Name of Institute: Indus Institute of Sciences, Humanities and Liberal Studies (IISHLS)

Name of Faculty: Dr. Manisha Vithalpura

Course code: MPH0301

Course name: Solid State Physics

Pre-requisites: B.Sc Physics (Electrostatics, crystal physics, electromagnetism)

Credit points: 04

Offered Semester: III

Course Coordinator (weeks 01 - 17)

Full name: Dr. Manisha Vithalpura

Department with sitting location: Physics Department, Physics lab

Telephone: 3314 (sitting location), 7874636405 (Mobile)

Email: manishavithalpura.gd@indusuni.ac.in

Consultation times: 1:30 pm to 4:45 pm (Friday)

Course Lecturer (weeks 01 - 17)

Full name: Dr. Manisha Vithalpura

Department with sitting location: Physics Department, Physics lab

Telephone: 3314 (sitting location), 7874636405 (Mobile)

Email: manishavithalpura.gd@indusuni.ac.in

Consultation times: 1:30 pm to 4:45 pm (Friday)

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

By participating in and understanding all facets of this Course a student will be able:

1. To introduce the physical properties of solids including the electrical, magnetic, optical, thermal and mechanical properties

2. To relate and guide the study of the classical, semi-classical and quantum theories forming the basis for our understanding of condensed matter

3. To learn crystal structure, crystal binding, lattice dynamics, electron, electron distribution theories and the concept of energy bands.

4. to determine the properties and behavior of solid materials

5. To under the features of condensed or solid materials using quantum and statistical mechanics concepts and formalisms

6. Learn about the technological applications of condensed matter physics through examples

Course Outcomes (CO)

1. To analyze the crystal structures by applying crystallographic parameters and by analysis of different techniques
2. To study different crystal defects and the lattice vibration phenomenon in the solids
3. To evaluate and analyze the electrical and optical properties of solids
4. To analyze electron transport and energy related problems by applying quantum mechanical principles
5. To understand the properties and structure of semiconducting material and develop the theory in the application
6. To understand the properties of superconductors and to apply the concept of it in the application.

Course Outline

Unit-1: Crystallography:
Elementary concepts of point and space group and its relevance to crystal structure. Interaction of X-rays with matter, absorption of X-rays. Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques. The Laue, powder and rotating crystal methods, crystal structure factor and intensity of diffraction maxima Extinctions due to lattice centering.

Unit-2: Defects in Crystals:
Point defects, line defects and planer (stacking) faults. Role of defects in crystal growth. The observation of imperfections in crystals, X-ray and electron microscopic techniques.
Lattice Dynamics: Vibration of lattice with two atoms per unit cell, quantisation of lattice vibrations, interaction of electromagnetic waves and particle waves with phonons.

Unit-3: Electronic Properties of Solids:
Band theory: Tight-bonding, cellular and pseudopotential methods. Fermi surface, Landau levels, de Hass-van Alphen effect, cyclotron resonance, magnetoresistance, Giant magneto resistance, colossal magneto resistance, Magnetic Resonance,
Magnetism: Spin waves and magnons, Ferri- and antiferro-magnetic order, Ferro and antiferro electric effect. Domains and Bloch-wall energy.

Unit-4
Semi-conductor Physics: Charge carrier density in intrinsic semiconductors, doping of semiconductors, carrier densities in doped semiconductors, conductivity of semiconductors, Hall effect (Classical and Quantum), semiconductor Hetrostructures and Superlattices. Junction capacitance of a PN junction, Luminescence, photo conductivity and optical absorption, Diffusion.

Superconductivity: Phenomena without observable Quantization: Zero resistance and Persistent currents, Meissner Effect, London Equations, Type I and II superconductors, Thermodynamic Properties, BCS theory, High Tc superconductors (Introduction)

Method of delivery

(Face to face lectures, video lectures Power Point Presentation, Self assessment, Active Learning Techniques)

Study time

(4 hours per week for lectures)

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally.	**1 Professional knowledge, grounding & awareness**

Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**Concept of Quantum physics** **Also application of the quantum physics principle in practical problems**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing** Critical and logical thinking is developed through numerical practice. Used various sources of the material and technology to perform the experimental part.
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills** **By practicing numerical, logical and critical thinking will be developed.**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **Conducting frequent unit test will develop their written communication skill**
	6 Oral communication **Arranging presentation on different physics topics throughout the semester**
	7 Teamwork **Group discussion in class and lab is arranged**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Lecture/tutorial times

Example:

Tuesday 02:00–03.00 pm Room Class-CL-08, 5th floor

Wednesday 02:00–03.00 pm Room Class-CL-08, 5th floor

Friday 02:00–03.00 pm Room Class-CL-08, 5th floor

Saturday 02:00–03.00 pm Room Class-CL-08, 5th floor

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Unit test will be conducted in the classes and test papers will be kept with course coordinator for the future reference.

Text books

1. Solid State Physics; Ashcroft & Mermin; Brooks/Cole; 2003.

2. Principles of electronic materials and devices, S. O. Kasap, McGraw Hill Company, Inc., 2006.

3. Solid State Physics-Structure and Properties of Materials; Wahab; Narosa; 2000.
4. C. Kittel, Introduction to Solid State Physics, Wiley India Pvt. Ltd., 2012.

Additional Materials

1. Introduction of Solids; Azaroff; Tata Mgraw Hill; 1984.

2. Crystallography Applied to Solid State Physics; Verma & Srivastava; New Age; 1991.

3. Introduction to Solid State Physics; Kittel; Wiley India Pvt Ltd; 2007.

4. Element of X-ray diffraction, B. D. Cullity, Addison-Wesley Publishing Company, Inc. Reading, MA, USA, 1956.

5. Solid State Physics (Introduction to the theory), James Patterson, Bernard Bailey, Springer-Verlag Berlin Heidelberg, 2010.

6. Elementary Solid State Physics, M. Ali Omar, Addison-Wesley, 1994.

Web resources:

- nptel.ac.in/courses/115/105/115105099
- nptel.ac.in/courses/115/106/115106061

MOOCs:

- mooc.es/course/solid-state-physics.

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Continuous Internal Evaluation (Theory)			
Mid Sem Exam		40% , Unit-1/2, Objective (1,2,3)	
Assignments		**10% , Objective (1 to 6)**	
Project/Presentation		5% , Objective (1 to 6)	
Attendance	5%		
Total		**60% (CIE theory)**	
Final exam (*closed book*)		40%	Objectives (1-6)

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 50% in CIE or end semester will be considered for supplementary assessment in the respective components (i.e CIE or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 50% marks to clear the concerned components.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -50% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.

Do not share your work with other students (except where required for a group activity or assessment.

Course schedule(subject to change)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Elementary concepts of point and space group and its relevance to crystal structure	1,2	PPt, chalk and board

	Weeks 2	Interaction of X-rays with matter, absorption of X-rays	1,2	Ppt,Chalk and Board
	Week 3	Elastic scattering from a perfect lattice. The reciprocal lattice and its applications to diffraction techniques	1-3	Ppt, Chalk and Board
	Week 4	The Laue, powder and rotating crystal methods, crystal structure factor, intensity of diffraction maxima Extinctions due to lattice centering	1-4	Ppt, Chalk and Board
	Week 5	U-2: introduction to crystal defects, presentation	1-4	PPT and chalk-board, presentation
	Week 6	. Point defects, line defects and planer (stacking) faults, Role of defects in crystal growth. The observation of imperfections in crystals,	1-4	Ppt, Chalk and board
	Week 7	X-ray and electron microscopic techniques, assignments, **Lattice Dynamics**: Vibration of lattice with two atoms per unit cell	1-4	Ppt and chalk and board,
	Week 8	quantisation of lattice vibrations, interaction of electromagnetic waves and particle waves with phonons.	1-4	Ppt and chalk-board
	Week 9	U-3: Introduction to Band theory, Tight-bonding, cellular and pseudopotential methods. Fermi surface,	1-5	PPt, chalk and board
	Week 10	Landau levels, de Hass-van Alphen effect, cyclotron resonance, magnetoresistance, Giant magneto resistance, colossal magneto resistance, Magnetic Resonance	1-5	PPt, chalk and board, assignments
	Week 11	**Magnetism:** Spin waves and magnons, Ferri- and antiferro-magnetic order, Ferro and antiferro electric effect	1-5	Chalk and board
	Week 12	U-4: Charge carrier density in intrinsic semiconductors, doping of semiconductors, carrier densities in doped semiconductors, conductivity of semiconductors, Hall effect (Classical and Quantum)	1-5	Chalk and board,

	Week 13	semiconductor Hetrostructures and Superlattices. Junction capacitance of a PN junction, Luminescence,	5,6	PPTs and Chalk and board
	Week 14	photo conductivity and optical absorption, Diffusion, assignments	5-6	PPTs and Chalk and Board, assignments
	Week 15	**Superconductivity:** Phenomena without observable Quantization: Zero resistance and Persistent currents, Meissner effect	5-6	Chalk and Board
	Week 16	London Equations, Type I and II superconductors, Thermodynamic Properties, BCS theory, High Tc superconductors (Introduction)	5-6	PPTs and chalk and board
	Week 17	Revision and Discussion	1-6	Chalk and Board

PROGRAM MAP for M.Sc. Physics

(Indus Institute of Sciences, Humanities and Liberal Studies)

Subject Mind Mapping