UNSW Course Outline

ZPEM3528 Nuclear Physics - 2024

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General Course Information

Course Code : ZPEM3528
Year : 2024
Term : Semester 2
Teaching Period : Z2
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : UC Science
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Nuclear and particle physics in the big bang and in stars are responsible for the very character of our natural environment. Furthermore many modern technologies are based on subatomic physics. Examples can be found in the areas of power generation, medical diagnostics and treatment, industrial processing and control, as well as in environmental protection. In this course important aspects of nuclear and particle physics and their applications are discussed.

Relationship to Other Courses

The course is part of a group of upper level physics courses leading to a Major in Physics. The course has its foundation in the first-year physics courses ZPEM1501 and ZPEM1502. It is assumed that the student will be familiar with the material presented in these courses and also the material presented in first-year and relevant upper-level courses in Mathematics.
Prerequisites are the courses ZPEM2502 and ZPEM2506.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Mastered the key concepts in the topic areas of nuclear physics, particles and applied quantum mechanics, demonstrated by the ability to discuss, describe and explain the topics.
CLO2 : Demonstrate the ability to solve problems relating to nuclear physics and quantum mechanics.
CLO3 : Develop an appreciation of how the basic principles in the areas of nuclear physics and related topics foster current directions in research, policy and radiological protection.
CLO4 : by carrying out the associated laboratory experiments, students should also gain (i) a deeper knowledge of the associated physics, (ii) the ability to carry an experiment through to completion and to document the results, (iii) an appreciation of some of the techniques employed in these fields of physics (iv) experience in team work and self-direction.

Course Learning Outcomes	Assessment Item
CLO1 : Mastered the key concepts in the topic areas of nuclear physics, particles and applied quantum mechanics, demonstrated by the ability to discuss, describe and explain the topics.	• In Class Quizzes 1 and 2 • Laboratory • In Class Test • Final Exam
CLO2 : Demonstrate the ability to solve problems relating to nuclear physics and quantum mechanics.	• In Class Quizzes 1 and 2 • In Class Test • Final Exam
CLO3 : Develop an appreciation of how the basic principles in the areas of nuclear physics and related topics foster current directions in research, policy and radiological protection.	• In Class Quizzes 1 and 2 • In Class Test • Final Exam
CLO4 : by carrying out the associated laboratory experiments, students should also gain (i) a deeper knowledge of the associated physics, (ii) the ability to carry an experiment through to completion and to document the results, (iii) an appreciation of some of the techniques employed in these fields of physics (iv) experience in team work and self-direction.	• Laboratory

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Learning and Teaching in this course

Enrolment in this course or participation in any activity that is recorded constitutes consent to be

recorded during tutorial and other teaching sessions. Recordings will only be used for the purposes of teaching this course. If you do not
consent to be recorded, you must notify your course convenor immediately so other arrangements can be made.

All face-to-face classes, tutorials and laboratory sessions are compulsory. In online teaching, if required, we expect students to be present with video camera and microphone operational so that interactive teaching is possible.

Students are expected to prepare for classes through the study of notes, textbooks, videos and other materials available via Moodle, library or internet.

It is a good idea to use three or four sources for studying. For example, material on the Moodle site may be combined with a textbook, an internet e-book or an internet lecture series on the same topic.

Classes involve the presentation of material and addressing questions as well as tackling specific problems to deepen theoretical knowledge. Students may be called upon to share their screen and discuss or present their work in order
to lead a discussion.

The problems set will require either numerical solutions, descriptive answers or conceptual explanations. They are specifically designed to consolidate the material presented, to develop detailed understanding, to advance problem-solving skills, and to help students assess their own progress.

Additional Course Information

The 6-Units-of-Credit course involves 60 contact hours, plus an expectation of about 90 hours of additional self-directed study over the semester. This workload is divided approximately evenly between the two course sections. The
objective of the course is to provide students with an opportunity to study selected topics in each section that are beyond what is possible in foundation courses.

In this course, nuclear and particle physics topics are presented as they are relevant to the cosmos and to our technical world. The topics covered include, among others, the classification of subatomic particles and the quantum behaviour of the nucleus and its constituents.

Part 1 focuses on the nuclear force and nuclear structure and also covers the subatomic physics in the Big Bang and in stars responsible for the very character of our natural environment.

Part 2 of the course discusses nuclear and particle physics and their applications, including examples in the areas of power generation, medical diagnostics and treatment, industrial processing and control, as well as environmental protection.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
In Class Quizzes 1 and 2 Assessment Format: Individual	20%	Due Date: Quiz #1: Wednesday 31/7 1600h, Quiz #2 Wednesday 23/10, 1600h
Laboratory Assessment Format: Group	20%	Start Date: See semester planner. Due Date: Day after last session of each experiment.
In Class Test Assessment Format: Individual	30%	Due Date: Friday 23/8, 1300h
Final Exam Assessment Format: Individual	30%	Due Date: Exam week. (Exact date TBA.)

Assessment Details

In Class Quizzes 1 and 2

<u>**Assessment Overview**</u>

Exam condition quizzes, results will be reviewed in class.

<u>**Course Learning Outcomes**</u>

- CLO1 : Mastered the key concepts in the topic areas of nuclear physics, particles and applied quantum mechanics, demonstrated by the ability to discuss, describe and explain the topics.
- CLO2 : Demonstrate the ability to solve problems relating to nuclear physics and quantum mechanics.
- CLO3 : Develop an appreciation of how the basic principles in the areas of nuclear physics and related topics foster current directions in research, policy and radiological protection.

<u>**Detailed Assessment Description**</u>

Quiz#1 (counts 10%) assesses knowledge and understanding including models, estimations, and calculations in Part I.

Quiz#2 (counts 10%) assesses knowledge and understanding including models, estimations and calculations in Part II.

Assessment Length

1 hour each

Assignment submission Turnitin type

Not Applicable

Laboratory

Assessment Overview

Students will complete lab reports and will be provided feedback on this work.

Course Learning Outcomes

- CLO1 : Mastered the key concepts in the topic areas of nuclear physics, particles and applied quantum mechanics, demonstrated by the ability to discuss, describe and explain the topics.
- CLO4 : by carrying out the associated laboratory experiments, students should also gain (i) a deeper knowledge of the associated physics, (ii) the ability to carry an experiment through to completion and to document the results, (iii) an appreciation of some of the techniques employed in these fields of physics (iv) experience in team work and self-direction.

Detailed Assessment Description

Two computer laboratories (count 10% combined). Numerical experimental aptitude, data analysis and interpretation will be
assessed.

An experimental laboratory (counts 10%). Experimental aptitude, data analysis and interpretation will be assessed.

Assessment Length

12 hours total, spread across 6 sessions.

Assignment submission Turnitin type

Not Applicable

In Class Test

Assessment Overview

Exam condition test, results will be reviewed in class.

Course Learning Outcomes

- CLO1 : Mastered the key concepts in the topic areas of nuclear physics, particles and applied quantum mechanics, demonstrated by the ability to discuss, describe and explain the topics.

- CLO2 : Demonstrate the ability to solve problems relating to nuclear physics and quantum mechanics.
- CLO3 : Develop an appreciation of how the basic principles in the areas of nuclear physics and related topics foster current directions in research, policy and radiological protection.

Detailed Assessment Description

An in-class test (counts 30%) assessing knowledge and understanding, including models, estimations and calculations. The test is scheduled at the end of the first half of the course (week 6).

Assessment Length

1 hour

Assignment submission Turnitin type

This is not a Turnitin assignment

Final Exam

Assessment Overview

Formal examination. Feedback via formal notification of course results.

Course Learning Outcomes

- CLO1 : Mastered the key concepts in the topic areas of nuclear physics, particles and applied quantum mechanics, demonstrated by the ability to discuss, describe and explain the topics.
- CLO2 : Demonstrate the ability to solve problems relating to nuclear physics and quantum mechanics.
- CLO3 : Develop an appreciation of how the basic principles in the areas of nuclear physics and related topics foster current directions in research, policy and radiological protection.

Detailed Assessment Description

A two-hour examination (counts 30%) in the scheduled examination period, assessing an in-depth knowledge of nuclear physics as
well as mathematical skills to solve associated problems.

Assessment Length

2 hours

Assignment submission Turnitin type

This is not a Turnitin assignment

General Assessment Information

Use of Generative Artificial Intelligence (AI) - such as ChatGPT:

It is prohibited to use any software or service to search for or generate information or answers. If its use is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension and exclusion.

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is the only official mark.

Grading Basis

Standard

Requirements to pass course

The assessment for the course has been designed so that an overall mark of 50% or greater indicates that the student has unambiguously demonstrated satisfactory completion of each learning outcome. For this reason, and consistent with the UNSW policy of abolishing the Pass Conceded grade, students who receive less than 50% overall for the course will receive a fail grade.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 15 July - 19 July	Lecture	History & introduction & nucleon structure
Week 2 : 22 July - 26 July	Lecture	Nuclear force & nuclear structure
Week 3 : 29 July - 2 August	Lecture	Nuclear decay
	Assessment	Quiz #1, 31/7
Week 4 : 5 August - 9 August	Lecture	Nuclear reactions
	Laboratory	Computational lab #1, 5/8
Week 5 : 12 August - 16 August	Lecture	Big Bang nucleosynthesis & Cosmology
	Laboratory	Computational lab #1 & #2, 12/8
Week 6 : 19 August - 23 August	Lecture	Stellar nucleosynthesis
	Laboratory	Computational lab #2, 19/8
	Assessment	Test, 23/8
Week 7 : 9 September - 13 September	Lecture	Nuclear medicine
Week 8 : 16 September - 20 September	Lecture	Radioactive decay series
Week 9 : 23 September - 27 September	Lecture	Natural background radiation
Week 10 : 30 September - 4 October	Lecture	Detection of ionising radiation
Week 11 : 7 October - 11 October	Lecture	Muon physics
	Laboratory	Muon lab (Date TBD)
Week 12 : 14 October - 18 October	Lecture	Technical applications of ionising radiation
	Laboratory	Muon lab, 14/10
Week 13 : 21 October - 25 October	Lecture	Advanced topics in applied nuclear science
	Laboratory	Muon lab, 21/10
	Assessment	Quiz #2, 23/10

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings. Students are indeed expected to attend all lectures, tutorials, laboratory sessions and assessments unless their absence has been approved by the course coordinator. Students who have missed assessments or a laboratory, or expect to miss such a requirement, must inform the course coordinator by email at the earliest practicable date:
In typical circumstances of missed assessments, a formal application for Special Consideration via the prescribed University procedure may be appropriate. Alternative assessment can then be arranged. Otherwise, in the case of absence a mark of zero will be awarded for the assessment. Further information is available under 'assessments'.

Course Resources

Prescribed Resources

QED, The Strange Theory of Light and Matter
Richard Feynman
(any edition)

Recommended Resources

Introductory Nuclear Physics by Kenneth S. Krane

Modern Physics, by Kenneth S. Krane

Quantum Physics by Robert Eisberg & Robert Resnick

Modern Physics from α to Z0 by James W. Rohlf.

Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be
asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff,
and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this

course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct Policy https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
	Paul Fraser					No	Yes
	Christopher W right					No	No