MPHC4103

Electronics and Statistical Mechanics I

Group A: Electronics

Semiconductor Physics:
Direct and indirect semiconductors; intrinsic and extrinsic semiconductors; energy band diagram; carrier concentration in both cases; non degenerate and degenerate semiconductors.

[4 lectures]

Carrier transport phenomena: Mobility; Hall effect; diffusivity; generation and recombination; direct and indirect recombination; surface and Auger recombination.
Continuity equation: Utilised for steady state injection from one-side.

[6 lectures]

P-N Junction diode: Equilibrium Fermi level constant; built in potential, depletion layer width, depletion layer width and energy band diagram of a p-n junction diode under various biasing conditions (a) Thermal equilibrium condition (b) forward biasing conditions (c) reverse bias conditions.
Depletion capacitance, capacitance voltage characteristics.
Avalanche and Zener breakdown, Zener diode
Varactor diode

[6 lectures]

Metal semiconductor junction, Schottky barrier. Bipolar junction transistor equation for Ebers Moll model.
Tunnel diode: order of the width of the depletion region; reverse and forward bias is showing positions of Fermi levels. Explanation of I-V characteristics using the diagrams; Tunnel diode as oscillator, other applications.

[6 lectures]

Unijunction transistor (UJT) applications as a relaxation oscillator. MOSFET:
MOS diode and drain current drain voltage characteristics.
JFET: Structure, Operation, Principle I-V characteristics.
Logic families: DTL, TTL, TTL Schottky, Low Power Schottky, CMOS
ADC and DAC

[14 lectures]

References:

1. S M Sze(2^{nd} edition)

2. J. Millman and C. Halkias: Integrated Electronics

3. J. Kennedy: Electronic Communication Systems

5. J. Millman and A. Grabel: Microelectronics

6. B.G. Streetman, S. Banerjee: Solid State Electronic Devices

9. Digital Circuits (Vol I and II), D. Roy Choudhury, Platinum Publishers

Group B: Statistical Mechanics I

Introduction: Objective of statistical mechanics, specification of the state of a many particle system, phase space, counting the number of microstates in phase space, phase points, statistical ensemble, Density of phase points, postulate of equal a priori probability, Liouville's theorem, ergodic hypothesis, H-theorem, probability calculation, thermal, mechanical and general interaction.

[8 lectures]

Microcanonical ensemble: Thermal interaction between systems in equilibrium, temperature, heat reservoirs, sharpness of the probability distribution, applications.

[6 lectures]

Canonical ensemble: System in contact with a heat reservoir, Boltzmann distribution, canonical partition function, calculation of mean values in canonical ensemble, connection with thermodynamics, entropy of an ideal gas, Gibbs' paradox, applications.

[8 lectures]

Grand canonical ensemble: System in contact with a particle reservoir, chemical potential, grand canonical partition function and grand potential, fluctuation of particle number, chemical potential of an ideal gas, applications.

[8 lectures]

Fluctuation in energy and particles. Equilibrium properties of ideal systems: ideal gas, Harmonic oscillators, rigid rotators. Para magnetism, concept of negative temperature.

[6 lectures]

References:

1. F. Reif, Fundamentals of Statistical and Thermal Physics.

2. K. Huang, Introduction to Statistical Mechanics

3. R. K. Pathria, Statistical Mechanics

4. David Chandler, Introduction to Modern Statistical Mechanics

5. R. Kubo, Statistical Mechanics (Collection of problems).

6. An Introductory Course of Statistical Mechanics, Palash B. Pal, Alpha Sciences.

7. Statistical Physics, J. K. Bhattacharjee

8. Statistical Mechanics: An elementary outline, Abhijit Lahiri

9. Equilibrium and Non-Equilibrium Statistical Thermodynamics, Michel Le Bellac, Maurice Le Bellac, Fabrice Mortessagne, G. George Batrouni, George Batrouni, CUP.