Second Order Phase Transitions.
10. Electron Phonon Interaction. The BCS Theory of Superconductivity.
11. The Anderson Hamiltonian: magnetic impurities; telescoping charge states; chemisorbtion.
12. The Hubbard Hamiltonian: Stoner criterion fo magnetism; metal insulator transition. x
13. Special Enrichment Lectures: Classical and Quantum Scaling Laws of the Nano-World, High T_c Superconductivity etc
14. Time permitting:
    (a) Bose-Einstein Condensation
    (b) Band Structure Methods.
    (c) Quantum Dots: an Introduction.
    (d) Quantum Hall Effect.

Dated: Aug 1 2024 Signature

Dr. Vijay A. Singh