

# Quant Finance Research Cohort Season 2 Curriculum:

## Computational Finance and Financial Mathematics

### Module 1: Introduction to Financial Markets and Products:

- Structure and functions of financial markets
- Derivative Instruments: forwards, futures, options, swaps
- Fixed Income Securities and Interest rate dynamics
- Hedging Strategies using derivatives
- Exotic Derivatives and structured products
- Credit derivatives and their application

### Module 2: Foundations of Risk Management:

- Risk management concepts and applications
- Risk Types: market risk, credit risk, operational risk & liquidity risk
- Corporate Governance and risk oversight
- Historical development of risk management
- The role of risk management in financial Institutions
- Risk Adjusted Performance Measurement (RAPM)

### Module 3: Quantitative Analysis:

- Probability and Statistical Methods
- Linear Algebra
- Regression and Time Series Analysis
- Monte Carlo Simulation
- Hypothesis Testing and confidence interval
- Linear and Non-Linear optimization techniques
- **Application of Machine Learning in risk modelling and quant trading** - Regression, Classification, Clustering, Time Series Analysis, Deep learning, Reinforcement learning, PCA, Kalman filter and use of all of these in Quantitative Finance.

## Module 4: Valuation and Quant Models:

- Valuation techniques for bonds and stocks
- Value at Risk (VaR) Methodologies
- Stress Testing and Scenario analysis
- **Pricing models for options and derivatives-** Options Basics, Arbitrage and Hedging, Option Payoff Structures, Time Value and Intrinsic Value, Put-Call Parity, Introduction to Greeks, Black-Scholes Model Assumptions, Derivation of Black-Scholes PDE, Risk-Neutral Valuation, Numerical Solutions to Black-Scholes (Finite Difference, Binomial Trees, Monte Carlo Simulations), Delta, Gamma, Vega, Theta, and Rho (First Order Greeks), Second-Order Greeks (Vanna, Charm, Vomma), Volatility Smile and Skewness, Kurtosis in Options, Implied Volatility and Volatility Surface.
- Risk Neutral Valuation Techniques

## Module 5: Financial Mathematics:

- **Introduction to Stochastic Calculus** - Random Walk, Weiner Process, Markov Chain, Martingale, Stochastic Differential Equation, Ito's formula, Probability Measures, Change of measures, Radon-Nikodym Derivatives, Girsanov theorem, Ito's Integral, Fractional Brownian Motion, Gyongy's theorem, multi-variable stochastic calculus, Feynman-Kac theorem and its applications.
- **Quantitative Trading-** Market microstructure, Trading instruments, Backtesting frameworks (Statistical arbitrage, Pairs trading using cointegration, Kalman Filter for dynamic hedge ratios, Z-score based spread trading, Dispersion trading with volatility arbitrage, Realized vs implied vol, Vega-neutral trade construction, Feature engineering for signals, Clustering for asset selection, Machine learning for trade signals, Slippage and Transaction Cost, Option strategies.
- **Volatility Modelling-** Introduction to Volatility Models, Implied Volatility Basics, Volatility Smile and Skew, Local Volatility Models, Deriving Dupire's Formula, Numerical Implementation of Dupire's Formula, Relationship between Local Volatility and Implied Volatility, Understanding Volatility Surfaces, Calibration of Local Volatility Models,

Stochastic Volatility Models, Heston Model Introduction and Derivation, Heston Model Parameter Estimation (Maximum Likelihood, Method of Moments), Solving Heston Model (PDE and Monte Carlo Methods), Volatility of Volatility, SABR Model Basics, Calibration of SABR Model, Local Stochastic Volatility Models, Calibration of Local Stochastic Volatility Models, Bergomi-Guyon Model, Applications of Volatility Models in Option Pricing.

- **Interest Rate Modelling-** Introduction to Bonds and Fixed Income Securities, Bond Pricing Basics, Zero-Coupon Bonds (ZCB) and Yield Calculation, Coupon Bonds and Pricing Formulas, Yield to Maturity (YTM) and Yield Curves, Spot Rates and Forward Rates, Bootstrapping Yield Curves, Constructing Discount Curves, Par Yield and Par Yield Curve, Duration and Convexity, Modified Duration and Interest Rate Sensitivity, Introduction to Interest Rate Models, Short Rate Models (Vasicek, CIR, Hull-White), Calibration of Short Rate Models, Pricing Bonds using Short Rate Models, Two factor Interest Rate Models, Heath-Jarrow-Morton (HJM) Framework.

**Please Note: Each of the modules will conclude with assignments and tasks. There will be weekly doubt-solving classes.**

### **Capstone Projects (Season 2):**

Students can choose either of the following topics:

- **Project 1: Cross-Asset Volatility Arbitrage & Delta-Hedging Engine**
- **Project 2: Neural Stochastic Differential Equations for Risk Management**

Further details and threshold parameters will be provided during the sessions along with personalized mentorship.

## Student Success & Professional Development

### 1-on-1 Mentorship

- **Industry Practitioners:** Every student is paired with a Quantitative Researcher or Risk Manager.
- **Code & Model Reviews:** Bi-weekly deep dives into your Python/C++ implementations.
- **Guided Research:** Personalized assistance in selecting and refining your Capstone Project to ensure it meets institutional standards.

### Career Assistance

- **Quant Resume Workshop:** Tailoring your CV to highlight technical proficiencies in Stochastic Calculus, Machine Learning, and Financial Engineering.
- **Mock Technical Interviews:** Intense practice sessions covering Brainteasers, Probability theory, and "Whiteboard Coding" common in Quant interviews.
- **Hiring Network Access:** Referrals to our partner firms in Fintech, Asset Management, and Prop Trading.
- **GitHub Portfolio Building:** We help you document your Capstone Projects into a professional-grade repository to showcase your "Proof of Work" to recruiters.

**Our research cohort season 1 already saw several students recruited at top quant and investment firms such as Squarepoint Capital, JP Morgan Chase, Barclays, iRage Capital, etc. Join them in the quant revolution!**