Program	BS Solid State Physics	Course Code	SSP-401	Credit Hours	3 (3-0)

Course Title	Advanced Solid State Physics

Course Introduction

Solid State Physics is a major branch of Condensed Matter Physics and provides a theoretical basis to Material science. The course will provide a valuable introduction to Solid State Physics and an overview of crystal structure. The course not only will equip the students with the theoretical knowledge of crystal structure determination methods, but students will also learn X- ray diffraction, Neutron Diffraction, and Electron Diffraction experimental techniques as well. Inaddition, students will also get comprehensive knowledge about atomic bonding and the elastic behavior of the crystal lattice.

Learning Outcomes

With the completion of the course, students will be able to:

1. Understanding the basic theme of Solid State Physics
2. Theoretical knowledge of the Crystal Structure
3. Learning the Experimental techniques to determine the crystal structure
4. Knowledge of atomic bonding in Solids and elastic behavior of crystal lattices

Course Content

Week 1	• Basics Solid State Physics and its application
Week 2	• Phonon momentum; Inelastic scattering by phonons
Week 3	• Thermal Properties: Phonon heat capacity (Plank Distribution, NormalMode Numeration, Density of States in one dimension)
Week 4	• Density of States in three dimensions; Debye Model for Density of states; Einstein Model of the Density of states
Week 5	• Inharmonic crystal interactions; Thermal conductivity; electronic heatcapacity
Week 6	• Free Electron Theory: Energy levels in 1D; Effect of Temperature on the Fermi-Dirac distribution
Week 7	• Free electron Gas in 3D; Heat capacity of the electron gas

Week 8	• Electrical conductivity and Ohm's law
Week 9	• Motion in a magnetic field
Week 10	• Hall Effect; Thermal conductivity of metals
Week 11	• Band Theory: Nearly free electron model
Week 12	• Bloch function; Kronig-Penney model
Week 13	• Wave equation of electron in a periodic potential • Number of orbital in a band: Metals and Insulators
Week 14	• Semiconductor: Theory of semiconductors; Extrinsic semiconductors • Mobility of current carriers; Minority carriers; Lifetime; Surfaces; Contacts; • Semiconductor devices.
Week 15	Computational Techniques: Hartee-Fock Methods
Week 16	Density Functional Theory and LAPW method

Textbooks and Reading Material

1. Introduction to Solid State Physics (7^{th}Edition), C. Kittle, *John Wiley & Sons, Inc.* (1996).
2. Solid State Physics, J. S. Blakemore, *Cambridge University Press* (1991).
3. Solid State Physics Simulations, Steven Spicklemire, *John Wiley & Sons* (1996).
4. Solid State Physics, Neil W. Ashcroft, *Thomson Press (India)*, 2003).
5. Solid State Physics (2^{nd}Edition), G. Grosso, G. P. Parravicini, Academic Press (2013).

Teaching Learning Strategies

The instructor is required to make use of visualization/animations and symbolic/numerical calculations to teach the concepts. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes. A course project may also be assigned.

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. At least fifty percent of the question paper would involve new problems related to the concepts learned in the course. 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.