LNMIIT, Jaipur Department of Mathematics	LNMIIT The LNM Institute of Information Technology

Programme: Ph.D. (Mathematics)	Course Title: **Introduction to Option Pricing – Mathematical Modeling & Computation**			Course Code: MTH-6XXX
Type of Course: Program Core	**Prerequisites:** A basic knowledge of probability theory, stochastic processes and differential equations is helpful.			**Total Contact Hours:** 45L+30P
Year/Semester:	**Lecture (L) Hrs/Week:** 3	**Tutorial (T) Hrs/Week:**	**Practical(P) Hrs/Week:** 2	**Credits:** 4

Learning Objective:

This is an introductory course on basic theoretical and computational aspects of the financial option pricing model. their applications. We will start with defining derivatives and options, continue with discrete-time, binomial tree models, and then develop continuous-time, Brownian Motion models. A basic introduction to Stochastic, Ito Calculus will be given. The benchmark model will be the Black-Scholes-Merton pricing model, but we will also discuss more general models,. We will discuss both the Partial Differential Equations approach, and the probabilistic approach. This course serve as an introductory course for the theory and computation of option pricing problems and student can lead to pursue research in this area with the gain knowledge in this course.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		**Bloom's Level**
CO-1	Understanding with the basics of the option pricing problems	
CO-2	Solve the resulting problem classes efficiently by computational methods based on a sound mathematical analysis	
CO-3	Pursue further research in the allied areas	

Course Topics	Lecture Hours	
UNIT – I **Topics: Introduction to Options, Arbitrage, Markets & Random Variables**		**16**
1.1) A concise introduction to arbitrage and option pricing, Typical option pricing- Vanilla options like European options, American options and Exotic options like digital options, barrier options, Asian options, etc. Financial derivatives, Basic practical information about option trading,	6	
1.2) Basics about Stochastic processes – Stochastic variables, Stochastic processes, Martingales, Stochastic integration, Ito integral	10	
UNIT – II **Topics: Black Scholes Option Pricing Model & Merton's Jump diffusion model**		15
2.1) Geometric Brownian motion assest price process, Ito process, Ito's lemaa, Distribution of S(t) and log S(t), Proportional dividend model, Volatility variation, Time dependent volatility, Martingales and asset prices,	**5**	
2.2) Stochastic differential equation model, Derivation of partial differential equation model, The Feynman-Kac Theorem, The Black-Scholes model, The closed form option prices, Volatility variations, Delta hedging under the Black-Scholes model	5	
2.3) Jump diffusion processes, Ito's lemma and jumps, partial-integro differential equation (PIDE) derivation for jump-diffusion process, Special cases for the jump distribution (Classical Merton's model, Kou's model), Feynman-Kac theorem for for jump diffusion process, Analytic option prices, Characteristic function for Merton's model, Dynamic hedging of jumps with Black-Scholes model	5	
UNIT – III **Topics: Various methods for valuation of options**		**14**
3.1) Binomial tree methods – Motivation, Description of the method for Vanilla and Exotic	3	

options, Deriving the parameters, Computational implementation of the method		
3.2) Monte Carlo Methods – Generating random variables, Monte Carlo basics, Monte Carlo for option valuations, Monte Carlo for Greeks, Computational implementation of the method	4	
3.3) Finite Difference Methods – The Black-Scholes heat equation, Reduction of the Black-Scholes PDE to the heat equation, Explicit and implict schemes, Crank-Nicolson scheme, Exponentially fitted schemes	7	

Textbook References:
Text Book:

1. An Introduction to Financial Option Valuation by Desmond J. Higham - Cambridge University Press (2004).
2. Option Pricing: Mathematical Models and Computation by Paul Wilmott, Jeff Dewynne, and Sam Howison - Oxford Financial Press (1993).

Reference Book:

3. Futures, and other Derivatives by John C. Hull - Pearson, Eleventh Edition (2021).
4. Stochastic Calculus for Finance by Marek Capinski, Ekkehard Kopp, and Janusz Traple - Cambridge University Press (2012).
5. An Algorithmic Introduction to Numerical Simulation of Stochastic Differential Equations by Desmond J. Higham - SIAM Review, Vol.43, No.3, pp.525–546 (2001).

6. Mathematical Modeling and Computation in Finance by CW Oosterlee and LA Grzelak – World Scientific (2020)

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

https://www.ma.imperial.ac.uk/~ajacquie/IC_Num_Methods/IC_Num_Methods_Docs/NMImperial.pdf

Evaluation Method	
Items	**Weightage (%)**
Presentation	40
Midterm	20

End-Term	40

CO and PO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3
CO1							
CO2							
CO3							
CO4							

S- Strong; M-Medium; L-Low

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Approved By: