School of Physics

Course Outline 2022

PHYS2111

Quantum Physics

School of Physics

Faculty of Science

T1, 2022

CRICOS Provider Code 00098G

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	Adam Micolich	adam.micolich@gmail.com	Consultation time Thu 3-4pm and by arrangement via email	(02) 9385 6132
Lecturer	Peter Reece	p.reece@unsw.edu.au	Consultation times: by arrangement via email	
Laboratory Staff	Tamara Reztsova	t.reztsova@unsw.edu.au		
Teaching Support Officer	Zofia Krawczyk-Bernotas	z.krawczyk-bernotas@unsw.edu.au	School of Physics office G06, Old Main Building	(02) 9065 5719

2. Course information

Units of credit: 6

Pre-requisite(s): PHYS1221 or PHYS1231 or DPST1024 or PHYS1241 and MATH1231 or DPST1014 or MATH1241

Teaching times and locations: http://timetable.unsw.edu.au/2022/PHYS2111.html

2.1 Course summary

Quantum mechanics addresses the interesting wave-like quantised physical phenomena that occur at microscopic scales. The subject was a major research focus of the 'modern physics' revolution of the 1900s and quantum information is rapidly evolving into a key innovation and technology paradigm for the early-mid 2000s. This first course in quantum mechanics provides students with a broad and comprehensive introduction to the technical fundamentals of quantum mechanics and builds a strong foundation for further studies.

2.2 Course learning outcomes (CLOs)

At the successful completion of this course students should be able to:

1. Explain the core principles of quantum mechanics, which are the basis of many of the unique behaviours and properties found in quantum mechanical systems, e.g., interference, uncertainty, entanglement.
2. Apply the associated mathematical frameworks to analyse a variety of basic problems related to two-level quantum systems using the Heisenberg matrix mechanics formalism.
3. Apply the associated mathematical frameworks to analyse a variety of basic problems related to quantum systems from the perspective of Schrödinger wave-mechanics formalism.

4. Acquire and interpret experimental data for laboratory experiments related to basic quantum mechanical phenomena.

2.3 Relationship between course and program learning outcomes and assessments

Course learning outcomes 1-3 are assessed by assignments, quizzes and final exam. These assessments are largely of a problem-solving nature designed to determine students' ability to deploy acquired knowledge to new situations, which is a key graduate attribute for successful physics-trained graduates. Course learning outcomes 1 and 4 are also assessed via the laboratory component of the assessment.

3. Strategies and approaches to learning

3.1 Learning and teaching activities

Assumed Knowledge

Appropriate Physics 1 courses (e.g. PHYS1121 or PHYS1131 or PHYS1141 and PHYS1221 or 1231 or PHYS1241), plus MATH1131 or MATH1141 and MATH1231 or MATH1241 courses and a sound knowledge of linear algebra.

Timetable

Lectures: 1 × 2hr plus 2 × 1hr lectures per week equivalent (Weeks 1-9 except Week 6) – n.b. arrangement may differ due to COVID restrictions/requirements and may also differ between the two lecturers.

Tutorial: 1 hr per week (Weeks 1-9 except Week 6)

Laboratory: 2 × 3hr per term

Lecture Timetable

Day	***Time***	***Location***	***Weeks***
Tuesday	1700-1800	Online* (or Burrows*)	1-5, 7-10
Thursday	1300-1500	Law Theatre G04 (or online*)	1-5, 7-10
Friday	1100-1200	Online* (or CLB 7*)	1-5, 7-10

* Online lectures may be synchronous or asynchronous depending on the lecturer doing the online lectures. Further information will be given by the lecturer in the Moodle or during the first lecture.

Lecture Information

Lecturer: This course is taught by two lecturers teaching 18 hours each. They may have different approaches, details will follow on Moodle.

Tutorial: Thur 1600-1700 in Matthews A Theatre, Weeks 1-5, 7-10.

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/PHYS2111.html or contact Laboratory Staff. The laboratory manager is Tamara Reztsova (t.reztsova@unsw.edu.au)

3.2 Expectations of students

Attendance at workshop and tutorial classes and engagement with the formative assessment (Moodle quiz component) is strongly encouraged. Strong engagement with course material and formative assessment during the term is highly correlated with strong performance in the final summative assessment components (e.g., final exam).

Academic misconduct will not be tolerated in any form in this course. Substantiated instances of cheating, plagiarism or copying of answers may result in penalties ranging from a significant deduction of marks to a fail grade in the course. 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 them 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 tutorial 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

The expected progression through content in the course is as follows.

Week	Topics
1	Quantum measurement (APM) Hilbert space (APM) Projections (APM)
2	Operators (APM) Fundamental theorem and principles of quantum mechanics (APM) Pauli vectors (APM)
3	Classical & Quantum correlation (APM) Entanglement (APM) From two states to many (APM)
4	Simultaneous observables (APM) Statistics of uncertainty (APM) The uncertainty principle (APM)
5	Developments leading up to the wave equation (PJR) Schrödinger's equation (PJR)

6	Flexibility week (no classes by university requirement)
7	Wavefunctions and expectation values (PJR) Infinite and finite square wells (PJR) Quantum harmonic oscillators (PJR)
8	Time evolution and coherence (PJR) Fourier's theorems and Fourier transforms (PJR) Quantum propagation of a free particle (PJR)
9	Barriers and Steps (PJR) The delta function potential (PJR) Periodic potentials (PJR)
10	Revision sessions & tutorials only (PJR/APM)

5. Assessment

5.1 Assessment tasks

Course assessment comprises assignments and quizzes, laboratory and final examination.

Assessment task	Length	Weight	Due date *(normally midnight on due date)*
Assessment 1: Assignments & Quizzes		20%	See Moodle for details during term.
Assessment 2: Laboratory		20%	See Moodle for details during term.
Assessment 3: Final Exam	2 hours	60%	See Exam Schedule – TBA

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 details for each assessment task.

5.3 Submission of assessment tasks

Unless otherwise specified, assignments should be submitted via Moodle/Turnitin by the specified time and date on Moodle for the given task. Assignments will not be accepted in hard-copy form or via email. Marks will be deducted for late assignments according to university policy.

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.

7. Readings and resources

Recommended resources:

Introduction to Quantum Mechanics, 2nd Ed, David J Griffiths, ISBN 978-0-131-11892-8, Pearson Education

Quantum Mechanics – The Theoretical Minimum, Leonard Susskind & Art Friedman, ISBN 978-0-141-97781-2, Penguin Books

Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Edition; Robert Eisberg & Robert Resnick, ISBN 978-0-47187-373-0, John Wiley and Sons.

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

Laboratory Information

Two experiments need to be conducted during the laboratory period. These are conducted in the Higher Year Laboratory on the first level of the Old Main Building. Before your first lab class, you must complete the online OH&S induction on Moodle. Lab classes are streamed; you will have selected your stream upon enrolment. For details of lab days, times and class codes please see http://timetable.unsw.edu.au/2021/PHYS2111.html

Other Resources

The PHYS2111 lecture notes will be posted to Moodle.

Additional resources such as articles, papers, websites, other published material will be referred to during lectures and listed at the 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:

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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