SEMESTER LEARNING ACTIVITY PLANS
(SLAP)
SEMESTER EVEN 2022/2023

Condensed Matter Optics

MFF5780 / 3 Credits

Lecturer Coordinator:

Moh. Adhib Ulil Absor, S.Si., M.Sc., Ph.D.

UNIVERSITAS GADJAH MADA
FACULTY OF MATHEMATICS AND NATURAL SCIENCE
2022

	Universitas Gadjah Mada Faculty of Mathematics and Natural Science Physics Department / Study Program Master Physics Semester Even 2022/2023

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (credits)	Semester	Status	Prerequisite
MFF5780	*Condensed Matter Optics*	*3*	*Even*	*Elective*	*None*

Short Description	Condensed Matter Optics course is Elective course 3 credits (Theory) in the 2022 Curriculum Master Physics Study Program, Faculty of Mathematics and Natural Science UGM. The syllabus of this course is as follows: Introduction of fundamental optical properties of materials: the theory of propagation of electromagnetic waves in materials, optical constants, refractive indices, dispersions. Basic optical studies for conductor materials, insulators, and semiconductors. The optical properties of several compressed materials: photonic crystals, surface plasmons, metamaterials, spintronic materials, organic semiconductors, magneto-optics, thin films, and exciton. Nonlinear optical properties of the material are compressed. The courses are held in class for 14 weeks, each week's session last for 3 x 50 minutes. Four weeks of course period is used for Midterm Exam and Final Exam, each held for two weeks as scheduled. Student evaluation for course assessments is performed summative and formative. The summative evaluation is implemented as written exams, both Midterm and Final Exam, which take a maximum of 120 minutes. The formative evaluation is implemented as individual assignments for each student in the form of completing an assignment individually. Monitoring is carried out by observing student activities during the course, such as attendance, Q&A and discussion about the material presented, and student performance in completing individual assignments.

Program Learning Outcomes (PLO) Imposed on the Course

PLO 3	Mastering further knowledge of classical and modern physics theory, and its relationship with other disciplines, and has mastered an advanced field of physics specialization that allows him to keep up with the latest international research developments.
PLO 4	Mastering various mathematical disciplines related to an advanced field of physics, and able to develop physical models using various mathematical and computational tools with an inter or multidisciplinary approach to solving problems related to an advanced field of physics.
PLO 6	Able to apply knowledge to analyze, synthesize, formulate problems and solve problems comprehensively in one of advanced field of physics, through experimental or theoretical research, then be able to classify and draw conclusions about their findings for the development of science and technology.

Upon completion of this course, students should be able to:

Course Outcomes (CO)	***CO1***	Formulate and describe the physical phenomena being studied and reveal vital information in the physics problem through various tricks or specific mathematical procedures and utilizing different approximations.		
	CO2	Pay attention to physics problems in detail, analyze issues, and build arguments logically and carefully.		
	CO3	Research physics problems from various sources and references to understand important information.		
	CO4	Solve issues with structured solutions (well-defined solutions), formulate a problem carefully, and try other approaches to improve the solution of a challenging problem.		
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Introduction: classification of optical processes, optical coefficients, refractive index and dielectric constant, optical materials, optical characteristics in solids, and microscopic models.	Lecture	3 x 50 minutes
	CO1	Classical propagation (Part I): propagation of light in a medium, the dipole oscillator model, and Dispersion.	Lecture	3 x 50 minutes
	CO1	Classical propagation (Part II): propagation of light in a medium, the dipole oscillator model, and Dispersion.	Lecture	3 x 50 minutes
	CO2	Interband absorption part I: interband transition, rate of direct absorption transition, absorption in direct semiconductor, indirect semiconductor absorption, interband absorption, absorption spectrum measurement, and semiconductor photodetector.	Lecture	3 x 50 minutes
	CO2	Interband absorption part II: interband transition, Direct absorption transition rate, absorption in direct semiconductor, indirect semiconductor absorption, interband absorption, absorption spectrum measurement, and semiconductor photodetector.	Lecture	3 x 50 minutes
	CO2	Exciton: basic concept, free exciton, Frenkel exciton.	Lecture	3 x 50 minutes
	CO2	Luminescence: Emission of light in solids, interpita luminescence,	Lecture	3 x 50 minutes

		photoluminescence, and electroluminescence.		
	CO3	Semiconductor quantum well (Part I): quantum confined structure, Energy level, Optical absorption and exciton, stark effect.	Lecture	3 x 50 minutes
	CO3	Semiconductor quantum well (Part II): quantum confined structure, Energy level, Optical absorption and exciton, stark effect.	Lecture	3 x 50 minutes
	CO3	Free electrons (Part I): Plasma reflectivity, Free carrier conductivity, Drude models in metals, Interpita transitions in metals, Doped semiconductors, and Plasmons.	Lecture	3 x 50 minutes
	CO4	Free electrons (Part II): Plasma reflectivity, Free carrier conductivity, Drude models in metals, Interpita transitions in metals, Doped semiconductors, and Plasmons.	Lecture	3 x 50 minutes
	CO4	Molecular materials: introduction of electronic states, molecular optical spectra, aromatic hydrocarbons, conjugated polymers, optoelectronic organics.	Lecture	3 x 50 minutes
	CO4	Phonons: Active infrared phonons, Reflectivity and absorption infrared, Polariton, Polaron, inelastic scattering of light.	Lecture	3 x 50 minutes
	CO4	Nonlinear optics: susceptibility tensor non-linear, second-order nonlinear, third-order non-linear effects.	Lecture	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture			
Student Learning Experience	Learn to analyze and review: Introduction: classification of optical processes, optical coefficients, refractive index and dielectric constant, optical materials, optical characteristics in solids, and microscopic models., Classical propagation (Part I): propagation of light in a medium, the dipole oscillator model, and Dispersion., Classical propagation (Part II): propagation of light in a medium, the dipole oscillator model, and Dispersion., Interband absorption part I: interband transition, rate of direct absorption transition, absorption in direct semiconductor, indirect semiconductor absorption, interband absorption, absorption spectrum measurement, and semiconductor photodetector., Interband absorption part II: interband transition, Direct absorption transition rate, absorption in direct semiconductor, indirect semiconductor absorption, interband absorption, absorption spectrum measurement, and semiconductor photodetector., Exciton: basic concept, free exciton, Frenkel exciton., Luminescence: Emission of light in solids, interpita luminescence, photoluminescence, and electroluminescence., Semiconductor quantum well (Part I): quantum confined structure, Energy level, Optical absorption and exciton, stark effect., Semiconductor quantum well (Part II): quantum confined structure, Energy level, Optical absorption and			

<table>
<tr><td></td><td>exciton, stark effect., Free electrons (Part I): Plasma reflectivity, Free carrier conductivity, Drude models in metals, Interpita transitions in metals, Doped semiconductors, and Plasmons., Free electrons (Part II): Plasma reflectivity, Free carrier conductivity, Drude models in metals, Interpita transitions in metals, Doped semiconductors, and Plasmons., Molecular materials: introduction of electronic states, molecular optical spectra, aromatic hydrocarbons, conjugated polymers, optoelectronic organics., Phonons: Active infrared phonons, Reflectivity and absorption infrared, Polariton, Polaron, inelastic scattering of light., Nonlinear optics: susceptibility tensor non-linear, second-order nonlinear, third-order non-linear effects..</td></tr>
<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td>Sync (google meet), Asynchronous (google classroom, video)</td></tr>
<tr><td>Assessment Methods and Synchronization with CO</td><td>
<table>
<tr><th>Assessment Methods</th><th>Assessment Percentage</th><th>Criteria/Indicators</th><th>CO1</th><th>CO2</th><th>CO3</th><th>CO4</th></tr>
<tr><td>Participatory Activity*</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project Results/ Case Study Results/ PBL Results*</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Cognitive</td></tr>
<tr><td>Assignment</td><td>30%</td><td></td><td>7,5%</td><td>7,5%</td><td>7,5%</td><td>7,5%</td></tr>
<tr><td>Quiz</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Midterm Exam</td><td>35%</td><td></td><td>17,5%</td><td>17,5%</td><td></td><td></td></tr>
<tr><td>Final Exam</td><td>35%</td><td></td><td></td><td></td><td>17,5%</td><td>17,5%</td></tr>
<tr><td colspan="7">*) can also be obtained from the Midterm or Final Exam as the result of participatory activities or project/ case study results. According to IKU 7, the percentage of project results/ case study/ PBL results is at least 50%.</td></tr>
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<tr><td>References</td><td>Main references:
1. Jai Singh, 2006, Optical Properties of Condensed Matter and Applications,John Wiley & Sons, Chichester, England, UK.
2. Joseph H Simmons, Kelly S Potter, 2000, Optical Materials, AcademicPress, San Diego, USA.
3. Yoshinobu Aoyagi, Kotaro Kajikawa (editors), 2013, Optical Properties ofAdvanced Materials, Springer-Verlag Berlin, Heidelberg.
4. Mark Fox, 2001, Optical Properties of Solids, Oxford University Press,Oxford, UK.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td>1. Moh. Adhib Ulil Absor, S.Si., M.Sc., Ph.D.
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4.</td></tr>
<tr><td>Authorization</td><td>
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<tr><th>Date of Drafting</th><th>Lecturer Coordinator</th><th>Head of Curriculum Committee</th><th>Head of Study Program</th></tr>
<tr><td></td><td>Moh. Adhib Ulil Absor, S.Si., M.Sc., Ph.D.</td><td>Dr.Ing. Ari Setiawan</td><td>Mirza Satriawan, M.Si., Ph.D</td></tr>
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