Indian Institute of Technology Kanpur

New Course Proposal

1. **Course Number**: DMSxxx
2. **Course Title**: Introduction to Mathematical Finance
3. **Credits**: 3-0-0-0 [9]

   Duration of Course: Full Semester
4. **Proposing Department**: Department of Management Sciences

   Other Department/IDPs which may be interested in the proposed course:

   Other faculty members interested in teaching the proposed course:
5. **Proposing Instructor(s)**: Sourav Majumdar
6. **Course Description**: This introductory course on Mathematical finance focuses on the principle of pricing contingent claims under absence of arbitrage. The course will build a working knowledge of topics in Stochastic calculus with respect to Brownian motion and convex analysis, and use them to rigorously build the theory of no-arbitrage pricing. Special emphasis will be on the characterization of no-arbitrage, in terms of its existence and relation to pricing. The course will apply the theory to hedging and pricing financial derivatives. The course will also discuss topics relevant in contemporary research and practice, including pricing-hedging duality and pricing in incomplete markets.

   A) **Contents**:

S. No.	**Broad Title**	**Topics**	**No. of Lectures**
1.	Probability preliminaries	Probability as a measure: Sigma algebra, Random variable, Independence, Expectation, Conditional expectation, Martingales	5
2.	Stochastic Integration	Brownian Motion, Itô’s integral, Itô’s formula, Itô’s isometry, Stochastic differential equations	5
3.	No-Arbitrage pricing in Complete Markets	No-arbitrage and related notions, Equivalent Martingale measure, Fundamental theorems of asset pricing, Girsanov’s theorem, Delta-Hedging approach to Black-Scholes-Merton formula (BSM), Martingale approach to BSM	6
4.	Pricing and Hedging duality	Convex sets, Convex programming, Lagrange multiplier, Fenchel conjugate, Convex Duality. Applications to: Super-hedging and Sub-hedging bounds, Delta hedging and duality, Determining the hedging process, Hedging with contingent claims	6
5.	Pricing in Incomplete Markets	Examples of incomplete markets, Minimal entropy martingale measure approach, Good deal bounds	4

C) **Pre-requisites, if any**: Probability (DMS602/HSO201/MSO201 or equivalent), Familiarity with linear programming is recommended but not necessary (DMS605 or equivalent)

7. **References**:

1. Shreve, S. E. (2004). *Stochastic calculus for finance II: Continuous-time models*. Springer.
2. Kallianpur, G. and Karandikar, R. L. (2000). *Introduction to Option Pricing Theory*. Birkhauser.
3. Dineen, S. (2013). *Probability theory in finance: a mathematical guide to the Black-Scholes formula*. American Mathematical Society.
4. Carr, P. and Zhu Q. J. (2018). *Convex Duality and Financial Mathematics*. Springer.
5. Björk, T. (2020). *Arbitrage Theory in Continuous Time*. Oxford University Press.
6. Bingham, N.H. and Kiesel, R. (2004). *Risk-Neutral Valuation: Pricing and Hedging of Financial Derivatives*. Springer.
7. Danna, R. and Jeanblanc, M. (2007). *Financial Markets in Continuous Time*. Springer.

Dated: 20 January 2025 **Proposer**: Sourav Majumdar

Dated:________________ **DUGC/DPGC Convener**:____________________

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:______________________________