PHY-304 Quantum Mechanics II

Credit Hours: 3-0

Pre-requisite: Quantum Mechanics I

Course Objectives: It is an undergraduate course which aims to make students understand certain phenomena which cannot be handled by a straightforward application of the four postulates of quantum mechanics. Students are familiarized with various approximation methods to deal with situations where Schrodinger equation cannot be exactly solved.

Core Contents: Addition of Angular Momenta, approximation methods, identical particles, scattering theory

Detailed Course Contents: Perturbation Theory: Examples: Spin ½, General two level system, Nondegenerate perturbation theory, 2nd order nondegenerate perturbation, Degenerate Perturbation Theory, Hyperfine Interaction, Angular Momentum review, Angular momentum ladder operators, Example of addition of angular momenta, The general problem, Addition of angular momentum, Clebsch-Gordan coefficients, Perturbation of hydrogen, Zeeman effect, Two spin half particles, Two identical particles in one dimension, Interacting particles, Helium atom, Time dependent perturbation theory: Transition probability, Harmonic perturbation, Electric dipole interaction, Selection rules, Scattering theory, the asymptotic wavefunction and the differential cross section, the Born approximation, the Yukawa potential, the partial wave expansion or the phase shift analysis

Course Outcomes: At the end of the course, students will be able to:

- understand the angular momenta addition in quantum mechanics
- understand and apply the approximation methods like time independent and dependent perturbation theory and variational method to situations where Schrodinger equation cannot be exactly solved
- understand identical particles and scattering theory

Textbook: D. H. McIntyre, Quantum Mechanics, 2nded. Pearson Addison Wesley 2012. (referred as Mc)

Reference Books:

J. S. Townsend, A Modern Approach to Quantum Mechanics, 2nded. University Science Books 2012. (referred as JT)

J. J. Sakurai, Modern Quantum Mechanics, 2nded. Addison-Wesley 1994.

R. Shankar, Principles of Quantum Mechanics, 2nded. Springer 1994.

R. Liboff, Introductory Quantum Mechanics, 4thed, Addison-Wesley 2002.

N. Zettili, Quantum Mechanics Concepts and Applications, 3rded, Jon Wiley 2009.

Weekly Breakdown		
Week	Section	Topics
1	Mc 10.1-10.2	Perturbation Theory: Examples: Spin ½, General two-level system
2	Mc 10.3-10.4	Nondegenerate perturbation theory, 2nd order nondegenerate perturbation
3	Mc 10.5-10.6	Degenerate Perturbation Theory
4	Mc 11.1-11.3	Hyperfine Interaction, Angular Momentum review, Angular momentum ladder operators
5	Mc 11.4, 11.5	Example of addition of angular momenta, The general problem,
6	Mc 11.6	Addition of angular momentum, Clebsch-Gordan coefficients
7	Mc 12.1, 12.2	Perturbation of hydrogen
8	Mc 12.3	Zeeman effect
		Midterm Exam
9	Mc 13.1, 13.2	Two spin half particles, Two identical particles in one dimension
10	Mc 13.3, 13.4	Interacting particles, Helium atom
11	Mc 14.1, 14.2	Time dependent perturbation theory: Transition probability, Harmonic perturbation
12	Mc 14.3	Electric dipole interaction
13	Mc 14.4	Selection rules
14	JT 14.5	Scattering theory, the asymptotic wavefunction and the differential cross section, the Born approximation, the Yukawa potential, the partial wave expansion or the phase shift analysis

15		Revision