QUANTITATIVE FINANCE (M.S.)

Courses

QFGB 8900. Greenpoint/Finastra Project. (0 Credits)
The goal of this program is conceptual learning and hands-on research with real-life portfolios and enterprise systems, including the Finastra Capital Markets Fusion Platform. At the end of the program students are expected to have enriched their learning—and their CVs—with projects that have direct industry applicability and through achievements that will enhance their employment prospects and career growth. The research will include FRTB QIS on a portfolio, model sensitivity of PLA tests, impact of specific portfolio features, and risk parameters on FRTB SA and IMA charges.

QFGB 8901. Foundations of Accounting. (1 to 3 Credits)
This course provides students with a basic understanding of the preparation and analysis of corporate financial statements. It also introduces generally accepted accounting principles (GAAP) and the standard-setting process, and students discuss current issues in the reporting process, such as the benefits and problems of the Sarbanes-Oxley Act.

QFGB 8902. Foundations of Economics. (1 to 3 Credits)
Covers both microeconomics and macroeconomics. Microeconomics topics include theory of demand and the nature of profit and utility-maximizing market equilibrium that constitute the economic basis of finance theory and applications. The macroeconomics segement defines the major components of the economy, outlines a simple model of long-run, real economic behavior with competitive, market clearing prices, then establishes a companion model of short-run adjustments without flexible pricing.

QFGB 8903. Foundations of Finance. (1 to 3 Credits)
Provides a conceptual framework for decision-making processes in many diverse areas of finance. Concepts including time value of money, stock and bond valuation, project and firm valuations, risk and return measures, portfolio management, basic CAPM and APT, diversification and hedging are reviewed. Basic theoretical aspects of corporate finance, such as dividend policy and capital structure, are also introduced.

QFGB 8905. Math for Quantitative Finance. (1.5 Credits)
Reviews the basics of mathematics in preparation for advanced courses in the MSQF program. Topics include: Special functions, Multivariate calculus, Optimization, Integration, Differential equations (ODE and PDEs), and Linear algebra.

QFGB 8906. Probability and Statistics. (1.5 Credits)
Reviews the basics of probability and statistics in preparation for advanced courses in the MSQF program. Topics include special distributions like binomial, poisson, normal, lognormal, gamma, beta, and fat-tailed distributions.

QFGB 890C. Cloud Computing and Finance Uses. (1 to 1.5 Credits)
This course introduces the core concepts of cloud computing, including networking, storage, database, access control, security, compliance, and pricing. Cases will be drawn from the finance Industry. The course does not require prior programming or cloud computing experience. Students will create their own account on a cloud platform and gain some hands-on experience by provisioning a cloud service and working with it.

QFGB 890H. Advanced Machine Learning. (2 to 3 Credits)
The primary focus of this course is on developing computational models to identify/forecast economic regimes, factor-based smart beta, strategic risk budgeting, and trading decisions. The topics covered in this course will help students gain theoretical knowledge and practical skills to work with global financial firms across different asset classes. Students are required to be proficient in Python programming and have knowledge of basic data mining algorithms and techniques.
Prerequisites: QFGB 8923 and QFGB 8905 and QFGB 8906.

QFGB 890K. Python Bootcamp. (0 Credits)
The goal of this bootcamp and workshop is for the students to learn basic Python. The coverage includes Python programming environment, Python shell, Python IDE, Jupyter notebook, Python data types and complex type operations, Pandas data structure, I/O, and visualization.

QFGB 890M. Market Impact Model. (1 Credit)
Stochastic calculus and derivatives pricing courses must be completed prior to taking this demanding quantitative finance course. Market Impact Model is designed to provide students with a mathematical framework grounded in academic references to apply price impact models to quantitative trading and portfolio management. Automated trading is now the dominant form of trading across all frequencies. Furthermore, the rise of algorithmic trading introduces questions professionals must answer. For instance: How do stock prices react to a trading strategy? How can you scale a portfolio considering its trading costs and liquidity risk? How can you measure and improve trading algorithms while avoiding biases? Price impact models answer these novel questions at the forefront of quantitative finance. Using these models, students learn how to build a market simulator to back-test trading algorithms, implement closed-form strategies that optimize trading signals, measure liquidity risk and stress-test portfolios for fire sales, analyze algorithm performance controlling for common trading biases, and estimate price impact models using public trading tape.

QFGB 890N. Real Estate Capital Market Analysis. (3 Credits)
This course examines selected topics and issues related to real estate capital markets. Special emphasis will be placed on mortgage backed securities (MBSs) and real estate investment trusts (REITs). This class will be conducted using a lecture format. The topics include the primary mortgage market and secondary markets, the objectives and processes for designing, implementing, and servicing mortgage and asset backed securities, the tools used by the capital market for pricing and analyzing risks of MBSs, and the regulatory environment and trend of the securitization market.

QFGB 890P. AI in Asset Management. (1 Credit)
The objective of this course is to use AI or machine learning to evaluate complex financial contracts (often involving derivatives). To do that, we not only need to be able to use on-the-shelf libraries but also need to understand the underlying math and algorithms. In other words, we will "open the black box" of every method we use in this class. Derivations as well as good skills in Python or R are required for this course.

QFGB 890Q. Monte Carlo Simulations. (1 Credit)
This course introduces and develops methods and techniques for applying simulations and using them to solve a variety of problems in finance. Simulations are a powerful numerical technique that allow us to solve complex, otherwise difficult or intractable problems. Simulations also give us the ability to make predictions under given scenarios. This course will proceed linearly. First, we'll have a standard review of statistics and probability topics. Then we'll introduce a new simulation method or technique that will be applied to solve problems in quantitative finance. All applications will be done using Python programming language incorporating widely used Python packages in scientific computing and mathematical modeling.
Prerequisites: QFGB 8906 and QFGB 890K.

QFGB 890R. Machine Learning and LLMs. (2 Credits)
The goal of this course is to introduce students to the modern techniques of machine learning and their application to practical problems. Throughout the term, students will learn multiple classical and model machine learning tools, their uses, limitations, and how the performance of each technique depends on the quantity and quality of the available training data. Special emphasis will be put on working with actual data sets, using proper methodology for model selection, and performance evaluation.

QFGB 890S. Quantitative Asset Management Capstone Consulting Projects. (2 to 3 Credits)
The course bridges the gap between academics and practice by immersing students in the entire life cycle of real-world analytics engagements. Divided into small groups, students will work on pre-defined projects designed to boost your career with real-world experience and formulated to be completed within a single semester. This project-based course is structured as a consulting internship with actual companies, augmented with lectures to form a comprehensive framework based on the course textbook. Big data combined with machine learning and artificial intelligence provides amazing opportunities for institutional investors. Apply modern tools to investing with real-world details such as currency controls, market impact, and taxes. Study the entire investing process, from designing goals to planning, research, implementation, testing, and risk management. Use Python, MATLAB, and R to build alpha and risk engines, optimal multi-factor models, contextual nonlinear models, multi-period portfolio implementation, and more.

QFGB 890T. Blockchain, Cryptocurrency, and Algorithmic Trading. (2 to 3 Credits)
This comprehensive course explores the dynamic world of blockchain technology, cryptocurrency markets, and algorithmic trading strategies. It provides a deep dive into decentralized finance (DeFi), digital assets, market structure, and the role of automated trading in financial markets. Students will work with real market data and build their own predictive models by the end of this course.
Prerequisite: QFGB 890K.

QFGB 890U. Advanced Credit Risk Modeling. (2 Credits)
This course provides an in-depth understanding of advanced credit risk modeling techniques, with a focus on stochastic approaches. The course will cover various advanced credit models and their applications to credit derivatives such as Credit Default Swaps (CDS), Collateralized Debt Obligations (CDOs), and CDO tranches. Students will gain practical skills in modeling credit risk using these approaches and learn to apply them in real-world scenarios.

QFGB 890V. Market Microstructure and Trade Execution Strategies. (2 Credits)
This course examines the quantitative principles underlying modern electronic markets, focusing on three key areas: order book dynamics, market impact, and optimal execution. Students begin by analyzing the structure and behavior of limit order books, order flow, and liquidity provision. The course then explores empirical and theoretical models of market impact and transaction costs. In the final part, students apply these concepts to design and evaluate optimal execution algorithms, such as VWAP, TWAP, implementation shortfall, and adaptive strategies. Hands-on projects using real and simulated data provide practical experience in modeling market behavior and implementing data-driven trading strategies.
Prerequisites: QFGB 890K and QFGB 8915.

QFGB 890W. Industry Capstone Projects. (1 to 3 Credits)
Industry Capstone Projects immerses students in semester-long, real-world quantitative finance projects sourced directly from industry partners. Students must apply to projects aligned with their interests and skills to be considered and selected to participate. Working in teams, they apply advanced quantitative modeling, data analysis, and computational techniques to develop practical solutions. Project deliverables include presentations to business stakeholders, delivery of applications where applicable, and the potential for write-up and publication of project findings.

QFGB 890X. MBS and Structured Finances. (2 Credits)
This course provides a rigorous quantitative framework for the analysis, valuation, and risk management of Mortgage-Backed Securities (MBS) and Structured Finance products. Students will learn the practical data analysis and model-building skills essential for a mortgage desk quant. The curriculum culminates in a final project requiring students to implement quantitative models using Python and mortgage datasets.
Prerequisites: QFGB 8915 and QFGB 8934 and QFGB 8925.

QFGB 890Y. Modelling for Private Markets. (2 Credits)
Private markets products require analytics similar but distinct from public market equivalent products. This course explores the full range of private markets products—credit, equity, infrastructure, hedge funds, and real estate—and the unique analytics that are used to evaluate them at the asset and portfolio level. These assets tend to have more flexible commitment and payment structures and more opaque data, making analytical evaluation more complicated than public market equivalent products.
Prerequisites: QFGB 8911 or QFGB 8914.

QFGB 890Z. Global Commodities Markets & Trading. (2 Credits)
The aim of this course is to introduce students to the structure of the global commodity markets and the fundamental concepts of physical and financial commodity trading, hedging, and arbitrage. The course will cover the cash, derivative, and bank-lending markets related to energies, precious metals, and agricultural commodities. It will explore the value chain of each commodity from the upstream point of production to the downstream point of distribution and consumption. The course will cover cash, derivative, and financial market pricing, as well as risk-management tools and techniques employed in the "spot," commodity, "listed," and "over-the-counter" markets, utilizing live financial derivative markets and real-world case studies. A knowledge of the basic operation of the futures, forwards, and listed options markets would be helpful for all students enrolled in this course.

QFGB 8911. Financial Markets and Modeling. (2 Credits)
This course provides the foundation for developing skills in the quantitative analysis of financial decisions, primarily using R and Python. Topics include business planning, forecasting, sensitivity and scenario analyses, risk and return measures, portfolio analysis, binomial option pricing, and value-at-risk (VAR) analysis. It emphasizes practical skills to produce computer models that are useful for a variety of decision-making purposes.

QFGB 8914. Derivatives. (2 Credits)
This course introduces deferred delivery (i.e., exchange-traded futures and OTC-traded forward) markets and option markets. The course covers the following: (1) briefly examines the institutional features of these markets; (2) discusses hedger, arbitrageur, and speculator strategies; (3) provides an analytical foundation for the pricing of these contracts; (4) reviews some of the available empirical evidence concerning these markets; and (5) uses the data to perform small-scale, suggestive tests of the theories and strategies.

QFGB 8915. Introduction to Stochastic Calculus. (2 Credits)
Focuses on the practical applications of stochastic differential equations subject to appropriate boundary conditions, solving valuation problems, and using measure-transformations as required in advanced financial engineering practice to value assets within a risk-neutral framework. Builds a theoretical foundation for continuous-time models that are essential for the pricing and hedging of financial derivatives.
Prerequisites: QFGB 8905 and QFGB 8906.

QFGB 8923. Machine Learn & Econometrics. (2 Credits)
Covers estimation of parametric and non-parametric techniques commonly used in finance, applying high-frequency financial databases. Discusses properties of financial data, linear time series data analysis, basic theory of statistical inference with linear models, general linear models, conditional Heteroskedasticity models, nonlinear models and Bayesian inference and estimation.

QFGB 8924. Advanced Derivatives. (2 Credits)
Designed to complement and extend the topics discussed in QFGB 8914, this course includes all types of derivatives for which a commodity, equity, or currency is the underlying asset. Hull's software and a Bloomberg/Reuters terminal are used for pricing options and gathering data. The data to perform small-scale, suggestive tests of theories and strategies is used.

QFGB 8925. Simulation Applications. (2 Credits)
Introduces state-of-the-art computational techniques essential for implementing financial models, pricing derivatives, obtaining numerical solutions to estimation problems, and simulating stochastic systems in risk management. Provides conceptual framework for gaining experience on simulation design and implementation using METLAB. This course builds a skill set that combines financial modeling, data analysis, and computation.
Attribute: ASDM.

QFGB 8926. Finance Theory. (2 Credits)
This course introduces financial theory with a particular emphasis on portfolio choice and the fundamentals of asset pricing. Focuses on both the partial equilibrium theory (CAPM) and the general equilibrium theory (Arrow-Debrew Pricing Theory), with brief introductions on the arbitrage-based theories. The course introduces the basics of asymmetric information and how the problems it imposes can be mitigated via security design. It also emphasizes an understanding of the theories of Discrete-Time Asset Pricing, studies the application of the theory of stock options to real options and complex corporate liabilities, and explores the basic foundation of the GMM tests of asset-pricing theories.

QFGB 8928. Auto Trading Systems - Intro. (2 to 3 Credits)
This course discusses key issues involved in the design of an auto (algorithmic) trading system and provides hands-on experience. The end product is a prototype auto trading system designed by students that successfully trades in the real market (stocks, futures, options) using live data feeds from exchanges. Issues covered include typical structures of trading systems, efficient processing of live information, minimizing trade slippages, handling a large number of securities, asynchronous information processing, and GUI interfaces. Industry experts are invited to discuss new developments, and key programming techniques will be reviewed. The course is suitable for MSF, MSQF, and other master's-level students with programming skills equivalent to one formal course. Students with less programming skill may take the course with instructor approval.

QFGB 8931. Fixed Income Securities. (2 Credits)
Introduces fixex-income securities, basic fixed-income concepts, the different sectors of the fixed-income market, and basic ond mathematics. Studies quantitative fixed-income analysis and its use in valuing bonds and quantifying risk-return characteristics. Involves extensive training in the mathematical formulation of bond valuation problems and in the use of the existing models and software to solve these problems.

QFGB 8933. Time Series Econometrics. (2 Credits)
This course introduces modern financial econometric techniques with a special focus on applications to finance. Both the theoretical framework for making statistical inference and exemplary applications using data in modern finance are emphasized. The course involves extensive use of commercial software packages, as well as implements new financial econometric techniques using high-level programming language, such as MATLAB.

QFGB 8934. Interest Rate Derivatives. (2 Credits)
Studies continuous time no-arbitrage models of yield curves and pricing of fixed-income securities and derivatives. In paricular, treasury bonds as well as more complicated instruments, such as options on bonds, interest rate swaps, option on interest rate swaps, caps, floors, and Mortgage Backed Securiteis are priced and analyzed.
Prerequisites: QFGB 890K and QFGB 8915.

QFGB 8935. Risk Management. (2 Credits)
Builds strong understanding of the risks of individual products and methods of hedging and/or replication those products. Also examines firm-wide risk issues from a financial perspective which requires aggregation of multiple postions and consideration of interrealationships among asset price fluctuations. Regulatory and other non-market risk issues are considered and simulation techniques for modeling risk are practiced.
Attribute: ASDM.

QFGB 8943. Large-Scale Data Modeling. (2 Credits)
Explores financial modeling topics using large data sets and various econometric techniques applied in a variety of financial problems. Topics include modeling the yield curve in the US and other countries, application of pattern recgonition techniques in developing stock-rating systems, factor models in portfolio construction, and portfolio performance evaluation. Emphasis on project analysis using SAS to process large data sets and develop appropriate models for solving real problems in equity and fixed-income research.

QFGB 8944. Credit Risk Mgmt. (2 to 3 Credits)
Introduces modern credit risk models with particular focus on credit derivative instruments. Focuses on derivative market methods, rather than accounting analyses of business risks. Exposes students to institutional practices and commonly used data. Students will be expected to thoroughly understand professional software output, along with the risks and rewards of credit product strategies. **Attribute:** GFCD.

QFGB 8946. Financial Programming. (2 Credits)
This course introduces students to computer programming and software engineering using modern C++, with a special emphasis on applications in quantitative finance. By the end of the semester, students will be comfortable with core C++ programming concepts and modern design techniques, as well as their application to quantitative financial problems. The course does not assume any previous programming experience but additional challenges will be provided for students with stronger technical backgrounds or prior experience.

QFGB 8948. Quantitative Methods for Portfolio Management. (2 to 3 Credits)
Introduces the scope of the quantitative concepts used in asset management, with focus on practical application, challenges and limitations in constructing optimal portfolios, evaluating performance and portfolio risk. Involves extensive discussions of case studies and group project.* *Subject to NY Approval.

QFGB 8950. Alternative Investments. (2 to 3 Credits)
The course is an introduction to the rapidly evolving universe of alternative investments. Delivered in modules, the course covers a broad array of alternative strategy classeS(Quantitative/Systematic, Fundamental Long/Short, Global Macro, Private Equity) ranging across all major asset classes (Equities, Fixed Income, Currencies, Commodities, Derivatives).* *Subject to NY Approval.

QFGB 8951. Internship and Project Report. (1 to 4 Credits)
A professional project report and presentation are the final outputs of this course. Students complete these projects under the supervision of a faculty member. Both individual and group-projects are possible.

QFGB 8952. Business Comm for Quants A. (0.5 to 1 Credits)
Covers the basics of professional speaking and writing. Develops oral and written presentation skills essential for successful careers. Coordinated with summer term internship to give students the opportunity to apply their new communication skills in a business setting.

QFGB 8953. Research Seminar 1. (1 Credit)
This fall course features a series of lecturers from the finance industry. They discuss research projects that their companies are working on.

QFGB 8954. Research Seminar 2. (1 to 1.5 Credits)
This spring course features a series of lecturers from the finance industry. They discuss research projects that their companies are working on.

QFGB 8955. Computational Finance. (2 Credits)
This course offers both theoretical and practical experience in investing and risk management, including financial market microstructure, types of arbitrage, and principles of modeling the price dynamics of financial assets and market risk. We will derive the Black-Scholes option pricing model, binomial models, yield curve models, credit default risk models, and volatility forecast models using mathematical tools such as copulas. We will also implement all of these models in Python. Students are required to be proficient in Python programming and have a knowledge of stochastic calculus. **Prerequisites:** QFGB 8915 and QFGB 890K.

QFGB 8957. Applied Capital Markets and Financial Regulations. (3 Credits)
This course will explore how the market structure has fundamentally changed after the 2008 liquidity and credit crisis, and how this crisis has impacted on liquidity, balance sheets, risk taking, and returns across the entire financial services industry. The new reality is that regulation has changed the landscape of Wall Street and the dynamic of how the sell-side and buy-side will interact in the foreseeable future.

QFGB 8960. Advanced C++ for Finance. (2 Credits)
In this course, students solve a variety of asset pricing and risk-management problems using the C++ programming language. Over the course of the semester, a quant library of algorithms is constructed and used by the students to analyze instruments and portfolios from the equities, fixed income, and credit markets. The mathematical foundations of the pricing algorithms are also explained in class. Upon successful completion, students will be fluent in those aspects of the C++ language, tools, and third-party libraries that are relevant for creating efficient and reusable software, following financial industry practices and standards.

QFGB 8961. Business Comm for Quants B. (0.5 to 1 Credits)
Covers the basics of professional speaking and writing. Develops oral and written presentation skills essential for successful careers.

QFGB 8963. Stress Tests and Cap Adequacy. (3 Credits)
The financial crisis of 2007 -08 taught us all a lesson: that preparedness is everything. How resilient and prepared will we be, and how fast will we be able to recover? This is the key focus of this course: how to plan for moments of distress so that firms such as yours have capital of a sufficient quality to survive potential storms. We will demonstrate how to create a robust capital plan and test it for moments of hypothetical stress. We will investigate exactly how a bank holding company and an insurance company should conduct their capital plan, highlighting the significant differences between the two industries. By the end of the course, you will be able to create a capital plan for your business on your own.

QFGB 8965. Trading - Market Making and Algorithms. (3 Credits)
This course will introduce students to basic market microstructure, algorithmic trading, and quantitative investment strategies. Mathematical and statistical techniques along with their computational implementation in R or Python will be used throughout the course. **Prerequisites:** QFGB 8911 and QFGB 8923 and QFGB 8926.

QFGB 8966. Behavioral Finance. (2 Credits)
Over the past several decades, the field of finance has developed a successful paradigm based on the notions that investors and managers are generally rational and that the prices of securities are generally efficient. In recent years, however, anecdotal evidence as well as theoretical and empirical research has shown this paradigm to be insufficient to describe various features of actual financial markets. In this course we will use psychology and more realistic settings to guide and develop alternative theories of financial markets. We will examine how the insights of behavioral finance complement the traditional paradigm and shed light on investors' trading patterns, the behavior of asset prices, corporate finance, and various financial market practices through lectures, case studies, and our own discussions.

QFGB 8967. Bank Capital and CCAR. (2 Credits)
This course will provide an overview of the range of risks that banking institutions undertake to perform their role as credit intermediaries. It will delve into the choices that bank managers make to measure the risks they undertake, and will explore the approaches that a bank can take to translate risk measurement into stress tests of a bank's capital position. Students will have an opportunity to apply methodologies discussed while developing a model to stress test a bank's exposure to market, credit, or operational risk for the purpose of testing the adequacy of a bank's capital position.

QFGB 8968. Blockchain Technology and Application Development. (3 Credits)
The main objective of this course is to familiarize you with the ecosystem, technologies, and development skills surrounding Blockchain. The course starts with foundational concepts such as distributed state machine, hash tree, P2P network, GPU processing, cryptocurrency, and cryptography. Using both simulated sandbox and locally installed environments, the course then guides you through the development, front-end integration, and deployment of Blockchain-based smart contracts. Other topics covered include rapid prototyping, design patterns, and agile process to maximize the success likelihood for Blockchain projects. The lab portion of this course involves weekly submissions of programming exercises, assignments, and project deliverables. Prior knowledge required: Proficiency in computer programming; basic knowledge in analysis and linear algebra.
Attribute: ISEL.

QFGB 8969. Systematic Investment Strategies. (2 Credits)
This lecture series will cover a variety of topics on quantitative investment management. We start with an overview of the evolution of the current state of affairs, both with respect to individual strategies as well as topics related to their management within the context of a portfolio. We will first cover the basic set of thematic strategies (e.g., value/reversion, momentum/trend, carry, volatility, etc.) across different asset classes with some representative specific strategies covered in detail. We will then consider extensions and refinements. We will also cover various portfolio construction approaches for baskets of systematic strategies and their consequences. The lecture series will feature readings from “Wall Street” practitioner research series at the major asset managers and investment banks, with guest lecturers from industry on specific topics. Students will be expected to participate via data collection, strategy construction, and back-testing analysis, etc.

QFGB 8972. Deep Machine Learning. (3 Credits)
The goal of this course is to acquaint you with the objectives and methods of deep machine learning (DML). We will explore and learn the basic types of deep neural networks including convolutional, recurrent, and generative adversarial, and the type of data each is designed for. Key additional topics include learning techniques to improve training, preventing overfitting, and finding best practices for minimizing error. Students will study the major technology trends driving DML. A key takeaway is a working knowledge of the vocabulary of concepts and algorithms in DML. The challenges and issues surrounding the use of DML including design issues, ethics, governance, ownership of data, privacy, and security standards. Quality control and validation are also discussed. Emphasis is on business applications. The course is organized as a seminar-style course, with hands-on assignments in DML tools. Familiarity with basic calculus and linear algebra expected.

QFGB 8999. Independent Study. (1 to 3 Credits)
Independent study.