PATH INTEGRAL METHODS IN PHYSICS & FINANCE

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IIT Roorkee

TYPE OF COURSE : New | Elective | UG/PG
COURSE DURATION : 12 weeks (20 Jul' 20 - 9 Oct' 20)
EXAM DATE : 17 Oct 2020

PRE-REQUISITES : (i)Basics of classical & qquantum mechanics;(ii)Bscics of financial derivatives;(iii)senoir school mathematics(algerbra,calculus & probability).

INTENDED AUDIENCE : The audience would comprise of those desirous of getting acquainted with the intricacies of the path integral formalism and its applications in contemporary physics, (quantum field theory, in particular) and finance (pricing of path dependent and exotic options and other derivatives) and also, appreciating the nuances that have led to the origin and extensive development of this field of knowledge.

INDUSTRIES APPLICABLE TO : Path integrals form the basis of QFT computations and as such, proficiency in this area will attract immense demand in research and industrial establishments engaged in activities involving applications of field theoretic methods. This course will also attract immense recognition in the entire financial services industry including banks, stock & commodity exchanges, stock & commodity brokers, portfolio managers, investment bankers, market regulators etc as the newer derivative products

COURSE OUTLINE : With the gradual acceptance of path integral based string theory as a strong candidate for unification, knowledge of the nuances of the path integral formalism of QFT is indispensable for academic progression in this area. The applications of this versatile concept are also growing by the day, one of the cardinal ones being in pricing of complex financial assets. Scientific risk management by the investor fraternity has become of cardinal necessity for generating competitive returns and surviving in the marketplace.

ABOUT INSTRUCTOR : Prof. Jatinder Pal Singh, is a Professor at the Indian Institute of Technology Roorkee. He is also a postgraduate in Physics, Mathematics and a graduate in Law Operational Research.

COURSE PLAN :

Week 1: Basic Theory of Path Integral, Feynman Propagators, Correlations & Green Functions.

Week 2: The NR Free Particle Path Integral, Equivalence of the Feynman & Schrodinger Formulations.

Week 3: The Harmonic Oscillator Path Integral, Quadratic Hamiltonians in Non-Cartesian Metrics.

Week 4: Perturbation Theory, Generating Functionals & Functional Derivatives.

Week 5: 0-Dimensional Field Theory, Correlation Functions, Generating Functionals, Propagators.

Week 6: Field Interactions, Feynman Rules, Schwinger-Dyson Equation, Perturbative Expansions.

Week 7: Divergences & Renormalization

Week 8: Free & Interacting Scalar Fields, Wick's Theorem, Generating Functionals, Perturbative Expansions.

Week 9: Gauge Fields.

Week 10: Fluctuation Properties Of Financial Assets, Harmonic Approximation, Levy Distributions, Stock Price Distribution, Black Scholes Model, Superposition Of Gaussian Distributions, Fokker-Planck-Type Equation, Ito Lemma.

Week 11: Time Evolution Of Distributions, Central Limit Theorem, Additivity Property Of Noises, Black-Scholes Option Pricing Model, Evolution Equations Of Portfolios With Options

Week 12: Option Pricing For Gaussian Fluctuations, Option Pricing For Boltzmann Distribution, Option Pricing For General Non-Gaussian Fluctuations, Option Pricing For Fluctuating Variance, Perturbation Expansion And Smile.