UNSW Course Outline

PHYS3112 Experimental and Computational Physics - 2024

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General Course Information

Course Code : PHYS3112
Year : 2024
Term : Term 1
Teaching Period : T1
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

The intended audience is primarily Level 3 undergraduates taking a Physics major, for which this course is a core component. The purpose of this course is to improve experimental skills through hands-on laboratory work, and to improve computational skills through learning Python

and using Jupyter Notebook. The key topics include the statistical analysis of data, sampling and information theory, numerical solutions of ordinary differential equations, Fourier transform theory and discrete Fourier transforms, spectroscopy, numerical modelling of noise and stochastic processes, inverse problems, experimental control, nonlinear systems, and quantum measurements. The course will consist of a lecture component (40%) and a laboratory component (60%). The Higher Year Laboratory offers a large range of interesting experiments for students to select from, covering many key concepts and techniques in Physics.

Course Aims

The aim of this course is to provide students with the knowledge and skills required to undertake advanced physics experiments, together with the computational skills needed for experimental and theoretical Physics. The laboratory component will involve experimental design, data collection, data analysis and computational modelling of experimental results. The lectures will concentrate on developing computational skills, with examples chosen from a wide variety of fields within Physics.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Design and conduct physics experiments, such as determining the lifetime of a muon, based on non-proscriptive guidelines provided with the equipment.
CLO2 : Explain the theoretical basis for techniques used in experimental physics.
CLO3 : Use computational methods such as non-linear parameter estimation to analyse the data from experiments.
CLO4 : Critically evaluate the outcome of experiments to determine whether the aims of the experiment were met and to quantify the degree of agreement with theoretical expectations.
CLO5 : Write computer programs in Python and notebooks in Jupyter Notebook to solve problems in experimental and theoretical Physics.

Course Learning Outcomes	Assessment Item
CLO1 : Design and conduct physics experiments, such as determining the lifetime of a muon, based on non-proscriptive guidelines provided with the equipment.	• Laboratory • Final lab report
CLO2 : Explain the theoretical basis for techniques used in experimental physics.	• Computational report • Quizzes • Laboratory • Final lab report
CLO3 : Use computational methods such as non-linear parameter estimation to analyse the data from experiments.	• Computational report • Quizzes • Laboratory • Final lab report
CLO4 : Critically evaluate the outcome of experiments to determine whether the aims of the experiment were met and to quantify the degree of agreement with theoretical expectations.	• Computational report • Laboratory • Final lab report
CLO5 : Write computer programs in Python and notebooks in Jupyter Notebook to solve problems in experimental and theoretical Physics.	• Quizzes • Computational report • Laboratory • Final lab report

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360 | Zoom

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Computational report Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Week 10: 15 April - 21 April
Quizzes Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Not Applicable
Laboratory Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Not Applicable
Final lab report Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Not Applicable

Assessment Details

Computational report

Assessment Overview

You will be expected to submit a report on an assigned task using Python and Jupyter Notebook. The rationale of this assessment is to test your skills in applying Python and Jupyter Notebook to aspects of Physics. The report is expected to be roughly 12 pages in length (specific word counts/formatting to be provided), and you will have at least 3 weeks to work on the report prior to submission at the end of Week 10. The mark for the report will be based on the following four categories: (1) Completeness of the tasks (with evidence such as code, equations, etc.), (2) Quality and correctness of the figures and the results, (3) Quality of the write up (organization, format, soundness of arguments, references), (4) Analysis of results, understanding, insights. Feedback will be provided through marks and comments in Moodle.

Course Learning Outcomes

- CLO2 : Explain the theoretical basis for techniques used in experimental physics.
- CLO3 : Use computational methods such as non-linear parameter estimation to analyse the data from experiments.
- CLO4 : Critically evaluate the outcome of experiments to determine whether the aims of the experiment were met and to quantify the degree of agreement with theoretical expectations.
- CLO5 : Write computer programs in Python and notebooks in Jupyter Notebook to solve problems in experimental and theoretical Physics.

Detailed Assessment Description

See Assessment Overview. More details will be provided in Moodle during the term.

Assessment Length

Roughly 12 pages

Assignment submission Turnitin type

This is not a Turnitin assignment

Quizzes

Assessment Overview

You will be expected to complete 8 weekly Moodle quizzes on the lecture material, worth 1 mark each. The quizzes will run during Weeks 2-5 and 7-9. The quizzes are formative assessments, i.e., designed to help you learn). Feedback will be provided through Moodle. You will be encouraged to attend a weekly synchronous lecture where the quizzes will be discussed, and further formative questions (unassessed) will be asked interactively. There will be a final summative Moodle quiz worth 12 marks in Week 10.

Course Learning Outcomes

- CLO2 : Explain the theoretical basis for techniques used in experimental physics.
- CLO3 : Use computational methods such as non-linear parameter estimation to analyse the data from experiments.
- CLO5 : Write computer programs in Python and notebooks in Jupyter Notebook to solve problems in experimental and theoretical Physics.

Detailed Assessment Description

See Assessment Overview. More details will be provided in Moodle during the term.

Assignment submission Turnitin type

This is not a Turnitin assignment

Laboratory

Assessment Overview

You will be expected to complete 8 weekly 4-hour lab sessions. Three of these sessions are dedicated to the experiment you choose for the final report, two are for a “long experiment”, and the remaining three sessions are for a “short experiment”, a computational experiment, and a “flexible experiment” where you dig deeper into one experiment and go beyond the lab notes.

Apart from the final report (see separate assessment item), the experiments are marked pass/ fail by demonstrators in a 10-15 minute oral interview with you in the week following each lab. You will pass if you demonstrate an appropriate level of achievement. If you do not do so, you

will be given supportive feedback and invited to return for reassessment in the following week. The expectation is that all students will pass all the experiments. The reasoning behind this assessment scheme is to emphasise meeting the learning goals and reduce the stress associated with trying to maximise marks.

Of the 20 marks for the lab component, 6 are given for the long experiment, 6 for the short experiment, 6 for the computational experiment, and 2 for the flexible experiment.

Feedback is provided on the same day as the interview.

Course Learning Outcomes

- CLO1 : Design and conduct physics experiments, such as determining the lifetime of a muon, based on non-proscriptive guidelines provided with the equipment.
- CLO2 : Explain the theoretical basis for techniques used in experimental physics.
- CLO3 : Use computational methods such as non-linear parameter estimation to analyse the data from experiments.
- CLO4 : Critically evaluate the outcome of experiments to determine whether the aims of the experiment were met and to quantify the degree of agreement with theoretical expectations.
- CLO5 : Write computer programs in Python and notebooks in Jupyter Notebook to solve problems in experimental and theoretical Physics.

Detailed Assessment Description

See Assessment Overview. More details will be provided in Moodle during the term.

Assignment submission Turnitin type

This is not a Turnitin assignment

Final lab report

Assessment Overview

You will be expected to choose one of your five lab experiments and complete a longer report on this experiment, with a limit of 5000 words and 5 figures/tables. The task includes a peer review process in Weeks 5-7, and a short viva with the marker after the report is submitted in Week 9. Of the 30 marks available for this assessment, 15 are for the report, 6 are for the viva, and 9 are for the peer review process. Feedback will be provided through marks and comments.

Course Learning Outcomes

- CLO1 : Design and conduct physics experiments, such as determining the lifetime of a muon, based on non-proscriptive guidelines provided with the equipment.
- CLO2 : Explain the theoretical basis for techniques used in experimental physics.
- CLO3 : Use computational methods such as non-linear parameter estimation to analyse the data from experiments.

- CLO4 : Critically evaluate the outcome of experiments to determine whether the aims of the experiment were met and to quantify the degree of agreement with theoretical expectations.
- CLO5 : Write computer programs in Python and notebooks in Jupyter Notebook to solve problems in experimental and theoretical Physics.

Detailed Assessment Description

See Assessment Overview. More details will be provided in Moodle during the term.

Assessment Length

500 words

Assignment submission Turnitin type

This is not a Turnitin assignment

General Assessment Information

Please note that the marks in Moodle are raw marks and may be subjected to moderation in order to calculate your final mark.

Grading Basis

Standard

Requirements to pass course

Total mark of at least 50%.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 12 February - 18 February	Topic	Introduction to Python and Jupyter notebook
Week 2 : 19 February - 25 February	Topic	Numerical integration of ODEs; using Python libraries such as numpy, scipy, and matplotlib for common applications in Physics (e.g., fitting functions to data).
Week 3 : 26 February - 3 March	Topic	Analog to digital converters; random numbers; fast Fourier transforms; the concepts of parity, Hamming codes, Reed-Solomon codes, cyclic-redundancy checks, hashes, and their applications to data integrity.
Week 4 : 4 March - 10 March	Topic	Sources of noise in physical experiments; extracting signals from noise; lock-in amplifiers; control theory and PID loops.
Week 5 : 11 March - 17 March	Topic	Differential equations using finite-difference techniques (Representation as difference equations, matrix forms, boundary conditions, types of finite differences, examples from Physics).
Week 7 : 25 March - 31 March	Topic	Forms of ODE/PDEs in physics and solution techniques (Linear & non-linear DEs, coupled DEs, time-dependence/time stepping, finite element, convergence, assessment of solutions).
Week 8 : 1 April - 7 April	Topic	Eigenvalue problems and matrix methods (The example of Schrodinger equation as an Eigenvalue problem in Physics, numerical solutions using techniques from Weeks 5 & 7, matrix methods as efficient ways to solve Eigenvalue problems, data storage in sparse matrix, memory versus speed/ ease of accessibility, concepts of parallel algorithms).
Week 9 : 8 April - 14 April	Topic	Monte Carlo methods and simulations (Concept as a solution technique to various problems, statistical assessment of solutions, generating probability distributions that represent the problem, examples – Monte Carlo integration, Monte Carlo simulation from magnetism/electron flow in solids).

Attendance Requirements

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

Course Resources

Course Evaluation and Development

The course is modified each year after consideration of student feedback. In particular, the laboratory assessment has been regularly updated to manage student workloads and experience.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Year coordinator	Elizabeth Angstmann					Yes	No
Administrator	Zofia Krawczyk					No	No
Lab director	Tamara Reztsova					No	No
Lecturer	Rajib Rahman					No	No
Convenor	Michael Ashley					No	Yes
Lab supervisor	Adam Micolich					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