

# CHEMISTRY 120A - QUANTUM MECHANICS (3 UNITS)

## COURSE OVERVIEW

### Summary

Chemistry 120 serves as an informal yet rigorous introduction to many concepts prevalent in modern quantum mechanics. The first few weeks focus on formalisms which require a decent mathematical background in multivariable calculus, ordinary differential equations, and linear algebra. Abilities such as diagonalizing matrices and identifying separable equations is important. The next few weeks focus on basic physical systems, approximation methods, and applications. The topics covered in this class vary based on professor; though typically, computational methods for quantum chemistry and quantum statistics are introduced. Note that this class is pretty much unrelated to Chem 120B; you can take the two classes in either order.

### Prerequisites

Math 53 (Required)

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Physics 7A (Required)

Physics 7B (Recommended)

### Topics Covered

1. Formalisms
  - a. Motivations for quantum mechanics
  - b. Vector and inner product spaces
  - c. Hermitian and linear operators
  - d. Postulates of quantum mechanics
  - e. Commutator algebra
  - f. Particle wave duality
  - g. The uncertainty principle
2. Basic Physical Examples
  - a. Particle in a box
  - b. Harmonic oscillator
  - c. Angular momentum and spin
  - d. The hydrogen atom
  - e. The hydronium ion
3. Approximation Methods

- a. The variational principle
  - b. Time-independent perturbation theory
  - c. Time-dependent perturbation theory
  - d. Fermi's Golden Rule
4. Application (Flavors vary based on professor)
- a. Spectroscopy
  - b. Hückel method
  - c. Mean field theory
  - d. Hartree Fock theory
  - e. Slater Determinants
  - f. Fermionic Statistics
  - g. Density Function Theory

### **Course Work**

1. 10-12 problem sets
2. 2-3 midterms and a final

### **Time Commitment**

1. 3 hours of lecture per week
2. 15-20 hours per problem set

## **CHOOSING THE COURSE**

### **When to take**

This class is usually taken by second-semester sophomores, or juniors and seniors. This class is very time-intensive. Most students work in groups or consult GSI's and students who took the class before.

### **What next?**

1. Chem 195: Special Topics (Usually Computational Chemistry)
2. Chem/Physics 221A/B: Advanced Quantum Mechanics
3. Physics 137B: Second Course in Quantum Mechanics
4. Physics 141A/B: Solid State Physics

## **ADDITIONAL COMMENTS/TIPS**

This class requires a strong background in mathematics. Make sure to fully review 54 and perhaps 53 before class. The homework for this class often requires a tremendous amount of time, make sure to start early and go to office hours.

This class does not correlate to Chem 120B. Many students take Chem 120B before Chem 120A.

This class covers more than Physics 137A covers. ChemE majors have a choice between Chem 120A and Physics 137A.

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