TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

TRANSPORT AND OPTICAL PROPERTIES OF MATERIALS

by

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UNIVERSITAS INDONESIA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
PHYSICS UNDERGRADUATE STUDY PROGRAM

TEACHING INSTRUCTIONAL DESIGN

Course Name	Transport and Optical Properties of Materials	**Credit(s)**	**Prerequisite course(s)**	**Requisite for course(s)**	**Integration Between Other Courses**
Course Code	SCPH603706	4	None	None	None
Relation to Curriculum	Elective Course				
Semester	6^{th} / 8^{th}				
Lecturer(s)	Efta Yudiarsah, Ph.D.				
Course Description	This course covers two major topics namely the transport properties of solids (energy band structure, electric charge transport phenomena, heat transport, electron beam by phonons, defects and impurities, magneto-transport phenomena, two-dimensional electron gas, quantum wells and semiconductor superlattices, transport in low dimension system) and optical properties of solids (fundamental relationships in optical phenomena, Drude's theory, transitions between bands, joint density of states, absorption of light in solids). 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.				

Program Learning Outcome (PLO)	
PLO-1	Applying the concepts of Materials Physics
PLO-2	Formulating problems and solving Physics and its application, as well as interdisciplinary problems related to

	science and mathematics clusters critically, creatively, and innovatively.
PLO-3	Solving simple scientific problems and presenting them orally and in writing
Course Learning Outcome (CLO)	
CLO-1	Explain the concept of the emergence of transport properties of charge and heat, as well as the optical properties of solids from a simple view of a free electron system to a more complex one with respect to the potential effects of crystals, phonons, etc.
Sub-CLO(s)	
Sub-CLO 1	Distinguishing the crystal structure of a solid substance (C4)
Sub-CLO 2	Explain the vibrational motion of atoms in the solid matter (C4)
Sub-CLO 3	Classifying the electronic structure of solids (C4)
Sub-CLO 4	Identifying the optical phenomenon of solids (C4)
Study Materials	Energy band structure, electric charge transport phenomena, heat transport, electron beam by phonons, defects and impurities, magneto-transport phenomena, two-dimensional electron gas, quantum wells and semiconductor superlattices, transport in low dimension system, fundamental relationships in optical phenomena, Drude's theory, transitions between bands, joint density of states, absorption of light in solids.
Reading List	[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

I. Teaching Plan

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

		[1] Ch. 7	Learning [200 minutes]	F		
11	4	Crystal Electronic Structure [1] Ch. 8	Collaborative Learning [200 minutes]	20% O, 70% E, 30% F	Describe semiconductors	8
12	4	Crystal Electronic Structure [1] Ch. 9	Collaborative Learning [200 minutes]	20% O, 70% E, 30% F	Describes Fermi and Metal surfaces	8
13	4	Crystal Optical Properties [1] Ch. 10	Collaborative Learning [200 minutes]	20% O, 70% E, 30% F	Identify the optical phenomenon of solids	8
14	4	Crystal Optical Properties [1] Ch. 10	Collaborative Learning [200 minutes]	20% O, 70% E, 30% F	Describing plasmon, Polariton and polaron,	8
15	4	Crystal Optical Properties [1] Ch. 11	Collaborative Learning [200 minutes]	20% O, 70% E, 30% F	Describe Optical and Exciton processes	8
16	**Final Exam**					

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

II. 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

III. 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

IV. Rubric(s)

This rubric is used as a guideline for assessing or giving levels of student performance results. a rubric usually consists of assessment criteria that include the dimensions / aspects that are assessed based on indicators of learning achievement. This assessment rubric is useful for clarifying the basics and aspects of the assessment so that students and lecturers can be guided by the same thing regarding the expected performance demands. Lecturers can choose the type of rubric according to the assessment given.

A. Conversion of the student's final score

Score	Grade	Equivalent
85 - 100	A	4.00
80 - < 85	A-	3.70
75 - < 80	B+	3.30
70 - < 75	B	3.00
65 - < 70	B-	2.70
60 - < 65	C+	2.30
55 - < 60	C	2.00
40 - < 50	D	1.00
< 40	E	0.00

B. Assessment rubric: assignment and exam

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