Fundamental concepts of semiconductors - Web course

COURSE OUTLINE

The aim of the course is to develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices.

COURSE DETAIL

Module	Description	Hrs	Key points
Module 1	Introduction to solid state materials - crystal structure - Reciprocal lattice - Brillouin zone and rules for band (*k* - space) representation. Dynamics of electrons in periodic potential: Kronig - penny and nearly free electron models - Real methods for band structure calculations; Bandgaps in semiconductors - Holes and effective mass concept - Properties of conduction and valance bands.	8	Introduction and Electronic states of semiconductors
Module 2	Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic	8	Carriers and doping

NPTEL

http://nptel.iitm.ac.in

Physics

Pre-requisites:

Basic Modern physics (10+2 knowledge).

Coordinators:

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	Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap engineering.		
Module 3	Scattering Mechanism: electron - electron and electron - phonon scattering. Macroscopic transport: Carrier transport by Diffusion - Carrier transport by Drift: Low field, High field and very high field (Impact ionization) - Einstein relation.	8	Electrical Transport
Module 4	Electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons : Origin, electronic levels and properties Radiative and nonradiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.	8	Optical Transport
Module 5	Processing of Semiconductor devices (Brief), p - n		Semiconductor

	Semiconductor junctions - Homo and hetero Junctions. Semiconductors Quantum structures, Density of states and excitons, Semiconductor photonic structures: 1D, 2D and 3D photonic crystals. Active and passive optoelectronic devices: performance and response enhancement (photo processes).	8	as device and recent advances

References:

Crystal and energy band structure:

1. "The Physics of Semiconductors" by Kevin F Brennan, Cambridge Univ. Press (1999).
2. "Fundamentals of Semiconductors" by Peter Y Yu and Manuel Cardona, Spriger, (1996).
3. "Introduction to Solid State Physics" by Charles Kittel, 6th Ed., Willey (1991).

Carrier transport & device related information:

1. "Semiconductor Physics and Devices" by D.A. Neamen, 3rd Ed.,Tata McGraw-Hill, (2002).
2. "Physics of Semiconductor Devices" S.M. Sze, John Willey, 2nd Ed., (1981).
3. "Semiconductor Optoelectronics (Physics and Technology)", Jasprit Singh, McGraw-hill, (1995).