Hong Kong Baptist University
Faculty of Science – Department of Physics

Title (Units): **PHYS 4075 SOLID STATE PHYSICS (3, 3, 1)**

Course Aims: This course studies the applications of statistical physics and quantum mechanics to the solid state of matter. Aspects included are crystal structures, X-ray diffraction, lattice dynamics, thermal properties, and band theory of solid.

Pre-requisite: PHYS 3015 Structure and Properties of Matter or consent of instructor

Course Reviewed by: Prof. Fu-rong Zhu and Prof. Kok-wai Cheah

Course Intended Learning Outcomes (CILOs):

No.	**Upon successful completion of this course, student should be able to:**
1	Describe structures in solid state crystals, principles of diffraction and experimental determination of crystal structures.
2	Describe the basic theory of crystal lattice dynamics, thermal properties of crystal lattices, classical and quantum models of electrons in solid state crystals.
3	Describe electron motion in solid state crystals and electronic band structure of solids.
4	Explain the Debye and Einstein Models, free electron Fermi energy and use the theory to solve problems.
5	Use the potential of the nuclei to calculate simple band structure.

Teaching & Learning Activities (TLAs)

CILOs	**TLAs will include the following:**
1-3	Lectures are given to provide a systematic explanation of the subject in relation to the course objectives. Students will learn how to deal with crystalline solids, diffraction theory and why the important electronic properties of solids can be best expressed in crystals.
3-5	Students will learn phonon dispersion relations, thermal properties, electronic energy band structures, free electron Fermi gas, exam classical and quantum models of electrons in solids, and are able to use the theory calculating the important electronic properties in solids.
1-5	Tutorials are organized as part of the learning of the course to help students' problem-solving skills using the knowledge leant, more interactive discussions related to the topics, examples and problems in assignments will be encouraged.
1-5	Mid-term test will be arranged to measure how well the students have learnt the basic concepts and the ability to apply the theory solving problems.

Assessment Methods (AMs):

Type of Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
Continuous Assessment	50%	1-5	Mid-term test and problem assessments are designed to measure how well the students have learned the basic concepts and theory.
Final Examination	50%	1-5	2 hours final: 60% of the final at easy problems. 40% of the final at the relatively difficult problems.

Learning Outcomes and Weighting:

Content	CILO No.	Teaching (in hours)
I. Crystal structures.	1	6
II. Wave diffraction from periodic structures.	1,2	7
III. Dynamics of atoms in crystals.	1,2	7
IV. Thermal properties of crystal lattices.	2,3,4	6
V. The electronic band structure of solids.	1-5	10

Textbook: C. Kittle, Introduction to Solid State Physics, 8th Ed., John Wiley & Sons, 2005.

References:

1. David W. Snoke, Outlines & Highlights for Solid State Physics: Essential concepts, AIPI, 2009.
2. Phillip Hofmann, Solid State Physics: An Introduction, Wiley-VCH, 2008.
3. Harald Ibach and Hans Luth, Solid-State Physics: An Introduction to Principles of Materials science, Springer, 2009.

Course Content in Outline:

	Topic	Hours
I.	Crystal Structures	6
	A. The crystal lattice.	
	B. Symmetry.	
	C. Simple crystal structures	
II.	Wave diffraction from periodic structures	7
	A. Reciprocal lattice.	
	B. General theory of diffraction.	
	C. Diffraction conditions.	
	D. The structure factor.	

III.	Dynamics of atoms in crystal	7
	A. Crystal binding	
	B. Monatomic linear chain.	
	C. Diatomic linear chain.	
	D. Phonons.	
IV.	Thermal properties of crystal lattices	6
	A. The density of states.	
	B. The specific heat capacity of the lattice.	
	C. Heat conduction by phonons.	
V.	The electronic band structure of solids	10
	A. The nearly-free-electron approximation.	
	B. The tight-binding approximation.	
	C. Examples of band structures.	