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

Quantum Field Theory

MFF5115 / 3 Credits

Lecturer Coordinator:

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**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 2022/2023

## SEMESTER LEARNING ACTIVITY PLANS (SLAP)

| Code | Course Name | Credits (credits) | Semester | Status | Prerequisite |
|---|---|---|---|---|---|
| *MFF5115* | *Quantum Field Theory* | *3* | *Odd* | *Elective* | *None* |

**Short Description**

Quantum Field Theory 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:
Teori medan klasik, teorema Noether, Medan Klein Gordon, Kuantisasi medan Klein Gordon, Medan Dirac, Kuantisasi medan Dirac, Simetri Diskrit–konjugasi muatan, paritas dan pembalikan waktu (CPT), Teori gangguan, teorema Wick, Diagram Feynman, Tampang lintang dan Matrik-S, Aturan Feynman untuk Elektrodinamika kuantum, Proses-proses elementer dalam Elektrodinamika kuantum: Hamburan electron-muon, produksi muon, hamburan Compton, Anihilasi pasangan elektron menjadi foton.

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**

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

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| **Course Outcomes (CO)** | ***CO1*** | Explain the cohesive relationship between particular relativity theory and quantum mechanics in quantum field theory. | | |
| | ***CO2*** | Describe the non-interaction field solution for the Klein-Gordon equation and the Dirac equation. | | |
| | ***CO3*** | Explain the various discrete and continuous symmetries in Lagrangian field theory, particularly Klein Gordon's Lagrangian and Dirac's Lagrangian. | | |
| | ***CO4*** | Calculate scattering cross-section and decay rate using a simple lowest-order Feynman diagram. | | |
| | ***CO5*** | Analyze some simple problems in particle physics phenomena using quantum field theory. | | |
| | ***CO6*** | | | |
| | ***CO7*** | | | |
| | ***CO8*** | | | |
| **The Correlation of CO to Learning Materials and Methods, and Time Allocation** | | **Learning Materials** | **Learning Methods** | **Time Allocation** |
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| | ***CO1*** | Introduction: The position of Quantum Field Theory in the study of the world of Particle Physics and its relation to previous concepts (the theory of special relativity and quantum mechanics). | Lecture | 3 x 50 minutes |
| | ***CO1*** | Klein Gordon Field | Lecture | 3 x 50 minutes |
| | ***CO1*** | Klein Gordon Field | Lecture | 3 x 50 minutes |
| | ***CO2*** | Klein Gordon Field | Lecture | 3 x 50 minutes |
| | ***CO2*** | Dirac Field | Lecture | 3 x 50 minutes |
| | ***CO2*** | Dirac Field | Lecture | 3 x 50 minutes |
| | ***CO2*** | Dirac Field | Lecture | 3 x 50 minutes |
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| | ***CO3*** | Feynman Diagram and the Interacting Field. | Lecture | 3 x 50 minutes |
| | ***CO3*** | Feynman Diagram and the Interacting Field. | Lecture | 3 x 50 minutes |
| | ***CO3*** | Feynman Diagram and the Interacting Field. | Lecture | 3 x 50 minutes |
| | ***CO4*** | Elementary Processes in Quantum Electrodynamics. | Lecture | 3 x 50 minutes |
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| | ***CO4*** | Elementary Processes in Quantum Electrodynamics. | Lecture | 3 x 50 minutes |
| | **Final Exam/ Project Task Results/ Case Analysis Results** | | | |

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| **Learning Methods** | Lecture |
| **Student Learning Experience** | Learn to analyze and review: Introduction: The position of Quantum Field Theory in the study of the world of Particle Physics and its relation to previous concepts (the theory of special relativity and quantum mechanics)., Klein Gordon Field, Klein Gordon Field, Klein Gordon Field, Dirac Field, Dirac Field, Dirac Field, Feynman Diagram and the Interacting Field., Feynman Diagram and the Interacting Field., Feynman Diagram and the Interacting Field., Elementary Processes in Quantum Electrodynamics., Elementary Processes in Quantum Electrodynamics., Elementary Processes in Quantum Electrodynamics., Elementary Processes in Quantum Electrodynamics.. |
| **Access to Learning Media/ LMS and Offline and Online Percentage** | LCD, textbooks, whiteboard, website |
| **Assessment Methods and Synchronization with CO** | |

| **Assessment Methods** | **Assessment Percentage** | **Criteria/Indicators** | **CO1** | **CO2** | **CO3** | **CO4** |
|---|---|---|---|---|---|---|
| **Participatory Activity*** | | | | | | |
| **Project Results/ Case Study Results/ PBL Results*** | | | | | | |
| **Cognitive** | | | | | | |
| **Assignment** | 30% | | 7,5% | 7,5% | 7,5% | 7,5% |
| **Quiz** | | | | | | |
| **Midterm Exam** | 35% | | 17,5% | 17,5% | | |
| **Final Exam** | 35% | | | | 17,5% | 17,5% |

*) 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%.

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| **References** | **Main references:**<br>M.E. Peskin dan D.V. Schroeder, 1995, An Introduction to Quantum Field Theory, Perseus Book, Massachusetts. |
| **Lecturers (*Team Teaching*)** | 1. Mirza Satriawan, S.Si., M.Si., Ph.D.<br>2.<br>3.<br>4. |

| **Authorization** | **Date of Drafting** | **Lecturer Coordinator** | **Head of Curriculum Committee** | **Head of Study Program** |
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| | | *Mirza Satriawan, S.Si., M.Si., Ph.D.* | Dr.Ing. Ari Setiawan | Mirza Satriawan, M.Si., Ph.D |