FINANCIAL ENGINEERING

Program Director:
Charles Tapiero

GRADUATE PROGRAMS

MASTERS IN FINANCIAL ENGINEERING

The Department of Finance and Risk Engineering offers in its Financial Engineering MS Program graduate level courses in Finance, Economics, Financial Markets and Corporate Finance, Quantitative Finance, Financial Econometrics, Financial Technology, Risk Management, Risk Analysis and Assessment in Financial Services, Stochastic Finance Calculus, Stochastic Financial Modeling, and in related applied fields (Fixed Income, Derivatives, Securitization, Investment and Risk Management, Algorithmic Trading, Financial Physics, Data Mining and Intelligent Finance, CDOs, LBOs, ABS, MBS, etc.). These courses form a major portion of the coursework for an advanced degree in Financial Engineering, seeking to bridge the gap between theoretical Finance and Applied Finance. Courses may also be taken by students in other departments (subject to approval by the responsible academic supervisor) to satisfy minor and elective requirements and by qualified pre-degree students who desire further study in graduate-level Financial Engineering.

REQUIREMENTS FOR THE MASTER OF SCIENCE

A Bachelor’s degree is required for admission to this program. Students with degrees in other fields may be admitted, possibly with undergraduate deficiencies, at the discretion of departmental advisors. Before beginning graduate studies, students conditionally approved will be required to demonstrate proficiency in basic Statistics, Probability and Mathematics. E-Poly courses will be recommended to this effect but can be waived as well as at the discretion of the academic faculty supervisor.

Pre-requisites:
Economic (EC 2514, EC 2534 or equivalent)
Calculus (MA 1112, MA 1122 or equivalent)
Probability and Statistics (MA 2212, MA 2322 or equivalent)
Linear Algebra (MA 2012 or equivalent)

Master’s in Financial Engineering: 36 credits
All tracks will include in their program:
1. 5 Core courses, each 3 credits
2. 5 Required courses, each 1.5 credits
3. 1 Required Applied Lab, worth 1.5 credits
4. 4 Elective courses, each 1.5 credits
5. 1 Capstone worth 6 credits

Core Courses (Required): 15 credits
1. FRE 6003, Financial Accounting, 3
2. FRE 6023, Economic Foundations in Finance, 3
3. FRE 6083, Quantitative Finance, 3
4. FRE 6103, Corporate Finance, 3
5. FRE 6123, Financial Management & Risk Asset Pricing, 3

All tracks: Core courses = 15 credits.

There are three track options for incoming MS students of Financial Engineering, in each track there are 5 classes worth 1.5 credits each, totaling 7.5 credits.

1. Financial Markets and Corporate Finance
2. Computational Finance
3. Financial Information Services and Technology

Required Courses Per Track: 7.5 credits

Financial Markets and Corporate Finance
1. FRE 6091, Financial Econometrics, 1.5
2. FRE 6291, Options & Derivatives, 1.5
3. FRE 6411, Fixed Income Securities & Interest Rate Derivatives, 1.5
4. FRE 6711, Portfolio Theory and Applications, 1.5
5. FRE 6271, Valuation of Equity Securities & Financial Statement Analysis, 1.5

Computational Finance Track
1. FRE 6231, Stochastic Calculus and Financial Modeling, 1.5
2. FRE 6251, Numerical and Simulation Techniques in Finance, 1.5
3. FRE 6311, Dynamic Assets and Options Pricing, 1.5
4. FRE 6331, Financial Risk Management and Optimization, 1.5
5. FRE 6351, Advanced Financial Econometrics, 1.5

Financial Information Services and Technology Track
1. FRE 6131, Foundations of Financial Technology and Services, 1.5
2. FRE 6151, Clearing and Settlement of Financial Transactions, 1.5
3. FRE 6791, Operational Risk Measurement and Management, 1.5
4. FRE 6071, Derivatives, Financial Markets and Technology, 1.5
5. FRE 6431, Electronic Market Design, 1.5

Required Labs per Track: 1.5 credits
Students from all tracks must choose one of the following labs: each 1.5 credits
1. FRE 6811, Financial Lab 1, Excel, Risk and Yieldbook
2. FRE 6821, Financial Lab 2: Eviews and Stata
3. FRE 6831, Financial Lab 3: Matlab, GAMS and optimization software
4. FRE 6841, Financial Lab 4: S-Plus and R
5. FRE 6851, Financial Lab 5: Excel with VBA and C++

Please note that all students must take one lab, but that additional labs taken do not count towards MS FE electives.

**Capstone Options: 6 credits**

1. FRE 7003, Master’s Thesis (required for potential Ph.D candidates)
2. FRE 7023, Internships (4 Months at least, concluded with a document presented to the faculty.)
3. FRE 7043, Selected Project, under Faculty supervision.

**Credit Allocation**
- Core Courses: 15
- Required Courses: 7.5
- Electives Credits: 6
- Labs: 1.5 (2 labs)
- Capstone: 6
- Total Credits: 36

All these options require a review by faculty advisors and certification of satisfactory work.

**GRADUATE CERTIFICATE PROGRAMS**

The Graduate Certificate programs have the same application requirements and prerequisites as the Master of Science Degree. Admission to the program requires a baccalaureate from an accredited institution. Candidates to the Certificate program are not required to take the GRE/GMAT, but should have obtained a minimum GPA of 3.0.

**Graduate Certificate Program in Financial Engineering**

**Program Prerequisites**
Calculus MA 1122 or equivalent
Statistics MA 2222 or equivalent
Linear Algebra MA 2012* or equivalent
FRE 6023, Economic Foundations in Finance or its equivalent
*Knowledge of spreadsheets expected. Some exposure to computer programming languages.

**Financial Engineering Certificate Credits**
1. FRE 6083, Quantitative Finance, 3
2. FRE 6103, Corporate Finance, 3
3. FRE 6411, Fixed Income Securities & Interest Rate Derivatives, 1.5
4. FRE 6291, Options & Derivatives, 1.5
5. FRE 6511, Intermediate Derivatives Valuation and Applications, 1.5
6. FRE 6711, Portfolio Theory and Applications, 1.5
7. Free elective, 1.5
8. Lab, 1.5

To satisfy the 1.5 credits of lab required, students choose one of the following labs:
1. FRE 6811, Financial Lab 1, Excel, Risk and Yieldbook
2. FRE 6821, Financial Lab 2: Eviews and Stata
3. FRE 6831, Financial Lab 3: Matlab, GAMS and optimization software
4. FRE 6841, Financial Lab 4: S-Plus and R
5. FRE 6851, Financial Lab 5: Excel with VBA and C++

Total Credits: 15

**Graduate Certificate Program in Risk Management**

**Program Prerequisites**
Economics EC 2524 or equivalent
Calculus MA 1122 or equivalent
Statistics MA 2222 or equivalent
Linear Algebra MA 2012* or equivalent
FRE 6023, Economic Foundations of Finance or equivalent
FRE 6053 or equivalent
*Knowledge of spreadsheets expected. Some exposure to computer programming languages.

**Risk Management Certificate, Credits**
1. FRE 6083, Quantitative Finance, 3
2. FRE 6271, Valuation of Equity Securities & Financial Statement Analysis, 1.5
3. FRE 6411, Fixed Income Securities & Interest Rate Derivatives, 1.5
4. FRE 6291, Options & Derivatives, 1.5
5. FRE 6511, Intermediate Derivatives Valuation and Applications, 1.5
6. FRE 6711, Portfolio Theory and Applications, 1.5
7. FRE 6731, Basel 2 and Value at Risk, 1.5
8. FRE 6751, Credit Risk Measurement and Management, 1.5
9. FRE 6791, Operational Risk Measurement and Management, 1.5
10. Free elective, 1.5
11. Lab, 1.5

To satisfy the 1.5 credits of lab required, students choose one of the following labs:
1. FRE 6811, Financial Lab 1, Excel, Risk and Yieldbook
2. FRE 6821, Financial Lab 2: Eviews and Stata
3. FRE 6831, Financial Lab 3: Matlab, GAMS and optimization software
4. FRE 6841, Financial Lab 4: S-Plus and R
5. FRE 6851, Financial Lab 5: Excel with VBA and C++

Total Credits: 18

Graduate Certificate Program in Financial Technology Management
Program Prerequisites
Financial Accounting: FRE 6003 or equivalent
Economics: EC 2524 or equivalent
Probability and Statistics: MA 2222 or equivalent

Financial Technology Management Certificate, Credits
1. FRE 6131, Clearing and Settlement of Financial Transactions, 1.5
2. FRE 6151, Financial Technology and Services, 1.5
3. FRE 6171, Management of Financial Institutions, 1.5
4. FRE 6103, Corporate Finance, 3
5. FRE 6071, Derivatives, Financial Markets and Technology, 1.5
6. MG 7503, Management of Electronic Business, 3
7. MG 8203, Project Assessment & Management, 3
Total Units: 18

UNDERGRADUATE COURSES

FIN 2003 Economic Foundations of Finance
3:0:0:3
This course focuses on the fundamental economic concepts underpinning modern financial theory. Material covered includes: consumer behavior, utility theory, analysis of production and costs, competitive markets, monopolistic and monopsonistic markets, time value of money, game theoretic analysis of oligopoly, asymmetric information in markets, externalities, market efficiency and more. The calculus will be used as appropriate in developing these concepts. Prerequisites/Corequisites: EN 1204, MA 2054 or MA 2212 or MA 3012, and 8 credits of calculus

FIN 2103 Creating & Understanding Financial Statements
3:0:0:3
This course provides the student with a solid understanding of the creation and interpretation of modern financial statements. Topics covered include: the compelling reasons for financial statements, Sarbanes-Oxley, accounting principles in the US and how they differ abroad, quality of financial information, financial ratios and their uses, cash flow analysis, measurement of corporate performance, credit analysis, introduction to managing financial risk. Prerequisites/Corequisites: EN 1204

FIN 2203 Corporate Finance and Financial Markets
3:0:0:3
This course covers the fundamentals of corporate finance: valuation, risk, capital budgeting, and market efficiency. Students who complete this class will have acquired a solid foundation for the study of intermediate and advanced topics in finance this class serves as a pre-requisite for all FIN classes at the 3000-level. Prerequisite: EN 1204; Co–Registration Requirements: FIN 2003, FIN 2103

FIN 3213 Financial Management and Risk Engineering
3:0:0:3
The purpose of this course is to introduce the student to the elements and techniques of risk engineering spanning: Probabilities and their distributions, data analysis and statistics as well as Monte Carlo simulation. Throughout, these techniques are demonstrated through special problems and cases providing the necessary tools and concepts for dealing with outstanding problems in risk engineering, decision making under uncertainty and financial management and pricing. The course is based on a multiple sessions in a Financial Laboratory environment using computational risk software, statistical

FIN 3233 Derivatives and the Options Market
3:0:3
This course builds on mathematical models of bond and stock prices and cover two major areas of mathematical finance that have a significant impact on the operation of model financial markets, namely, Black–Scholes arbitrage pricing of options as well as other derivative securities and interest rates together with their term structure. The course makes significant use of probability and calculus covering the material in a mathematically rigorous and complete manner. Prerequisite: FIN 2203; Co–Registration Requirements: FIN 2003, FIN 2103

FIN 3403 Entrepreneurship and Financial Management
3:0:0:3
This course introduces the student to the finance of entrepreneurship and venture capital. The perspectives of both the start-up firm and the venture capitalist are considered, and a framework for understanding the laws, contracts and issues involved in reaching mutually profitable contracts is developed. Prerequisite: FIN 2203

FIN 3503 Operational Risk Modeling and Analytics
3:0:3
This course focuses how to optimize business strategies from both qualitative and quantitative points of view with respect to operational risk. The course is organized around the principle that the analysis of operational risk consists, in part, of the collection of data and the building of mathematical models to describe the risk of failures in human resource, processes and
technology. Beginning with a foundation for operational risk modeling and a focus on the modeling process, the course discusses probabilistic tools for operational risk modeling and statistical methods for calibrating models of operational risk. The quantitative assessment of operational risk uses the tools of probability, statistics and actuarial science.  

Prerequisite: FIN 2203; Co-Registration Requirements: FIN 2003, FIN 2103

FIN 4903 Special Topics in Finance and Risk Engineering

3:0:0:3

: Topics of interest in Finance and Risk Engineering. The specific subject of each offering is generally unique. The course may feature a detailed look at a single topic or a series of focused topical presentations.  

Prerequisite: Permission of Department or Instructor

REQUIRED GRADUATE COURSES

MS in Financial Engineering/All Tracks

FRE 6003, Financial Accounting

3:0:0:3

This course provides a solid foundation in the construction and interpretation of financial statements. Topics include: accounting terminology, financial statement preparation and analysis, liquidity and credit risk ratios, depreciation calculations, revenue recognition, accrued liabilities, and asset valuation. Also covered are the effects of equity transactions, cash flows, and various accounting methods on financial statements.  

Pre-Requisite: none  
Co-Requisite: none  
Notes: none

FRE 6023, Economic Foundations in Finance

3:0:0:3

FRE 6083, Quantitative Methods in Finance

3:0:0:3

This course focuses on the use of quantitative methods for construction and application of models in financial engineering. Modern probability, stochastic processes and optimization are the mathematical foundations. Topics covered include probability spaces, conditional probability, densities, distributions, density estimators, multivariate probability, moment generating functions, random walks, Markov processes, Poisson processes and the Brownian motion process.  

Pre-Requisite: Students are expected to have knowledge in calculus and elementary probability.  
Co-Requisite: none  
Notes: none

FRE 6103, Corporate Finance

3:0:0:3

The modern corporation, as issuer of financial securities and end-user of financial risk management products, is one of the major participants in financial markets and the economic counterpart to investors and financial intermediaries. Whereas the mechanism of financial markets and the valuation of instruments are studied in further detail elsewhere, in this course the tools of the trade of financial economics and corporate finance are applied to the financial decision-making process of firms. Upon successful completion of this course, students will know how to contribute to optimal financial decisions in a corporation: valuation, capital budgeting, risk, capital structure, dividend policy, long-term financing, risk management, mergers & acquisitions. Increasingly important international factors, which affect corporate finance, will be stressed throughout the course.  

Pre-Requisite: none  
Co-Requisite: none  
Notes: none

FRE 6123, Financial Management & Risk Asset Pricing

3:0:0:3

This course introduces the students to the techniques and problems of Financial Risk Management and Asset Pricing. Risk finance and attitudes, Value at Risk, risk measurement and principles of decision making under uncertainty, valuation and expected utility and their relevance in the valuation and the pricing of financial investments, insurance, the management of derivatives, risk management etc. are emphasized. Throughout the course, application problems in risk management are treated. In addition, fundamental applications in financial engineering including the Arrow-Debreu risk neutral pricing framework, Binomial models in option pricing, essential elements of Itô calculus and the Black Scholes model for pricing options is introduced.  

Pre-Requisite: none  
Co-Requisite: none  
Notes: none

Required Courses in Tracks:

Track: Financial Markets and Corporate Finance

FRE 6091, Financial Econometrics

1.5:0:0:1.5
This focuses on the art and science of statistical modeling of processes applied to business, finance and economics. These may include models of aggregate economic activity, economic behavior of firm or behavior of financial assets. Topics include statistical inference, maximum likelihood estimation, method of moments, Bayesian estimation, least-squares estimation, robust estimation, kernel estimation, copula estimation, analysis of variance, linear regression models, multiple regression, logistic regression, quantile regression, time series estimation, unit root tests, bootstrapping. Pre-Requisite: FRE 6083. Students are expected to have knowledge in basic statistics. Co-Requisite: Notes: none

FRE 6271, Valuation of Equity Securities and Financial Statement Analysis

1.5:0:0:1.5

This course provides a detailed examination of the tools and techniques for analyzing financial statements for purposes of credit evaluation, forecasting, identifying merger candidates, enhancing the efficiency of decision making, and diagnosing problem areas within the firm before crises develop. Students will also be taught to use financial ratios to conduct duPont (i.e., decomposition) analysis, a methodology to track down sources of poor performance through interrelationships among a firm’s financial ratios. Pre-Requisite: FRE 6003, FRE 6103 Co-Requisite: Notes: none

FRE 6291, Options and Derivatives

1.5:0:0:1.5

This course covers derivative contracts including futures, forward contracts, option, and swap contracts. The focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts and the use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed, as are the specifics of the contracts and the markets in which they trade. Financial derivatives such as interest rate, currency, and equity contracts, and some brief discussion of commodity contracts and specialty contracts such as insurance derivatives and credit derivatives are also discussed. Pre-Requisite: FRE 6003, FRE 6023, FRE 6103 Co-Requisite: Notes: none

FRE 6411, Fixed Income Securities and Interest Rate Derivatives

1.5:0:0:1.5

This course examines the body of analytical tools and measures that constitute modern fixed income markets. The valuation of interest-rate sensitive cash flows is the unifying theme. Major topics covered include theories of term structure, institutional aspects of fixed income markets, and analytical techniques for managing interest rate risk. Bond refunding, defeasance, corporate bonds, mortgage-backed securities, forwards, futures, options and interest rate swaps are discussed. The course also provides an overview of the major classes of fixed income securities and the markets in which they trade. Among the major classes of fixed income instruments discussed are Treasury and agency securities, mortgage-backed securities (including CMOs and Strips), asset-backed securities, municipals, floating and inverse floating rate securities. Pre-Requisite: FRE 6023, FRE 6083, FRE 6103 Co-Requisite: Notes: none

FRE 6711, Portfolio Theory and Applications

1.5:0:0:1.5

This course provides an examination of modern portfolio theory and investment selection. It considers portfolio analysis, single-period risk and return measures, and the process of optimal portfolio selection. The basic portfolio model is extended to consider alternative risk concepts and multiperiod portfolio horizons. Single factor and multi-factor models are also discussed. Optimization techniques are applied. The basic portfolio model is extended to explain hedging theory and to build firm-wide risk management models. Pre-Requisite: FRE 6411

Track: Computational Finance

FRE 6231, Stochastic Calculus and Financial Modeling

1.5:0:0:1.5

This course extends the core course FE6083 to Applied Stochastic Calculus in Finance, emphasizing the modeling approach and resolution of important problems in derivatives finance, in pricing assets and complex financial products. In addition, cases highlighting the impact of theoretical finance on practical market trading, portfolio management and related problems are emphasized. Some of the techniques required and covered in the course include: Markov chains, random walks, stochastic differential equations and Ito Calculus, optimal stochastic control and stochastic dynamic programming as well as Monte Carlo simulation. These techniques are then applied to selected financial engineering models to assess and simulate (using Matlab and other software) essential derivative and related problems of practical importance in finance. Pre-Requisite: FRE 6083 Co-Requisite: Notes: none

FRE 6251, Numerical and Simulation Techniques in Finance

1.5:0:0:1.5
Advanced numerical techniques for the solution of ordinary, partial and stochastic differential equations are presented. These techniques are analyzed both mathematically and using computer aided software that allows for the solution and the handling of such problems. In addition, the course introduces techniques for Monte Carlo simulation techniques and their use to deal with theoretically complex financial products in a tractable and practical manner. Both self-writing of software as well as using outstanding computer programs routinely used in financial and insurance industries will be used. Pre-Requisite: FRE 6083 Co-Requisite: Notes: none

FRE 6311, Dynamic Assets and Options Pricing  
1.5:0:0:1.5
The purpose of this course is to focus on inter-temporal assets pricing both in discrete and continuous time. Problems in complete and incomplete markets of both theoretical and practical interest requiring an appreciation of financial economic theories and computational techniques are profusely used and the financial engineering techniques needed are introduced. Problems and cases are presented spanning Fixed Income (Bonds), Stocks and Derivatives (Options of various sorts), Real Asset Pricing and Implied Risk Neutral Pricing. Pre-Requisite: FRE 6083, FRE 6123 Co-Requisite: Notes: none

FRE 6351, Advanced Financial Econometrics  
1.5:0:0:1.5
Financial econometrics has matured into an important and necessary field providing an opportunity to deal with practical problems in finance. For example, techniques such as ARCH and GARCH and their subsequent development are used to estimate the volatility of underlying financial processes; the analysis of intra-day trading data requires particular mathematical techniques; Memory based and persistent stochastic processes can be used for algorithmic trading and detecting markets incompleteness; Copulas are now applied routinely to model and estimate dependent risks, etc. These financial and risk problems require the application of advanced financial econometric techniques that the course provides from both theoretical and empirical-applied viewpoints. Selected cases are used to provide a real-world sense of financial engineering when it is faced with the reality and the complexity of financial markets. Pre-Requisite: FRE 6083 Co-Requisite: Notes: none

FRE 6151, Clearing and Settlement of Financial Transactions  
1.5:0:0:1.5
This course focuses on issues involved in the processing of financial transactions from order execution to final settlement of transactions. The course examines the procedures and market conventions for processing completed transactions, verifying transactions, confirming transactions, resolving conflicts, decisions involved in developing one's own clearing operations or purchasing clearing services, the role played by the clearing houses, and numerous issues associated with cross border transactions. Pre-Requisite: none Co-Requisite: Notes: none

FRE 6071 Derivatives, Financial Markets and Technology  
1.5:0:0:1.5
This is a half semester course that covers basic derivatives including futures contracts, forward contracts, option contracts, and swap contracts. The principal focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts are discussed. The use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed. The specifics of the contracts and the markets in which they trade are also discussed. The main focus is to give students in the Financial Technology track a general understanding of the derivatives market and risk management. Prerequisites: FRE 6003, FRE 6023, FRE 6103

FRE 6331, Financial Risk Management and Optimization  
1.5:0:0:1.5
This course provides solution to the inter-temporal management of portfolios, financial products of various sorts, credit risks, market making etc. Dynamic and stochastic dynamic programming techniques as well optimal control and stochastic control principles of optimality are presented and their financial contexts emphasized. Both theoretical and practical facets of inter-temporal management of financial risks and risk pricing are emphasized. Pre-Requisite: FRE 6083, FRE6123 Co-Requisite: Notes: none

Track: Financial Information Services and Technology

FRE 6131 Financial Technology  
1.5:0:0:1.5
Every year, financial institutions spend billions to exploit the latest development in information technology. This course introduces a framework with which to understand and leverage information technology. The technology components covered include telecommunications, groupware, imaging and document processing, artificial intelligence and object-oriented analysis and design. The course also covers the entire technological planning process specifically for financial institutions. Pre-Requisite: none Co-Requisite: Notes: none
FRE 6791, Operational Risk Measurement and Management
1.5:0:0:1.5
The operational difficulties faced by financial institutions have created a need for tools to measure and manage operational risk. An accurate appreciation of risks, exposures, and controls is critical to effectively managing risk in today’s dynamic global business environment. This course examines the effects of transaction processing, liquidity management, organizational structure, personnel, and compliance on the nature of operational risk. Qualitative and quantitative measures of operational risk are discussed. Pre-Requisite: Graduate status.

FRE 6431, Electronic Market Design
1.5:0:0:1.5
This course covers topics on the design and analysis of electronic market places. This is an exciting new research area which incorporates ideas from economics (in particular game theory and mechanism design), AI, and theoretical computer science. Electronic markets have many interesting applications, from the obvious ones such as automated negotiation for ecommerce, to more non-obvious applications like resource allocation in grid computing settings. In this course we will focus on computational and game-theoretic questions related to electronic markets, and will look at what it means to design electronic markets with good properties. Course topics include the following: Introduction to game theory and mechanism design, winner determination in combinatorial auctions, bidding languages, approximate single shot auctions, iterative auctions, preference elicitation and communication complexity, mechanisms for selling digital goods, false-name bids, reputation mechanisms, computationally limited agents, trading agents, and privacy and auctions. Pre-Requisite: Graduate status.

Financial Labs
FRE 6811 Financial Lab 1: Excel, Risk, and Yieldbook
1.5:0:0:1.5
This course focuses on teaching students to use Excel, Risk, and Yieldbook

FRE 6821 Financial Lab 2: Eviews and Stata
1.5:0:0:1.5
This course focuses on teaching students to use Eviews and Stata

FRE 6831 Financial Lab 3: Matlab, GAMS, and optimization software
1.5:0:0:1.5
This course focuses on teaching students to use Matlab, GAMS, and optimization software

FRE 6841 Financial Lab 4: S–Plus and R
1.5:0:0:1.5
This course focuses on teaching students to use S–Plus and R

FRE 6851 Financial Lab 5: Excel with VBA and C++
1.5:0:0:1.5
This course focuses on teaching students to use Excel with VBA and C++

Capstone Options
FRE 7003 Financial Engineering Capstone: Thesis
3:0:0:3
This course is a research course. The student undertakes proprietary or non-proprietary research and writes a thesis-type research paper. Generally, the student will work under the supervision of a faculty member; however, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. Prerequisites: This course should be taken during the student’s final semester. Prerequisites will vary depending on the student’s track and the nature of the project to be undertaken.

FRE 7023 Financial Engineering Capstone: Internship
3:0:0:3
This course is an internship course. The student, with the help of the Career Services office secures an internship. The student will work under the supervision of a faculty member; however, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A paper based on the student’s internship work is required. Prerequisites: This course should be taken during the student’s final semester. Prerequisites will vary depending on the student’s track and the nature of the project to be undertaken.

FRE 7043 Financial Engineering Capstone: Project
3:0:0:3
This course is a project course. Students work with faculty on proprietary or non-proprietary research projects. Generally, the student will work under the supervision of a faculty member; however, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A significant written research component is required. Prerequisites: This course should be taken during the student’s final semester.
**Electives**

**FRE 6031 Money, Banking and Financial Markets**

3:0:0:3

Financial econometrics has matured into an important and necessary field providing an opportunity to deal with practical problems in finance. For example, techniques such as ARCH and GARCH and their subsequent development are used to estimate the volatility of underlying financial processes; the analysis of intra-day trading data requires particular mathematic techniques; Memory based and persistent stochastic processes can be used for algorithmic trading and detecting markets incompletion; Copulas are now applied routinely to model and estimate dependent risks, etc. These financial and risk problems require the application of advanced financial econometric techniques that the course provides from both theoretical and empirical-applied viewpoints. Selected cases are used to provide a real-world sense of financial engineering when it is faced with the reality and the complexity of financial markets.

**FRE 6051 Insurance Finance and Actuarial Science**

1.5:0:1.5

This course highlights essential facets of actuarial science, insurance and the finance-insurance convergence. The course assumes that students are familiar with basic notions of expected utility and stochastic processes and options pricing. Topics covered in the course include: The Insurance Business and Insurance Firms Management; Principles of Actuarial Science and Risk Pricing in Insurance and in Finance (Complete Markets); The Expected Utility Approach to Insurance Risk Pricing and Management; Derivatives and The Financial Approach to Insurance Pricing; Insurance Products (Life Insurance, Casualty, Pension Funds Defined Benefits and so on); Principles of Insurance Management in a Dynamic and Global Setting. Throughout the course, we shall numerous problems and cases drawn from actuarial and insurance problems and provide a financial perspective to their analysis. In particular, relating to insurance pricing, reserve policies, insurance pension funds, CAT Bond and weather (insurance) derivatives and regulation are emphasized. **Prerequisite: FRE 6103**

**FRE 6071 Derivatives, Financial Markets and Technology**

1.5:0:1.5

This is a half semester course that covers basic derivatives including futures contracts, forward contracts, option contracts, and swap contracts. The principal focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts are discussed. The use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed. The specifics of the contracts and the markets in which they trade are also discussed. The main focus is to give students in the Financial Technology track a general understanding of the derivatives market and risk management. **Prerequisites: FRE 6003, FRE 6023, FRE 6103**

**FRE 6111 Investment Banking and Brokerage**

1.5:0:1.5

This course provides an introductory overview of Wall Street, Back Office and general brokerage operations, investment banking and capital markets. The subjects covered are essential to the understanding of how products, once created, are actually distributed and sold. The course will rely heavily on The Wall Street Journal, Financial Times and other trade publications. Topics to be covered include: a brief history of Wall Street, an understanding of the major securities laws and how they have changed over time, basics of equity and debt securities, creation of debt and equity securities, pricing and sale of debt and equity securities. The course will seek to understand how and where opportunities for the creation of new securities arise. **Prerequisites: none**

**FRE 6131 Foundations of Financial Technology**

1.5:0:1.5

Every year, financial institutions spend billions to exploit the latest development in information technology. This course introduces a framework with which to understand and leverage information technology. The technology components covered include telecommunications, groupware, imaging and document processing, artificial intelligence and object-oriented analysis and design. The course also covers the entire technological planning process specifically for financial institutions. **Prerequisites: none**

**FRE 6151 Clearing and Settlement of Financial Transactions**

1.5:0:1.5

This course focuses on issues involved in the processing of financial transactions from order execution to final settlement of transactions. The course examines the procedures and market conventions for processing completed transactions, verifying transactions, confirming transactions, resolving conflicts, decisions involved in developing one’s own clearing operations or purchasing clearing services, the role played by the clearing houses, and numerous issues associated with cross border transactions. **Prerequisites: none**
FRE 6171 Management of Financial Institutions 1.5:0:0:1.5

This course focuses on managing institutions from a financial management perspective. By analyzing the factors that define the dynamics of the rapidly changing financial services industry, it explores the normative consequences of financial management decision-making to create shareholder value. Prerequisites: FRE 6031, FRE 6023

FRE 6191 Advanced Topics in Financial Technology 1.5:0:0:1.5

This course complements the Foundations of Financial Technology by providing in-depth treatment of advanced topics in this rapidly changing field. Students will prepare and present case studies applying the concepts covered in class. Prerequisites: FRE 6151

FRE 6123 Financial Risk Management & Asset Pricing 3:0:3

This course introduces the students to the problems and opportunities of Financial Risk Management and Asset Pricing and to their associated techniques Risk finance and attitudes, principles of decision making under uncertainty, valuation and expected utility and their relevance to the valuation and the pricing of financial investments, portfolios, insurance, the management of derivatives, etc. are considered as fundamental applications in financial engineering. Managing risks such as trading risks, credit risks, portfolio risks and other problems encountered in finance practice will be formulated and solved using both financial software and financial and mathematical techniques. To price risk, the course will provide an introduction to the Arrow-Debreu framework for complete markets and risk neutral pricing as well as treat some practical problems in implied risk neutral pricing. Prerequisites: none

FRE 6211 Financial Market Regulation 1.5:0:0:1.5

This course considers the role and forms of regulation in the U.S. financial markets, the role of the Securities and Exchange Commission (SEC), the Commodity Futures Trading Commission (CFTC), the Federal Reserve, the Office of the Controller of the Currency (OCC), self-regulating organizations (SROs) such as the National Association of Securities Dealers, and the National Futures Association are examined. Also examined are the roles of the state insurance commissions, and the Department of Labor. Prerequisites: FRE 6031

FRE 6231 Stochastic Calculus and Financial Modeling 1.5:0:0:1.5

This course extends the core course FE6083 to Applied Stochastic Calculus in Finance, emphasizing the modeling approach and resolution of important problems in derivatives finance, in pricing assets and complex financial products. In addition, cases highlighting the impact of theoretical finance on practical market trading, portfolio management and related problems are emphasized. To do so, the course introduces the student to the elements of stochastic processes and stochastic calculus as they are applied in financial engineering. Some of the techniques covered include, Markov chains, random walks, stochastic differential equations and Ito Calculus. These techniques are then applied to model, assess and simulate (using Matlab) essential derivative and related problems of practical importance I finance. Parts of the course will be based on the book of Tapiero C.S., Applied Stochastic Models and Control for Finance and Insurance, Kluwer, 1998. Prerequisites: FRE 6083

FRE 6251 Numerical and Simulation Techniques in Finance 1.5:0:0:1.5

Advanced numerical techniques for the solution of ordinary, partial and stochastic differential equations are presented. These techniques are analyzed both mathematically and using computer aided software that allows for the solution and the handling of such problems. In addition, the course introduces Monte Carlo simulation techniques and their use to deal with theoretically complex financial products in a tractable and practical manner. Both self-writing of software as well as using outstanding computer programs routinely used in industry will be used. Prerequisites: FRE 6083

FRE 6271 Valuation of Equity Securities and Financial Statement Analysis 1.5:0:0:1.5

This course provides a detailed examination of the tools and techniques for analyzing financial statements for purposes of credit evaluation, forecasting, identifying merger candidates, enhancing the efficiency of decision making, and diagnosing problem areas within the firm before crises develop. Students will also be taught to use financial ratios to conduct duPont (i.e., decomposition) analysis, a methodology to track down sources of poor performance through interrelationships among a firm’s financial ratios. Prerequisites: FRE 6003, FRE 6103

FE 6291 Options and Derivatives
This course covers basic derivatives including futures contracts, forward contracts, option, and swap contracts. The focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts and the use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed, as are the specifics of the contracts and the markets in which they trade. Financial derivatives such as interest rate, currency, and equity contracts, and some brief discussion of commodity contracts and specialty contracts such as insurance derivatives and credit derivatives are also discussed. Prerequisites: FE 6003, FE 6023, FE 6103

FRE 6311 Dynamic Assets and Option Pricing
1.5:0:0:1.5

The purpose of this course is to focus on inter-temporal assets pricing both in discrete and continuous time. Problems in complete and incomplete markets of both theoretical and practical interest requiring an appreciation of financial economic theories and computational techniques are profusely used and the financial engineering techniques needed are introduced. Problems and cases are presented spanning Fixed Income (Bonds), Stocks and Derivatives (Options of various sorts), Real Asset Pricing and Implied Risk Neutral Pricing. Reference Text: Tapiero C.S., Applied Stochastic Models and Control for Finance and Insurance, Kluwer, 1998. Prerequisites: FRE 6083, FRE 6123

FRE 6331 Financial Risk Management and Optimization
1.5:0:0:1.5

This course provides solution to the inter-temporal management of portfolios, financial products of various sorts, credit risks, market making etc. using dynamic optimization techniques. Dynamic and stochastic dynamic programming techniques as well optimal and stochastic control principles of optimality are presented in financial contexts emphasizing both theoretical and practical facets of the inter-temporal management of financial risks. Prerequisites: FRE 6083, FRE 6123

FRE 6351 Advanced Financial Econometrics
1.5:0:0:1.5

Financial econometrics has matured into an important and necessary field providing an opportunity to deal with practical problems in finance. For example, techniques such as ARCH and GARCH and their subsequent development are used to estimate the volatility of underlying financial processes; the analysis of intra-day trading data requires particular mathematical techniques; Memory based and persistent stochastic processes can be used for algorithmic trading and detecting markets incompleteness; Copulas are now applied routinely to model and estimate dependent risks, etc. These financial and risk problems require the application of advanced financial econometric techniques that the course provides from both theoretical and empirical-applied viewpoints. Selected cases are used to provide a real-world sense of financial engineering when it is faced with the reality and the complexity of financial markets. Prerequisites: FRE 6083

FRE 6371 Contract Economics
1.5:0:0:1.5

This course provides advanced material in applied economics for students in financial engineering. The materials discussed in this course are topics important to the development of contractual relationships between parties with dissimilar interests, and include: moral hazard and the design of incentives, adverse selection and market signaling, auction theory and the winner’s curse, distributed and integrative negotiation, and more. Students who successfully complete this course will obtain an appreciation for the theoretical and practical challenges in completing contracts that provide satisfactory economic incentives to each party that also satisfy the other party’s belief that the terms they require will be met. Prerequisite: FRE 6023

FRE 6391 Mergers and Acquisitions and Corporate Finance
1.5:0:0:1.5

In this half-semester course we will examine the theories and empirical evidence related to mergers & acquisitions and other corporate transactions and reorganizations. We will look at friendly mergers, hostile takeovers (including takeover and anti-takeover tactics), leveraged buyouts, and bankruptcy. Throughout the course, we will pay close attention to the motives behind these transactions and reorganizations. Prerequisites: FRE 6103

FRE 6411 Valuation of Fixed Income Securities and Basic Interest Rate Derivatives
1.5:0:0:1.5

This course examines the body of analytical tools and measures that constitute modern fixed income markets. The valuation of interest-rate sensitive cash flows is the unifying theme. Major topics covered include theories of term structure, institutional aspects of fixed income markets, and analytical techniques for managing interest rate risk. Bond refunding, defeasance, corporate bonds, mortgage-backed securities, forwards, futures, options and interest rate swaps are discussed. The course also provides an overview of the major classes of fixed income securities and the markets in which they trade. Among the major classes of fixed income instruments discussed are Treasury and agency securities, mortgage-backed securities (including
CMOs and Strips), asset-backed securities, municipals, floating and inverse floating rate securities. Prerequisites: FRE 6023, FRE 6083, FRE 6103

FRE 6431 Electronic Market Design

1.5:0:0:1.5

This course covers topics on the design and analysis of electronic market places. This is an exciting new research area which incorporates ideas from economics (in particular game theory and mechanism design), AI, and theoretical computer science. Electronic markets have many interesting applications, from the obvious ones such as automated negotiation for e-commerce, to more non-obvious applications like resource allocation in grid computing settings. In this course we will focus on computational and game-theoretic questions related to electronic markets, and will look at what it means to design electronic markets with good properties. Course topics include the following: Introduction to game theory and mechanism design, winner determination in combinatorial auctions, bidding languages, approximate single shot auctions, iterative auctions, preference elicitation and communication complexity, mechanisms for selling digital goods, false-name bids, reputation mechanisms, computationally limited agents, trading agents, and privacy and auctions. Prerequisites: Graduate status.

FRE 6451 Behavioral Finance, Trading and Investment Strategy

1.5:0:0:1.5

This course provides a deep discussion of the investors’ systematic deviations from the level of financial rationality assumed by modern financial theory. Such biased behavior can lead to market inefficiencies, market opportunities, and market failure. After a brief introduction to the topic and its research history is conducted, the course will focus on major areas including the limits to arbitrage created by decision bias, the equity premium puzzle, market over-reaction and under-reaction, and more. The course will seek to understand how and where opportunities for and threats to wealth accumulation exist as a result of the mismatch between investor behavior and the assumptions about investment behavior inherent in financial theory. Prerequisites: FRE 6023

FRE 6471 Applied Financial Econometrics

1.5:0:0:1.5

This course builds on the concepts covered in FRE 6091 and addresses the design, estimation and application of both univariate and multivariate time series models that are widely used in finance and risk engineering. Applications include simulation and forecasting. Prerequisites: FRE 6083, FRE 6091

FRE 6491 Municipal and Public Finance

1.5:0:0:1.5

This course provides an overview and analysis of the market for debt obligations of state and local governments. Topics that will be covered include: the micro structure of the market, including the types of debt issued, as well as the characteristics of the buyers. Federal and state taxation of munis will be discussed, along with the regulatory structure of the industry. Bond structure, risk assessment, and risk management utilizing cash bonds, futures and options will be covered. Prerequisites: FRE 6411

FRE 6511 Intermediate Derivatives Valuation and Applications

1.5:0:0:1.5

This course covers exchange traded and over-the-counter (OTC) derivatives. The principal focus of the course is on financial engineering and risk management applications. Valuation concepts and the use of derivatives for speculative purposes, hedging, and arbitrage are discussed. Prerequisites: FRE 6023, FRE 6083, FRE 6103

FRE 6551 Accounting for Financial Products

1.5:0:0:1.5

This course addresses accounting issues as they pertain to innovative financial products, risk management strategies, tax driven strategies, and other manifestations of financial engineering, particularly those in which derivative financial instruments play an important role. Accounting and tax rules are reviewed and applied. Prerequisites: FRE 6003

FRE 6571 Asset-backed Securities

1.5:0:0:1.5

Asset-backed securities (ABSs) have become a hot topic in today’s fixed income arena, with a potential for returns exceeding that of other investments. This course examines the writings of leaders in this field and provides comprehensive coverage of the major asset-backed securities, structuring issues and relative value analysis. Topics to be covered include: The expanding frontiers of asset securitization: Introduction to ABS accounting; Trends in the structuring of ABSs; Prepayment nomenclature in the ABS market. Prerequisites: FRE 6411, FRE 6511

FRE 6591 Mortgage-backed Securities

1.5:0:0:1.5
This course takes the student from a general introduction to mortgage-backed securities (MBS) and real estate finance to a detailed treatment of some of the issues that make these instruments some of the most complex. Students will learn the fundamentals of yield curves, mortgage cash flows, prepayments, and analysis. The course will cover pass-throughs, CMOs, mortgage derivatives, and ARMs. Asset/Liability management of MBS will be discussed. Students will build a price-yield calculator for MBS pass-throughs (using a spreadsheet) and complete a course project. Prerequisites: FRE 6411, FRE 6511

FRE 6611 Basic Credit Derivatives Valuation and Applications
1.5:0:0:1.5
This course is designed as a basic introduction to credit derivatives and Collateralized Debt Obligations (CDO’s). The course will review the most important credit instruments, starting with risky bonds and credit default swaps, through basket swaps, structured products, and CDO’s. Each instrument will be defined and explained, including its markets, modeling, pricing, and risk management. The classwork will be illustrated with both theoretical homework and practical Excel projects. Prerequisite: FRE 6411, FRE 6511

FRE 6631 Applied Derivatives Finance
1.5:0:0:1.5
This course focuses on applied financial engineering applications using derivative securities, alone and in combination with other financial instruments. The course is taught by a financial engineering practitioner. In addition to complex financial engineering structures, students will also consider reverse engineering of structures. Cases presented will be from recent deals. Examples of applications might include tax arbitrage, the construction of equity collars on restricted stock, the alteration of the investment characteristics of large portfolios, the creation of synthetic financial instruments, and so forth. Prerequisites: FRE 6411, FRE 6511

FRE 6651 Term Structure Modeling and Advanced Interest Rate Derivatives
1.5:0:0:1.5
This course covers term structure models, the term structure of volatility, interest-rate processes with time-dependent volatility and mean reversion, a closer look at path-dependent securities including sinking fund bonds and options with look-back features, multi-factor models, and multinomial methods of discrete numerical implementations. Course readings will be drawn from current literature. Prerequisites: FRE 6411, FRE 6511. Students are expected to have knowledge in numerical analysis.

FRE 6671 Global Finance
1.5:0:0:1.5
This course covers the international dimensions of finance. It focuses on markets, players and instruments. It explores the main theoretical insights into the workings of the foreign exchange, international currency and bond markets, as well as how their integration serves price securities. While a detailed study of the institutions that frame these markets and international macro-economics is beyond the scope of this lecture series, we must nevertheless examine some of these concepts in order to understand the fundamental determinants of exchange rates and linkages between different countries’ interest rates. A number of parity conditions that prevent arbitrage as well as the role of expectations contribute to an understanding of the level and the volatility of international asset prices. Theory and institutional description are complemented by analyzing the mechanics of international financial instruments. The Value-at-Risk methodology will be employed to illustrate pricing and the use of the financial instruments in the context of international risk measurement and management. Prerequisites: FRE 6411, FRE 6511

FRE 6691 Credit Derivatives Valuation and Applications
1.5:0:0:1.5
Credit derivatives have emerged as an area of significant interest in global derivatives and risk management practice. These instruments have the potential to revolutionize the management of credit risk in banking and capital markets. This course introduces students to the full range of products available in today’s marketplace, the economic value of credit derivatives, valuation techniques, and guidelines on using them to manage and control risk. Prerequisites: FRE 6411, FRE 6511

FRE 6711 Portfolio Theory and Applications
1.5:0:0:1.5
This course provides an in-depth examination of modern portfolio theory and investment selection. It considers the mathematics of portfolio analysis, single-period risk and return measures, and the process of optimal portfolio selection. The basic portfolio model is extended to consider alternative risk concepts and multi-period portfolio horizons. Single factor and multi-factor models are also discussed. Optimization techniques, such as linear programming and quadratic programming are applied. The basic portfolio model is extended to explain hedging theory and to build firm-wide risk management models. Prerequisites: FRE 6411, FRE 6511.
FRE 6731 Basel 2 and Value at Risk
1.5:0:0:1.5
This course addresses financial risk management with particular focus on Basel 2 directives and Value at Risk (VaR), a method of assessing risk which uses standard statistical techniques routinely used in other fields. VaR analysis is used by bank and corporate managers, and by financial market regulators.  Co-requisite: FE 6711

FRE 6751 Credit Risk Measurement and Management
1.5:0:0:1.5
This course deals with issues in credit risk measurement, credit risk management, and related areas in which credit considerations are important. These issues arise in credit rating activity, credit extension by banks and other financial services, and in derivative markets where counter party risk is perceived to be an important management issue.  Co-requisite: FE 6711

FRE 6771 Financial Optimization Techniques
1.5:0:0:1.5
The purpose of this course is to illustrate and describe the role of optimization in computational finance, in both their static and dynamic contexts. Throughout the course, theoretical problems are developed and contrasted to real problems drawn for financial engineering practice.  Prerequisites: FE 6311

FRE 6791 Operational Risk Measurement and Management
1.5:0:0:1.5
The operational difficulties faced by financial institutions have created a need for tools to measure and manage operational risk. An accurate appreciation of risks, exposures, and controls is critical to effectively managing risk in today’s dynamic global business environment. This course examines the effects of transaction processing, liquidity management, organizational structure, personnel, and compliance on the nature of operational risk. Qualitative and quantitative measures of operational risk are discussed.  Co-requisite: FE 6711

FRE 6803 Financial Engineering (research course)
3:0:0:3
This course is a research/case course. It can be handled a number of different ways at the discretion of the faculty supervisor. It may involve a serious of cases that are dissected and analyzed, it may involve teaming students with industry personnel for proprietary or non-proprietary research projects, and it may involve thesis-type research. Generally, the student will work under the supervision of a faculty member but the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A significant written research component is required.  Prerequisites: This course should be taken during the student’s final semester. Prerequisites will vary depending on the student’s track and the nature of the project to be undertaken.

FRE 6901-6991 Selected Topics in Financial Engineering
1.5:0:0:1.5
Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others.  Prerequisites: Graduate standing and instructor’s permission

FRE 7203 Selected Project in Financial Engineering
6:0:0:6
Project selected with academic advisor’s permission

FRE 7801 Quantitative Topics in Finance & Financial Markets 1
1.5:0:0:1.5
Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others.  Prerequisites: Graduate standing and instructor’s permission

FRE 7811 Quantitative Topics in Finance & Financial Markets 2
1.5:0:0:1.5
Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others.  Prerequisites: Graduate standing and instructor’s permission

FRE 7831 Topics in Financial & Risk Engineering 1
1.5:0:0:1.5
Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. Prerequisites: Graduate standing and instructor’s permission.

FRE 7851 Topics in Financial & Risk Engineering 2

1.5:0:0:1.5

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. Prerequisites: Graduate standing and instructor’s permission.