

Chem 324: Introductory Quantum Mechanics

Instructor:

Xueyu Song

Meeting Time and Location: MWF 8:50-9:40am, AGRON 2050

Office Hours: MW 3:00-4:00pm via webex at <https://iastate.webex.com/join/xsong>

or by appointment

office: 303C Wilhelm; xsong@iastate.edu

Grader: Ian Morgan, imorgan@iastate.edu, 326 Wilhelm Hall

Office Hour: Tuesday 10-11am at <https://iastate.webex.com/join/imorgan>

or by appointment

Syllabus:

Learning Objective

In Chem 324 you will learn how quantum mechanics describes features of nature that classical mechanics cannot by using mathematical and conceptual tools. In addition, you will learn how quantization of energy is manifested in real-world situations, especially spectroscopy and molecular bonding.

I Elementary Principles of Quantum Theory

- Particles and Waves
- Uncertainty Principle
- Free-particle Wave Equation (a Particle in a Box)
- Postulates of Quantum Mechanics
- Solution of Schrödinger Equations for the Harmonic Oscillator and the Rigid Rotor

II Atoms

- The Hydrogen Atom
 - * Solution of the Schrödinger Equation of the Hydrogen Atom
 - * Orbitals and Angular Momentum
- Many Electron Atoms
 - * Approximation Methods
 - * Pauli Exclusion Principle and electron spin
 - * Periodic Table

III Molecules and Chemical Bonding

- Types of Bonding: Ionic, Covalent etc.
- Valence-bond Treatment
- Molecular Bond Treatment
- The Exploitation of Symmetry

IV Elementary Spectroscopy

- Separation of Electronic and Nuclear Motion
- Rotational and Vibration Spectra of Diatomic Molecules
- Electronic Transitions
- Magnetic Resonance
- Laser Spectroscopy and Photochemistry

Course Mechanics:

- **Problem Sets:** Assignments will be posted on Canvas with due dates. Problems are due at the end of class on the due date - no exceptions, no excuses, unless the Dean of Students notifies me that you have a personal emergency. No credit will be received for homework sets handed in late. Feel free to work with other students on the homework, but you must turn in your own individual set of solutions. No plagiarism is allowed. Answers to problem sets will be posted to Canvas after the class when the assignment is due.
- **Examinations:** There will be **three** hour examinations and a final. The three hour exams will be on , **February 26, March 26 and April 16** . The date/time for the final exam will be determined by the registrar's office and will be announced as soon as the information is available. Make-up exams will be administered only in exceptional cases, which must be discussed with the instructor and which absolutely requires documentation. In some cases, at the instructor's discretion, in lieu of a make-up exam, the final grade may be comprised of the remaining requirements, each taking on a proportionally higher weighting.

For each examination, including the final, you are permitted to use one 8.5×11" sheet of paper bearing information you deem useful on both sides. A calculator is also permitted. No other aids or texts are allowed.

Note: Illegible exams or problem sets will NOT be graded. All work must be presented reasonably neatly and logically.

- **+/- grading will be used.** The grade will be determined as the following: home work(10%), hour exam1 (25%), hour exam3 (25%) and final(40%). There is no curve for the course. Grades will tentatively be assigned as follows: 100-90:A, 89-75:B, 74-50:C, 49-40:D, < 40:F.

Required Book:

- D.A. McQuarrie, *Quantum Chemistry, 2nd*, required textbook.

Student Learning Outcomes. Students completing Chemistry 324 are expected to understand at an intermediate level the topics listed above in the syllabus. In general, students should acquire an appreciation of the fundamental wave-particle duality of matter and its consequences, the structure of the Schrödinger equation, an understanding of its solutions, and how these solutions are used to determine molecular structure. Students are expected to acquire a rudimentary understanding of how light interacts with matter (i.e., spectroscopy).

Canvas, <https://canvasiastate.edu/>. This site provides access to the syllabus, general resources, announcements, answer keys, and other miscellaneous class materials.

Free Expression

Iowa State University supports and upholds the First Amendment protection of freedom of speech and the principle of academic freedom in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.

COVID-19 health and safety requirements: Students are responsible for abiding by the university's COVID-19 health and safety expectations <https://www.dso.iastate.edu/guidance-for-supporting-community-expectations-during-covid-19-pandemic> weblink. All students attending this class in-person are required to:

- properly wear a face covering and/or face shield, covering the nose and mouth, while in classrooms, laboratories, studios, offices, and other learning spaces. It is important to remember that a face covering and/or face shield is required to be worn whenever you are on campus, in the presence of others, and unable to maintain physical distance;
- practice physical distancing to the extent possible;
- assist in maintaining a clean and sanitary environment;
- not attend class if you are sick or experiencing symptoms of COVID-19;
- not attend class if you have been told to self-isolate or quarantine by a health official.
- follow the faculty member's guidance with respect to these requirements. Failure to comply constitutes disruptive classroom conduct. Faculty and teaching assistants have the authority to deny a non-compliant student entry into a classroom, laboratory, studio, conference room, office, or other learning space.

These requirements extend outside of scheduled class time, including coursework in laboratories, studios, and other learning spaces, and to field trips. These requirements may be revised by the university at any time during the semester.

Faculty may refer matters of non-compliance to the Dean of Students Office for disciplinary action, which can include restrictions on access to, or use of, university facilities; removal from university housing; required transition to remote-only instruction; involuntary disenrollment from one or more in-person courses; and such other measures as necessary to promote the health and safety of campus.

It is important for students to recognize their responsibility in promoting the health and safety of the Iowa State University community, through actions both on- and off-campus. The university's faculty asks that you personally demonstrate a commitment to our Cyclones Care campaign. Iowa State University's faculty support the Cyclones Care campaign and ask you personally to demonstrate a commitment to our campaign. Your dedication and contribution to the campaign will also protect your classmates and friends, as well as their friends and families.

Other relevant statements:<https://www.celt.iastate.edu/teaching/preparing-to-teach/how-to-create-an-effective-syllabus/recommended-iowa-state-university-syllabus-statements/>: Academic Dishonesty and Accessibility etc.