SEMESTER LEARNING ACTIVITY PLANS (SLAP)

SEMESTER EVEN 2022/2023

Physics Undergraduate Study Program

Physics Department

Advanced Quantum Mechanics

MFF 4034/ 2 Credits

Lecturer Coordinator:

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

UNIVERSITAS GADJAH MADA
FACULTY OF MATHEMATICS AND NATURAL SCIENCE
2022

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

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (Credits)		Semester	Status	Prerequisite
MFF 4034	*Advanced Quantum Mechanics*	*T: 2*	*P: …*	*EVEN*	*Elective*	*Quantum Physics I (MFF 2034)*

Short Description	This lecture has three topics: symmetry in quantum mechanics, the formulation of path integrals for quantum mechanics, and relativistic quantum mechanics. Symmetry in quantum mechanics: spatial translational symmetry, rotational symmetry, time shift symmetry, space translation group, rotation group, dynamic group, space translation generator, rotation generator, time shift generator. Formulating path integrals for quantum mechanics: propagator, formulation for free particles, and harmonic vibrations. Relativistic quantum mechanics: Klein-Gordon equations, Dirac equations, probability density, and current density problems, antiparticle interpretation, Dirac equation covariance, symmetry generators in relativistic quantum mechanics.

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 3	General Skills. Able to communicate the results of problem studies and physical behavior both in writing and verbally, as well as being able to lead and collaborate at various levels of roles in a team.
	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 symmetry in quantum mechanics and master the concepts of groups that describe this symmetry: spatial translational symmetry, rotational symmetry, time shift symmetry, space translation group, rotation group, dynamic group, space translation generator, rotation generator, and time shift generator.
	CO2	Mastering and applying path integral formulations for quantum mechanics: path integrals, propagators, formulations for free particles, and harmonized vibrations.
	CO3	Mastering and applying relativistic quantum mechanics: Klein Gordon equation, Dirac equation, probability density and probability current density problems, antiparticle interpretation, Dirac equation covariance, symmetry generator in relativistic quantum mechanics

		Learning Materials	Learning Methods	Time Allocation
The Correlation of CO to Learning Materials and Methods, and Time Allocation	***CO 1***	spatial translational symmetry, rotational symmetry, time shift symmetry,	TCL-SCL mixed	***6X50 minutes***
	CO 1	Space translation group, rotation group, dynamic group,	TCL-SCL mixed	***4X50 minutes***

	CO 1	Space translation generator, rotation generator, and time shift generator.	TCL-SCL mixed	***4X50 minutes***
	Midterm exam/Project Task Results/Case Analysis Results			
	CO 2	The path integral, propagator,	TCL-SCL mixed	***4X50 minutes***
	CO 2	the formulation for free particles and harmonized vibrations.	TCL-SCL mixed	***4X50 minutes***
	CO 3	Klein-Gordon equation, Dirac equation,	TCL-SCL mixed	***2X50 minutes***
	CO 3	the problem of opportunity density and opportunity flow density, antiparticle interpretation,	TCL-SCL mixed	***2X50 minutes***
	CO 3	covariance of the Dirac equation, a symmetry generator in relativistic quantum mechanics	TCL-SCL mixed	***2X50 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 carry out axiomatic ways of thinking, making mathematical inferences, and their application in the formulation of 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**	**CO1**	**CO2**	**CO3**
	Participatory Activity*					
	Project Results/ Case Study Results/ PBL Results*					
	Cognitive					
	Midterm Exam	**50**		√		
	Final Exam	**50**			√	√
	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%.					

<table>
<tr><td>References</td><td colspan="4">Main References;
1. Mueller-Kirsten, H.W, 2006, Introduction to Quantum Mechanics: SchroedingerEquation and Path Integral, World Scientific, Singapore..
2. Greiner, W. dan Mueller, B., 1994, Quantum Mechanics: Symmetries, Springer-Verlag, Berlin..
3. Greiner, W., 1994, Relativistic Quantum Mechanics: Wave Equations, Springer-Verlag, Berlin.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td colspan="4">1. Dr.rer.nat. Muhammad Farchani Rosyid, M.Si.</td></tr>
<tr><td rowspan="2">Authorization</td><td>Date of Drafting</td><td>Lecturer Coordinator</td><td>Head of Curriculum Committee</td><td>Head of Study Program</td></tr>
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