Optoelectronic Materials and Devices - Video course

COURSE OUTLINE

This course is offered to introduce the junior students (III rd year) to the Materials Science and Engineering basics as well as the applications in optoelectronics and semiconductor devices.

The course is divided in four modules: First module introduces electronic structure of materials; Second module discusses electrical properties of metal, semiconductors and insulators; Third module discusses optical properties of materials; Fourth module introduces basic devices - p-n junctions, their application in solar cells and light emitting diodes, MOS devices, transistors.

COURSE DETAIL

Module No.	Topic/s	Number of Lectures
1.	**Electronic Structure of Materials**	
	• Pre-quantum mechanics picture: Drudes Model.	1
	• Review of quantum mechanics and free electron theory, failures of free electron theory and introduction to the role of lattice.	4
	• Review of reciprocal lattice, Brillouin zone, free electron band diagram, potential in a crystal, electron dynamics and concept of holes, conductivity in relation to band structure.	5
2.	**Electrical Properties of Materials**	
	• Band structure of metals and semiconductors, empirical estimates of conductivity in metals and alloys.	2
	• Semiconductors - band diagrams, direct and indirect bandgap, degenerate and non-degenerate semiconductors, intrinsic and extrinsic semiconductors, determination of dopant levels and mobility measurements.	4
	• Dielectric materials - dielectric constants and polarization, linear dielectric materials, capacitors and insulators, C-V characterization.	2
	• Electronic structure of interfaces: metal-semiconductor, insulator-semiconductor, semiconductor heterostructures.	2
3.	**Optoelectronic Device Physics**	
	• Optical materials - electron-hole recombination, bandgap engineering.	2

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Metallurgy and Material Science

Pre-requisites:

- Undergraduate level basic Physics
- Introduction to quantum mechanics

Coordinators:

Prof. Deepak Gupta
Department of Materials and Metallurgical EngineeringIIT Kanpur

Prof. Monica Katiyar
Department of Materials and Metallurgical EngineeringIIT Kanpur

	• Light interaction with materials-transparency, translucency and opacity, refraction and refractive index, reflection, absorption and transmission. • Carrier generation processes, recombination processes, R-G statistics, surface R-G processes. • Carrier transport, drift, diffusion, equation of state.	2 3 3
4.	**Basic Electronic Devices** • p-n junction their application in solar cells and light emitting diodes. • MOS devices and Transistors. • Organic electronics - Thin Film Transistors, Light Emitting Diodes, Solar cells.	5 2 3

References:

1. Electronic Properties of Materials: An Introduction for Engineers, Rolf E. Hummel, Springer Verlag, 1985
2. Physical Properties of Semiconductors, Charles M. Wolfe, Nick Holonyak and Gregory E. Stillman, Prentice Hall, 1989
3. Solid State Physics, Neil W. Ashcroft and N. David Mermin, Sauders College, Philadelphia, USA, 1976
4. Advanced Theory of Semiconductor Devices, Karl Hess, Prentice Hall, 1988
5. Advanced Semiconductor Fundamentals, Robert F. Pierret as part of Modular Series on Solid State Devices Vol. 6, Addison Wesley, 1989
6. Introduction to Solid State Physics, Charles Kittel, John Wiley & Sons 1991
7. Electrical Properties of Materials, L. Solymar and D. Walsh, Oxford University press, 1998.
8. Physics of Solids, C. A. Wert and R.M. Thomson, McGraw-Hill Book Company, 1970 or later
9. Solid State Electronic Device, Streetman, Ben, G, Streetman, Prentice-Hall, inc., N.J. USA, 1980