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Faculty of Science Course Syllabus
Department of Physics and Atmospheric Science
PHYC 3640.03 - Quantum Physics I - Fall 2023

Instructor(s): Kimberley Hall Email: Kimberley.Hall@dal.ca

Lectures: Links to prerecorded lectures are posted on the course website. Each module on average corresponds to a single 50 minute lecture taking into account the time spent for you to pause the video presentation and take notes in your own handwriting, such that an average week of lectures corresponds to 3 modules. To prepare for assignments and tests, the lectures are your primary resource. It is essential that you understand the lecture material. After viewing the lecture and taking notes, ask questions as needed during the help sessions to be sure you understand the lectures.

Workshops/Help Sessions: Mondays/Wednesdays 2:35 pm -3:55 pm Dunn 221C

Course delivery: Asynchronous prerecorded Lectures with synchronous in-person Workshops and Help Sessions. The in-person Workshops/Help Sessions will not be recorded.

Course Prerequisites: MATH 2002.03, MATH 2030.03, PHYC 2515.03, and PHYC 2140.03

Teaching Assistant: Grant Wilbur Email: grant@dal.ca

Course Materials:

Textbook: *Introduction to Quantum Mechanics, 3rd Edition*, D. J. Griffiths and D. Schroeter

Other Reference Text: *Modern Quantum Mechanics*, J. J. Sakurai.

Course Website: *http://fizz.phys.dal.ca/~khall/phyc3640/*

Course Assessment:

ASSIGNMENTS: There will be 5 assignments, posted on the course website, with due dates as shown in the course schedule. For help with your assignments, in-class help sessions will be hosted with dates as shown in the course schedule.

WORKSHOP QUIZES: There will be a quiz given during each workshop. The dates of the workshops are shown in the course schedule.

MIDTERM TEST: There will be a written midterm test to be held during class. The date of the midterm is provided in the course schedule.

FINAL EXAM: There will be a written final exam. The exam will be carried out during the final exam period. It will be scheduled by the registrar.

Marking Scheme: The weight (%) of each assessment component used in calculating your final mark is indicated in the table below. Your mark will automatically be calculated using both Marking Schemes 1 and 2 and the larger of the two will be assigned as your final grade. Letter grades will be determined using the Faculty of Science grade conversions.

Component	Dates and Other Information	Weight (% of final grade) Scheme 1	Weight (% of final grade) Scheme 2
Assignments	Posted to course website – to be handed in by email to both the instructor and TA	35	35
Workshop Quizzes	Held during workshops – See Course Schedule for dates	15	15
Midterm	In-class – See Course Schedule	20	0

DALHOUSIE UNIVERSITY

Final Exam	Date/Time TBD	30	50

Course Policies: If you miss a midterm or exam for good reason, you must provide acceptable documentation. If you are not able to complete an assignment on time due to illness or other good reason, you must communicate the situation to the instructor prior to the due date and provide acceptable documentation. Extensions without late penalties will be provided at the discretion of the instructor. If an extension is not granted, assignments that are late will have 20% deducted per day after the due date, and no credit will be given for assignments that are not handed in prior to the solutions posting date. Working together on assignments is encouraged, however the work that you submit for assignments must be your own calculations and be written in your own words.

Course Description: This course introduces the formal structure of quantum mechanics as well as quantum mechanical calculations. The course includes quantum measurement, particle in a box, the quantum harmonic oscillator, quantum mechanical operators, quantum angular momentum, and the solution of the hydrogen atom. The course covers an introduction to these topics from both wave mechanic and Dirac notation perspectives.

Course Content:

1. Math Methods - I (Review)
(a) Complex numbers and operators
(b) Eigenfunctions and Eigenvalues

2. The Schrödinger Equation (Chapter 1,2)
(a) De Broglie's hypothesis. Wave properties of matter and the genesis of quantum mechanics
(b) The meaning of the wave function
(c) Conservation of probability
(d) The time-dependent Schrödinger equation
(e) The time-independent Schrödinger equation
(f) Stationary states

3. One-dimensional examples (Chapter 2)
(a) The free particle
(b) The potential step
(c) The potential barrier
(d) The infinite square well
(e) The linear harmonic oscillator

4. Math Methods - II (Chapter 3, supplementary material)
(a) Properties of Linear Operators
(b) Vector spaces
(c) Inner products and Basis sets
(d) Introduction to Dirac Notation
(e) Revisiting the Formalism of Quantum Mechanics

5. The Schrödinger Equation in 3 dimensions (Chapter 4)
(a) Solution in Rectangular Coordinates
(b) Angular Momentum
(c) Solution in Spherical Coordinates
(d) The Hydrogen Atom

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Course Objectives/Learning Outcomes:

Use complex numbers and operators in calculations.
Identify the difference between Linear and Nonlinear Operators.
Understand and use Eigenfunctions and Eigenvalues associated with Linear Operators.
Identify the Classical and Quantum Mechanical Regimes.
Understand, interpret, calculate and apply the wave function as it applies to a statistical ensemble of identical particles.
Be able to use the state of a system to predict the average result of a series of measurements.
Solve the time-independent Schrodinger equation for a given potential function.
Understand the concept of stationary states.
Understand and apply the time-dependent Schrodinger equation.
Understand the properties of linear operators.
Be able to solve problems in different vector space representations, understanding how to switch between representations.
Understand and apply Dirac notation.
Solve the Schrodinger equation in 3 dimensions using spherical or Cartesian coordinates.
Be able to solve problems involving angular momentum.
Understand and apply the solution to the hydrogen atom.

DALHOUSIE COMMON GRADE SCALE

A+ (90-100)	**B+** (77-79)	**C+** (65-69)	**D** (50-54)
A (85-89)	**B** (73-76)	**C** (60-64)	**F** (<50)
A- (80-84)	**B-** (70-72)	**C-** (55-59)	

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure

academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the

rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:
https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.