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

Particle Physics

MFF5114 / 3 Credits

Lecturer Coordinator:

Mirza Satriawan, S.Si., M.Si., 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
MFF5114	*Particle Physics*	*3*	*Even*	*Elective*	*None*

Short Description

Particle Physics 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:
The background and the latest conditions for the development of particle physics. Quantum electrodynamics of spinless particles, Klein Gordon equations, Quantum electrodynamics of spin particles 1/2, Dirac's equations. Abelian Symmetry, Quantum Electrodynamics interactions, Feynman diagram rules for Quantum Electrodynamics. The symmetry of Non-Abelaneous Tera, Electroweak Interactions, Quantum Chromodynamics, Standard Models, Symmetry Destruction and the Higgs Mechanism, Hadron Structure. Standard Model Extension.

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***	Understand abelian symmetries and Feynman diagram rules for quantum electrodynamics, and calculate cross-section and decay rate using simple Feynman diagrams for quantum electrodynamic interactions.		
	CO2	Understand non-Abelian tera symmetry, electroweak interactions, quantum chromodynamics, and calculate cross-section and decay rate using simple Feynman diagrams for electroweak interactions and quantum chromodynamics.		
	CO3	Understand the standard model, symmetry breaking, Higgs mechanism, and be able to calculate the approximation mass of the weak interaction tera field.		
	CO4	Understand the hadron structure and calculate simple equations related to the hadron structure.		
	CO5			
	CO6			
	CO7			
	CO8			
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	Standard model of particle physics and development of elementary particle physics research.	Lecture	3 x 50 minutes
	CO1	Symmetry and symmetry groups	Lecture	3 x 50 minutes
	CO1	Klein Gordon Equation	Lecture	3 x 50 minutes
	CO2	Electrodynamics of non-spinning particles	Lecture	3 x 50 minutes
	CO2	Dirac Equation	Lecture	3 x 50 minutes
	CO2	Electrodynamics of spinning particles	Lecture	3 x 50 minutes
	CO2	Normalization	Lecture	3 x 50 minutes
	CO3	Hadron Structure	Lecture	3 x 50 minutes
	CO3	Parton	Lecture	3 x 50 minutes
	CO3	Quantum Chromodynamics	Lecture	3 x 50 minutes
	CO4	Weak Interaction	Lecture	3 x 50 minutes
	CO4	Electroweak Interaction	Lecture	3 x 50 minutes
	CO4	Tera Symmetry	Lecture	3 x 50 minutes
	CO4	Standard Model	Lecture	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture			

<table>
<tr><td>Student Learning Experience</td><td>Learn to analyze and review: Standard model of particle physics and development of elementary particle physics research., Symmetry and symmetry groups, Klein Gordon Equation, Electrodynamics of non-spinning particles, Dirac Equation, Electrodynamics of spinning particles, Normalization, Hadron Structure, Parton, Quantum Chromodynamics, Weak Interaction, Electroweak Interaction, Tera Symmetry, Standard Model.</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>
</table>
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<tr><td>References</td><td>Main references:
1. Halzen, F dan Martin, A.D., 1984, Quarks and Leptons, An Introductory Course in ModernParticle Physics, John-Wiley, New York.
2. Mandl, F., 1966, Introduction to Quantum Field Theory, Wiley Interscience, New York.
3. Perkins, D. H., 1982, Introduction to High Energy Physics, Addison-Wesley.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td>1. Mirza Satriawan, S.Si., M.Si., Ph.D.
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4.</td></tr>
<tr><td>Authorization</td><td>
<table>
<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>Mirza Satriawan, S.Si., M.Si., Ph.D.</td><td>Dr.Ing. Ari Setiawan</td><td>Mirza Satriawan, M.Si., Ph.D</td></tr>
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