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<b>DEPARTMENT</b>	Department of Metallurgy and Material Sciences
<b>INSTITUTE</b>	Indian Institute of Technology Kanpur
<b>COURSE OUTLINE</b>	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 DETAILS

S. No	Module ID/ Lecture ID	Lecture Title/Topic
1.	Module1_L1	Conductivity of Materials, Drude's Theory and its Failures
2.	Module1_L2	Free Electron Theory
3.	Module1_L3	Free Electron Theory
4.	Module1_L4	Crystal Structure, Reciprocal Lattice -I
5.	Module1_L5	Reciprocal Lattice II, Brillouin Zone And Bragg's Diffraction Condition
6.	Module1_L6	Electrons in a Crystal, Bloch's Electron
7.	Module1_L7	Free Electron Band Diagrams in an Empty Lattice
8.	Module1_L8	Effect of Periodic Potential, Origin of Band-Gap through Kronig-Penny Model
9.	Module1_L9	Electron Dynamics

10.	Module1_L10	Conduction in Relation to Band Diagrams
11.	Module2_L11	Semiconductor E-K Diagrams and their Material Properties
12.	Module2_L12	Equilibrium Carrier Statistics in Semiconductors: Density Of States, Fermi Function and Population Density in Bands
13.	Module2_L13	Equilibrium Carrier Statistics in Semiconductors: Qualitative Examination of Carrier Densities in Conduction and Valence Bands
14.	Module2_L14	Equilibrium Carrier Statistics in Semiconductors: Quantitative Examination of Carrier Densities in Intrinsic Semiconductor
15.	Module2_L15	Doping in Semiconductors
16.	Module2_L16	Equilibrium Carrier Statistics in Semiconductors: Complete Ionization of Dopant Levels
17.	Module2_L17	Equilibrium Carrier Statistics in Semiconductors: Carrier Freeze Out
18.	Module2_L18	Semiconductor Junctions in Band-Diagrams
19.	Module2_L19	Linear Dielectric Behavior
20.	Module2_L20	Non-Linear Dielectric Behavior
21.	Module3_L21	Carrier Recombination-Generation-I: Band-to-Band Transition
22.	Module3_L22	Carrier Recombination-Generation –II: Other Mechanisms
23.	Module3_L23	R-G Statistics Via R-G Centers
24.	Module3_L24	Optoelectronic Materials and Bandgap Engineering
25.	Module3_L25	Optical Properties of Materials
26.	Module3_L26	Optical Properties of Single Interfaces: Fresnel Reflection Coefficients
27.	Module3_L27	Optical Properties of Two Interfaces: Thin Film Case
28.	Module3_L28	Drift
29.	Module3_L29	Diffusion

30.	Module3_L30	Continuity Equation
31.	Module4_L31	Resistor and Diode (P-N Junction)
32.	M4_L32	Fundamentals of P-N Junction
33.	Module4_L33	Fundamentals of P-N Junction Contd.
34.	Module4_L34	Solar cells
35.	Module4_L35	Microelectronics processing
36.	Module4_L36	MOS capacitor
37.	Module4_L37	Transistor
38.	Module4_L38	Organic Electronics
39.	Module4_L39	Organic Light Emitting Diodes
40.	Module4_L40	Organic Solar Cells and Organics Thin Film Transistors

**List of reference material/ books:**

Electronic Properties of Materials: An Introduction for Engineers, Rolf E. Hummel, Springer Verlag, 1985.

Physical Properties of Semiconductors, Charles M. Wolfe, Nick Holonyak and Gregory E. Stillman, Prentice Hall, 1989.

Solid State Physics, Neil W. Ashcroft and N. David Mermin, Saunders College, Philadelphia, USA, 1976.

Advanced Theory of Semiconductor Devices, Karl Hess, Prentice Hall, 1988.

Advanced Semiconductor Fundamentals, Robert F. Pierret as part of Modular Series on Solid State Devices Vol. 6, Addison Wesley, 1989.

Introduction to Solid State Physics, Charles Kittel, John Wiley & Sons 1991.

Electrical Properties of Materials, L. Solymar and D. Walsh, Oxford University press, 1998.

Physics of Solids, C. A. Wert and R.M. Thomson, McGraw-Hill Book Company, 1970 or later.

Solid State Electronic Device, Streetman, Ben, G, Streetman, PrenticeHall, inc., N.J. USA, 1980.

**Name and contact details of two referees for the course:**