PHYS 323 – Quantum Mechanics I
Course Outline: May 2026 – Aug 2026

Instructor:	Dr. M. Laidlaw
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Lectures:	TWF 9:30-10:20
Office Hours:	F 10:30-11:20

Unless there is a material change in health guidelines all course activities will be exclusively face-to-face; there will not be an opportunity to do exams or labs remotely.

Prerequisite: PHYS 215 and MATH 204.
Concurrent enrolment or prior completion of either MATH 342 or 346.

Strongly Recommended Texts:
Griffiths, *Introduction to Quantum Mechanics,* and/or
McIntyre, *Quantum Mechanics*

Calendar Description:
Introduction to quantum mechanics, historical review, postulates, development of the theory and applications.

Course Content and tentative schedule.

1. Invitation: Energies (1 week)
    a. Time independent Schrodinger Equation
    b. Infinite square well
    c. Harmonic Oscillator
2. Wavefunction (1-2 weeks)
    a. Statistical interpretation; normalization
    b. Expectation values; position, momentum, energy
    c. Probability and uncertainty
    d. Time evolution
    e. Uncertainty principle
3. Schrodinger Equation in one dimension (1-2 weeks)
    a. Finite square well
    b. Delta function potential
    c. Free particle
    d. Scattering and tunnelling
4. Formalism and Dirac Notation (1-2 weeks)
    a. Vector spaces over complex numbers, bases.
    b. Inner products, inner product spaces, orthonormality.
    c. Change of basis, projection, linear operators.
    d. Sturm-Liouville theorem: expansion in orthogonal functions, inner products on function space.

    e. Matrices: eigenvalues and eigenvectors, linear operators as matrices.
    f. Descriptive statistics: mean, variance, standard deviation.
5. 2-state and N-state systems (3 weeks)
    a. Spin-1/2 and the Stern-Gerlach experiment
    b. Operators, observables, commutators
    c. Schroedinger's equation
    d. Time evolution
    e. Spin-1
    f. Addition of angular momentum.
6. Quantum mechanics in 2 or 3 dimensions (3 weeks)
    a. Square well revisited
    b. Harmonic oscillator in 2 dimensions
    c. Hydrogen atom
        i. Separation of variables
        ii. Angular equation
        iii. Radial equation
        iv. Spectrum and wavefunction
7. Synthesis (1-2 weeks)
    a. Spin-orbit coupling in Hydrogen
    b. Harmonic oscillator; raising and lowering operators.

Note that precise content and timings are subject to change at my discretion. If I have overestimated the time to cover some material I will edit the topics list; if I have underestimated I will add more.

Organizational Details:

Midterm Exam:

There will be two in-person midterm exams on June 12 and July 10.

Final Exam:

There will an in-person final exam during the August exam period.

Essential Elements:

You must attend the final exam and attend and submit at least two labs.
Labs cannot be deferred to another term.

Course Material:

All posted material will be available via the UVic LMS Brightspace.

Assignments:

There will be regular assignments. I anticipate that many weeks there will be 2-3 written questions for you to respond to.

Computational Assignments:

There will be regular computational assignments which will require programming in a language such as Python to produce output relevant to our course material. The purpose of these questions is not to practice programming, but rather to use it as a tool to check claims and to develop intuition for complicated cases. I anticipate that many weeks there will be 1-2 computational questions.

Accommodations:

I am willing to make reasonable arrangements for issues that need to be addressed consistent with custom and discipline norms. If you miss a course requirement, I expect you to contact me as soon as reasonably possible, and I expect you to give me advance warning of issues that you could have reasonably foreseen. I will only consider "last minute" requests due to sudden or exceptional circumstances, and I will not consider requests made an unreasonable amount of time after the issue or deadline.
Labs, Assignments, and Computational Assignments may not be deferred past the end of the lecture period (July 31)

Labs:

Labs will be in person.
There will be an introductory session during the week of May 11-15.
You must exhibit satisfactory performance in the labs to obtain credit for the course. You are expected to submit your lab work in a timely fashion, respecting the customary deadlines. If you do not submit your lab work in a timely manner I may contact you and impose a final deadline for that work.
Students applying for permission to be exempt from the labs require both permission from the lab coordinator and also the instructor.

I take Academic Integrity in this course extremely seriously.
You can find UVic's Policy on Academic Integrity in the Calendar; here is a link.
You can also find the Faculty of Science's Student Code of Conduct here.
In overview, your responsibilities are:

- You must complete all work on exams on your own without help from another person or from outside sources.
- You must submit only your own original work for the labs. You may seek help or advice from me, your lab instructor, or from another student. You may not copy or paraphrase from another student. You may not permit your work to be copied or paraphrased by another student.
- You must undertake the work on assignments by yourself. You may seek advice or help from me, other students, or other people, but you are responsible for undertaking and understanding the work you submitted.
- You may not share or post course material that I have created without my express permission.
- You must engage respectfully with your peers and engage honestly and forthrightly with processes and procedures at the University.

Marking and Grades:

The skills you must demonstrate in this course include

1. Identify and/or calculate the energy eigenstates of a constrained system
2. Express a quantum state as a linear combination of appropriate basis states
3. Correctly calculate the time-evolution of a state
4. Calculate probability distributions and expectation values for the results of measurements on a state
5. Understand and apply how measurement changes a quantum system.
6. Apply both the wavefunction and Dirac formalisms as appropriate
7. Other applications of the material taught in class and outlined in the text.

Examinable material includes everything discussed in class, in the assigned readings, and topics I think you should be able to deduce from those.

Grades will be assigned in accordance with the narrative descriptions in the undergraduate calendar, found here.

You should note that the narrative descriptions of the grade ranges indicate:

> A-range grades are earned by technically superior work which shows mastery of the subject.
> B-range grades are earned by work which shows good comprehension, command of course skills, and full engagement with the course material.
> C or D-range grades are earned by work which show adequate or minimal comprehension of course material, or minimal acceptable participation.
> F indicates work that is inadequate and unworthy of credit.

What this means is that in grading I make two determinations:

1. I assess the quality of your work, and
2. I assess the level of your engagement.

I will assess your engagement as follows:

- Full engagement means completing all labs, completing essentially all (~90%) assignment questions and computational questions.
- Basic engagement means completing all labs, completing most (~70%) assignment questions and computational questions.
- Minimal participation means completing at least two labs, completing half (~50%) the assignment questions and computational problems.

Full engagement is required for a grade in the A or B range, basic engagement is required for a C-range grade, minimal participation is required for a passing grade.

Individual questions on class work or exams are marked on a 0 to 4 ordinal scale. These definitions form the basis for the grades in the exam and assignment elements:

4 – Indicates that the question is answered clearly and that the answer is technically correct using techniques and concepts from class. There are no discernable problems with the mathematical exposition. The work has clear and appropriate written explanations and diagrams. The work is comparable in quality to the solution set.
3 – Indicates that the work is broadly correct in addressing the question using techniques and concepts from class. The work competently attempts to address the posed question. There may be small mathematical errors or omissions. There may also be defects in the written exposition such as poor explanations or unclear diagrams. The errors, omissions, and defects do not undermine the marker's inference that the writer understands the solution of the problem.
2 – Indicates work that competently uses techniques or concepts from class to attempt to solve the question. The work does not reach the correct answer because of calculational errors, inappropriate approximations, or similar issues, but the work shows meaningful and appropriate effort to apply the reasoning methods taught in class.
1 – Indicates work which has significant conceptual or mathematical deficits in the attempt to solve the question. This category includes being unable to meaningfully proceed past the mathematical formulation of a question.
0 – Indicates work which is not submitted, that is unable to formulate the posed problem mathematically, that does not use techniques and concepts from class, or that makes mathematical claims that are not appropriately supported by the work presented. This category includes all forms of question-begging including "mathematical miracles" which take incorrect work and transform it into the expected answer.

A note about negative signs, numerical prefactors, and notation: In mathematical derivations these are common places for errors to occur. Sometimes those errors are inconsequential, and sometimes those errors communicate a significant lack of understanding. It is my job in marking to determine which is which.

I will determine a letter grade based on the UVic scale for each of the six marked components: Final Exam, 2 Midterm Exams, Assignments, Computational, Labs

Final Exam:
A-range – demonstrates a broad capability of at least the "2" level in all skills listed. The bulk of the work will be at the "3" level.
B-range – indicates work of at least the "2" level in most skills; some of the work must be at the "3" level.
Passing – indicates work of at least the "2" level at least half the skills examined. Some of the work must be at the "3" level.
Failing – indicates work which does not meet the "2" level in at least half the skills examined and/or did not attain the "3" level in any skill.

Midterm Exam:
A-range – indicates work of at least the "3" level across the whole exam OR A-range work on the final exam.
B-range – indicates work of at least the "3" level in one tested skill and work across the exam of at least level "2" OR B-range work on the final exam.
Passing – indicates work of at least the "2" level in two tested skills OR passing work on the final exam.
Failing – indicates work which does not meet the "2" level in the tested skills, or that the midterm exam was not written AND failing work on the final exam.
This scheme replaces either or both midterm grades by the final exam if it is higher.

Assignments and Numerical Work:
A-range – indicates work of at least the "2" level on essentially all assigned problems, with the vast majority of the "3" level or higher.
B-range – indicates work of at least the "2" level on essentially all assigned problems, with over half of the "3" level or higher.
Passing – indicates work of at least the "2" level on a significant majority of all assigned problems.
Failing – indicates work below the "2" level on approaching half the assigned problems.

Labs:
A-range – all labs completed promptly and an average score over 80% assigned.
B-range – all labs completed and an average score over 70% assigned.
Passing – at least two labs completed and an average score over 50% assigned.
Failing – at least two labs completed and an average score under 50% assigned.
N – at least two labs not completed.

To determine your grade I will average the letter grades on the course components equally weighted equally weighted except the final counts double, subject to the following:

- A-range grade requires full participation, A-range grade on the final, and Passing grade on the labs.
- B-range grade requires full participation, B-range or better grade on the final, and Passing grade on the labs.
- C-range grade requires at basic participation or better, Passing or better grade on the final, and Passing grade on the labs.
- D requires minimal participation or better, Passing or better grade on the final, and Passing grade on the labs.
- F results from Failing grade on the final or Failing grade on the labs.
- N results from not completing at least two labs or from not writing the final.