UNSW Course Outline

PHYS2113 Classical Mechanics and Special Relativity - 2024

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General Course Information

Course Code : PHYS2113
Year : 2024
Term : Term 2
Teaching Period : T2
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

Classical mechanics is the study of the motion of objects obeying Newton's laws of motion, while Einstein's special theory of relativity revises the Galilean notion of relativity between inertial frames. This course will provide students with strong grounding in the fundamentals of these

concepts through a series of lectures, tutorials and hands-on laboratory work. This will pave the way for advanced topics in electrodynamics, quantum mechanics, and statistical mechanics later in their studies.
Topics to be covered include: Lagrangian and Hamiltonian formulations of mechanics; variational principles; Noether's theorem, symmetry and conservation laws; damped and forced harmonic oscillators; resonance phenomena; coupled oscillators and normal modes; foundations of special relativity, 4-formalism, Lorentz transformations; space-time diagrams; relativistic kinematics and dynamics; relativistic Doppler effect.

Course Aims

This course aims to introduce students to the elegant Lagrangian and Hamiltonian formulations of Newtonian mechanics, and the fundamentals of special relativity and the associated 4-formalism. Students will receive a strong grounding in these methods, paving the way for advanced topics in electrodynamics, quantum mechanics, and statistical mechanics.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Solve problems in classical mechanics using the Lagrangian and Hamiltonian formulations.
CLO2 : Explain the fundamental principles of special relativity and Lorentz transformation.
CLO3 : Analyse relativistic systems by applying the 4-formalism of special relativity.
CLO4 : Acquire experimental data to examine classical mechanics and special relativity.
CLO5 : Interpret experimental data to examine classical mechanics and special relativity.

Course Learning Outcomes	Assessment Item
CLO1 : Solve problems in classical mechanics using the Lagrangian and Hamiltonian formulations.	• Weekly Question Sets • Final exam
CLO2 : Explain the fundamental principles of special relativity and Lorentz transformation.	• Weekly Question Sets • Final exam
CLO3 : Analyse relativistic systems by applying the 4-formalism of special relativity.	• Weekly Question Sets • Final exam
CLO4 : Acquire experimental data to examine classical mechanics and special relativity.	• Laboratory
CLO5 : Interpret experimental data to examine classical mechanics and special relativity.	• Laboratory

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Weekly Question Sets Assessment Format: Individual	20%	
Final exam Assessment Format: Individual	60%	
Laboratory Assessment Format: Individual	20%	

Assessment Details

Weekly Question Sets

<u>Assessment Overview</u>

Each week you will be given a set of questions to complete.

In some weeks of term, these may be in the form of an assignment for you to submit online. These questions are typically calculation or short-answer based.

In other weeks, the questions may be split between assignment-style submission and online quiz-style activity. The quiz activities are typically multiple-choice style questions.

The contribution of marks for each activity toward your final grade will be articulated in the task description (roughly 1-2% per task).

Marks for each task will be entirely allocated based on the demonstration of your ability to sensibly engage with the questions and content and not on the accuracy of your answers. Feedback on your responses will be provided in-term.

<u>Course Learning Outcomes</u>

- CLO1 : Solve problems in classical mechanics using the Lagrangian and Hamiltonian formulations.
- CLO2 : Explain the fundamental principles of special relativity and Lorentz transformation.
- CLO3 : Analyse relativistic systems by applying the 4-formalism of special relativity.

Final exam

<u>Assessment Overview</u>

The final exam is designed to summarise your learning and problem-solving skills on all topics delivered across the term, including material from lectures, tutorials and workshops. The exam is typically 2hrs and consists of short numerical and short answer responses - details will be confirmed during the course. The examination will occur during the official university examination period. General feedback will be provided on the course Moodle at the end of term.

<u>Course Learning Outcomes</u>

- CLO1 : Solve problems in classical mechanics using the Lagrangian and Hamiltonian formulations.
- CLO2 : Explain the fundamental principles of special relativity and Lorentz transformation.
- CLO3 : Analyse relativistic systems by applying the 4-formalism of special relativity.

Laboratory

<u>Assessment Overview</u>

You will complete 3 three-hour laboratory sessions over the term, focused on preparing a single final experimental report on a classical mechanics or special relativity experiment for the end of the term.
The first experiment is scheduled in the first three weeks of Term, with the additional following as an opportunity to gain more data, improve aspects of the experiment or explore creative directions.
You will submit a draft report (6%) at mid-term, which is part of a student peer feedback process. Your final report (10%) is submitted at the end of term with a short oral exam (4%) on the report in the following week.

<u>Course Learning Outcomes</u>

- CLO4 : Acquire experimental data to examine classical mechanics and special relativity.
- CLO5 : Interpret experimental data to examine classical mechanics and special relativity.

General Assessment Information

<u>Grading Basis</u>

Standard

Course Schedule

Attendance Requirements

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

General Schedule Information

Weeks 1-4 will be taught by Dr. Jan Hamann and Weeks 5, 7-9 will be taught by A/Prof. Oleg Tretiakov. Each has slightly different approaches, full details on precise scheduling will be given on the course Moodle during O-week.

Detailed Syllabus

(section numbers refer to Classical Mechanics by JR Taylor)

*Topics marked * are advanced topics that may be covered if time allows.*

First half: Calculus of Variations and the Euler-Lagrange equation (6.1, 6.2). Applications, more than two variables (6.3, 6.4). Lagrange's equations. Unconstrained motion, constrained motion (7.1, 7.2). Constrained systems in general (7.3, 7.4). Examples. Generalised momenta and ignorable coordinates (7.5, 7.6). Conservation laws, Lagrange multipliers, Symmetry, Noether’s theorem. (7.6, 7.8, 7.10). Hamilton mechanics in 1D systems, several dimensions (13.1, 13.2, 13.3). Canonical transformation, Lagrange vs. Hamilton (13.4, 13.5), Phase space orbits*, Liouville's theorem* (13.6, 13.7). Oscillations, Hooke’s Law (5.1). Simple harmonic motion (5.2). 2D Oscillation (5.3). Damped and driven oscillations (5.4-5.5). Resonance (5.6).

Second half: Dynamics of vibrating systems, Normal modes, normal coordinates, coupled oscillators, loaded string (Chapter 11). Special relativity, Empirical background, Michelson-Morley, Postulate of SR, Time dilation, Length contraction (15.3, 15.4, 15.5), Lorentz transformation (15.6), Relativistic velocity addition, 4D space-time, 4–vectors (15.7, 15.8). Invariant scalar product, light cone, Doppler effect (15.9, 15.10, 15.11), Mass, 4-velocity, 4-momentum (15.12, 15.13), Forces in relativity, massless particles (15.15, 15.16), Tensors (15.17).

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Oleg Tretiakov					No	Yes
Lecturer	Jan Hamann					No	No
Year coordinator	Elizabeth Angstmann					No	No
Lab director	Tamara Reztsova					No	No
Administrator	Zofia Krawczyk					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