UNSW Course Outline

PHYS3115 Particle Physics and the Early Universe - 2024

Published on the 03 Sep 2024

General Course Information

Course Code : PHYS3115
Year : 2024
Term : Term 3
Teaching Period : T3
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Physics
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course aims to provide an introduction to modern elementary particle physics and modern cosmology from both an experimental and theoretical viewpoint. Topics covered include: Basic ideas of the standard model. Interaction and fields. Feynman diagrams. Cross section and decay

rates. Invariance principle and conservation laws: parity, charge conjugation, time reversal, CPT. Concepts of QCD and asymptotic freedom. Concepts of electroweak theory, Higgs mechanism. Geometry, kinematics and dynamics of Friedmann-Lemaître-Robertson-Walker universes. Cosmic inflation, Klein-Gordon equation, scalar field dynamics. Thermal history of the Universe, equilibrium and out-of-equilibrium dynamics, Boltzmann equation, WIMP dark matter, recombination and the cosmic microwave background radiation, big bang nucleosynthesis. The topics are introduced during lectures and tutorials.

Course Aims

This course aims to provide an introduction to modern elementary particle physics and modern cosmology from both an experimental and theoretical viewpoint.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Describe the fundamental concepts of the standard model of particle physics.
CLO2 : Analyse simple particle interaction problems using conservation laws.
CLO3 : Explain the concepts underlying the Friedmann-Lemaître-Robertson-Walker model of the Universe.
CLO4 : Perform simple analytical and numerical calculations to deduce the evolution of the Friedmann-Lemaître-Robertson-Walker Universe.
CLO5 : Explain the principles of modern particle physics experiments and cosmological observations.

Course Learning Outcomes	Assessment Item
CLO1 : Describe the fundamental concepts of the standard model of particle physics.	• Weekly Quizzes • Final exam • Mid-term test
CLO2 : Analyse simple particle interaction problems using conservation laws.	• Weekly Quizzes • Final exam • Mid-term test
CLO3 : Explain the concepts underlying the Friedmann-Lemaître-Robertson-Walker model of the Universe.	• Assignment • Weekly Quizzes • Final exam
CLO4 : Perform simple analytical and numerical calculations to deduce the evolution of the Friedmann-Lemaître-Robertson-Walker Universe.	• Assignment • Weekly Quizzes • Final exam
CLO5 : Explain the principles of modern particle physics experiments and cosmological observations.	• Assignment • Mid-term test • Final exam

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment Assessment Format: Individual	15%	
Weekly Quizzes Assessment Format: Individual	15%	
Final exam Assessment Format: Individual	55%	
Mid-term test Assessment Format: Individual	15%	

Assessment Details

Assignment

Assessment Overview

You will be presented with a set of slightly more challenging problems, whose solution requires analytical as well as numerical techniques. The assignment paper is typically released around Week 8 and you will have a week to submit your solutions. Assignment results and comments will be returned within two weeks.

Course Learning Outcomes

- CLO3 : Explain the concepts underlying the Friedmann-Lemaître-Robertson-Walker model of the Universe.
- CLO4 : Perform simple analytical and numerical calculations to deduce the evolution of the Friedmann-Lemaître-Robertson-Walker Universe.
- CLO5 : Explain the principles of modern particle physics experiments and cosmological observations.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.

For more information on Generative AI and permitted use please see here.

Weekly Quizzes

Assessment Overview

You will complete 8 short weekly quizzes to test your understanding of the concepts introduced during the previous week.

These quizzes will provide continuous feedback on your learning throughout the term, with instant automated feedback provided upon submission of your solutions.

Course Learning Outcomes

- CLO1 : Describe the fundamental concepts of the standard model of particle physics.
- CLO2 : Analyse simple particle interaction problems using conservation laws.
- CLO3 : Explain the concepts underlying the Friedmann-Lemaître-Robertson-Walker model of the Universe.
- CLO4 : Perform simple analytical and numerical calculations to deduce the evolution of the Friedmann-Lemaître-Robertson-Walker Universe.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

Final exam

Assessment Overview

You will complete a 2-hour final exam during the formal university exam period. Questions will test your understanding of all topics covered in the course and typically involve solving problems using analytical calculations as well as summarising physical concepts.

Feedback is available through inquiry with the course convenor.

Course Learning Outcomes

- CLO1 : Describe the fundamental concepts of the standard model of particle physics.
- CLO2 : Analyse simple particle interaction problems using conservation laws.
- CLO3 : Explain the concepts underlying the Friedmann-Lemaître-Robertson-Walker model of the Universe.

- CLO4 : Perform simple analytical and numerical calculations to deduce the evolution of the Friedmann-Lemaître-Robertson-Walker Universe.
- CLO5 : Explain the principles of modern particle physics experiments and cosmological observations.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

Mid-term test

Assessment Overview

You will complete a 50-minute in-class test around Week 5. Questions will test your understanding of the topics covered in the first part of the course and typically involve solving problems using analytical calculations.

Test results and comments will be returned to you within a week.

Course Learning Outcomes

- CLO1 : Describe the fundamental concepts of the standard model of particle physics.
- CLO2 : Analyse simple particle interaction problems using conservation laws.
- CLO5 : Explain the principles of modern particle physics experiments and cosmological observations.

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

General Assessment Information

Grading Basis

Standard

Course Schedule

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Detailed Syllabus

Week 1: Review of special relativity; cross section and decay rates

Week 2: Klein-Gordon and Dirac equation

Week 3: Interaction and fields; Feynman diagrams

Week 4: Invariance principle and conservation laws; Introduction to the Standard Model of Particle Physics

Week 5: Basic concepts of the FLRW universe

Week 7: Distance measures, Horizons, Energy content of the Universe, Dynamics of the scale factor

Week 8: Flatness and horizon problems, Inflation, Scalar fields, Klein-Gordon equation, Slow-roll

Week 9: Thermal history, Equilibrium dynamics, Decoupling, Relativistic degrees of freedom

Week 10: Boltzmann equation, WIMP freeze-out, Recombination and the Cosmic Microwave Background radiation, Big Bang Nucleosynthesis

Course Resources

Prescribed Resources

Mark Thomson, Modern Particle Physics
David Griffiths, Introduction to Elementary Particle Physics
Daniel Baumann's lecture notes: http://cosmology.amsterdam/education/cosmology/

Recommended Resources

Lecture notes will be posted on Moodle

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Yvonne Wong					No	Yes
Administrator	Zofia Krawczyk					No	No
Lecturer	Dipan Sengupta					No	No
Director of teaching	Peter Reece					No	No
Year coordinator	Elizabeth Angstmann					No	No
Lab director	Tamara Rezstova					No	No

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as

a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a “fit to sit/submit” rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines