	Universitas Negeri Surabaya Faculty of Mathematics and Natural Sciences Physics Education Undergraduate Study Program	Document Code

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Core Physics	8420303068	Compulsory Study Program Subjects	T=3	P=0	ECTS=4.77	7	July 17, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Prof. Tjipto Prastowo, Ph.D.	Prof. Dr. Wasis, M.Si.	Mita Anggaryani, M.Pd., Ph.D.

Learning model	**Project Based Learning**

Program Learning Outcomes (PLO)

PLO study program which is charged to the course

Program Objectives (PO)

PO - 1	Realizing an independent and honest character in carrying out Core Physics lecture assignments.
PO - 2	Mastering a structured study of the concept of the atomic nucleus in various aspects ranging from the history of the discovery of the atomic nucleus to opportunities for applying knowledge of nuclear technology and nuclear waste management.
PO - 3	Understand the different views on nuclear technology and the search for alternative energy sources based on nuclear reactions.
PO - 4	Mastering the techniques for making posters on radioisotope applications in various fields of life.

PLO-PO Matrix

P.O
PO-1
PO-2
PO-3
PO-4

PO Matrix at the end of each learning stage (Sub-PO)

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																
PO-4																

Short Course Description	Nuclear Physics studies the history of discoveries and physical concepts of atomic nuclei, properties and behavior of atomic nuclei, nuclear stability and nuclear binding energy, detrons as the simplest nuclei, nuclear energy levels, various models of nuclei, nuclear radioactivity, radioactive nuclear decay mechanisms, calculations Q-value for various types and conditions of nuclear reactions, building blocks of matter, 'families' of elementary particles, fundamental conservation principles in the world of elementary particles, the birth of mesons, fission reactions and fusion reactions, alternative energy sources based on fusion reactions, nuclear technology and management nuclear waste, and radioisotope applications in various fields of life.
References	**Main :**

1. Krane, K.S. 1988. Introductory Nuclear Physics. New York, US : John wiley & Sons Inc.
2. P Arya, Atam. 1966. Fundamentals of Nuclear Physics . Allyn and Bacon, Inc. Boston.
3. Das and Ferbel. 2003. Introduction to Nuclear and Particle Physics (2 nd Edition). World Scientific Publishing Co, Pte, Ltd. Singapore.
4. E. Meyerhoff, Walter. 1967. Elements of Nuclear Physics. McGraw-Hill, Inc. USA.
5. Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK

Supporters:	

Supporting lecturer	Prof. Tjipto Prastowo, Ph.D. Prof. Dr. Wasis, M.Si. Mita Anggaryani, M.Pd., Ph.D. Lydia Rohmawati, S.Si., M.Si. Dr. Rohim Aminullah Firdaus, S.Pd, M.Si Dr. Muhimmatul Khoiro, S. Si.

Week-	Final abilities of each learning stage (Sub-PO)	Evaluation		Help Learning, Learning methods, Student Assignments, [Estimated time]		Learning materials [References]	Assessment Weight (%)
		Indicator	Criteria & Form	Offline (*offline*)	Online (*online*)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Able to understand the history of the discovery of the atomic nucleus from the perspective of modern physics, understand the classification of nuclides based on the number of protons and neutrons or atomic number and mass number, and understand the dominant interactions in the structure of the nucleus	Students are able to explain the history of the discovery of the atomic nucleus from the perspective of modern physics, explain the classification of nuclides based on the number of protons and neutrons or atomic number and mass number, and explain the dominant interactions in the structure of the nucleus	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 x 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • A brief history of Core Physics • Terminology for sub-atomic particles • Atomic scale measurements • Mass-energy equivalence • Classification of nuclides • Fundamental interactions • Gravitational interactions • Electromagnetic interactions • Nuclear interactions **Bibliography:** *Das and Ferbel. 2003. Introduction to Nuclear and Particle Physics (2 nd Edition). World Scientific Publishing Co, Pte, Ltd. Singapore.*	1%
2	Able to understand nuclear properties (static and dynamic) and nuclear behavior based on proton and neutron configurations (stable and unstable), understand nuclear characteristics based on binding energy per nucleon, and understand techniques for determining the type and mass of isotopes	Students are able to explain the properties of nuclei (static and dynamic) and the behavior of nuclei based on the configuration of protons and neutrons (stable and unstable), explain the characteristics of nuclei based on binding energy per nucleon, and explain techniques for determining the type and mass of isotopes	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 X 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • Nuclear properties • Nuclear radius • Nuclear density • Nuclear mass • Stable nuclear structure • Unstable nuclear structure • Nuclear stability bands • Nuclear binding energy • Nucleon release energy (proton or neutron) • Mass spectroscopy **References:** *Das and Ferbel . 2003. Introduction to Nuclear and Particle Physics (2 nd Edition). World Scientific Publishing Co, Pte, Ltd. Singapore.*	1%

3	Able to understand nuclear properties (static and dynamic) and nuclear behavior based on proton and neutron configurations (stable and unstable), understand nuclear characteristics based on binding energy per nucleon, and understand techniques for determining the type and mass of isotopes	Students are able to explain the properties of nuclei (static and dynamic) and the behavior of nuclei based on the configuration of protons and neutrons (stable and unstable), explain the characteristics of nuclei based on binding energy per nucleon, and explain techniques for determining the type and mass of isotopes	**Criteria:** 1.Individual 2.Group 3.Mini Articles on nuclear technology and radioisotope applications in various fields of life (1) **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Learning 3 X 50	Project - Based Team Learning 3 x 50	**Material:** • Nuclear properties • Nuclear radius • Nuclear density • Nuclear mass • Stable nuclear structure • Unstable nuclear structure • Nuclear stability bands • Nuclear binding energy • Nucleon release energy (proton or neutron) • Mass spectroscopy **References:** *Das and Ferbel . 2003. Introduction to Nuclear and Particle Physics (2 nd Edition). World Scientific Publishing Co, Pte, Ltd. Singapore.*	3%
4	Able to understand the comparison between hydrogen and detron in the context of physical structure, understand the energy levels, interactions involved, and understand the characteristics of nuclei based on spin and parity properties	Students are able to explain the comparison between hydrogen and detrons in the context of physical structure, explain the energy levels, interactions involved, and explain the characteristics of nuclei based on spin and parity properties.	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 x 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Matter:** • Hydrogen, the simplest atom • Detron, the simplest nucleus • Atomic energy levels • Nuclear energy levels • Nuclear force • Detron binding energy • Detron spin and parity **Bibliography:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	1%
5	Able to understand various characteristics of nuclear models and understand the role of valence nucleons as determinants of nuclear properties and behavior	Students are able to explain various characteristics of the nuclear model and explain the role of valence nucleons as determinants of the properties and behavior of the nucleus	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 X 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • Core model • Fermi model • Liquid-drop model • Core shell model • Magic numbers • Valence nucleons **References:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	1%

6	Able to understand the concept of nuclear stability and radioactive nuclei, understand the mechanism of radioactive decay and the principle of conservation of charge, and understand the principle of conservation of matter-energy	Students are able to explain the concept of nuclear stability and radioactive nuclei, explain the mechanism of radioactive decay and the principle of conservation of charge, and explain the principle of conservation of matter-energy	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 X 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • Radioactive nuclei • Radioactive decay • Mechanism of radioactive decay and the principle of conservation of charge • Nuclear reactions, Q-value • Alpha decay • Beta decay • Positive and negative beta • Electron capture • Gamma emission • Radioactive series **References:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	1%
7	Able to understand the concept of nuclear stability and radioactive nuclei, understand the mechanism of radioactive decay and the principle of conservation of charge, and understand the principle of conservation of matter-energy	Students are able to explain the concept of nuclear stability and radioactive nuclei, explain the mechanism of radioactive decay and the principle of conservation of charge, and explain the principle of conservation of matter-energy	**Criteria:** 1.Individual 2.Group 3.Mini Articles on nuclear technology and radioisotope applications in various fields of life (2) **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Learning 3 X 50	Project - Based Team Learning 3 x 50	**Material:** • Radioactive nuclei • Radioactive decay • Mechanism of radioactive decay and the principle of conservation of charge • Nuclear reactions, Q-value • Alpha decay • Beta decay • Positive and negative beta • Electron capture • Gamma emission • Radioactive series **References:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	8%
8	UTS	UTS	**Criteria:** Individual **Form of Assessment** : Test	UTS 3 X 50	UTS 3 x 50	**Material:** Core Physics **Bibliography:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	20%

9	Able to understand the concept of elementary particles, classification of elementary particles, understand the concept of 'everything is made in pairs', and understand fundamental conservation laws	Students are able to explain the concept of elementary particles, classify elementary particles, explain the concept of 'everything is made in pairs', and explain fundamental conservation laws	**Criteria:** 1.Individual 2.Group 3.Poster with the theme of nuclear technology and radioisotope applications in various fields of life (1) **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Learning 3 x 50	Project - Based Team Learning 3 x 50	**Material:** • Building blocks of matter • Classification of elementary particles • Quarks and Leptons • Bosons, Hadrons, Fermions • Particles and Anti-Particles • Standard Model • Conservation principles in the world of elementary particles **References:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	8%
10	Able to understand the concept of elementary particles, classification of elementary particles, understand the concept of 'everything is made in pairs', and understand fundamental conservation laws	Students are able to explain the concept of elementary particles, classify elementary particles, explain the concept of 'everything is made in pairs', and explain fundamental conservation laws	**Criteria:** 1.Individual 2.Group 3.Poster with the theme of nuclear technology and radioisotope applications in various fields of life (1) **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Learning 3 x 50	Project - Based Team Learning 3 x 50	**Material:** • Building blocks of matter • Classification of elementary particles • Quarks and Leptons • Bosons, Hadrons, Fermions • Particles and Anti-Particles • Standard Model • Conservation principles in the world of elementary particles **References:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	8%
11	Able to understand the history of the birth of meson particles as 'messengers' between nucleons based on Yukawa's hypothesis, understand the types of meson particles and reactions involving meson particles, and understand meson resonance	Students are able to explain the history of the birth of meson particles as 'messengers' between nucleons based on Yukawa's hypothesis, explain the types of meson particles and reactions involving meson particles, and explain meson resonance	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 X 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • Birth of meson particles • Yukawa's hypothesis • Properties of phi-mesons (pions) • Pion-nucleon reactions • Meson resonances **References:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	1%

12	Able to understand the difference between fission reactions and fusion reactions, understand alternative energy sources based on hydrogen fusion reactions, understand the application of radioisotopes in various fields of life, and understand nuclear waste management	Students are able to explain the difference between fission reactions and fusion reactions, explain alternative energy sources based on hydrogen fusion reactions, explain the application of radioisotopes in various fields of life, and explain nuclear waste management	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 X 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • Fission and Fusion Reactions • Fission and Fusion Reactors • Alternative energy sources • Nuclear transmutation • Artificial radioisotopes • Nuclear technology and waste • Applications of radioisotopes in various areas of life **Reference:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	1%
13	Able to understand the difference between fission reactions and fusion reactions, understand alternative energy sources based on hydrogen fusion reactions, understand the application of radioisotopes in various fields of life, and understand nuclear waste management	Students are able to explain the difference between fission reactions and fusion reactions, explain alternative energy sources based on hydrogen fusion reactions, explain the application of radioisotopes in various fields of life, and explain nuclear waste management	**Criteria:** Individual **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and Answers 3 X 50	Contextual Learning Discussion Questions and Answers 3 x 50	**Material:** • Fission and Fusion Reactions • Fission and Fusion Reactors • Alternative energy sources • Nuclear transmutation • Artificial radioisotopes • Nuclear technology and waste • Applications of radioisotopes in various areas of life **Reference:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	1%
14	Able to understand various important issues of nuclear technology and aspects of its benefits	Students are able to explain various important issues of nuclear technology and aspects of its benefits in poster presentation sessions	**Criteria:** 1.Individual 2.Group 3.Poster 4.Presentation **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Leering Presentation Questions and Answers 3 x 50	Project - Based Team Leering Presentation Questions and Answers 3 x 50	**Material:** Nuclear Technology **Library:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	15%
15	Able to understand various important issues of nuclear technology and aspects of its benefits	Students are able to explain various important issues of nuclear technology and aspects of its benefits in poster presentation sessions	**Criteria:** 1.Individual 2.Group 3.Poster 4.Presentation **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Leering Presentation Questions and Answers 3 x 50	Project - Based Team Leering Presentation Questions and Answers 3 x 50	**Material:** Nuclear Technology **Library:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	15%

16	Able to understand various important issues of nuclear technology and aspects of its benefits	Students are able to explain various important issues of nuclear technology and aspects of its benefits in poster presentation sessions	**Criteria:** 1.Individual 2.Group 3.Poster 4.Presentation **Form of Assessment** : Project Results Assessment / Product Assessment	Project - Based Team Leering Presentation Questions and Answers 3 x 50	Project - Based Team Leering Presentation Questions and Answers 3 x 50	**Material:** Nuclear Technology **Library:** *Cottingham and Greenwood. 2004. An Introduction to Nuclear Physics (2 nd Edition). Cambridge University Press, UK*	15%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	8%
2.	Project Results Assessment / Product Assessment	72%
3.	Test	20%
		100%

Notes

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** abilities in the process and student learning outcomes are specific and measurable statements that identify the abilities or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.