ECE 471A: Semiconductor Physics

IN

Math

- Calculate polynomial and exponential integrals and derivatives
- Understand hyperbolic trigonometric functions
- Understand divergence and gradient
- Calculate Taylor expansions

Electrostatics

- Familiar with Poisson equation
- Solve E-field for arbitrary 1D charge distribution
- Understand electrostatic potential in 1D and relationship to E-field and charge distribution

Pre-requisites

- MATH340 or MATH345; PH142

Concepts:

- Introduction to Quantum theory of solids
  - Crystal structure of solids
  - Schrodinger equation for free electron and different potentials of interaction.
  - Concept of confinement and tunneling
- Basic semiconductor band structure
  - Conduction and valence bands
  - Energy gap
  - Density of states
  - E vs k diagram
  - Effective mass
- Carrier statistics
  - Intrinsic concentration, doping.
  - Occupation probability
  - Fermi-Dirac and Maxwell-Boltzmann distributions
- Carrier transport
  - Drift, mobility
  - Diffusion, Einstein relation

Applications:

- Microelectronics
- Semiconductor processing
- VLSI

OUT

Basic Physics of Semiconductors

- Understand how the electronic structure of solids is obtained
- Draw and interprets E vs k diagrams
- Understand the concept of electron and hole states
- Understand effective mass
- Calculate density of states
- Calculate intrinsic, doped, equilibrium, and non- equilibrium carrier concentrations
- Describe Fermi level concept and calculates Fermi energy from carrier concentrations
- Understand Fermi-Dirac distribution and assumptions that lead to the Maxwell-Boltzmann approximation
- Calculate conductivity of semiconductors from material parameters
- Understand drift and diffusion and calculates the corresponding currents

Semiconductors Structural and Electronic Properties

- Describe crystal structures
- Understand Miller indices
- Use the concepts of electron and hole transport to calculate macroscopic properties of materials
- Understand how the electronic structure of material is modelled
- Calculate current density from fundamental principles

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