TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

INTRODUCTION TO SOLID STATE PHYSICS

by

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PREFACE

In this introductory solid state physics course, students study a variety of topics in solid-state physics that are related to the basic concepts of physics. These topics include crystal structure, X-ray diffraction and reciprocal lattice, crystal bonds and elasticity constant, crystal vibration (phonons) and thermal properties, free electron gas models, energy bands, semiconductors, Fermi and metal surfaces, plasmon, polaritons and polaron, and optical excitation processes. These topics are traditionally taught in the classroom using the teacher-centered learning method. In implementing this learning method, students passively listen to lecturers' explanations about basic concepts and some examples of applications while noting things that are deemed necessary. Students will master the subjects by doing structured assignments in the form of homework and papers.

In order for students to actively build their knowledge and also train various abilities besides mastery of teaching materials, this course will be studied by students using the student-centered learning method, namely Collaborative Learning (CL). However, for important concepts, interactive lecture methods are still being used. By using these methods, students are allowed to practice soft skills such as collaboration and communication skills.

This Teaching Instructional Design (BRP) was prepared for teaching in the Department of Physics, Faculty of Mathematics and Natural Sciences at the University of Indonesia. This book is a guide for activities during the learning process. Thus, the learning process carried out by students can be directed and, in the end, the learning objectives can be achieved.

I would like to thank the leadership of the Physics Department and staff so that this book can be completed.

Depok, 24 November 2016

Efta Yudiarsah, Ph.D.

I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Introduction to Solid State Physics
3.	Course Code	:	SCFI603117
4.	Semester	:	5
5.	Credit	:	4 credits
6.	Teaching Method(s)	:	Interactive learning and Collaborative learning
7.	Prerequisite course(s)	:	Quantum Mechanics 1, Statistical Physics
8.	Requisite for course(s)	:	Undergraduate Thesis
9.	Integration Between Other Courses	:	Solid State Physics
10.	Lecturer(s)	:	Efta Yudiarsah, Ph.D.
11.	Course Description	:	This course covers eight major topics, namely crystal structure, X-ray diffraction and reciprocal lattice, crystal bonds and elasticity constants, crystal vibration (phonons) and thermal properties, free electron gas models, energy bands, semiconductors, Fermi surfaces. and metal, plasmon, polariton and polaron, and optical excitation processes. After completing this course, when faced with problems in known solid material systems, students are able to explain the concept of the crystalline state of solids, the motion of electrons and vibrations of atoms in crystals, and their implications in forming the specific properties of solids.

II. Course Learning Outcome (CLO) and Sub-CLOs

A. CLO

After completing this lecture, students are able to explain the concept of the crystalline state of solids, the motion of electrons and the vibrations of atoms in crystals, and their implications for forming the specific properties of solids. (ELO 3,5,6 and 7)

B. Sub-CLOs

1. Distinguishing the crystal structure of a solid substance (C4)
2. Explain the vibrational motion of atoms in the solid matter (C4)
3. Classifying the electronic structure of solids (C4)
4. Identifying the optical phenomenon of solids (C4)

III. Teaching Plan

Week	Sub-CLO	Study Materials	Teaching Method	Time Required	Learning Experiences (*O-E-F)	Sub-CLO Weight on Course (%)	Sub-CLO Achievement Indicator	References
1	1	Structure of Crystalline Solids	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	6	Distinguishing the crystal structure of a solid material	[1] Ch. 1
2	1	Structure of Crystalline Solids	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	6	Describe X-ray diffraction	[1] Ch. 2
3	1	Structure of Crystalline Solids Oscillators	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	6	Describe reciprocal lattice	[1] Ch. 2
4	2	Phonons	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	6	Describe the vibrational motion of atoms in solid matter	[1] Ch. 4; [1] Ch. 5
5	2	Phonons	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	6	Describe the crystal bond and elasticity constants	[1] Ch. 4; [1] Ch. 5
6	2	Phonons	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	6	Describe the vibrations in the crystal	[1] Ch. 4; [1] Ch. 5
7	**Mid-Term Exam**							
8	3	Crystal Electronic Structure	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Classifies the electronic structure of solids	[1] Ch. 6
9	3	Crystal Electronic Structure	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Describe the free electron gas model	[1] Ch. 6
10	3	Crystal Electronic Structure	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Describe energy bands	[1] Ch. 7
11	4	Crystal Electronic Structure	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Describe semiconductors	[1] Ch. 8
12	4	Crystal Electronic Structure	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Describes Fermi and Metal surfaces	[1] Ch. 9
13	4	Crystal Optical Properties	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Identify the optical phenomenon of solids	[1] Ch. 10

14	4	Crystal Optical Properties	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Describing plasmon, Polariton and polaron,	[1] Ch. 10
15	4	Crystal Optical Properties	Collaborative Learning	200 minutes	20% O, 70% E, 30% F	8	Describe Optical and Exciton processes	[1] Ch. 11
16	**Final Exam**							

*) O : Orientation (Interactive Learning)
E : Exercise (Collaborative Learning)
F : Feedback (Quizzes)

References:

[1] C. Kittle, *Introduction to Solid State Physics* 8th Ed., Wiley, 2005.

[2] J. R. Hook and H. E. Hall, *Solid State Physics* 2nd Ed, Wiley, 1991.

[3] N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Saunders College Publishing, 1976.

[4] H. Ibach and H. Luth, *Solid-State Physics* 4th Ed., Springer, 2009.

IV. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
1-4	Individual assignment / HW 1	1	Problem set	Crystal Structures, X-ray Diffractions, and Reciprocal Lattice	Independent	1 week	Written report
3-7	Quiz 1	2	Problem set	Crystal Bonds, Elasticity Constants, and Vibrations in Crystal	Independent	40 minutes	Written report
8	**Mid-Term Exam**						
9	Individual assignment / HW 2	3	Problem set	Free-electron gas model and Energy Bands	Independent	1 week	Written report
10-11	Individual assignment / HW 3	3	Problem set	Semiconductors	Independent	1 weeks	Written report
12-13	Quiz 2	3	Problem set	Fermi surface and Metal	Independent	40 minutes	Written report
14-15	Individual assignment / HW 4	4	Problem set	Plasmon, Polariton and Polaron, Optical Excitation Processes	Independent	2 weeks	Written report
16	**Final Exam**						

*) HW: Homework

V. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Individual Assignments / Homework	1, 3, 4	Problem set	4	30
Quizzes	2, 3	Answer sheet	2	15
Class Involvement	4	Evaluation sheet	1	5
Mid-Term Exam	1, 2	Independent assignments evaluationt	1	25
Final Exam	3, 4	Independent assignments evaluationt	1	25
			Total	**100**

VI. Rubric(s)

A. Criteria of Assignment and Exam Score

Score	Answer Quality
100	The answer is very precise and all the concept and main component are explained completely
76-99	The answer is fairly precise and the concept and main component are explained fairly complete
51-75	The answer is less precise and the concept and main component are explained less complete
26-50	The answer is poorly precise and the concept and main component are explained poorly complete
<25	Wrong answer

VII. Appendix: Example of Exam Problems

Appendix 1. Assignment Examples

1. Homework example:

   Homework 1; Solid Material Structure. Solve the questions in the textbook Chapter 1, questions 3, 4, and 5.

2. Paper assignment example:

   Paper Assignments 1. Read some literature related to the topic of the crystal structure of a material. Write a paper on the topic in the form of a review from at least three credible sources.

Appendix 2. Evaluation Examples

1. Essay

   Give an overview of the polaron phenomenon in solid materials. Provide example.