

# CEM 991: Quantum Chemistry and Statistical Thermodynamics I (Fall 2022)

## Course Syllabus

### 1. Introduction to Quantum Mechanics

- Electromagnetic waves and photons
- Material particles and matter waves
- Quantum description of a particle; wave packets
- Particle in a time-independent scalar potential

### 2. The Postulates of Quantum Mechanics

- Introduction
- Statement of the postulates
- The physical interpretation of the postulates concerning observables and their measurement
- The physical implications of the Schrödinger equation
- The superposition principle and physical predictions

### 3. Spin

- Spin  $\frac{1}{2}$  particle: quantization of the angular momentum
- Illustration of the postulates in the case of a spin  $\frac{1}{2}$
- General study of two-level systems

### 4. The harmonic oscillator

- Introduction
- Eigenvalues of the Hamiltonian
- Eigenstates of the Hamiltonian
- Discussion

### 5. Angular momentum

- Introduction: the importance of angular momentum
- Commutation relations characteristic of angular momentum

### 6. Central potentials

- Stationary states of a particle in a central potential
- The hydrogen atom

### 7. Perturbation theory (time independent)

- Description of the method
- Perturbation of a non-degenerate level
- Perturbation of a degenerate level

### 8. Perturbation theory (time dependent)

- Statement of the problem
- Approximate solution of the Schrödinger equation
- An important special case: sinusoidal or constant perturbation

**Textbook:** Cohen-Tannoudji, Diu, Laloë, *Quantum Mechanics Vols. One and Two*