## PPH312: ADVANCED QUANTUM MECHANICS

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**Course Objectives:** To impart knowledge of advanced quantum mechanics for solving relevant physical problems.

**Relativistic Quantum Mechanics:** Klein-Gordon equation, Dirac equation and its plane wave solutions, solution of Klein Gordan equation for a particle with Coulomb potential, significance of negative energy solutions, spin angular momentum of the Dirac particle. The non-relativistic limit of Dirac equation, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lamb shift.

**Field Quantization:** Classical field theory, Lagrangian and Hamiltonian formalism of a particle in an electromagnetic field, Second quantization, Concepts and illustrations with Schrödinger field.

**Relativistic Quantum Field Theory:** Quantization of a real scalar field and its application to one meson exchange potential. Quantization of a complex scalar field, Dirac field and e.m. field, Commutation relations.

**Interaction:** Yukawa interaction, Coupling of electron and electromagnetic field, Global and guage invariance Feynman diagrams, Feynman rules, Feynman graphs for Compton and e-e scattering, Path integration method: Wick's Theorem. Scattering matrix.

**Course Learning Outcomes (CLO):**
Students will have understanding of:

1. Importance of relativistic quantum mechanics compared to non-relativistic quantum mechanics.
2. Various tools to understand field quantization and related concepts.
3. Exposure to quantum field theory and universal interactions.

***Recommended Books:***


1. *Mathews, P.M. and Venkatesan K.A., Textbook of Quantum Mechanics, Tata McGraw Hill (2004).*
2. *Thankappan, V.K., Quantum Mechanics, New Age International (2004).*
3. *Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).*
4. *Bethe, H.A. and Jackiew, R., Intermediate Quantum Mechanics, Perseus Book Group (1997).*