Course Specification

(Postgraduate Programs)

Course Title: :	SOLID STATE PHYSICS
Course Code:	PHYS640
Program:	Master of Science in Physics
Department:	Physical Sciences
College:	SCIENCE
Institution:	JAZAN UNIVERSITY
Version:	
Last Revision Date:	20/4/2024

Table of Contents

A. General information about the course:

1. Course Identification:

1. Credit hours: (3)				
2. Course type				
A.	☐University	☐College	☒ Department	☐Track
B.	☐Required		☒ Elective	
3. Level/year at which this course is offered: (level 2 or 3 / year 1 or 2)				
4. Course general Description: This course is designed to provide a framework for graduate students to understand at an "advanced" level some of the important aspects of solid-state physics and is designed to introduce crystal structures and symmetries, electron levels in periodic, weak periodic and tight binding potential, classification of solids, dielectric properties of insulators, homogeneous semiconductors and inhomogeneous semiconductors.				
5. Pre-requirements for this course (if any): Non				
6. Co-requirements for this course (if any): Non				
7. Course Main Objective(s):				
The main objectives of this course are focused on the following: • **Review the crystal structure and crystal symmetries.** • **Explore Electron Levels in periodic potential.** • **Analyze the electrons in a weak periodic potential and tight binding potential.** • **Discuss the classification of solids.** • **Explain the dielectric properties of insulators.** • **Discuss the homogeneous and inhomogeneous semiconductors.**				

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning		

No	Mode of Instruction	Contact Hours	Percentage
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)……**	
	Total	45

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding **Upon completing the course students will be able to**			
1.1	**Describe** all the physical quantities related to crystal lattices, the reciprocal lattice, Brillouin zone, Miller indices, symmetry operations, crystallographic point groups and space groups, Sommerfeld theory of metals, the periodic potential and Bloch's theorem, Boundary condition, Fermi surface, Density of levels, Bragg plane, extended and repeated zone schemes in one dimension, Fermi surface, tight binding levels, ionic crystals, covalent crystals, molecular crystals, metals and hydrogen–bonded solids, local field, polarizability, covalent insulators, Pyroelectricity, Ferroelectricity,	PLO1.1	Lectures, Tutorials, Seminars, and Interactive Discussions .	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect**: student survey

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	semiconductors, Band structure, intrinsic and extrinsic semiconductors, impurity levels, carrier densities, impurity band conduction, p-n junction, drift and diffusion currents, collision and recombination times, carrier densities and currents in the non-equilibrium p-n junction.			
1.2	**Discuss** the crystal lattices, the reciprocal lattices, Brillouin zone, Miller indices, symmetry operations, crystallographic point groups and space groups, ionic crystals, covalent crystals, molecular crystals, metals and hydrogen–bonded solids, ionic crystal, covalent insulators. Pyroelectricity and Ferroelectricity, intrinsic and extrinsic semiconductors, p-n junction, drift and diffusion currents, collision and recombination times, carrier densities and currents in the non equilibrium p-n junction.	PLO1.2	Lectures, Tutorials, Seminars, and Interactive Discussions .	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect**: student survey
…				
2.0	Skills **Upon completing the course students will be able to**			
2.1	**Solve** problems related to the reciprocal lattice, Brillouin zone, Miller indices, and symmetry operations, Sommerfeld theory of metals, the periodic potential and Bloch's theorem, Boundary condition, Fermi surface, Density of levels, Energy levels near a single Bragg plane, tight binding levels, ionic crystals, covalent crystals, molecular crystals, metals and hydrogen–bonded solids, Macroscopic electrostatic Maxwell's equation, theory of local field, theory of polarizability, optical properties of ionic crystal, covalent insulators, Pyroelectricity and Ferroelectricity, Band structure, carrier statistics in thermal equilibrium, intrinsic and extrinsic semiconductors, and statistics of impurity levels in thermal equilibrium, carrier densities,	PLO2.1	Lectures, Problem Based Teaching and Interactive Discussions	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect**: student survey

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	impurity band conduction, and transport in nondegenerate semiconductors, fields and carrier densities in the equilibrium p-n junction, drift and diffusion currents, collision and recombination times, carrier densities and currents in the nonequilibrium p-n junction.			
2.2	Derive formulas related to the reciprocal lattice, Brillouin zone, Miller indices, and symmetry operations, Sommerfeld theory of metals, the periodic potential and Bloch's theorem, Boundary condition, Fermi surface, Density of levels, Energy levels near a single Bragg plane, tight binding levels, ionic crystals, covalent crystals, molecular crystals, metals and hydrogen–bonded solids, Macroscopic electrostatic Maxwell's equation, theory of local field, theory of polarizability, optical properties of ionic crystal, covalent insulators, Pyroelectricity and Ferroelectricity, Band structure, carrier statistics in thermal equilibrium, intrinsic and extrinsic semiconductors, and statistics of impurity levels in thermal equilibrium, carrier densities, impurity band conduction, and transport in nondegenerate semiconductors, fields and carrier densities in the equilibrium p-n junction, drift and diffusion currents, collision and recombination times, carrier densities and currents in the nonequilibrium p-n junction.	PLO2.1		
3.0	Values, autonomy, and responsibility **Upon completing the course students will be able to**			
3.1	**Take** responsibility for managing professional development of individuals and groups.	PLO3.3	Expository and Discovery, and Interactive Discussions	

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
...				

C. Course Content:

No	List of Topics	Contact Hours
1.	**Crystal Structure and Crystal Symmetries:** Review of crystal lattices, the reciprocal lattice, Brillouin zone, Miller indices, and symmetry operations, classification of lattices, crystallographic point groups and space groups.	6
2.	**Electron Levels in a Periodic Potential:** Review of Sommerfeld theory of metals, the periodic potential and Bloch's theorem, Boundary condition, Fermi surface, Density of levels.	7.5
3.	**Electrons in a Weak Periodic Potential and the Tight-binding method:** Energy levels near a single Bragg plane, extended and repeated zone schemes in one dimension, Fermi surface and Brillouin zone, general features of tight binding levels.	7.5
4.	**Classification of Solids:** The spatial distribution of valance electrons, ionic crystals, covalent crystals, molecular crystals, metals and hydrogen–bonded solids.	6
5.	**Dielectric Properties of Insulators**: Review of Macroscopic electrostatic Maxwell's equation, theory of local field, theory of polarizability, optical properties of ionic crystal, covalent insulators. Pyroelectricity and Ferroelectricity.	6
6.	**Homogeneous Semiconductors:** Review of general properties of semiconductors, Band structure, carrier statistics in thermal equilibrium, intrinsic and extrinsic semiconductors, and statistics of impurity levels in thermal equilibrium, carrier densities, impurity band conduction, and transport in nondegenerate semiconductors.	6
7.	**Inhomogeneous Semiconductors:** Fields and carrier densities in the equilibrium p-n junction, drift and diffusion currents, collision and recombination times, carrier densities and currents in the nonequilibrium p-n junction.	6
Total		45

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**First mid-term exam**	**6**	**10**
2.	**Quizzes**	**4 , 8**	**10**
3.	**Activities (home-works, tests, class activities)**	**Over the semester**	**30**
3.	**Second mid-term exam**	**12**	**10**
4.	**Final Exam**	**16**	**50**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	• N. Ashcroftand N. Mermin, SolidS tateP hysics, (Brooks/Cole Publishing 1976)
Supportive References	• Kittel,Introduction to Solid State Physics, 8th edition, (WileyCharles 2005). • D. A. Neamen, Semiconductor physics and devices, (McGraw-Hill, 2011). • S.M.SzeandM.K.Lee, Semiconductor Devices-Physics and T echnology,3rdEdition, JohnWiley
Electronic Materials	
Other Learning Materials	

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms
Technology equipment (projector, smart board, software)	Data show and Smart board
Other equipment (depending on the nature of the specialty)	NONE

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students, Peer and program leader	Indirect (CES)- Indirect peer evaluation
Effectiveness of students assessment	Students, Program assessment committee	Direct/ Indirect
Quality of learning resources	Students, Faculty members	Indirect
The extent to which CLOs have been achieved	Instructor	Direct/ Indirect
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	**Department Council**
REFERENCE NO.	**Psci2415**
DATE	**1/10/2024**