SEMESTER LEARNING ACTIVITY PLANS (SLAP)

SEMESTER ODD 2022/2023

Physics Undergraduate Study Program

Physics Department

Quantum Mechanics

MFF 4033/ 2 Credits

Lecturer Coordinator:

Dr.rer.nat. Muhammad Farchani Rosyid, M.Si.

UNIVERSITAS GADJAH MADA

FACULTY OF MATHEMATICS AND NATURAL SCIENCE

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	Universitas Gadjah Mada Faculty of Mathematics and Natural Science Physics Department / Physics Undergraduate Study Program Semester ODD 2022/2023	**Document Number :** ……

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Code	Course Name	Credits (Credits)		Semester	Status	Prerequisite
MFF 4033	*Quantum Mechanics*	*T: 2*	*P: …*	*ODD*	*Elective*	*Quantum of Physics I (MFF 2034)*

Short Description	This course leads students to master and understand Quantum Mechanics in a formal and general (abstract) form. General description of mechanics: state space, Observable, expected value, deviation standard, dynamics. Hilbert spaces as natural spaces: complex vector spaces, scalar products, norms, orthogonality and orthonormality, orthonormal basis, and Fourier series, the completeness of the scalar product space. Linear operators in Hilbert space: adjoint operator, selfadjoint operator, unitary operator, exponential operator, self-value equation, degeneracy, self-value, and operator swavector self-adjoint and unitary operators. Postulations of quantum mechanics: quantum state space, quantum observables, probability quantum, expected value and standard deviation, Heisenberg uncertainty, quantum dynamics. Quantum dynamics: the time shift operator, derivation of the Schroedinger equation for time shift operators, and state vectors. Position representation and momentum representation: external basis, position basis, and basis momentum, Fourier transform, positional operators, and momentum operators in bases position and momentum, the Schroedinger equation based on position and momentum. Schroedinger's depiction and Heisenberg's depiction. Some examples of quantum systems.	
Program Learning Outcomes (PLO) Imposed on the Course	***PLO 2***	Knowledge. Able to explain theoretical concepts and principles of classical and modern physics and able to apply basic concepts of physics and related mathematical methods in finding solutions to physical problems.
	PLO 5	Long Life Learning. Able to analyze various alternative solutions to physical problems and conclude them for appropriate decision-making, both in familiar and new problems.
Course Outcomes (CO)	**After completing this course, students are expected to be able to:**	
	CO1	Understand the general description of mechanics: state space, Observables, expected values, standard deviations, dynamics
	CO2	Mastering and applying the concept of Hilbert space as a physical space: complex vector space, scalar product, norm, orthogonality and orthonormality, orthonormal basis and Fourier series, completeness of scalar product space.
	CO3	Mastering and applying the concepts of linear operators in Hilbert space: adjoint operators, self-adjoint operators, unitary operators, exponential operators, self-value equations, degeneration, self-adjoint and self-adjoint operators, and unitary operators.
	CO4	Mastering and applying the postulations of quantum mechanics: quantum state space, quantum observables, quantum probability, expected value and standard deviation, Heisenberg uncertainty, and quantum dynamics.

	CO5	Mastering and applying quantum dynamics: time shift operators, derivation of the Schroedinger equation for time shift operators, and state vectors.		
	CO6	Master and apply position representation and momentum representation: external basis, position basis, and momentum basis, Fourier transform, position operator and momentum operator in position and momentum basis, and Schroedinger equation in position and momentum basis.		
	CO7	Mastering and applying Schroedinger Drawing and Heisenberg Drawing.		
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO 1	1. Overview of mechanics in general: state space, Observables, expected values, standard deviations, dynamics. 2. Examples		***2X50 minutes***
	CO 2	Hilbert space as a state space: a complex vector space,		***2X50 minutes***
	CO 2	Scalar product, norm, orthogonality and orthonormality, orthonormal basis and Fourier series, and space completeness have a scalar product.		***2X50 minutes***
	CO 2	Mastering and applying the concept of linear operators in Hilbert space: adjoint operators, self-adjoint operators, unitary operators, exponential operators,		***2X50 minutes***
	CO 3	Self-assessment, degeneracy, self-assessment, and self-adjoint operators and unitary operators.		***2X50 minutes***
	CO 3	Postulations of quantum mechanics: quantum state space, quantum observables, quantum probability, expected value, and standard deviation,		***2X50 minutes***
	CO 3	Heisenberg uncertainty, quantum dynamics. Examples		***2X50 minutes***
	Midterm exam/Project Task Results/Case Analysis Results			
	CO 4	Quantum dynamics: time shift operators, derivation of the Schroedinger equation for time shift operators and state vectors,		***2X50 minutes***
	CO 5	Quantum dynamics examples		***2X50 minutes***
	CO 6	Position and momentum representatives: external basis, position and momentum basis, Fourier transform, position operator and momentum operator in position and momentum basis, Schroedinger equation in position and momentum basis		***2X50 minutes***

	CO 6	Examples of Position Representative and Momentum Representative		***4X50 minutes***
	CO 7	Mastering and applying Schroedinger Drawing and Heisenberg Drawing. Examples		***4X50 minutes***
	Final exams/ Project Task Results/Case Analysis Results			

Learning Methods	**SCL (Student Centered Learning): Project-based learning (Team-based Project)/Case-based learning/PBL/other SCL methods**
Student Learning Experience	**Students get an overview and simultaneously postulate on ways of thinking and drawing conclusions in formulating physical theories.**
Access to Learning Media/ LMS and Offline and Online Percentage	Offline (LCD, PPT Slide, Whiteboard, Laptop) and Online (Zoom Meeting, Google Meet, Google Classroom)

Assessment Methods and Synchronization with CO

Assessment Methods	Assessment Percentage	Criteria/ Indicators	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7
Participatory Activity*									
Project Results/ Case Study Results/ PBL Results*									
Cognitive									
Assignment	**10**			√	√		√	√	
Quiz	**10**				√	√		√	√
Midterm Exam	**40**		√	√	√				
Final Exam	**40**					√	√	√	√
Total	**100**								

*) 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%.

References	**Main References;** 1. Cohen-Tannoudji, C. dkk., 2003, Quantum Mechanics, John Wiley. 2. Bowman, G. E., 2008, Essential Quantum Mechanics, Oxford University Press, Oxford..
Lecturers (*Team Teaching*)	1. Dr.rer.nat. Muhammad Farchani Rosyid, M.Si.

Authorization	**Date of Drafting**	**Lecturer Coordinator**	**Head of Curriculum Committee**	**Head of Study Program**

		Dr.rer.nat. Muhammad Farchani Rosyid, M.Si.		*Dr. Eng. Ahmad Kusumaatmaja, S.Si., M.Sc.*