TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

SOLID STATE PHYSICS I

by

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PREFACE

In this solid matter physics course, students learn a variety of topics in solid matter physics which are related to the basic concepts of physics. These topics include crystal structure, X-ray diffraction and back lattices, crystal bonding and elasticity constants, crystal vibration (phonons) and thermal properties, free electron gas models, energy bands, semiconductors, Fermi and metal surfaces, plasmon, polaritons, and polaron, optical and excitement 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 practice mastery of the material 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. However, for important concepts, interactive lecture methods are still being used. By using these methods, students are given the opportunity to practice soft skills such as cooperation and communication skills.

This Learning Design Book was prepared as a complement to teaching in the Physics Master Program, 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, November 24th 2016

Efta Yudiarsah, Ph.D.

I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Solid State Physics 1
3.	Course Code	:	SCFI603611
4.	Semester	:	5
5.	Credit	:	4 credits
6.	Teaching Method(s)	:	Interactive Lectures and Collaborative Learning
7.	Prerequisite course(s)	:	Quantum Mechanics 1, Statistical Physics, Introduction to Solid State Physics
8.	Requisite for course(s)	:	Undergraduate Thesis
9.	Integration Between Other Courses	:	Introduction to Solid State Physics and Solid-State Physics 2
10.	Lecturer(s)	:	Efta Yudiarsah, Ph.D.
11.	Course Description	:	This Solid Physics course covers eight major topics, namely crystal structure, X-ray diffraction and back 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, optical and excitatory processes. Students learn this course with a combination of two active learning methods, namely interactive lectures and collaborative learning. Students have the opportunity to practice integrating understanding of the basic concepts of physics, and analytical skills in studying the eight topics above. Students also practice explaining and analyzing phenomena in solid matter systems using basic concepts of physics and their application to technology. In addition, students can develop the ability to synthesize and evaluate both qualitatively and quantitatively phenomena in solid material systems using basic physics concepts. 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. [Dept. Competency Based Curriculum. Physics FMIPA UI 2011].

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

A. CPMK

After completing this course, students are competent in explaining the concept of the crystalline of solid-states, the motion of electrons and the vibrations of atoms in crystals, and their implications for forming the specific properties of solids. (CLO 3,5,6 and 7)

B. Sub-CLOs

1. Distinguishes the crystal structure of a solid material (C4)
2. Describes the vibrational motion of atoms in solid matter (C4)
3. Classifies the electronic structure of solids (C4)
4. Identifies the optical phenomenon of solids (C4)

III. Lesson 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	Solid Crystalline Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	6	Distinguishes the crystal structure of a solid material	[1] chapter 1
2	1	Solid Crystalline Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	6	Explains x-ray diffraction	[1] chapter2
3	1	Solid Crystalline Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	6	Explains reciprocal lattice	[1] chapter 2
4	2	Phonon	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	6	Describes the vibrational motion of atoms in solid matter	[1] chapter 4 and 5
5	2	Phonon	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	6	Describe the crystal bonding and the elasticity constant	[1] chapter 4 and 5
6	2	Phonon	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	6	Explain vibrations in crystals	[1] chapter 4 and 5
7	**Midterm Exam**							
8	3	Electronic Band Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Classifies the electronic structure of solids	[1] chapter 6

9	3	Electronic Band Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Describes the free electron gas model	[1] chapter 6
10	3	Electronic Band Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Describes the energy bands	[1] chapter 7
11	4	Electronic Band Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Describes Semiconductors	[1] chapter 8
12	4	Electronic Band Structure	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Describes the Fermi Surfaces and Metals	[1] chapter 9
13	4	Crystal Optical Properties	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Identifies the optical phenomenon of solids	[1] chapter 10
14	4	Crystal Optical Properties	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Explains plasmon, Polariton and polaron,	[1] chapter 10
15	4	Crystal Optical Properties	*Collaborative Learning*	200 minutes	O : Interactive Lectures (20%) E : *Collaborative Learning* (70%) F : Quiz (10%)	8	Explains Optical and exciton processes	[1] chapter 11
16	**Final Exam**							

*) O : Orientation
E : Exercise
F : Feedback

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. Design of Assignment and Exercise

Week	Assignment Name	Sub-CLO	Assignment	Scope	Working Procedure	Deadline	Outcome
1-4	Individual-Assignment / Homework 1	1	Question(s)	Crystal Structure, X-ray Diffraction, and Reciprocal Lattice	Individual	1 week	Written Report
3-7	Quiz 1	2	Question(s)	Crystal bonds and elasticity constants, Vibration in crystals	Individual	40 minutes	Written Report
8	Midterm Exam						
9	Individual-Assignment / Homework 2	3	Question(s)	Free electron gas model Energy band	Individual	1 week	Written Report
10-11	Individual-Assignment / Homework 3	3	Question(s)	Semiconductors	Individual	1 week	Written Report
12-13	Quiz 2	3	Question(s)	Fermi Surfaces and Metals	Individual	40 minutes	Written Report
14-15	Individual-Assignment / Homework 4	4	Question(s)	Plasmon, Polariton and polaron, Optical and exciton processes	Individual	1 week	Written Report
16	Final Exam						

V. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Individual Assignment / Homework	1,3,4	Assignment File	4	30
Quiz	2,4	Test Sheet	2	15
Participation	4	Scoring Sheet	1	5
Midterm Exam	1,2	Individual Assignment Evaluation	1	25
Final Exam	3,4	Individual Assignment Evaluation	1	25
Total				**100**

VI. Rubric

A. **Criteria of Essay Assessment**

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

VII. Attachment: Sample of Examination Papers

Attachment 1. Sample of Assignments

1. Contoh Tugas Pekerjaan Rumah:

Pekerjaan Rumah ke-1, Struktur bahan padat. Kerjakan soal di buku teks Bab 1 soal nomor: 3, 4, dan 5.

2. Contoh Tugas Makalah: format penulisan, isi, dan logika

Tugas Makalah 1. Bacalah beberapa literature terkait topik struktur kristal suatu bahan. Tulislah sebuah makalah mengenai topik tersebut dalam bentuk review dari minimal tiga sumber.

Attachment 2 . Sample of Essay

1. **Essay**

Berikanlah gambaran fenomena polaron di bahan padat. Berikan juga contohnya.