

# MASTER OF SCIENCE IN FINANCE (MSF)

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## MSF 501

### Mathematics with Financial Applications

This course provides a systematic exposition of the primary mathematical methods used in finance and the financial markets. Mathematical concepts and methods discussed are precalculus, calculus, and probability and statistics. Applications include simple and compound interest, annuities and mortgages, forward and futures contracts, bond pricing and duration and convexity, option pricing and strategies, solution of equations of value, optimization, volatility, elementary portfolio theory, Black Scholes option pricing, Binomial Option Pricing, and statistical inference. The learning method includes doing problems in class, quizzes, Final Exam, films, supplementary reading of relevant articles.

**Lecture: 3 Lab: 0 Credits: 3**

## MSF 502

### Statistical Analysis in Financial Markets

Statistics is very important and useful for the analysis of financial markets, especially in today's financial world of large data. This course has three sections. The first section reviews the basics of statistics, including Tabular and Graphical tools, Descriptive Statistics, Exploratory Data, and Probability Distributions. The second section turns to the theory and methods of Statistical Inference. It explains Sampling Theory, Estimation, and Hypothesis Testing. The third section puts emphasis on Variance Analysis and Regression Analysis, a widely used statistical technique in finance. To emphasize the applications of statistics in financial market, during lectures I would regularly 1) explain statistical results presented in financial news and articles, 2) demonstrate the usage of financial data in statistical analysis, 3) emphasize statistical techniques that have broad financial applications. Students are expected to understand as much science of the subject as possible without sacrificing learning its applications in finance.

**Lecture: 3 Lab: 0 Credits: 3**

## MSF 503

### Financial Modeling

Modeling using databases and python programming is ubiquitous in the modern financial industry and business in general. In this course, students will learn how to implement quantitative models using Microsoft Excel, SQL, and Python. Models will include those statistical methods, time series, and valuation models most widely used in industry. Numerical techniques including Monte Carlo simulation, optimization, and root-finding will also be covered. Particular attention will also be paid to project management and testing.

**Lecture: 3 Lab: 0 Credits: 3**

## MSF 504

### Valuation and Portfolio Management

The course is a survey of asset pricing theory. The fundamentals of bond and option pricing are covered as well as the CAPM, APT, and the Fama-French models. Excel spreadsheet modeling is used to illustrate and understand the concepts of Markowitz's Mean Variance Optimization, equity valuation, option pricing, and utility theory. The course places a special emphasis on the relationship between macroeconomic conditions and investment opportunities.

**Prerequisite(s):** (MSF 501 and MSF 502 and MSF 503) or (MSC 511 and MSC 512)

**Lecture: 3 Lab: 0 Credits: 3**

## MSF 505

### Futures, Options, and OTC Derivatives

This three-credit foundation course, mainly for Master of Science in Finance (MSF) students, will examine the mechanism, pricing, trading, and risk management of financial derivatives. Specifically, the students will learn options, forwards, futures contracts, swaps, OTC derivatives, arbitrage-free pricing, risk-neutral pricing, binomial trees, the Black-Scholes-Merton approach, and the Monte Carlo simulation for derivatives pricing. Numerical examples in this course are paper-and-pencil-based, spreadsheet-based, or Python-based. Students will implement a simple derivatives trading strategy using trading software. At the end of the semester, a student should know the mechanism, terminologies, and basic properties of futures, options, and OTC Derivatives; be able to implement speculative, hedging, and arbitrage trading strategies using futures and options; be able to determine a price of futures/forward, options, and OTC Derivatives using non-arbitrage arguments, option bounds, a binomial model, Black-Scholes-Merton model, Monte Carlo Simulation, etc.; and understand dynamic delta hedging and other Greeks for financial risk management purposes.

**Prerequisite(s):** MSF 501 with min. grade of C and MSF 503 with min. grade of C and MSF 502 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

## MSF 506

### Financial Statement Analysis

The primary objective of this course is for the student to develop his/her financial analysis skills. This course will focus on key accounting concepts, financial ratios, forecasting techniques and industry issues which are critical in interpreting and analyzing external financial reports. Additionally, advanced analysis skills will be introduced, which should enable the student to look beyond the numbers (presented in a GAAP/IFRS format) and ultimately obtain a more informed decision regarding the financial strength (value) of the company (security). Throughout this course students will be involved in "hands-on" financial analysis by working on class exercises/problems, discussing special topical readings and completing an assigned case.

**Prerequisite(s):** MSF 501 with min. grade of C and MSF 503 with min. grade of C and MSF 502 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 524****Models for Derivatives**

The practice of financial engineering requires skill in financial theory and practice, mathematics and programming. This course includes instruction in all of these areas. In this class, students will learn mathematical and computational methods that are applicable to the pricing and risk management of derivatives. The class provides an introduction to options pricing theory, covering stochastic calculus, the Black-Scholes partial differential equation, risk-neutral valuation and hedging portfolio replication. The course will focus on important numerical techniques used in finance, including variance reduction techniques in Monte Carlo Simulation and finite difference methods applied to partial differential equations. These methods will be applied to the pricing of exotic options. In this class, students will learn to program and implement financial models in Matlab.

**Prerequisite(s):** MSF 505 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 525****Term Structure Modeling and Interest Rate Derivatives**

Upon completion of this course, students should know the strengths, weaknesses, appropriate uses, and ways of implementing the major term structure models that are in common use. The course will begin with bootstrapping of forward curves, principal component analysis, and a review of basic fixed income derivatives (swaps, swaptions, caps, and floors). We will then implement short rate models, such as Ho-Lee, Black-Derman and Toy, and extended Vasicek/Hull-White, followed by the Helath-Jarrow-Morton model and market rate models. Students will implement these term structure models in Excel/VBA and Matlab.

**Prerequisite(s):** MSF 505 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 534****Corporate Finance**

The primary objective of this course is for students to develop a strong understanding (and interest) of financial management related topics including: cost of capital, capital budgeting, capital structure decisions, working capital management, dividend payout policy, debt and equity financing, mergers & acquisitions, and corporate governance. Throughout this course, students will apply corporate finance topics to current company examples, which will be facilitated by class discussion, in-class exercises/problems, and assigned topic homework problems.

**Prerequisite(s):** MSF 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 535****Investment Banking and Venture Capital**

The primary goal is for students to develop an understanding of key investment banking concepts and applications. Students will be exposed to topics such as comparable companies' analysis, precedent transaction analysis, discounted cash flow analysis, leverage buyouts, venture capital, and sell-side and buy-side mergers and acquisitions. During the course, students will interact with real company scenarios and will be required to use investment banking applications to solve in-class examples and problems. In the latter part of this course, students will work on an assigned case pertaining to a specific investment banking topic. This case will include a comprehensive data set and require Excel modeling. Because this is a "hands on" course, it will require both the student's attendance and participation to learn the core concepts that are necessary to perform well on the class exams and apply the necessary material to the assigned case and homework problems.

**Prerequisite(s):** MSF 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 544****Asset Valuation**

The primary goal is for students to develop an understanding of equity valuation processes and applications. Topics discussed in class will include dividend discount, free cash flow, residual income, and market-based valuations as well as private and distressed company valuations. Throughout this course, students will apply equity asset valuation topics discussed in class to real world examples and in-class problems/exercises. During the latter part of this course, students will work in a group environment to complete and present an equity research report for a selected U.S. public company. Because this is a "hands on" course, it will require both the student's attendance and participation to learn the core concepts that are necessary to perform well on the class exams and apply to the group equity valuation project.

**Prerequisite(s):** MSF 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 545****Fixed Income Portfolio Management**

This course will cover the characteristics, valuation and risk management of fixed income instruments. These instruments include bonds, repos, interest rate derivatives, inflation indexed securities, mortgage-backed and asset-backed securities, CDOs and default swaps. The focus will be on understanding how these instruments are structured and used. Term structure modeling and hedging techniques will be presented, with a minimum of mathematics.

**Prerequisite(s):** MSF 505 and MSF 504

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 546****Quantitative Portfolio Management**

This course develops the primary quantitative tools used in the portfolio selection process. The applied focus of the course centers on the process of moving from a data set of historical information to the formulation of a forecasting model, the estimation of mean-variance efficient portfolios, and the testing of efficiency hypotheses within an in-sample and post-sample setting. The course covers the estimation of efficient portfolios, factor models, forecasting models, and risk analysis.

**Prerequisite(s):** MSF 505 with min. grade of C and MSF 504 with min. grade of C

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**MSF 547****Machine Learning for Finance and Business**

This class surveys machine learning techniques for empirical research in finance and business, including: 1. Linear machine learning algorithms for prediction and classification, including lasso and ridge regression, logistic regression, linear discriminant analysis. 2. Nonlinear machine learning algorithms, including decision trees, naïve Bayes, k-nearest neighbors, and support vector machines. 3. Ensemble algorithms, including bagging, random forests, and boosting models. 4. Neural networks, including RNNs, LSTM, as well as NLP for sentiment analysis. Students use Python to build scripts that encapsulate the algorithms presented. Various financial and business-related data sources will be used to develop a hands-on understanding of dimension reduction, regression, classification, and clustering. Emphasis will be given to performance evaluation of various models using, for example, confusion matrices, classification reports, and various graphical constructs.

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**MSF 554****Market Risk Management**

The course covers various issues related to investment and its risk management, including many statistical techniques around asset returns and asset volatilities. Chief among these is value-at-risk (VaR) analysis, which over the past 20 plus years has become established as the industry and regulatory standard in measuring market risk. Students are required to master spreadsheet modeling of risk models, as well as various backtesting procedures. When time allows, useful R packages and more real-life data examples are also presented, to expose students to a much larger set of quantitative tools.

**Prerequisite(s):** MSF 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

**Credit:** Variable

**MSF 555****Credit Risk Management**

The extensive use of leverage by individuals, corporations, hedge funds and private equity managers has led to a significant increase in the demand for models that analyze credit risk exposures. For many users, the credit risk function has evolved from models used to analyze the quality of an individual borrower to models that aggregate exposure across borrowers, industries and geographic regions. This course provides an extended overview of the exciting and rapidly developing field of credit risk analysis.

**Prerequisite(s):** MSF 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

**Lecture:** 3 **Lab:** 3 **Credits:** 3

**MSF 566****Time Series Analysis**

This course introduces the econometric theory and practice of time series analysis, with an emphasis on practical skills. Students coming to the class should have some basic knowledge about statistics including hypothesis testing (t-test and F-test), correlation and regression analysis based on ordinary least square estimator. This course develops a portfolio of techniques for the analysis of time series data. This course covers difference equation, modeling with stationary time series, modelling with volatility (ARCH and GARCH), modelling with trend, unit root, and non-linear time series models. Students will be given access large database to practice the skills during the semester.

**Prerequisite(s):** MSF 505 with min. grade of C and MSF 504 with min. grade of C

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**MSF 568****Energy Commodities Analytics and Trading**

Energy markets and ESG investment are essential in the real economy and financial markets. Finance/business students interested in trading, analytics, and financial risk management should pay attention to energy markets. In addition, some engineering/science students would like to widen their comfort zone to financial/commodity markets, which may be their future employers. Finally, this course is also for environmental management students who want to expand their comfort zone to finance and entrepreneurship students considering financial solutions for environmental/social problems. This three-credit course, designed for finance, business, engineering, science, environmental management, and entrepreneurship Master's or Upper-year Undergraduate students, introduces Environment, Social, and Governance (ESG) investments and energy markets and provides a systematic exposition of data-driven analytic models for energy prices and other risk factors. First, this course introduces ESG investment and financial solutions for environmental/social problems because these are important current affairs in finance, are closely related to energy markets, and provide context to energy commodities. Then, this course provides an overview of (green) energy markets and well-designed instruction on energy commodity analytics. Through readings, lectures, discussion/analytic homework assignments, a presentation, and peer evaluations, students will understand the basics of these topics and develop expertise. As a part of a term project, a student will present: 1) His/her own proposal for an ESG fund; 2) A financial solution for a specific environmental/social problem of the student's choice; or 3) An energy commodity-related analytic research report carefully designed by the instructor. Even though finance people cannot do much for the COVID-19 pandemic, financiers can contribute to resolutions of environmental or social problems. If you propose an ESG fund, the proposal should recommend a procedure to pick stocks or other securities that will be in the master list of the fund. If you propose a financial solution for an environmental/social problem, you can propose a solution to governments or private-sector investors. After you finish this course, you can use the outcome to participate in an external competition such as Climate Investment Challenge (<https://www.climateinvestmentchallenge.org/>). If a student chooses the analytic research report, the student will work on a carefully-designed practical problem, gain hands-on experience in programming for trading and financial risk management, do a presentation, and can write a white paper if he/she wants. Students may use his/her presentation and supporting materials for his/her job search purposes. After the presentation, the students will provide constructive feedback to classmates through peer evaluation. At the end of this semester, students will be able to research, propose, and implement investment/trading/hedging strategies in energy markets and other ESG-related markets. The learning objectives of this course is related to the social and climate risk (SCR) certificate from the Global Association of Risk Professionals (GARP). This course is a self-contained course which will help motivated, hard-working students develop themselves into a green/responsible/impact investment manager, an entrepreneur, a financial risk manager, an asset optimizer, a trader, a structuring and pricing analyst, a middle office analyst, a quantitative analyst, a data scientist, a quantitative programmer, etc.

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 577****High Frequency Finance and Technology**

High frequency trading is concerned with the development of robotic trading algorithms within a real time market environment. This course will be concerned with the development of high frequency models and the assessment of their performance.

**Prerequisite(s):** MSF 505 with min. grade of C and MSF 504 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 591****Global Markets and Technology**

This course will enable the student to understand the basics of financial markets and how they function in the global arena. The student will learn how the equities market, the bond market, the money market, the foreign exchange market and the derivatives markets are set up and operate. We will focus on the instruments, the players, the jargon, the details of the trade, and the institutional framework for each market. We cover both OTC and exchange-traded markets, and explore the dramatic transformation of these markets. The student will learn how each of these markets operates in the US, but will also learn how practices differ in Europe, Asia and Latin America.

**Prerequisite(s):** MSF 505 with min. grade of C and MSF 504 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 595****Entrepreneurial Finance**

Most new ventures are not created by financial analysts. However, the success of a new venture is vitally dependent upon the strength of its financial controls. Knowledge of finance is also an important determinant of an entrepreneur's ability to convey information about his company to banks, regulators, and potential investors. This course provides entrepreneurs with the financial knowledge that they require to create successful new ventures.

**Prerequisite(s):** MSF 504 with min. grade of C and MSF 506 with min. grade of C and MSF 505 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**MSF 597****Independent Study in Finance**

MSF 597 Independent Study allows students to undertake research projects under the supervision of a full time faculty member.

**Credit: Variable**

**MSF 599****Special Topics in Finance**

Special topics in finance.

**Lecture: 3 Lab: 0 Credits: 3**