School of Physics

Course Outline 2022

PHYS3112

Experimental and Computational Physics

School of Physics

Faculty of Science

T1, 2022

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Coordinator	Professor Michael Ashley	m.ashley@unsw.edu.au	Consultation times: by arrangement via email	(02) 9385 5465
Lecturer	A/Prof. Rajib Rahman	rajib.rahman@unsw.edu.au	Consultation times: by arrangement via email	(02) 9065 1880
Laboratory Staff	Tamara Reztsova	t.reztsova@unsw.edu.au	School of Physics, Higher Year Lab, Room 142, Old Main Building	(02) 9385 4577
Teaching Support Officer	Zofia Krawczyk-Bernotas	z.krawczyk-bernotas@unsw.edu.au	School of Physics office G06, Old Main Building	(02) 9065 5719
Tutor	TBA	TBA		

2. Course information

Units of credit: 6

Pre-requisite(s): (PHYS2111 or PHYS2113 or PHYS2114 or PHYS2110) and (MATH2089 or (MATH2301 and (MATH2801 or MATH2901)))

Teaching times and locations: http://timetable.unsw.edu.au/2022/PHYS3112.html

2.1 Course summary

This course will provide the skills and knowledge required to investigate, both experimentally and computationally, a wide range of physical phenomena. The course consists of both lecture and laboratory classes, covering topics such as statistical analysis of data, sampling and information theory, numerical solutions of ordinary & partial differential equations, finite-difference & finite-element techniques, numerical linear algebra and data storage, Monte Carlo simulations, Fourier transform theory and discrete Fourier transform, spectroscopy, handling and numerical modelling of noise and stochastic processes, inverse problems, experimental control, nonlinear systems, and quantum measurements.

2.2 Course aims

Graduate Attributes Developed in this Course

- Research, inquiry and analytical thinking abilities
- Capability and motivation for intellectual development
- Teamwork, collaborative and management skills

- Technical Communication

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Demonstrate knowledge of key concepts, principles and skills in experimental physics and use them to investigate a broad range of physical phenomena.
2. Demonstrate knowledge of key concepts, principles and skills in computational physics and use them to investigate and simulate a broad range of physical phenomena.
3. Demonstrate and appropriately apply a broad range of analytical skills and techniques in experimental and computational physics expected from a physics graduate.
4. Communicate concepts, ideas and analyses in experimental and computational physics to both specialist and non-specialist audiences.

2.4 Relationship between course and program learning outcomes and assessments

Course learning outcomes 1–4 are assessed by the weekly quizzes, laboratory sessions, a final experimental report, and a computational essay. These assessments offer a variety of ways for students to demonstrate their attainment of the course learning outcomes while being aligned with key graduate attributes for successful physics-trained graduates.

3. Strategies and approaches to learning

3.1 Learning and teaching activities

Assumed knowledge

Students should have completed the prerequisite courses. In addition, students should have completed at least one PHYS2XXX course with an experimental component.

Prerequisite courses: (PHYS2111 or PHYS2110 or PHYS2113 or PHYS2114) and (MATH2089 or (MATH2301 and (MATH2801 or MATH2901))

Timetable

Lectures:	2 per week 1x 2 hr (synchronous), and 1 x 1hr (asynchronous) (Weeks 1–5, 7–9)
Tutorial:	1 x 1 hr per week (Weeks 1–5, 7–8, 10)
Laboratory:	1 x 4 hr per week (Weeks 1–5, 7–10)

Lecture Timetable

Lecturer: This course is taught by two lecturers teaching 12 hours each.

NOTE: Details regarding the online or face-to-face aspects of the lectures & tutorials will be announced on the Moodle page at the start of term.

Day	***Time***	***Location***
Monday	14:00 – 16:00	Mathews 214 (K-F23-214)

Tutorial:

Day	***Time***	***Location***
Friday (Weeks 1-5, 7-8, 10)	15:00 – 16:00	Mathews 103 (K-F23-103)

Laboratory information

The laboratory component of the course will be held in the Physics Laboratory, Room 142, Old Main Building. For details about labs, see http://timetable.unsw.edu.au/2022/PHYS3112.html or contact Laboratory Staff or Student Advisor.

3.2 Expectations of students

Academic misconduct will not be tolerated in any form in this course. Substantiated instances of cheating, plagiarism or copying of answers may result in significant deduction of marks or a failure grade. Please ensure you are fully familiar with the University's requirements and rules on plagiarism, which are detailed at http://student.unsw.edu.au/plagiarism. Claims of being unaware of the rules and/or the requirement for you to meet these rules will not be accepted as mitigating circumstances.

The School endorses interactive group learning and fully understands that you may discuss the content of your courses including experiments and assignment problems during your studies. However, submitted assignments should be your own work outlining your own reasoning and demonstrating your own knowledge related to the assessment. Copying will not be tolerated (we are good at spotting it); please ensure you know where the line between studying together and cheating on assessments lies. We will expect you to stay firmly on the correct side of that line.

4. Course schedule and structure

	Week	Topic
Block 1: Ashley	**1**	Introduction to Python and Jupyter notebook
	2	Numerical integration of ODEs; using Python libraries such as numpy, scipy, and matplotlib for common applications in Physics (e.g., fitting functions to data).
	3	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.
	4	Sources of noise in physical experiments; extracting signals from noise; lock-in amplifiers; control theory and PID loops.
Block 2: Rahman	**5**	Differential equations using finite-difference techniques (Representation as difference equations, matrix forms, boundary conditions, types of finite differences, examples from Physics).
	7	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).
	8	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).
	9	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).

5. Assessment

5.1 Assessment tasks

Course assessment comprises assignments, laboratory and final examination.

Assessment task	Length	Weight	Mark	Due date
Final lab report:		30%		Submission in week 9; viva in week 10. See Moodle for details during term.
Computational essay:		30%		During final exam period. Exact date to be announced on Moodle during term.
Laboratory:		20%		See note below about lab classes.
Weekly quizzes:	1 hr	8%		Monday 9am (Weeks 2–5, 7–9)
Final quiz:	50 min	12%		Week 10. See Moodle for details during term.

Laboratory

Preparation work will be required before laboratory class. Marks will be awarded based on presentation of specified output and discussion with a marker for each experiment. Marking will normally occur the week after the laboratory is completed, though if revisions are requested by the marker, there will be a new marking session in a later week.

Final lab report

The final lab report is an assessment with several stages. Students will conduct the experiment during Weeks 1–4, submit a draft report for start of Week 7, provide peer feedback at end of Week 7, submit their final report in Week 9, and have their viva in Week 10. More complete details of the exact due dates will be made available on Moodle during term.

Information about Special Consideration is available from https://student.unsw.edu.au/special-consideration

Further information

UNSW grading system: student.unsw.edu.au/grades

UNSW assessment policy: student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Please see Moodle for a marking rubric for each assessment task.

5.3 Submission of assessment tasks

Details on submission of each assessment task will be provided on Moodle.

A downloadable assignment cover sheet, if needed, is available from https://www.physics.unsw.edu.au/current-students/cover-sheet

5.4. Feedback on assessment

Please see Moodle for details on how feedback will be provided for each assessment task

6. Academic integrity, referencing and plagiarism

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 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.[1] 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 and **plagiarism** can be located at:

- The *Current Students* site student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site subjectguides.library.unsw.edu.au/elise

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

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

7. Readings and resources

Textbooks

None.

Computer software

Python

The Course will be taught in Python, specifically Python 3.10 (or more recent), and Jupyter notebook. To install both of these, and a number of python packages you will need for this course, we recommend that you install the Anaconda distribution. This software will also be installed on the computers in the Physics Higher Year Laboratory.

Github

Example code will be available from the phys3112 "organisation" on github.com

A coding primer will be held during the mandatory Week 1 tutorial class, including assistance with installing Anaconda and getting github access.

Other resources

Information will be made available on the UNSW PHYS3112 Moodle Site

8. Administrative matters

Communications

Students should check their UNSW email account regularly as all official university communication will be sent to that address. Students should use their university email account when writing to UNSW staff and should always include their name and student number.

Health and safety

The School of Physics is actively committed to the health, safety and welfare of its staff and students. Information on relevant UNSW Occupational Health and Safety policies and expectations is available at: www.ohs.unsw.edu.au and https://www.physics.unsw.edu.au/about/safety

Recommended internet sites

The School of Physics website is www.physics.unsw.edu.au. Under the “Current Students” link students will find information about degrees, courses, and assessment.

The University website my.unsw.edu.au provides links to the UNSW Handbook, Timetables, Calendars and other student information.

Student complaint procedures

UNSW has procedures for dealing with complaints. These aim to solve grievances as quickly and as close to the source as possible. Information is available here: student.unsw.edu.au/complaints. Staff who can assist include:

School contacts:

Zofia Krawczyk-Bernotas
Teaching Support Manager
School of Physics
Room G06, OMB
z.krawczyk-bernotas@unsw.edu.au
Tel: 9065 57219

Adam Micolich
Teaching Director
School of Physics
Room G57A, OMB
adam.micolich@gmail.com
Tel:

Prof Susan Coppersmith
Head of School
School of Physics
s.coppersmtih@unsw.edu.au
Tel:

A/Prof Julian Berengut
Honours Coordinator
School of Physics
julian.berengut@unsw.edu.au
Tel:

9. Additional support for students

- The *Current Students* Gateway: student.unsw.edu.au
- Academic Skills and Support: student.unsw.edu.au/skills
- Student Wellbeing, Health and Safety: student.unsw.edu.au/wellbeing
- Disability Support Services: student.unsw.edu.au/disability
- UNSW IT Service Centre: www.it.unsw.edu.au/students