Class: Advanced Quantum Mechanics, PHYS 502

Instructor: Professor Jak Chakhalian

Textbooks: Class notes will be derived from multiple sources. The prime texts are

1. S. Rajasekar and R. Velusamy Quantum Mechanics I and II by CRC Press
2. Feynman Lectures on Physics v. III. http://www.feynmanlectures.caltech.edu

Additional texts: Advanced Quantum Mechanics Y. Nazarov and J. Danon , Cambridge UP.

Grading: Homework (30%), mid-term (30%), final (30%), in-class presentation + report (10%). Final grade is determined by averaging over all the components.

Office hours: Tuesday 9:30-10:30 am, room 109 Physics & Astronomy

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Important: Note, we will follow the University increment weather policy.
We will follow the University integrity and ethics policies.

TOPICS TO BE COVERED IN PHYS 502 – 2018

1. APPROXIMATION METHODS IN TIME-INDEPENDENT PERTURBATION THEORY

- nondegenerate case
- applications to nondegenerate levels
- degenerate levels
- first-order stark effect in hydrogen

2. APPROXIMATION METHODS IN TIME-DEPENDENT PERTURBATION THEORY

- transition probability
- constant perturbation
- harmonic perturbation
- adiabatic perturbation
- sudden approximation
- the semi classical theory of radiation

- calculation of Einstein coefficients

3. APPROXIMATION METHODS IN WKB AND ASYMPTOTIC METHODS

- principle of WKB method
- applications of WKB method
- WKB quantization with perturbation
- an asymptotic method

4. APPROXIMATION METHOD - VARIATIONAL APPROACH

- calculation of ground state energy
- trial eigenfunctions for excited states
- application to hydrogen molecule

5. SCATTERING THEORY

- classical scattering cross-section
- scattering amplitude
- Green's function approach
- Born approximation
- partial wave analysis
- scattering from a square-well system
- phase-shift of one-dimensional case
- inelastic scattering

6. IDENTICAL PARTICLES

- permutation symmetry
- symmetric and antisymmetric wave functions
- the exclusion principle
- spin eigenfunctions of two electrons
- exchange interaction
- collisions between identical particles

7. RELATIVISTIC QUANTUM THEORY

- Klein–Gordon equation
- Dirac equation for a free particle
- Negative energy states
- Jittery motion of a free particle
- Spin of a Dirac particle
- Particle in a potential
- Klein paradox
- relativistic particle in a box

8. BERRY'S PHASE, AHARONOV–BOHM AND SAGNAC EFFECTS

- derivation of Berry's phase
- origin and properties of Berry's phase
- classical analogue of Berry's phase
- examples for Berry's phase
- effects of Berry's phase
- applications of Berry's phase
- experimental verification of Berry's phase
- the Aharonov–Bohm effect
- Sagnac effect
- Topology in quantum mechanics

I am still internally debating about Berry phase after I found this wonderful lecture set and the class taught by Prof. David Vanderbilt PHYS 682 http://www.physics.rutgers.edu/grad/682/

As an alternative I am thinking of **DISSIPATIVE QUANTUM MECHANICS, TRANSITIONS AND DISSIPATIONS.**