Programme	BS Solid State Physics	Course Code	SSP-305	Credit Hours	3 (3-0)
Course Title	**Introduction to Semiconductor Physics**				

Course Introduction

This course provides an introduction to the fundamental principles of semiconductor physics, focusing on the properties and behavior of semiconductors. Topics include the electronic structure of semiconductors, carrier transport, p-n junctions, and semiconductor devices. The course is designed to give students a solid foundation in the physics of semiconductors, preparing them for more advanced studies in electronics, optoelectronics, and related fields.

Learning Outcomes

By the end of this course, students will have knowledge about:

1. Fundamental Concepts of Semiconductor Physics
2. Energy Bands and Charge Carriers
3. Intrinsic and Extrinsic Semiconductors
4. P-N Junctions
5. Semiconductor Devices
6. Thermal and Optical Properties
7. Quantum Wells, Wires, and Dots
8. Materials and Crystal Growth
9. Mathematical and Computational Tools
10. Laboratory Skills and Experimental Techniques
11. Problem-Solving and Critical Thinking
12. Current Trends and Applications

These outcomes ensure that students completing the course will have a thorough understanding of the physical principles governing semiconductors, preparing them for advanced studies or careers in semiconductor technology and related areas.

Course Content		Assignments/Readings
Week 1	**Unit-I** 1.1 Introduction to Semiconductors 1.1.1 Overview of semiconductors and their importance in technology 1.1.2 Types of semiconductors: elemental (e.g., silicon, germanium) and compound (e.g., GaAs, InP) 1.1.3 Basic crystal structures of semiconductors (e.g., diamond, zinc-blende structures) 1.1.4 Intrinsic and extrinsic semiconductors	What are semiconductors and what is their role in electronic industry?

Week 2	**Unit-II** 2.1 Energy Bands and Charge Carriers in Semiconductors 2.1.1 The concept of energy bands: valence band, conduction band, and bandgap 2.1.2 The effective mass of electrons and holes	Discussion about charge carriers
Week 3	**Unit-III** 3.1 Intrinsic carrier concentration 3.1.1 Doping in semiconductors: n-type and p-type materials 3.1.2 The Fermi level and its position in intrinsic and doped semiconductors	What is doping?
Week 4	**Unit-IV** 4.1 Carrier Dynamics in Semiconductors 4.1.1 Carrier generation and recombination processes 4.1.2 Direct and indirect bandgap semiconductors	
Week 5	**Unit-V** 5.1 Carrier mobility and drift velocity 5.1.1 Diffusion of carriers and the Einstein relation 5.1.2 Continuity equation for carriers	Practice
Week 6	**Unit-VI** 6.1 The p-n Junction 6.1.1 Formation of the p-n junction and depletion region 6.1.2 Built-in potential and electric field across the junction	What is the significance of p-n junction?
Week 7	**Unit-VII** 7.1 Current-voltage characteristics of the p-n junction (forward and reverse bias) 7.1.1 Capacitance of p-n junctions (junction capacitance and diffusion capacitance) 7.1.2 Applications of p-n junctions: diodes, photodiodes, LEDs	Quiz
Week 8	Mid Term Exams	
Week 9	**Unit-VIII** 8.1 Bipolar Junction Transistors (BJTs) 8.1.1 Structure and operation of BJTs (NPN and PNP transistors) 8.1.2 Modes of operation: active, cutoff,	What is the physical significance of BJTs?

	and saturation	
Week 10	**Unit-IX** 9.1 Current gain and the Ebers-Moll model 9.1.1 BJT characteristics and applications in amplification and switching	What are the applications of BJTs??
Week 11	**Unit-X** 10.1 Field-Effect Transistors (FETs) 10.1.1 Introduction to FETs: JFETs and MOSFETs 10.1.2 Structure and operation of MOSFETs	What are MOSFETs?
Week 12	**Unit-XI** 11.1 Threshold voltage and channel formation 11.1.1 Current-voltage characteristics of MOSFETs 11.1.2 Applications of FETs in digital and analog circuits	Review
Week 13	**Unit-XII** 12.1 Optoelectronic Properties of Semiconductors 12.1.1 Interaction of semiconductors with light: absorption, emission, and photoconductivity 12.1.2 Photodetectors and solar cells	What are solar cells?
Week 14	**Unit-XIII** 13.1 Light-emitting diodes (LEDs) and semiconductor lasers 13.1.1 Quantum wells, wires, and dots in optoelectronics	Practice
Week 15	**Unit-XIV** 14.1 Advanced Semiconductor Materials and Devices (Optional) 14.1.1 Compound semiconductors and heterojunctions 14.1.2 Semiconductor nanostructures (quantum dots, nanowires, 2D materials) 14.1.3 High-electron-mobility transistors (HEMTs) 14.1.4 Advanced applications: power electronics, RF devices, and photonics	What is the future of semiconductors?
Week 16	Final Term Exams	

Textbooks and Reading Material
1. "Semiconductor Physics and Devices: Basic Principles" by Donald A. Neamen 2. "Physics of Semiconductor Devices" by Simon M. Sze and Kwok K. Ng 3. "Solid State Electronic Devices" by Ben G. Streetman and Sanjay Banerjee 4. "Principles of Semiconductor Devices" by Sima Dimitrijev 5. "Introduction to Semiconductor Materials and Devices" by M.S. Tyagi 6. "Semiconductor Device Fundamentals" by Robert F. Pierret 7. "Fundamentals of Semiconductors: Physics and Materials Properties" by Peter Y. Yu and Manuel Cardona
Teaching Learning Strategies
1. Course Teaching 2. Presentations **3.** Quiz
Assignments: Types and Number with Calendar
1. 2. 3. 4.
Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.