

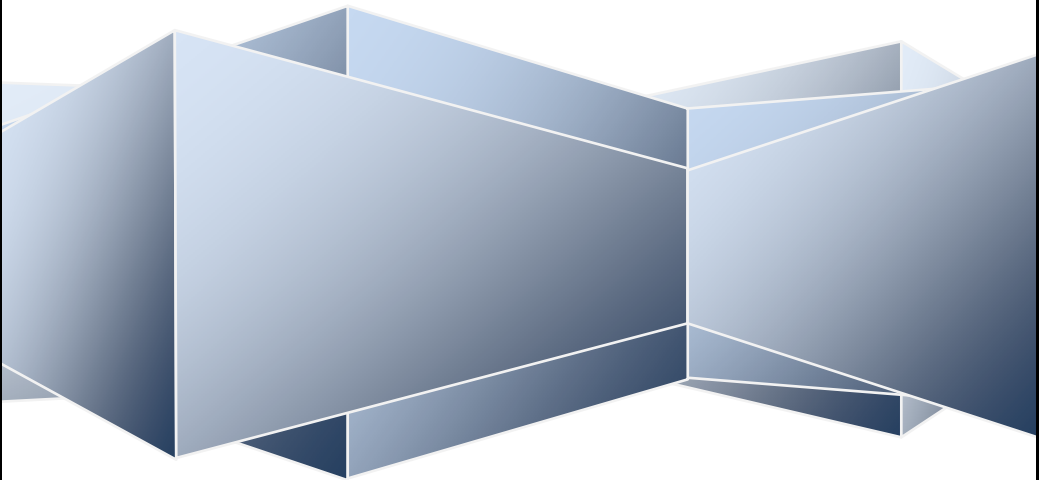


Department of Mathematical Sciences

# Program Guide

## MSMCF

**Master of Science in Mathematical and  
Computational Finance**



# Program Guide

## Master of Science in Mathematical and Computational Finance

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### 1. Mathematical Finance Matters

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Finance powers the international economy which directly determines the livelihoods of billions of people. That bold recognition alone tells us that the financial system, from the smallest service providers to the massive international institutions, deserves continuous, careful and critical attention.

Barely a few years ago the system nearly collapsed.

Careful and critical attention was missing. World views, colored by two decades of economic progress unprecedented in the modern political era, became unfailingly uncritical. Many risks were endemic, but long trending and very good times had hidden them from casual view. Unseen they were carelessly ignored. The result was the 2007 credit crisis with its enormously damaging global consequences.

Mitigating the harsh outcomes, eliminating them through reignited economic expansion, and pushing the world to ever better standards of living, urgently became the primary goal of governments of all affected countries.

International finance is essential to the achievement of the goal. The world's largest central banks deployed novel tools to stabilize the system and lay a foundation of trust in its future integrity and resilience. Building on that restored confidence is a critical component: carefully managed and monitored use of the sophisticated instruments of modern finance for pricing, hedging, and risk assessment.

A modern economy cannot function without these financial instruments. And it cannot function with these instruments unless they are understood and their use closely monitored. It is now widely recognized that the essential element of success is detailed knowledge of the mathematical structure of these instruments, individually and in composition.

### 2. Careers

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Graduates are well qualified for professional activity in many areas of finance.

- Quantitative analyst
- Risk assessment and management
- Asset management
- Trading
- Derivative and structured product development

The range of quantitative skills and practical modeling experience including applied mathematics, statistics, and programming are widely applicable in industry beyond finance (see Section 8 Graduate Profiles).

Graduates have also entered doctoral programs in Mathematical Finance, Applied Mathematics, and Computer Science.

#### 2.1 Career Development Services

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The NJIT Career Development Services website:

<http://www.njit.edu/cds/>

#### 2.2 National Financial Mathematics Career Fair

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MSMCF is a participating program in the annual National Financial Mathematics Career Fair hosted by the IαQF and NYU Courant Institute: <http://www.finmathjobfair.org/>

### 3. Time Requirements

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The MSMCF is a full time course of study extending over three semesters (15 months) or part time over an extended period.

- Formal courses: one 3-hour class each week for each course for a 14 week semester + homework + private study
- Standard full time semester load “4 – 4 – 3”
  - First fall semester: 4 courses
  - Spring semester: 4 courses
  - 2<sup>nd</sup> fall semester: 3 courses, one of which is a project ‘course’
- Part time load: 2 courses per semester; 5 semesters (project in 2nd summer)
- MSMCF Forum: weekly 2 hours; optional summer program
- Computer programming skill development in parallel to formal courses

### 4. Curriculum

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The program content comprises three domains of quantitative finance necessary for asset management, risk management, product development, and associated activities.

➤ Fundamental quantitative methods in finance

Numerical methods  
Partial Differential Equations  
Simulation  
Stochastic Calculus  
Regression Analysis  
Time Series Analysis

➤ Fundamentals of derivatives markets

Financial instruments  
Market mechanics

➤ No-Arbitrage Pricing of Derivatives

Mathematical Finance  
Term Structure Models  
Credit Risk Models

Things change. Market prices of assets change, and they change with uncertain components. Modeling the dynamics of asset prices requires the tools of applied mathematics, including partial differential equations and stochastic calculus.

Things are related to other things, now and in the past and will be in the future. Modeling the relationships of asset prices requires tools including regression and time series analysis.

Many of the relationships and dynamics are nonlinear, introducing a need for numerical methods including integration, optimization, root finding, and simulation.

### 4.1 Project

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The final semester project is designed to give students the opportunity to demonstrate attained mastery of the material studied in the core courses on the program, and to extend students' knowledge of specific areas beyond what is covered in courses.

Students may choose to work on projects, computer programming and communication skills over the summer recess. Regular faculty guidance is provided.

Previous projects have included

- Cointegration study of equities
- Implementation of multifactor short rate models
- Analysis and implementation of stochastic volatility models
- Monte Carlo analysis of jump diffusions
- Empirical study of credit risk models
- Application of copulas in pricing and risk

The project deliverable comprises two parts

- A written report
- An oral presentation to faculty and students

### 5. MSMCF Forum

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A weekly gathering for informal discussion and debate engaging students in the realities of living and working in the world focused on economics and finance. These realities include broad awareness of contemporary events, ethical implications of decisions, proper implementation and use of models, the research process and the critical skills of communication. Forum meetings are designed to promote understanding and build experience in all these areas.

- Discussions
  - World economic and financial developments
  - Business ethics
  - Latest journal papers
  - Jobs: types of work, skills required, firms hiring
  
- Programming Clinic
  - Principles, design, practice using C++, Java
  - Matlab, R
  
- Research Methods
  - Library resources
  - Online resources
  - The research process
  
- Communication Skills
  - Report Writing
  - Speaking
  - Presentations



## MS Mathematical & Computational Finance

NJIT is dedicated to educating students for careers in commercial fields of applied sciences. Recognizing that education only begins with instruction, formal classes combine explanation and observation, maintaining a serious focus of the educational process with a pointed philosophy of learning by and for doing.

- Learning: to understand
- Learning: to use
- Learning: to communicate

Forum extends this philosophy and dedication to building proficient workforce ready graduates. Regular discussions of world financial, economic and political events between faculty and students build a comprehensive awareness of the unfolding dynamic world: The critical and multifaceted issues facing businesses; the uncertain context in which businesses operate; the consequent need to make decisions in an environment of imperfect information; the impact of other people's decisions.

These activities provide an experiential context for study mirroring that of direct employment in industry: a real world embedding of classroom taught models and analytical methods and tools, forcing recognition of the need for synthesis, approximation, modification. Participation in Forum involves regular practice of critical judgment about suitability, relevance, and feasibility of alternative models and methods; in general, careful thinking about the appropriateness of assumptions and utility of theoretical results. Through regular use these professional skill sets grow as a staple alongside knowledge of the properties of techniques studied in specific courses.

### 5.1 English Skills

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Classroom discussions in formal courses help to build confidence in asking questions directly related to understanding of technical material, but often time is too limited to expand on ideas, interests, or prominent matters of the moment. Forum meetings are designed to allow open ended discussion, in which students will develop communication skills while deepening understanding of technical material. For non-native English speakers Forum provides a significant opportunity to improve pronunciation, expand vocabulary, and increase fluency in the context of finance and business.

An optional writing component is available.

*Forum is English Only to promote important language skills*

### ESL

Because English proficiency has a profound impact on study and career success, NJIT supports students' development of English skills in several ways. All students receive tutoring services by The Writing Center at no cost. A deeper, more structured study of English can be pursued through ESL courses. Programs in listening, speaking and writing English as a second language are provided by the Humanities department, part of the College of Science and Liberal Arts along with the Department of Mathematical Sciences.

### 5.2 Programming Skills

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Programming ability and experience is critical to succeeding as a finance quant. Forum provides regular peer and instructor guidance on building knowledge of programming and program design principles, and programming practice with C++ and Java. Assistance with Matlab, Python and R is also available. Over the three semester (15 month) duration of the MSMCF program, participants will systematically study C++ or Java and implement many of the models and analytical methods studied in core courses.

Programming skills are developed in tandem with knowledge of mathematical financial models and analytical and computational methods, and also with the discussion of world developments. Forum has a flexible format, not limited to specific model implementations, exercises or applications. Many examples are provided and students develop their own as they progress through the program, gaining deeper insight into and experience of practical implementation of classroom material. The interplay between theory and practice is thereby continually present as students engage themselves in the formal educational process embedded in the overarching guidance and collaboration of Forum.

### 5.3 Forum Prize

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MSMCF Forum awards two prizes annually in recognition of highest achievement in the domains of descriptive analysis of world financial developments, and proficiency in C++, Java or Python implementation of mathematical models in finance.

- Cavendish<sup>1</sup> Prize for best quarterly financial world review
  - Awarded at the beginning of the spring semester following the Christmas/New Year recess
  - Coverage of salient events
  - Insightful commentary and analysis
  - Expressive power
  - Clarity of analysis
  - Quality of oral delivery
  
- 5X<sup>2</sup> Prize for best C++/Java/Python
  - Awarded at the beginning of the 2<sup>nd</sup> Fall semester following the summer recess
  - Substantive implementation of one or more models or techniques
  - Coherence of design
  - Clarity and understandability of code
  - Demonstrated correctness
  - Ease of use

<sup>1</sup>Sponsored by Cavendish Consulting, providing Statistical and Risk Management services.

<sup>2</sup>Sponsored by DMS.

### 6. Internships

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Students are assisted in the search for summer internships. Previous placements include product research for an international insurance company, research analyst for a pension fund manager, research assistantship in a mid-western university, software development for a trading company, trading strategy research for a start up hedge fund, technical marketing assistant in a hedge fund, trading assistant on a propriety trading desk.

### 7. Off Campus Activities

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#### Group visits

- Trading floor of the New York Stock Exchange
- Federal Reserve Bank of New York
- Bloomberg headquarters
- HQ of a proprietary trading firm

#### Individually

- Industry professional mentoring

NJIT is located just minutes from downtown New York by subway and rail.

Also minutes away is the growing financial district in Jersey City, home to international banks, broker dealers, investment managers, electronic traders, hedge funds, credit unions, consultancies, insurers, accountants, and many other businesses.

### 8. Graduate Profiles

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Part time study has drawn students from international banks and financial service companies including:

- BNY Mellon
- Deutsche Bank
- Markit
- UBS

MSMCF graduates have placed in finance, insurance, and consulting companies, both privately held and publicly traded. Some of the larger companies are:

- AIG
- Merrill Lynch
- Prudential
- SMBC Capital Markets
- Wells Fargo

Graduates have also entered doctoral programs in Mathematical Finance, Applied Mathematics, and Computer Science.

### 9. Fees

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Information on tuition and other fees may be found on the NJIT website.

- <http://www.njit.edu/bursar/tuition/grad-tuition.php>
- <http://www.njit.edu/admissions/graduate/graduate-faqs.php>



### 10. Contact

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You can find information about NJIT and the Department of Mathematical Sciences online:

- NJIT home page <http://www.njit.edu>
- Department of Mathematical Sciences  
<http://math.njit.edu>
- MSMCF page includes links to NJIT Catalog entries for program core courses  
<http://math.njit.edu/academics/graduate/ms-computationalfinance/index.php>
- Admissions Office <http://www.njit.edu/admissions/>
- The Writing Center  
<http://humanities.njit.edu/commstudio/>

If you have questions regarding the structure and content of the MSMCF program please contact the Program Director:

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