SEMESTER LEARNING ACTIVITY PLANS (SLAP)

SEMESTER EVEN 2022/2023

Physics Undergraduate Study Program

Physics Department

Nuclear and Particle Physics I

MFF 2205/ 2 Credits

Lecturer Coordinator:

Dra. Eko T. Sulistyani, M.Sc.
Dr. Dwi Satya Palupi, S.Si, 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 2205	*Nuclear and Particle Physics I*	*T: 2*	*P: …*	*EVEN*	*Compulsory*	*Quantum Physics I (MFF2034), Atomic and Molecular Physics (MFF2310), Relativity Theory (MFF2031*), Statistical Physics (MFF2051)*

Short Description	This course studies the Particles that make up the Universe and Fundamental Interactions: Fermions: Leptons, and Quarks; Tera Bosons: Photons, W and Z, Gluons; Scalar Bosons: Higgs, Composite Particles/bonded states: Hadrons (Mesons and Barions), Nuclei, Atoms. n, and Bound state. Reaction cross section concept, Decay rate. Nucleus and Particle Phenomenology: Low energy reactions, Scattering Reactions, Decay Reactions, and transition energies. Experiments and detection in nuclei and particles. Bound state I – Hadron: Hadronization: plasma quark-gluon into a strongly interacting bound state, Analogy with hydrogen atom: a review of Schrodinger equation of hydrogen atom, positronium, quarkonium, light meson. Barion, barion wave function, magnetic moment, barion mass. Bound State II – Core: Nuclear nomenclature, The static properties of the core studied include: core mass, core radius, core angular momentum, and core magnetic moment. Nuclear binding energy includes the energy of separating particles and particle clusters, semi-empirical mass formula: semi-empirical formula terms. Bound State III - Core Model: includes the electron-proton model and its implications, the proton-neutron model, the Fermi Gas model, the shell model and its implications with good potentials, harmonic oscillators, Yukawa potentials and the addition of LS couplings.

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	Explain the core properties, static and dynamic properties, and the basics of core detection methods.
	CO2	Explain the static properties of the nucleus: intrinsic angular momentum, magnetic moment, nuclear states, nuclear states
	CO3	Provides an understanding of the binding energy of the nucleus that causes the particles that make up the nucleus to bind to each other, the energy separating the particles.
	CO4	Explaining the binding energy of the Core: Semi-empirical mass formula: semi-empirical formula terms, mass parabola.
	CO5	Explaining the Nucleus Model: the electron proton model and its implications, the proton-neutron model, the Fermi Gas model.
	CO6	Explaining about Core Model: Shell model: core state based on shell model with well potential, oscillator potential, L.S coupling.

	CO7	Mention the particles that make up the universe and can classify the particles that make up the universe (Fermions: Leptons and Quarks; Tera Bosons: Photons, W and Z, Gluons).		
	CO8	Describes the Particles that make up the Universe and Fundamental Interactions (Scalar Bosons: Higgs, Composite Particles/bonded states: Hadrons (Mesons and Baryons), Nuclei, Atoms).		
	CO9	Explaining the Phenomenology of Nuclear and Particles: Low energy reactions, Scattering Reactions, Decay Reactions, and Bonded States.		
	CO10	Explain the concepts of reaction latitude, decay rate, and transition energy.		
	CO11	Explain Hadronization: plasma quarks – gluons become in a strongly interacting bound state.		
	CO12	Explaining the I-Hadron Bound State: Baryon, baryon wave function, magnetic moment, baryon mass.		
The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO 1	Nuclear mass, nuclear radius, angular momentum Model of the proton-electron, proton neutron, nomenclature	TCL-SCL mixed	***2X50 minutes***
	CO 2	Crystal Structure: (ii) Crystal direction and plane (iii) Crystal structure of SC, BCC, FCC, diamond, and HPC	TCL-SCL mixed	***2X50 minutes***
	CO 3	Nuclear binding energy, Average binding energy, stability of the nucleus, Proton splitting energy, Neutron splitting energy	TCL-SCL mixed	***2X50 minutes***
	CO 4	Semi-empirical mass formula: semi-empirical formula terms, mass parabola.	TCL-SCL mixed	***2X50 minutes***
	CO 5	The proton-electron model and its implications, the proton-neutron model, and the Fermi Gas model.	TCL-SCL mixed	***2X50 minutes***
	CO 6	Shell model: core state based on petal model with well potential, oscillator potential, and L.S. coupling.	TCL-SCL mixed	***2X50 minutes***
	CO 6	Shell model: core state based on petal model with well potential, oscillator potential, and L.S. coupling.	TCL-SCL mixed	***2X50 minutes***
	Midterm exam/Project Task Results/Case Analysis Results			
	CO 7	Fermions: Leptons and Quarks; Tera bosons: Photons, W and Z, Gluon	TCL-SCL mixed	***2X50 minutes***
	CO 8	Scalar Bosons: Higgs, Composite/bonded state particles: Hadrons (Mesons and Baryons), Nuclei, Atoms.	TCL-SCL mixed	***2X50 minutes***

	CO 9	Low energy reactions, Scattering Reactions, Decay Reactions, and Bound States	TCL-SCL mixed	***2X50 minutes***
	CO 10	Concept of reaction latitude, decay rate, and transition energy. Experiments and detection in Core and particles.	TCL-SCL mixed	***2X50 minutes***
	CO 11	Hadronization: plasma quarks – gluons into a strongly bonded state of interaction, Analogy with the hydrogen atom: a review of the Schrodinger equation of hydrogen atoms, positronium, quarkonium, light mesons.	TCL-SCL mixed	***2X50 minutes***
	CO 12	Baryon, baryon wave function, magnetic moment, baryon mass.	TCL-SCL mixed	***2X50 minutes***
			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	**Listening to explanations, asking questions, discussing, and doing homework**			
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	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Participatory Activity*	**10**		√	√	√	√	√	√	√	√	√	√	√	√
Project Results/ Case Study Results/ PBL Results*														
Cognitive														
Assignment	**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%.

<table>
<tr><td>References</td><td colspan="4">Main References;
1. Arya, Atam H.,1966,Fundamental of Nuclear Physics,Allen and Bacon Inc..
2. Martin,R Brian, 2006, Nuclear and particle Physics, An Introduction, John Wiley & Sons, Ltd, England..
3. Krane.KS, 1988, Introductory Nuclear Physics, John Wiley & Sons..
4. Meyerhoff,W.E.,1967, Elemen of Nuclear Physics, McGraw Hill Book Co. .
5. David Griffiths, 2004: Introduction to elementary particles, Wiley-VCH..</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td colspan="4">1. Dra. Eko T. Sulistyani, M.Sc.
2. Dr. Dwi Satya Palupi, S.Si, 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>
<tr><td></td><td>Dra. Eko T. Sulistyani, M.Sc.</td><td></td><td>Dr. Eng. Ahmad Kusumaatmaja, S.Si., M.Sc.</td></tr>
</table>