هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T4
2020

Course Specifications

Course Title:	**Nuclear Physics II**
Course Code:	**462PHYS**
Program:	**Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Jazan University**

Table of Contents

A. Course Identification

1. Credit hours: 4				
2. Course type				
a.	University ☐	College ☐	Department ☑ √	Others ☐
b.	Required ☑ √	Elective ☐		
3. Level/year at which this course is offered: 8th/4th				
4. Pre-requisites for this course (if any)**:** **Nuclear Physics I (461PHYS)**				
5. Co-requisites for this course (if any)**:** **NIL**				

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	**42**	**46.6 %**
2	**Blended**	**6**	**6.8 %**
3	**E-learning**		
4	**Distance learning**		
5	**Other**	**42**	**46.6%**

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	**45**
2	**Laboratory/Studio**	**45**
3	**Tutorial**	**-**
4	**Others** (Problem Solving Sessions, Quizzes, Office Hours)	**50**
	Total	**140**

B. Course Objectives and Learning Outcomes

1. Course Description

This is an advanced course offered to the 8th level undergraduate senior students at the Jazan University, to complete their basic training in nuclear and particle physics (in continuation with the 461PHYS course). This is a comprehensive and quite involved course which covers interaction of particles and radiation with matter (via energy loss in media), particle detectors, particle accelerators, particle families and the standard model, as the main chapters in this course. The learning outcome of this course are to get students acquainted with the particle types and their interactions (based on their identifications, charge and mass, such as electron, proton, alpha, photon etc.) with matter. These interactions are measured by an electronic device named as detector. Students learn the theoretical aspects of detector physics and their development and how they work. In order to produce the particles in the laboratory we need high-energy particle accelerators. Students are taught the basic design of these accelerators and their working principles and mechanisms. Students also learn the elementary particles based on their spin, charge, mass and lifetime. Finally they will learn the Standard Model briefly that describes the elementary particles and their fundamental interactions (under the framework of QED, EW and QCD theories) that shape our known universe. Students are also required to perform the practical classes (labs) concerning the course contents.

2. Course Main Objective

This course is designed to provide students with:

- The fundamentals of particle and radiation interaction with matter, particle detection, acceleration, particle zoo and the standard model of elementary particles.
- Knowledge of how the particle detectors and accelerators are designed and familiarity with the modern cutting edge technologies as well as advanced research in nuclear and particle physics fields.
- Explanation particle classifications and the corresponding theoretical model.
- Demonstration of concepts concerning the course by means of practical classes.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**<u>Define</u>** Bethe-Bloch formula, definition of the Standard Model (SM), CPT Theorem, Gell-Mann-Nishijima Formula, Bremsstrahlung, cross section, stopping power/energy loss.	**PLO1.1**
1.2	**<u>Describe</u>** charged particle interaction pathways, photon interaction with matter, neutron interaction with matter; various ionization/ scintillation/semiconductor/calorimeter detectors, Photomultiplier tube and Geiger-Mueller counter; weak & electromagnetic interactions, quark content of mesons and baryons, principles of electrostatic and resonance accelerators; charge, spin, strangeness in particle decay, and violation of quantum number in the radioactive decays, symmetries, and color quantum number.	**PLO1.1**
1.3	**<u>Discuss</u>** Quark model for mesons and baryons, ionization, scintillation, time of flight, parity, QCD (Quantum Chromodynamics) and confinement, charge, spin, strangeness in particle decay, and violation of quantum number in the radioactive decays, symmetries, and color quantum number.	**PLO1.2**
2	**Skills:**	

CLOs		Aligned PLOs
2.1	**Solve** problems in particles energy and range in the collision with matter, photoelectric effect, Compton effect, pair production, flight time and the corresponding velocities for particles in collisions, FWHM, range of alpha and beta in media, and Lorentz force calculation.	**PLO2.1**
2.2	**Demonstrate** centre of mass energy in the colliding beams, the Baryon Octet and Decuplet symmetries with examples, plotting a GM plateau, plotting a γ spectrum, Inverse Square Law. Show competencies in communication, critical thinking and reporting during lab work, interactive discussion and group assignments.	**PLO2.2**
2.3	**Perform** laboratory experiments included in this course.	**PLO2.3**
2.4	**Develop** competency in understanding detector, accelerator and particle classifications based on their generation and properties.	**PLO2.4**
3	**Values:**	
3.1	**Show** the paradigm of collaboration with effective collaboration, demonstrating the important skills to work in groups, while taking responsibility for individual tasks during group assignments and lab work and practice safety awareness in the lab.	**PLO3.1**

C. Course Content

No	List of Topics	Contact Hours
1	**Energy Deposition in Media:** - Introduction - Charged particles interaction with matter - Bethe Bloch formula - Energy loss through bremsstrahlung - Photon interaction with matter - Photoelectric, Compton and pair production mechanism - Interaction of neutrons with matter - Interaction of hadrons with matter (briefly)	**10**
2	**Particle Detection:** - Introduction - Ionization detectors - Ionization counters, proportional counters and Geiger Muller counters - Scintillation detectors - Time of Flight - Cherenkov detectors - Semiconductor detectors - Calorimeters - Layer detectors (e.g. ATLAS, CMS at CERN)	**10**
3	**Accelerators:** - Introduction - Electrostatic accelerators - Resonance accelerators	**6**

	- Synchronous accelerators - Phase stability, strong focusing and colliding beam - Large Hadron Collider at CERN (basic information from web)	
4	**Properties and Interactions of Elementary Particle:** -Introduction - Four basic forces -Elementary particles (their history) -Quantum number (Baryon, lepton, strangeness, isospin etc.) -Gell-Mann_Nisjijima relation - Production and decay of resonances - Violation of quantum numbers - Weak interaction (Hadrinic weak decays, semileptonic processes etc.) - Electromagnetic interaction - Symmetries - Parity - Time Reversal - CPT theorem -	**12**
5	**Formulation of the Standard Model:** -Introduction - Quarks and leptons - Quark content of mesons - Quark content of baryons - Color quantum number - Quark model for mesons and baryons - Valance and sea quarks in hadrons - Chromodynamics and confinement	**4**
6	Review	**3**
Total		45

Experimental Part:

No	List of Topics	Contact Hours
1	Plotting a GM Plateau	3
2	Geiger Tube Efficiency	3
3	Inverse Square Law	**3**
4	Absorption of Gamma Rays	**3**
5	Backscattering of Gamma Rays	3
6	Determining the half-life of Ba-137	3
7	Recording and calibrating a γ spectrum	3
8	Detection Efficiency of a NaI(Ti) Detector	3
9	Calculation of β/Υ ratio	**3**
	Total	**27**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**Define** Bethe-Bloch formula, definition of the Standard Model (SM), CPT Theorem, Gell-Mann-Nishijima Formula, Bremsstrahlung, cross section, stopping power/energy loss.	Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student survey
1.2	**Describe** charged particle interaction pathways, photon interaction with matter, neutron interaction with matter; various ionization/ scintillation/semiconductor/calorimeter detectors, Photomultiplier tube and Geiger-Mueller counter; weak & electromagnetic interactions, quark content of mesons and baryons, principles of electrostatic and resonance accelerators.	Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student Survey
1.3	**Discuss** Quark model for mesons and baryons, ionization, scintillation, time of flight, parity, QCD (Quantum Chromodynamics) and confinement, charge, spin, strangeness in particle decay, and violation of quantum number in the radioactive decays, symmetries, and color quantum number.	Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion, Colored ball and stick model for quark model visualization	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student survey
2.0	**Skills**		
2.1	**Solve** problems in particles energy and range in the collision with matter, photoelectric effect, Compton effect, pair production, flight time and the corresponding velocities for particles in collisions, FWHM, range of alpha and beta in media, and Lorentz force calculation.	Lectures, blackboard and visualization, brainstorming, group and interactive discussion, Interactive illustration, Problem-based Learning	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student Survey
2.2	**Demonstrate** centre of mass energy in the colliding beams, the Baryon Octet and Decuplet symmetries with examples, plotting a GM plateau, plotting a γ spectrum, Inverse Square Law. Show competencies in communication, critical thinking and	Lab work and demonstrations, Blackboard lectures and visualization, group and interactive guided discussion, Interactive discussion.	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	reporting during lab work, interactive discussion and group assignments.	Movies, Group Assignments	survey
2.3	**Perform** laboratory experiments included in this course.	Lab Lectures, Blackboard lectures and visualization, brainstorming, group and interactive discussion, Interactive illustration, Problem-based Learning	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student Survey
2.4	**Develop** competency in understanding detector, accelerator and particle classifications based on their generation and properties.	Lectures, blackboard and visualization, brainstorming, group and interactive discussion, Interactive illustration, Problem-based Learning	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student Survey
3.0	**Values**		
3.1	**Show** the paradigm of collaboration with effective collaboration, demonstrating the important skills to work in groups, while taking responsibility for individual tasks during group assignments and lab work and practice safety awareness in the lab.	Interactive and Group discussion, expository and discovery teaching	**Direct:** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student Survey

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Homework assignment- Contribution in interactive discussion	3	2 (2%)
2	Quiz 1	4	2 (2%)
3	First Mid-term exam	7	8 (8%)
4	Quiz 2	8	1 (1%)
5	Homework assignment- Contribution in interactive discussion	9	2 (2%)
6	Second mid-term exam	11	8 (8%)
7	Homework assignment- Contribution in interactive discussion- Group work-essay or Project discussion	12	2 (2%)
8	Laboratory Examination	14	25(25%)
9	Final Examination	16	50(50%)

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student

consultations and academic advice : Each group of students is assigned to a staff member who will be available for help and academic guidance office hours at specific 2hours on daily basis.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	**Introduction to Nuclear and Particle Physics; A. Das and T. Ferbel (World Scientific Publishing, 2005).**
Essential References Materials	Radiation Detection and Measurement; G. Knoll (John Wiley & Sons, 2000). Nuclear Physics; Irving Kaplan (Addison-Wesley Publishing Company, Cambridge, Mass, 1962).
Electronic Materials	Particle Data Book (Online): http://pdg.lbl.gov
Other Learning Materials	CERN http://cern.ch JLab http://jlab.org

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Class Room
Technology Resources (AV, data show, Smart Board, software, etc.)	Multi-Media Projector
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	Nuclear Physics Laboratory

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students, Peers and Program Leader	Indirect (CES)- Indirect peer evaluation
Assessment	Students, Program assessment committee	Direct/Indirect
Extent of achievement of course learning outcomes	Instructor	Direct/Indirect
Quality of learning resources	Students, Faculty members	Indirect (CES)- Indirect peer evaluation

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Department council**
Reference No.	**8**
Date	**16/4/1442**