IITK-MSE: Electronic, Optical and Magnetic Properties

Course Structure

Supporting core courses (1-4th Semesters)

- Basic Sciences (Maths, Physics, Chemistry)
- Quantum Mechanics (Introductory)
- Nature and Properties of Materials
- Thermodynamics and Phase Equilibria
- Structure and Characterization of Materials

Core Course (5th Semester):

- Electronic and Magnetic Properties of Materials

Lab course (6th Semester):

- Functional Materials Laboratory

Electives (6-8th Semester)

- Science and Technology of Thin Films and Device Fabrication
- Energy Materials and Technologies
- Electronic Devices and Characterization
- Electroceramic Materials and Applications
Electronic and Magnetic Properties of Materials

1. Introduction to Electronic Structure
2. Electronic Structure in Crystalline Materials
3. Electron Dynamics
4. Semiconductors
5. Ionic Conductors
6. Dielectric Materials
7. Magnetic Materials
8. Optical Materials
Functional Materials Laboratory

1. Ionic Conductivity
2. Dielectric and ferroelectric/piezoelectric properties
3. Optical behavior of LCDs (transmittance)
4. OLED, fabrication and characterization
5. Solar cells, fabrication and characterization
6. Magnetic properties (magnetoresistance, M-H curves)
7. Semiconductor characterization (resistivity, Hall measurement, bandgap measurement)
Science and Technology of Thin Films and Device Fabrication

Thin Films:
1. Basics of thin film growth
2. PVD processes
3. CVD processes
4. Film Growth: nucleation and growth kinetics
5. Thin Film Characterization

Device Fabrication:
6. Substrate selection and preparation
7. Patterning (lithography)
8. Material removal (wet and dry etching)
9. Doping (diffusion, ion implantation)
10. Oxidation
11. Metallization and interconnects
12. Process Integration with examples (Si and III-V solar cell, CMOS, LEDs and Laser)
Energy Materials and Technologies

1. Introduction: Relevance of renewable energy
2. Optoelectronic Devices: Solar cell and LED device physics
3. Energy Generation (PV Technologies)
4. Energy Efficient Lighting
5. Energy Conversion
6. Energy Harvesting Materials and Technologies
Electronic Devices and Characterization

1. Semiconductor Material Properties and Characterization
2. Semiconductor-Semiconductor junctions: p-n junction, solar cells, BJTs, LEDs
3. Metal-Semiconductor Junctions: Schottky and ohmic contacts
4. Metal-Insulator-Semiconductor junctions: MOS capacitor, MOSFET and MISFET, Fin-FET
5. Defects and Semiconductors: recombination and generation, traps
6. Charge Carrier Lifetime: characterization methods
Electroceramic Materials and Applications

1. Structure of Common Oxides
2. Defect Thermodynamics
3. Defect Complexes and Associates
4. Defect Equilibria and Brouwer Diagrams
5. Ionic and Electronic Transport
6. Theory of Linear Dielectrics
7. Non-linear Dielectrics
8. Thermoelectric Oxides
9. Magnetic Ferrites
10. Multiferroics and Magnetoelectronics
11. Superconductors