First Course Handout
PHY 681 - Quantum Field Theory

2019-20 - I Semester;

Course Instructor: Nilay Kundu

(email - nilayhep(at)iitk.ac.in)

- **Aim:** This will be an introductory course on Quantum Field Theory (QFT) aimed at Master's level and beginning PhD students.
- **Pre-requisite:** Students should have prior exposure to Lagrangian mechanics of point particles, special theory of relativity, quantum mechanics at the level of the course *"Quantum Mechanics II (PHY432)"*.
- **Plan of the course:** The following topics will be covered in the course:
  1. *Elements of classical field theories:* Lagrangian formulation; Lorentz invariance; symmetries, Noether's theorem and conserved currents.
  2. *The method of second quantization:* Discussing the basic framework for the formulation of many-body quantum systems.
  3. *Quantum field theory with scalar fields:* (a) Free scalar fields: Klein-Gordon equation, canonical quantization, propagators. (b) Interacting scalar fields: Wick's theorem, Feynman rules.
  4. *Quantum field theory with fermionic fields:* Spinors in Lorentz group, Dirac equation, canonical quantization.
  5. *Quantum field theory with gauge fields:* Gauge symmetries, quantum electrodynamics (QED), canonical quantization, working with Feynman diagrams, studying QED processes.
  6. *Advanced topics (if time permits):* Introduction to path integral quantization, divergences in Feynman diagrams and few other possible topics.
- **References:** A few recommended text books which will cover the course material:
  1. M. Peskin and D. Schroeder, *An Introduction to Quantum Field Theory*
  2. L. Ryder, *Quantum Field Theory*
  3. A. Zee, *Quantum Field Theory in a Nutshell*
  4. M. Srednicki, *Quantum Field Theory*
- **Grading/Evaluation Policy:** Grading will be based on (a) Assignments + class tests/Quiz, (b) Mid-semester and final end-semester examinations.