



**TEACHING INSTRUCTIONAL DESIGN (BRP)
COURSE
INTRODUCTION TO NUCLEAR PHYSICS**

by

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UNIVERSITAS INDONESIA
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
PHYSICS UNDERGRADUATE STUDY PROGRAM

TEACHING INSTRUCTIONAL DESIGN

Course Name	Introduction to Nuclear Physics	Credit(s)	Prerequisite course(s)	Requisite for course(s)	Integration Between Other Courses
Course Code	SCPH603135	3	Modern Physics	Nuclear and Particle Physics, Scattering Theory, Introduction to Radiotherapy Physics, Health Physics and Radiation Protection, Laboratory Work of Medical Physics and Counter System, Introduction to Medical Imaging and Nuclear Medicine	
Relation to Curriculum	Compulsory Course				
Semester	5 th				
Lecturer(s)	<ol style="list-style-type: none"> 1. Prof. Dr. Terry Mart 2. Prof. Dr. Anto Sulaksono 3. Dr. rer. nat. Agus Salam 4. Dr. Imam Fachruddin 				
Course Description	This course aims at lecture participants to be able to explain the properties of the atomic nucleus, nuclear processes, and the benefits of nuclear physics. Formation of matter includes Rutherford scattering, nuclear properties, binding energy, bonding fraction, surface effect, energy separation, nuclear radius, semiempirical				

	mass formula, core spin, core electric moment, nuclear magnetic moment, nuclear instability, radioactivity, core models , nuclear force, particle physics, fundamental interactions, quark models, nuclear astrophysics, accelerators, detectors, nuclear reactors, the benefits of nuclear physics.
Program Learning Outcome (PLO)	
PLO-1	Applying classical and modern physics concepts in solving general physics problems
PLO-2	Formulating problems and solving physics and its application, as well as interdisciplinary problems related to science and mathematics clumps critically, creatively, and innovatively
Course Learning Outcome (CLO)	
CLO-1	After completing this lecture, Physics students are expected to be able to describe the properties of the atomic nucleus, nuclear processes, and the benefits of nuclear physics
Sub-CLO(s)	
Sub-CLO 1	Explaining the existence of the atomic nucleus, Rutherford's scattering experiment, the basic structure of the atomic nucleus
Sub-CLO 2	Describe the properties of the atomic nucleus, including binding energy, bonding fraction, surface effect, energy separation, nuclear radius, semiempirical mass formula, nuclear spin, nuclear electric moment, nuclear magnetic moment
Sub-CLO 3	Describes nucleus instability and radioactivity
Sub-CLO 4	Describe nucleus models
Sub-CLO 5	Describe the nuclear force at the hadronic level and its properties
Sub-CLO 6	Describes energy production and nucleosynthesis in stars
Sub-CLO 7	Describes the basic knowledge of particle physics as well as the fundamental weak and strong interactions according to the quark model
Sub-CLO 8	Describes the working principles of nuclear and particle physics equipment, such as nuclear accelerators, detectors, and reactors
Sub-CLO 9	Explain the benefits of nuclear physics

Study Materials	Rutherford scattering, nuclear properties, binding energy, bonding fraction, surface effect, energy separation, nuclear radius, semiempirical mass formula, core spin, core electric moment, nuclear magnetic moment, nuclear instability, radioactivity, core models , nuclear force, particle physics, fundamental interactions, quark models, nuclear astrophysics, accelerators, detectors, nuclear reactors, the benefits of nuclear physics.
Reading List	<p>[1] P. E. Hodgson, E. Gadioli, E. Gadioli Erba, <i>Introductory Nuclear Physics</i>, Oxford U. Press, 2000.</p> <p>[2] W. E. Meyerhof, <i>Elements of Nuclear Physics</i>, McGraw-Hill Book Co., 1989.</p>

I. Teaching Plan

Week	Sub-CLO	Study Materials [with reference]	Teaching Method [with est. time]	Learning Experiences (*O-E-F)	Sub-CLO Achievement Indicator		Sub-CLO Weight on Course (%)
					General	Specific	
1	1	Thomson's atomic model, Rutherford scattering illustration, Rutherford model of atom, the basic structure of the nucleus, some terms regarding the atomic nucleus, magic number [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe the existence of the atomic nucleus and its structure		8
2	1	Rutherford scattering calculation, scattering cross section [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe the cross-section of the scattering		8
3	2	Binding energy, bonding fraction, surface effect, separation energy, nuclear radius, semiempirical mass formula [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Explain and calculate binding energy, separation energy, nuclear radius, explain bond fraction, surface effect, semiempirical mass formula		8
4	2	Core spin, core electric moment, dipole moment and quadrupole moment, nucleon magnetic moment, core magnetic moment, effective core magnetic moment [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe core spin, core electric moment, dipole moment and quadrupole moment of nucleus, nucleon		8

					magnetic moment, core magnetic moment, effective core magnetic moment		
5	3	Core instability, core instability form, dynamic instability, beta instability, introduction of the base of the nuclear reactor [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe dynamic instability, beta instability, uranium fuels, chain reactions, general parts of a nuclear reactor		8
6	Mid-Term Exam						
7	4	Core model types: independent and collective, liquid drop model, Fermi gas model [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describes the independent and collective core models, liquid drop models, Fermi gas models		8
8	4	Skin model, rotational model, vibrational model, Nilsson model, alpha model [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe skin models, rotational models, vibrational models, Nilsson models, alpha models		8
9	5	Nuclear force / strong interaction at the hadronic level, Yukawa's idea, carrier mass relationship and interaction range, nucleon-nucleon (NN) interactions as	Discussion [150 minutes]	Presentation of material - question and answer	Describe Yukawa's ideas, carrier mass relations and		8

		pawn exchanges, types of NN interaction models, empirical properties of NN interactions, NN scattering and deuteron [1]		discussion	interaction range, nucleon-nucleon (NN) interactions as pawn exchanges, types of NN interaction models, empirical properties of NN interactions, NN and deuteron scattering	
10	6	First generation star formation, proton cycle, energy production and nucleosynthesis in first generation stars, star evolution, second generation star formation, energy production and nucleosynthesis in second generation stars [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describes first generation stars, second generation stars, energy production and nucleosynthesis, stellar evolution	8
11	7	The fundamental force and its carrier, classifying particles as hadrons and leptons, classifying hadrons as mesons and baryons, antiparticles, leptons number, baryon number, strangeness number, quark and lepton model (standard model of particle physics), charm number, topness number, number beauty, strong interaction and weak interaction according to the quark model [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe the fundamental force and its carrier, hadron, lepton, meson, baryon, antiparticle, lepton number, baryon number, strangeness number, quark, gluon, strong interaction and weak interaction according to the	8

					quark model		
12	8	Type of collision: fixed target collision and head on collision, accelerator, detector [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe the working principle of nuclear and particle physics equipment		8
13	9	The benefits and applications of nuclear physics in life [1]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describe the benefits and applications of nuclear physics to life		5
14	4	Core model types: independent and collective, liquid drop model, Fermi gas model [Books, literature, and internet]	Discussion [150 minutes]	Presentation of material - question and answer discussion	Describes the independent and collective core models, liquid drop models, Fermi gas models		7
15	Final Exam						

II. Assignment Design

Week	Assignment Name	Sub-CLOs	Assignment	Scope	Working Procedure	Deadline	Outcome
13	Presentation on nuclear and particle physics equipment	8	Describe and explain the working principles of nuclear and particle physics equipment	The working principle of nuclear and particle physics equipment	As a group, explain and explain the working principles of nuclear and particle physics equipment, then answer questions in the discussion	1 week	Presentation and discussion
14	Presentation on the benefits of nuclear physics	9	Describe and explain the benefits of nuclear physics	Benefits of nuclear physics	As a group, explain and explain the benefits of nuclear physics, then answer the questions in the discussion	1 week	Presentation and discussion

III. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
1 st Group Presentation	8	Presentation and discussion	1	20
2 nd Group Presentation	9	Presentation and discussion	1	20
Mid-Term Exam	1 - 3	Written test	1	30
Final Exam	4 - 7	Written test	1	30
			Total:	100

IV. Rubric(s)

This rubric is used as a guideline for assessing or giving levels of student performance results. a rubric usually consists of assessment criteria that include the dimensions / aspects that are assessed based on indicators of learning achievement. This assessment rubric is useful for clarifying the basics and aspects of the assessment so that students and lecturers can be guided by the same thing regarding the expected performance demands. Lecturers can choose the type of rubric according to the assessment given.

A. Conversion of the student's final score

Score	Grade	Equivalent
85 - 100	A	4.00
80 - < 85	A-	3.70
75 - < 80	B+	3.30
70 - < 75	B	3.00
65 - < 70	B-	2.70
60 - < 65	C+	2.30
55 - < 60	C	2.00
40 - < 50	D	1.00
< 40	E	0.00

B. Assessment rubric: project report and papers

Criteria	Score	Indicator
Introduction	4	Contains: (1) background for the preparation of the report, (2) problem identification / gap analysis, (3) questions (4) objectives, and (5) citing relevant and current references
	3	Loads the goal and 3 of the other 4 items
	2	Loading objective and 2 of the other 4 items
	1	Does not contain the purpose of preparing the report, there are one or more than 4 other items
	0	Does not contain objectives and 4 other items
Content	4	Structured & cohesive, conducts a comprehensive literature review and performs a complete critical analysis
	3	Structured, conduct a comprehensive literature review and complete critical analysis

	2	Less structured, conducting literature reviews but less comprehensive and carrying out simple critical analysis
	1	Unstructured & cohesive, review of literature is not comprehensive and does not contain critical analysis
Conclusion	4	Related to the implementation of tasks and there are suggestions for feasible improvements to the next assignment
	3	It is related to the implementation of tasks and there are suggestions for improvement of the next assignment but it is not feasible
	2	Regarding the implementation of the task but no suggestions
	1	Not related to the execution of duties and no suggestions
	4	The report is neat and attractive, complete with cover and photo / picture
	3	The report is neat and attractive, with a cover or photo / image
	2	The report includes a cover or photo / image but is not neat or attractive
	1	The report is not neat and unattractive, does not have a cover and photo / image
	4	Easy to understand, correct word choice, and spelling all right
	3	Easy to understand, correct word choice, some misspellings
	2	Less understandable, inaccurate word choice, and some misspellings
	1	It is not easy to understand, the choice of words is not quite right, and there are lots of misspellings