MANGALORE UNIVERSITY

Department of Physics

MSc Physics

PHH 452: QUANTUM MECHANICS II

[52 hrs.]

Course outcome

CO1 Acquire in-depth knowledge about matrix formalism of quantum mechanics.

CO2 Acquire the knowledge of quantum dynamics. Able to applymatrix formalism to solve harmonic oscillator problem.

CO3 The student will be use various approximation methods to solve quantum systems.

CO4 The student would acquire the knowledge of relativistic quantum mechanics and field quantization.

Unit I Matrix formalism of quantum mechanics

Linear vector spaces - orthogonality and linear independence, bases and dimensions, completeness, Hilbert's spaces. Hermitian operators. Bra and Ket notations for vectors. Representation theory. Schwartz's inequality theorem - proof of Heisenberg uncertainty relation.

[13 hrs]

Unit II Quantum dynamics

Equations of motion - Schrodinger and Heisenberg picture - quantum Poisson bracket. Harmonic oscillator problem solved by matrix method.

Angular momentum - angular momentum operator, commutation relations - raising and lowering operators - eigen values and eigen functions of L^2 andL_z - addition of two angular momentum - Clebech-Gordan coefficients - the 3-j symbol - Pauli spin matrices. [13 hrs]

Unit III Approximation methods

Perturbation theory for discrete levels - equations in various orders of perturbation theory - non-degenerate and degenerate cases, simple examples. Time dependent perturbation theory.

The variation method - the hydrogen molecule - exchange interaction. The WKB method. [13 hrs]

Unit IV Relativistic quantum mechanics and elements of second quantisation

Klein-Gordan equation for a free particle - Dirac equation - Dirac matrices. - spin and magnetic moment of the electron.

Transition from particle to field theory. Second quantisation of the Schrodinger, Klein, Dirac and Electromagnetic equations (qualitative). Creation and annihilation operators - commutation and anti-commutation relation and their physical implications. [13 hrs]

Text Books:

1. Thankappan V K, 'Quantum Mechanics' (Wiley Eastern Ltd., 1985)
2. Ghatak A K and Lokanathan S, 'Quantum Mechanics' (Macmillan, India, 1984)
3. Mathews P M and Venkatesan K, 'Text Book of Quantum Mechanics' (Tata McGraw Hill, 1976)
4. Powell J L and Crasemann B, 'Quantum Mechanics' (Addison Wesley, 1961)

Reference Books:

1. Schiff L I, 'Quantum Mechanics', III Edn. (McGraw Hill, 1969)
2. Merzbecher E, 'Quantum Mechanics', III Edn. (John Wiley & Sons, 1998)
3. Shankar R, 'Principles of Quantum Mechanics' (Plenum, 1980)
4. Sakurai J J, 'Modern Quantum Mechanics' Revised Edn. (Addison-Wesley, 1994)
5. Edmonds, 'Angular Momentum in Quantum Mechanics' (Princeton University Press, 1960)