

CHM 326: Introductory Quantum Mechanics and Spectroscopy

Fall 2023 Course Syllabus

I Instructor

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II COURSE OVERVIEW

Welcome to **CHM326H *Introductory Quantum Mechanics and Spectroscopy***

Quantum mechanics is a remarkable subject. Einstein (who won the Nobel Prize for his contributions to the foundations of quantum mechanics) wrote, "The more success the quantum theory has, the sillier it seems." At the same time, judging by the accuracy and precision of its description and its wide ranging applicability, quantum mechanics is the most successful theory ever developed.

This course provides an introduction to this subject. The course will start from postulates and develop the fundamental framework of quantum mechanics. Perturbation theory is introduced. A number of exactly soluble problems are treated in detail, and various applications to atoms, molecules, materials, spectroscopy and dynamics are covered in detail. Throughout the course, we will highlight links between theory and experiment. Yes, this stuff really works!

EXCLUSIONS AND PREREQUISITE COURSE(S):

Exclusions: JCP321H5

Pre-requisites: CHM225Y/(CHM220H/222H, 221H/223H), MAT235Y/237Y

TEXTBOOK:

Required:

- I. Levine, QUANTUM CHEMISTRY, 7th ed. Prentice Hall, 2009 (including Solution Manual) ISBN 0132090856; **OR**
- II. McQuarrie's Quantum Chemistry (Rev. 2nd Ed., 2007), from University Science Book ISBN 978-1-891389-50-4

OUTLINE:

1. Operators
2. Postulates of Quantum Mechanics and Their Basis in Experiment
3. Particle-in-a-box and Applications to Molecules and Quantum Dots
4. Harmonic Oscillator and Vibrational Spectroscopy
5. Angular Momentum, Rigid Rotor and Rotational Spectroscopy
6. Hydrogen Atom
7. Variational Method
8. Perturbation Theory

LEARNING OUTCOMES:

- Describe the postulates of quantum mechanics
- Write time the dependent Schrodinger's equation, separate variables for time-independent potentials and derive the time-independent Schrodinger's equation
- Solve the time-independent Schrodinger's equation for particle-in-a-box, outline the derivation and solutions (exact, approx.) for various other potentials, and relate the solutions to experiment
- Explain and apply superposition of solutions
- Be able to solve the problems solved in class, tutorials and homeworks

III HOW THE COURSE IS ORGANIZED

CLASSES:

Classes will be held on Mondays and Fridays 2:10 - 3 EST. It is essential that you attend the classes in order to solidify your understanding of the fundamental course material.

TUTORIALS:

The purpose of tutorials is to apply and deepen your understanding of material taught in lecture by solving problems with the tutor. It is expected that students will attend all the tutorials and will be able to solve such problems for tests and the exam. Questions are encouraged!

IMPORTANT FALL 2023 SESSIONAL DATES:

First Day of F & Y classes: 7th September

Thanksgiving (no classes): 9th October

Fall Reading Week (no classes): 6th – 10th November

Last Day of classes: 6th December

IV EVALUATION/GRADING SCHEME

Assignments (approx. 4 total, approx. 1 every 2-3 weeks): 20% total

A final exam held during the December examination period: 30%

2 tests @ 25% each will be held on the dates given below: 50% total

- **OCTOBER 4th**
- **NOVEMBER 17th**

NOTES ON ASSESSMENT

- Assignments must be:
 - hand written,
 - stapled,
 - identified with your student number and name (with last name underlined) clearly written on the first page
 - submitted on due dates (provided on the assignment) at the beginning of class
- Test questions can be drawn from any material taught before the test date.

V COURSE POLICIES

- Course website: q.utoronto.ca

Important: please check the Quercus course website regularly (weekly!) for:

- ✓ general course information
 - ✓ lecture notes
 - ✓ assignments
 - ✓ important announcements
- Email will generally be responded to if: (1) You send it from your utoronto.ca account; (2) You identify yourself in the e-mail subject using “chm326 student: LastName_FirstName, student number”. Please note that chemistry can be discussed through a live discussion arranged by appointment much more effectively than by email, and that email is not a substitute for attending classes.
 - Each member of this course is expected to maintain a:
 - (i) professional and respectful attitude during all course activities, including classes, laboratories, tutorials, and online activity.
 - (ii) personal calendar/schedule/organizer to ensure that all course activities are completed, and due dates are met.
 - (iii) collection of notes recorded independently based on concepts covered in course activities (students registered with Accessibility Services requiring a class note-taker will have access to this accommodation)
 - (iv) familiarity with the university policy on Academic Integrity (overleaf)
 - The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another’s differences. As a Course Instructor, I will neither condone nor tolerate behaviour that undermines the dignity or self-esteem of any individual in this course and wish to be alerted to any attempt to create an intimidating or hostile environment. It is our collective responsibility to create a space that is inclusive and welcomes discussion. Discrimination, harassment and hate speech will not be tolerated. If you have any questions, comments, or concerns, we encourage you to reach out to the staff in our Equity Offices.
 - If you are absent from your studies due to illness or other reasons and unable to complete course work (e.g., a term test or an assignment) then a piece of written documentation is required. The following four items are the recognized forms of documentation:
 1. Absence Declaration via ACORN (please note the circumstances under which an absence declaration can and cannot be submitted)
 2. U of T Verification of Illness or Injury Form
 3. College Registrar’s letter
 4. Letter of Academic Accommodation from Accessibility Services

Students who complete the ACORN Absence Declaration form must additionally contact the instructor to discuss their situation within five business days of the missed piece of work. This is essential action for any consideration to be granted.

For extended absences and for absences due to non-medical reasons, make sure to contact your College Registrar's Office. They can help you decide between a request for an extension or other types of academic consideration.

If you suspect or know that you have a disability that is affecting your studies, learn about the services and supports available through Accessibility Services. A disability can be physical disability, sensory disability, a learning disability, mental health disorder or a short-term disability like an injury. If you are not sure whether you have a disability, you can confidentially contact Accessibility Services with your questions.

- Collaboration and use of technologies (except a calculator) for assessments is prohibited. Use the homeworks as a learning tool. If you are unable to solve a problem,
 - 1) Do you have questions about materials taught in class?
 - 2) Do you have questions about problems solved in class and tutorial?If yes, ask the instructor! Working through this process is important to do well on the tests and exam.
- Privacy and appropriate use of course materials: See "Copyright" section.
- Policy for **late assignments**: Grades for late assignments will be reduced by 10% per day up to 5 days. After that, solutions will be posted, and a grade of 0% will be assigned.
- Policy for reweighting due to missed pieces of academic work: Note the above requirement for documentation
 - **Missed tests**: If 1 test is missed, your grade out of 75% for the remaining assessments will be scaled to 100%. If both tests are missed, an oral make-up test will be provided.
 - **Missed homework**: your course grade will be reweighted. For example, if you miss an assignment worth 5%, your grade out of 95% will be scaled to 100%.

VI INSTITUTIONAL POLICIES AND SUPPORT

ACADEMIC INTEGRITY

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.

4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see www.academicintegrity.utoronto.ca/).

COPYRIGHT

If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely prohibited.

ACCESSIBILITY NEEDS

Students with diverse learning styles and needs are welcome in CHM 326. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact [Accessibility Services](#) as soon as possible.

ACCOMMODATIONS FOR RELIGIOUS OBSERVANCES

Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

ADDITIONAL SERVICES and SUPPORT

The following are some important links to help you with academic and/or technical service and support:

- General student services and resources at [Student Life](#)
- Full library service through [University of Toronto Libraries](#)
- Resources on conducting online research through [University Libraries Research](#)
- Resources on academic support from the [Academic Success Centre](#)
- Learner support at the [Writing Centre](#)
- Information for [Technical Support/Quercus Support](#)

ACKNOWLEDGEMENT OF TRADITIONAL LANDS

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.