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

Quantum Mechanics

MFF5033 / 3 Credits

Lecturer Coordinator:

Drs. Pekik Nurwantoro, M.S., 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 Odd/Even 2022/2023

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (credits)	Semester	Status	Prerequisite
MFF5033	*Quantum Mechanics*	*3*	*Odd/Even*	*Compulsory*	*None*

Short Description

Quantum Mechanics course is Compulsory 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:
Understanding the experimental aspects and mathematical structures of quantum mechanics and their application to various atomic/nuclear phenomena include the principles and various formulations of quantum mechanics, operators, the implementations and their properties, one-dimensional and three-dimensional potential spherical symmetry, rotational angles of momentum. Identical particle systems and the Pauli principle, scattering and perturbation theory, and their implementation.

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 provide (to describe) the physical phenomena that are being studied and reveal important information contained in the physics problem through various tricks or certain mathematical procedures and utilize various approaches.		
	CO2	Applying various forms of visualization, graphs or simulations, for example through computer assistance, making it easier to understand the physics problem being studied, compared to simply basing understanding through abstraction of mathematical expressions.		
	CO3	Conduct a search for physics problems from various sources and references to get an understanding of important information.		
	CO4			
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Background and early development of Quantum Mechanics and its relation to Classical Mechanics.	Lecture	3 x 50 minutes
	CO1	Understanding of experimental aspects, the material properties of light: • Blackbody Radiation, • Planck's concept of the relation between energy and frequency, • Photoelectric effect, • Compton effect. • Others.	Lecture	3 x 50 minutes
	CO1	Understanding of experimental aspects, wave properties of particles: • Davisson and Germer, • Double Slit, • Bragg diffraction, • de Broglie's concept of the relation between wavelength and linear momentum.	Lecture	3 x 50 minutes
	CO2	• Simple interpretation of the Schrodinger equation and wave function, associated with the concept of energy for the physical system under consideration and based on the analogy of understanding plane waves or free particle motion in classical mechanics, • Introduction of some simple operators representing physical quantities and their properties. Hermitianoperator.	Lecture	3 x 50 minutes
	CO2	Introduction and interpretation of the formal aspects of the formulation of quantum mechanics	Lecture	3 x 50 minutes

		regarding: • probability density of finding a particle, • expected value of a physical quantity, • uncertainty of measurement of physical quantity and Heisenberg's concept of uncertainty.		
	CO2	An example of how to construct the Schrodinger equation for any potential form and its relation to the Eigen Value Problem.	Lecture	3 x 50 minutes
	CO2	Solving the Scrodinger equation for the form of a Potential Well as an illustration of a bound system (bound state).	Lecture	3 x 50 minutes
	CO3	Solving the Scrodinger equation for the form of a Potential Well as an illustration of an unbound system.	Lecture	3 x 50 minutes
	CO3	Solving the Scrodinger equation as a depiction of a solid system using the Kronig-Penney Model.	Lecture	3 x 50 minutes
	CO3	Solving the Schrodinger equation for the Hydrogen Atom, as an example of a 3-dimensional system.	Lecture	3 x 50 minutes
	CO4	Introduction to orbital angular momentum and spin.	Lecture	3 x 50 minutes
	CO4	The Pauli exclusion principle for systems of identical particles in complex atoms.	Lecture	3 x 50 minutes
	CO4	A review of the perturbation method for the Helium atom as an example for a system of identical particles.	Lecture	3 x 50 minutes
	CO4	An introduction to the theory of quantum scattering and the completion of its approximation.	Lecture	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture			
Student Learning Experience	Learn to analyze and review: Background and early development of Quantum Mechanics and its relation to Classical Mechanics., Understanding of experimental aspects, the material properties of light: • Blackbody Radiation, • Planck's concept of the relation between energy and frequency, • Photoelectric effect, • Compton effect. • Others., Understanding of experimental aspects, wave properties of particles: • Davisson and Germer, • Double Slit, • Bragg diffraction, • de Broglie's concept of the relation between wavelength and linear momentum., • Simple interpretation of the Schrodinger equation and wave function, associated with the concept of energy for the physical system under consideration and based on the analogy of understanding plane waves or free particle motion in classical mechanics, • Introduction of some simple operators representing physical quantities and their properties. Hermitianoperator. , Introduction and interpretation of the formal aspects of the formulation of quantum mechanics regarding: • probability density of finding a particle, • expected value of a physical quantity, • uncertainty of measurement of physical quantity and Heisenberg's concept of uncertainty., An example of how to construct the Schrodinger equation for any potential form and its relation to the Eigen Value Problem.,			

<table>
<tr><td></td><td>Solving the Scrodinger equation for the form of a Potential Well as an illustration of a bound system (bound state)., Solving the Scrodinger equation for the form of a Potential Well as an illustration of an unbound system., Solving the Scrodinger equation as a depiction of a solid system using the Kronig-Penney Model., Solving the Schrodinger equation for the Hydrogen Atom, as an example of a 3-dimensional system., Introduction to orbital angular momentum and spin., The Pauli exclusion principle for systems of identical particles in complex atoms., A review of the perturbation method for the Helium atom as an example for a system of identical particles., An introduction to the theory of quantum scattering and the completion of its approximation..</td></tr>
<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td>Powerpoint, whiteboard</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. Sakurai, J.J., 1985, Modern Quantum Mechanics, Benjamin Cummings.
2. Tannoudji, C.H., et al, 1977, Quantum Mechanics Vol.I & II., John Willey.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td>1. Drs. Pekik Nurwantoro, M.S., Ph.D.
2.
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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>Drs. Pekik Nurwantoro, M.S., Ph.D.</td><td>Dr.Ing. Ari Setiawan</td><td>Mirza Satriawan, M.Si., Ph.D</td></tr>
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