

FINANCE AND RISK ENGINEERING (FRE-GY)

FRE-GY 5010 FRE Bootcamp I (0 Credits)

Typically offered Summer term

This summer bootcamp online experience for the incoming MS Financial Engineering cohort prepares students for coursework in Financial Engineering and for summer internship interviews.

Grading: Class does not print on the transcript

Repeatable for additional credit: No

FRE-GY 5020 FRE Bootcamp II (0 Credits)

Typically offered Summer term

This summer bootcamp online experience for the incoming MS Financial Engineering cohort prepares students for coursework in Financial Engineering and for summer internship interviews.

Grading: Class does not print on the transcript

Repeatable for additional credit: No

FRE-GY 5030 FRE Bootcamp III -- From Brain Teasers to Black-Scholes (0 Credits)

Typically offered Summer term

This summer bootcamp experience for the incoming MS Financial Engineering cohort prepares students for coursework in Financial Engineering and for summer internship interviews. | Prerequisite: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the department. Corequisites: FRE-GY 5040

Grading: Grad Poly Pass/Fail

Repeatable for additional credit: No

Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the department.

FRE-GY 5040 FRE Bootcamp IV - Econometrics and Machine Learning with Python (0 Credits)

Typically offered Summer term

This summer bootcamp experience for the incoming MS Financial Engineering cohort prepares students for coursework in Financial Engineering and for summer internship interviews. | Prerequisite: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the department. Corequisites: FRE-GY 5030

Grading: Grad Poly Pass/Fail

Repeatable for additional credit: No

Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the department.

FRE-GY 5500 BLOOMBERG CERTIFICATION (0 Credits)

Typically offered Fall, Spring, and Summer terms

This course tracks the requirement for the self-paced, self-taught Bloomberg certification to be completed through a Bloomberg terminal. | Prerequisite: Graduate Financial Risk Engineering students only

Grading: Grad Poly Pass/Fail

Repeatable for additional credit: No

FRE-GY 5990 Capstone Assessment (0 Credits)

Typically offered occasionally

The Master of Science in Financial Engineering program offers four types of Capstone experiences to its graduate students: theses, projects, special topics, and internships. This Capstone Assessment will serve as a centralized measure for the various types of Capstone experiences to identify whether students have successfully completed this experience and garner feedback about graduating students' skills and professional readiness. Note: course should be completed during final semester of studies. | Prerequisites: FRE-GY 9973 or FRE-GY 7021 (taken two times for a total of 3 credits) or FRE-GY 7043 or two special topics courses of 1.5 credits each, with a capstone papers submitted to the faculty.

Grading: Grad Poly Pass/Fail

Repeatable for additional credit: No

FRE-GY 6003 FINANCIAL ACCOUNTING AND ANALYSIS (3 Credits)

Typically offered Fall and Spring

This course provides a solid understanding of the creation and interpretation of modern financial statements. Topics include the reasons for financial statements, U.S. accounting principles and how they differ abroad, quality of financial information, financial ratios and their uses, cash-flow analysis, measurement of corporate performance. The course will also cover various methods of forecasting statements and a discussion of valuation. | Prerequisite: Graduate Standing or permission of FRE department.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6021 INSURANCE AND FINANCIAL CREDIT DERIVATIVES (1.5 Credits)

Derivatives have moved to the center of modern corporate finance, investments and the management of financial institutions. Option pricing concepts are also applied to actuarial problems such as equity-linked insurance. This advanced course in derivatives introduces binomial option-pricing model and option pricing using the Black-Scholes model. The properties of a lognormal distribution are derived, and the Black-Scholes formula is introduced as a limited expected value for a lognormal distribution. The option Greeks are defined and analyzed. Applications to actuarial problems and risk-management techniques such as deltahedging are presented. Finally, interest models (e.g., Vasicek and Cox-Ingersoll-Ross models) for bond pricing are treated in detail. | Prerequisite: FRE-GY 6103 Corporate Finance. Co-Requisite: None. Notes: None.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6023 FINANCIAL ECONOMICS (3 Credits)

Typically offered Fall and Spring

This course provides a rigorous introduction to the principles and application of the theory of financial economics. Following a review of foundational theories of markets and competition, this course covers the following areas: certainty and perfect capital markets, the institutional setting of financial economics, risk and contingent claims theory, and capital market imperfections and the limits to arbitrage that these impose on financial systems. | Prerequisite: Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6031 Money, Banking and Financial Markets (1.5 Credits)*Typically offered Fall and Spring*

Studies how the interactions among money, the financial system and the economy determine interest rates and asset returns. It utilizes a consistent approach based in economics to explain the role of the financial system in matching savers and borrowers and in providing risk-sharing, liquidity and information services in efficient financial markets. Students study why and how financial markets and financial instruments evolve as a function of transactions and information costs, adverse selection and moral hazard problems, and summarize economic arguments for and against regulation. Finally, they examine the money supply process and monetary policy, in particular the link between monetary authorities and the macro-economy through a transmission mechanism involving banks and the non-financial public. | Prerequisite: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of Department

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6041 Extreme Risk Analytics (1.5 Credits)***Typically offered Fall and Spring*

The course covers failures of financial theory in risk management, deriving from fundamental definitions and assumptions in modeling, including pricing formulae; convexity; stochasticity and volatility; "fat tails"; and risk. Other topics: Portfolio robustness and extreme markets and moral hazard; data-mining biases and decision error; and decision-making with incomplete information. | Pre-Requisite: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6051 Insurance Finance and Actuarial Science (1.5 Credits)***Typically offered Fall and Spring*

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 include Insurance Business and Insurance Firms Management; Principles of Actuarial Science and Risk Pricing in Insurance and in Finance (Complete Markets); Expected Utility Approach to Insurance Risk Pricing and Management; Derivatives and the Financial Approach to Insurance Pricing; Insurance Products (Life Insurance, Casualty, Pension Funds and Defined Benefits); Principles of Insurance Management in a Dynamic and Global Setting. Throughout, the course uses numerous cases centered on actuarial and insurance problems and analyzes them from a financial perspective. Of particular interest are those related to insurance pricing, reserve policies, insurance pension funds, CATBOND and weather (insurance) derivatives and regulation. | Prerequisite: FRE-GY 6103. Co-Requisite: None. Notes: None.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6073 Introduction to Derivative Securities (3 Credits)***Typically offered Fall, Spring, and Summer terms*

This course explains in detail various models and methods for pricing and hedging derivatives including: European, American, exotic options, swaps, and convertible bonds. Presentation is done using equity, interest rate, and volatility derivative products. A short introduction to computational methods necessary for pricing derivatives is provided. | Prerequisites: Matriculation into MS Financial Engineering or permission of the department.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6083 Quantitative Methods in Finance (3 Credits)***Typically offered occasionally*

This course focuses on quantitative methods and financial modeling. Probability theory, stochastic processes and optimization are studied and applied to a broad variety of financial problems and their derivatives. Topics 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. | Prerequisite: Students are expected to know calculus and elementary probability and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6091 Financial Econometrics (1.5 Credits)***Typically offered Fall and Spring*

Topics include a review of probability and statistical inference and linear regression models. The focus of the course is time series analysis with special attention to the modeling of financial stock prices and returns. Volatility modeling and estimation will be also addressed through the analysis of intra-day trading data. | Prerequisite: FRE-GY 6083 and a working knowledge of statistics. Matriculation into MS Financial Engineering or permission of the department.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6103 VALUATION FOR FINANCIAL ENGINEERING (3 Credits)***Typically offered Fall and Spring*

This course introduces financial engineers to robust risk-based valuation methods in discrete and continuous time. This includes four major applications: cash flows, traded derivative contracts, nontraded and embedded derivatives, and corporate assets & liabilities. - "Cash flows" refers to risk-free and risky payments or expenditures. - "Traded derivatives" include a high level treatment of forward contracts and the most commonly traded option contracts. - "Nontraded and embedded derivatives" refer to contingent cash flows created in the normal processes of contracting and asset management - "Corporate assets" refer to claims to cash flows owned and managed by corporations - "Corporate liabilities" refers to corporate-issued securities or other payment obligations incurred by corporations. | Prerequisite: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6111 Investment Banking and Brokerage (1.5 Credits)***Typically offered Fall and Spring*

This course introduces an overview of Wall Street, the back office and general brokerage operations, investment banking and capital markets. The course covers subjects essential to understanding how products, once created, are distributed and sold. The course relies heavily on The Wall Street Journal, Financial Times and other trade publications. Topics 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, and pricing and sale of debt and equity securities. The course seeks to understand how and where opportunities for creating new securities arise. | Prerequisites: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 6123 FINANCIAL RISK MANAGEMENT (3 Credits)*Typically offered Fall and Spring*

This course introduces the techniques and problems of Financial Risk Management and Asset Pricing. It emphasizes risk finance and attitudes; Value at Risk; risk measurement principles; valuation and expected utility and their relevance in the valuation and the pricing of financial investments; insurance; management of derivatives; and risk management. Throughout, risk-management application problems are explored. The course introduces and focuses on the fundamental principles of the Arrow-Debreu state preference theory used to price derivatives and other assets in complete markets. Risk neutral-Binomial models in option pricing; essential elements of Ito calculus; and the Black-Scholes model for pricing options are introduced and applied to practical financial decision making and risk management problems.

Prerequisite: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6131 CLEARING AND SETTLEMENT AND OPERATIONAL RISK (1.5 Credits)***Typically offered Fall and Spring*

This course focuses on issues involved in processing financial transactions—from order execution to final settlement of transactions—and operational risk in general. The course examines the procedures and market conventions for processing, verifying, and confirming completed transactions; resolving conflicts; decisions involved in developing clearing operations or purchasing clearing services; the role played by clearing houses; and numerous issues associated with cross-border transactions. The course also examines the effects of transaction processing, liquidity management, organizational structure, and personnel and compliance on the nature of operational risk. Qualitative and quantitative measures of operational risk are discussed. |

Prerequisite: FRE-GY 6153 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6141 Static and Dynamic Hedging (1.5 Credits)***Typically offered occasionally*

The course discusses advanced topics in hedging exposures, with emphasis on adaptation of the mathematics to the real world. Examines applications in quantitative finance. Methods in the hedging of cash flows and liabilities for corporations and for option traders are covered. A synthesis is made of both theory and historical hedges traded. |

Prerequisite: Graduate Financial Risk Engineering students only

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6143 LIFE CONTINGENCIES I (3 Credits)***Typically offered occasionally*

This course introduces the Mathematics of Life Insurance. Basic topics covered are survival distributions, time-of-death as a continuous random variable, life tables and their interpretation. Applications include estate planning, tax ramifications and other specific issues related to the multiple uses of life insurance. Characteristics of life annuities are exhibited; the equivalence principle is introduced and used to evaluate future benefits. Prospective future loss on a contract already in force is investigated. An emphasis lies on the integration of life contingencies into a full risk-theory framework and the use of modern probabilistic and financial methods. Prerequisites: None. | Prerequisite: FRE-GY 6051 Insurance Finance and Actuarial Science and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6153 FOUNDATIONS OF FINANCIAL TECHNOLOGY (3 Credits)***Typically offered Fall and Spring*

Financial Institutions spend billions per year 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, networks, protocols, risk, and object-oriented analysis and design. The course also covers the entire technological-planning process specifically for financial institutions. | Prerequisite: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6163 LIFE CONTINGENCIES II (3 Credits)***Typically offered occasionally*

The course investigates annuity and insurance contracts involving two lives. Subsequently, a more realistic model is introduced in which several causes of decrement are possible. An overview of risk-theory application to insurance is given. Also covered are an extension of the individual model to incorporate operational constraints such as acquisitions and administrative expenses, accounting requirements and the effects of contract termination. | Prerequisite: FRE-GY 6143 Life Contingencies and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6171 Management of Financial Institutions (1.5 Credits)***Typically offered occasionally*

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, the course explores the normative consequences of financial management decision-making to create shareholder value. | Prerequisites: FRE-GY 6031, FRE-GY 6023.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6191 Advanced Topics in Financial Technology (1.5 Credits)***Typically offered occasionally*

This course complements the Foundations of Financial Technology by treating in-depth advanced topics in this rapidly changing field. Students prepare and present case studies applying the concepts covered in class. | Prerequisites: FRE-GY 6153.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6211 Financial Market Regulation (1.5 Credits)***Typically offered Fall and Spring*

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), and self-regulating organizations (SROs) such as the National Association of Securities Dealers and the National Futures Association. Also examined are the roles of the state insurance commissions and the STATE OR FEDERAL Department of Labor. | Prerequisites: FRE-GY 6031 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 6223 Actuarial Models (3 Credits)*Typically offered occasionally*

Many problems in actuarial science involve building a mathematical model to forecast or predict future insurance losses and revenues. Historical data guide the actuary in selecting the model and in calibrating its unknown parameters. The course introduces discrete and continuous actuarial models such as loss, frequency and severity models and their specific characteristics. It then studies aggregate loss models in which individual risks are pooled into a manageable aggregate risk. Finally, financial tools are used to market price these losses and allow a securitization of insurance firms' portfolios. | Prerequisite: FRE-GY 6051 Insurance Finance and Actuarial Science and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6233 OPTIONS PRICING & STOCHASTIC CALCULUS (3 Credits)***Typically offered Fall and Spring*

This course provides the mathematical foundations of Option Pricing models. The techniques covered include arithmetic and geometric Brownian motion, first passage time, the reflection principle, the stochastic Ito integral, Ito differential Calculus, change of probability measure, martingales, Stochastic Differential Equations and Partial Differential Equations. Some of the pricing models considered are the European, Barrier, Asian and American options. These problems are either solved analytically by the martingale approach or numerically, by applying approximation and simulation methods. Since the same techniques allow the treatment of more complex financial products, examples of credit derivatives will be also presented. This course is a requirement in the Computational Finance Track | Prerequisite: FRE-GY 6083

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6243 CREDIBILITY AND LOSS (3 Credits)***Typically offered occasionally*

This course deals with actuarial models and the estimation of their parameters. Statistical parameter estimation techniques and Bayesian methods are used to study and interpret survival models. Quantitative methods for model selection and model testing are introduced. The basics of credibility theory provide the mathematical tools for an insurer's prospective experience rating on a risk or a group of risks (e.g., to justify policy prices). Finally, model simulation techniques are treated in theory and practice. | Prerequisite: FRE-GY 6223 Actuarial Models.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6251 NUMERICAL & SIMULATION TECHNIQUES IN FINANCE (1.5 Credits)***Typically offered Fall and Spring*

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. | Prerequisite: FRE-GY 6083 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6273 CORPORATE VALUATION: FROM STARTUPS TO GIANTS (3 Credits)***Typically offered Fall and Spring*

This course provides students with the analytical skills needed to value firms ranging from early-stage startups to mature giants. Students will build and present a valuation model for a mature company of their choice, and will also present their valuation of a startup to its venture backers and its management team. Additionally, students will learn to value non-business related assets, such as vintage wines and residential real estate, by applying big-data techniques and robust econometric models to non-economic data. | Prerequisites: FRE-GY 6103 and FRE-GY 6003

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6291 APPLIED DERIVATIVE CONTRACTS (1.5 Credits)***Typically offered Fall and Spring*

This course provides an introduction to derivative contracts with a special emphasis on current practical applications in use today by financial institutions for investing, hedging, trading and issuing. The characteristics and features of futures, forwards, swaps, options and structured notes are all covered with a special emphasis on useful applications. For each of the four primary derivative contracts, we review in these lectures the appropriate definitions, terminology, market mechanics and theoretical fair value pricing. | Prerequisite: FRE-GY 6003, FRE-GY 6023, FRE-GY 6103 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6303 Dynamic Assets and Option Pricing (3 Credits)***Typically offered Fall and Spring*

This course provides the foundations of option pricing models. The problems are either solved analytically by the martingale and Partial Differential equation approaches, or numerically, by applying approximation and simulation methods. The applications to both European and American options, exotic options, and bonds will be presented. Since the same techniques allow the treatment of more complex financial products, application to fixed income derivatives such as interest rate caps will also be presented. This course is a requirement in the Computational Finance Track and is a track elective in the Risk Finance Track. | Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of Department & FRE-GY 6083.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6311 Dynamic Assets and Options Pricing (1.5 Credits)***Typically offered occasionally*

The course focuses on inter-temporal assets pricing in discrete and continuous time. The course explores problems in complete and incomplete markets of both theoretical and practical interest that require an appreciation of financial economic theories and computational techniques. Financial-engineering techniques are introduced including Martingales, stochastic calculus and jump processes; these are applied to engineering problems in finance. Problems and cases are presented that span Stocks and Derivatives (options of various sorts), Bonds and Implied Risk-Neutral Pricing. | Prerequisites: FRE-GY 6083, FRE-GY 6123 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 6321 CASUALTY I (1.5 Credits)

This course broadens perspectives on the business environment in which actuaries work and analyzes insurance-pricing cycles and regulatory developments. Rating and solvency issues are covered, as well as the rating of individual risks and the concept of loss reserve. The course also touches on issues behind daily events and the impact of current developments in the actuarial sciences on the actuarial function. | Prerequisite: FRE-GY 6051 Insurance Finance and Actuarial Science.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6331 FINANCIAL RISK MANAGEMENT AND OPTIMIZATION (1.5 Credits)

Typically offered Fall and Spring

This course provides solutions to the inter-temporal problems in financial management of portfolios, credit risks and market making. Dynamic and stochastic dynamic programming techniques as well as 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 also stressed. The course uses financial and optimization software to solve problems practically. | Prerequisites: FRE-GY 6083, FRE-GY 6123, and FRE-GY 6091 and Graduate Standing.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6341 CASUALTY II (1.5 Credits)

This course continues FRE-GY 6321. It covers operational issues of Property and Casualty insurance. Specialized Lines of Business are treated. An introduction to Classification Analysis is given. | Prerequisite: FRE-GY 6321.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6351 Econometrics and Time Series Analysis (1.5 Credits)

Typically offered Fall and Spring

Financial econometrics has matured into a necessary and essential part of financial engineering that provides opportunities to deal with real and 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 that requires particular models and techniques; memory-based and fractal stochastic processes to study complex markets behaviors and copulas applied routinely to model- and estimate-dependent risks. These financial and risk problems require the application of advanced financial-econometric techniques, which the course provides from both theoretical and empirical-applied viewpoints. Selected cases provide a real-world sense of financial engineering when it is faced with financial-market reality and complexity. | Prerequisite: FRE-GY 6083 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6361 Corporate and Financial Strategy (1.5 Credits)

Typically offered Fall and Spring

This is an introduction to financial strategy for MS Financial Engineering students. The course focuses on the role of financial engineers and financial officers in developing and sustaining competitive advantage through the use of financial engineering analyses. | Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the Department & FRE-GY 6023 and FRE-GY 6103.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6371 Contract Economics (1.5 Credits)

Typically offered occasionally

This course covers advanced material in applied economics for students of financial engineering. The topics discussed include the development of contractual relationships between parties with dissimilar interests. These include risks of moral hazard and the design of incentives, adverse selection and market signaling, auction theory and the winner's curse, and distributed and integrative negotiation. Students who complete this course successfully obtain an appreciation for the theoretical and practical challenges in completing contracts that provide satisfactory economic incentives to each party and satisfy the other party's belief that the required terms will be met. | Prerequisite: FRE-GY 6023 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6391 MERGERS & ACQUISITIONS (1.5 Credits)

Typically offered Fall and Spring

This course examines the theories and empirical evidence related to mergers and acquisitions and other corporate transactions and reorganizations. The course looks at friendly mergers, hostile takeovers (including takeover and anti-takeover tactics), leveraged buyouts and bankruptcy. Throughout, the course examines the motives behind these transactions and reorganizations. | Prerequisites: FRE-GY 6103 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6411 Fixed Income Securities and Interest Rate Derivatives (1.5 Credits)

Typically offered Fall, Spring, and Summer terms

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 include theories of term structure, institutional aspects of fixed-income markets and analytical techniques for managing interest-rate risk. Bond refunding, defeasance, corporate bonds, forwards, futures, options and interest-rate swaps are discussed. The course gives 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. | Prerequisite: FRE-GY 6023, FRE-GY 6083, FRE-GY 6103 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6451 BEHAVIORAL FINANCE (1.5 Credits)

Typically offered Fall and Spring

This course discusses 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, the course focuses on the limits to arbitrage created by decision bias, the equity premium puzzle, market over-reaction and under-reaction. The course seeks to understand how and where opportunities for and threats to wealth accumulation exist as a result of the mismatch between investor behavior and the algorithmic assumptions about investment behavior inherent in financial theory. | Prerequisite: FRE-GY 6023 and Graduate Standing.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6471 APPLIED FINANCIAL ECONOMETRICS (1.5 Credits)

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 used widely in finance and risk engineering. Financial econometric techniques such as ARCH-GARCH methods and the use of numerical techniques and simulation. | Prerequisites: FRE-GY 6083, FRE-GY 6091.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6491 Credit Risk & Financial Risk Management (1.5 Credits)

Typically offered Fall and Spring

This course provides a deep understanding of credit instruments from a qualitative and quantitative point of view. Students learn how to price credit derivatives and hedge credit risk. Both the structural and intensity models approaches are presented. Applications to a number of structured products are considered. | Prerequisites: FRE-GY 6411 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6511 DERIVATIVES ALGORITHMS (1.5 Credits)

Typically offered Fall and Spring

This course focuses on the algorithms behind derivatives valuation and applications. The focus is on the principles and practice of financial engineering and risk management and on developing intuition: understanding the reasons for the existence of the product, simulating possible paths and possible parameter values as an exploratory process, approximating complex derivatives as a combination of simpler ones, and attempting to replicate the payout. The goal is to prepare you to be able to evaluate an arbitrary derivative given only its term sheet. To that end, the course requires a project almost every week. Projects can be done in any programming language (Excel, Mathematica, R, Python, etc.), but the final result must be stand-alone tables and graphs. The primary prerequisite is familiarity with standard option pricing and Greeks.

A portion of the final exam may involve a live computation project. |

Prerequisite: FRE-GY 6123 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6513 INTERM DERIV VALUAT & APPLIC (3 Credits)

Typically offered occasionally

This course covers increasingly exotic derivatives. The focus is on the principles and practice of financial engineering and risk management and on developing intuition: understanding the reasons for the existence of the product, simulating possible paths and possible parameter values as an exploratory process, approximating complex derivatives as a combination of simpler ones, and attempting to replicate the payout. The goal is to prepare you to be able to evaluate an arbitrary derivative given only its term sheet. To that end, the course requires a project almost every week. Projects can be done in any programming language (Excel, Mathematica, R, Python, etc.), but the final result must be stand-alone tables and graphs. The primary prerequisite is familiarity with standard option pricing and Greeks. Prerequisite: FRE-GY 6123

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6531 FINANCIAL TAXATION (1.5 Credits)

Typically offered occasionally

Prerequisites: Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6551 Accounting for Financial Products (1.5 Credits)

Typically offered occasionally

This course addresses accounting issues pertaining 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-GY 6003.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6571 Asset-backed Securities and Securitization (1.5 Credits)

Typically offered Fall and Spring

This course examines essential contributions in this field and provides a comprehensive coverage of financial securitization and their application to major asset-backed securities, structuring issues and relative value analysis. Topics include the expanding frontiers of asset securitization; introduction to ABS accounting; trends in the structuring of ABSs; and prepayment nomenclature in the ABS market. | Prerequisites: FRE-GY 6411, FRE-GY 6511 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6591 Real Estate Finance and Mortgage-backed Securities (1.5 Credits)

Typically offered occasionally

This course takes the student from a general introduction to real estate finance and applied mortgage-backed securities (MBS) to a detailed treatment of issues that make real estate and these instruments some of the most complex. Students learn the fundamentals of yield curves, mortgage-cash flows, prepayments and analysis. The course covers pass-throughs, CMOs, mortgage derivatives and ARMs. Asset/Liability management of MBS will be discussed. Students build a price-yield calculator for MBS pass-throughs (using a spreadsheet) and complete a course project. | Prerequisites: FRE-GY 6411, FRE-GY 6571 and Graduate Standing

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6611 Credit Derivatives (1.5 Credits)

Typically offered occasionally

This course introduces credit derivatives and Collateralized Debt Obligations (CDO's). The course reviews the most important credit instruments and their marketing, starting with risky bonds and credit default swaps, through basket swaps, structured products and CDO's. Each instrument is defined and explained, including its markets, modeling, pricing and risk management. Class work is illustrated with theoretical homework and practical Excel projects. | Prerequisite: FRE-GY 6411, FRE-GY 6511.

Grading: Grad Poly Graded

Repeatable for additional credit: No

FRE-GY 6631 Applied Derivatives and Real Options Finance (1.5 Credits)*Typically offered occasionally*

This course focuses on financial-engineering applications using derivatives, alone and in combination with other financial instruments. In addition to studying complex financial-engineering structures, students consider applications of real options to the many industrial and assets management problems dealt with by business firms. Examples of applications include case problems in real options as well as issues in tax arbitrage, the construction of equity collars on restricted stock, the alteration of the investment characteristics of large portfolios, and the creation of synthetic financial instruments. | Prerequisites: FRE-GY 6411, FRE-GY 6511.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6651 Term Structure Modeling and Advanced Interest Rate Derivatives (1.5 Credits)***Typically offered occasionally*

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 are drawn from current literature. | Prerequisites: FRE-GY 6411, FRE-GY 6511. Students are expected to know numerical analysis.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6671 Global Finance (1.5 Credits)***Typically offered Fall and Spring*

The level of economic and financial globalization combined with the growth of the multinational firms and virtual firms with no boundaries may have altered the future of finance and its risk engineering. The purpose of this course is to focus attention on the essential elements that both large financial firms and institutions are confronting worldwide, the challenges of national and international financial investments, currencies speculations and investments, regulation as well as managing risks in a strategic and macroeconomic environment. In such an environment, financial markets are multi-polar, geographically distributed with national entities pursuing their own economic and political agenda. | Prerequisites: FRE-GY 6411 and FRE-GY 6511 and matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the Department

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6691 Intermediate Credit Derivatives Valuation and Applications (1.5 Credits)***Typically offered occasionally*

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 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-GY 6411, FRE-GY 6511.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6711 Quantitative Portfolio Management (1.5 Credits)***Typically offered Fall and Spring*

This course focuses on the quantitative foundations of portfolio management. It teaches the fundamental mathematical models such as the Markowitz, CAPM, and the Merton investment-consumption models, and discusses the issues related to the implementation of these models in practice to different types of portfolios. Finally, it also introduces some common portfolio construction and rebalancing techniques. | Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the Department & FRE-GY 6083

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6713 Advanced Investment Theory and Applications (3 Credits)***Typically offered Fall and Spring*

This course covers a wide range theoretical and practical issues that arise in the management of equity and fixed income portfolios, including the classical (Markowitz) foundations of mean-variance optimization, the use of constraints, risk budgeting, robust (outlier-resistant) optimization, tail risk aware optimization, the estimation of expected returns, and the measurement and monitoring of portfolio performance using ideas from statistical process control. It will also require the use of Bloomberg's PORT optimization tool to optimize, as well as to simulate the risk and return of, large portfolios. | Prerequisite: FRE-GY 6083, FRE-GY 6103 and Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of Department.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6731 Market Risk Management and Regulation (1.5 Credits)***Typically offered Fall and Spring*

This course covers quantitative methods of measurement and management of market risk as well as regulatory aspects of market risk management including both the current framework of Basel 2, 2.5, and 3 and the future methodology of FRTB. As the final project students produce a fully developed risk management system that includes risk calculations (sensitivities, VaR, Stressed VaR, Stress Analysis) on individual position and portfolio levels. | Co-requisite: FRE-GY 6711 and Graduate Standing.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6751 Credit Risk Measurement and Management (1.5 Credits)***Typically offered occasionally*

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: FRE-GY 6711.

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 6771 FINANCIAL OPTIMIZATION TECHNIQUES (1.5 Credits)*Typically offered occasionally*

The course introduces optimization concepts intended for coping with financial stochastic processes. The course involves both numerical analysis with commercial solvers and analytical approaches for gaining insights into underlying problems. The course covers three major optimization areas: convex optimization, non-convex optimization and stochastic programming. Conceptual frameworks and techniques are taught through applications and problems in financial engineering and management. | Prerequisite: FRE-GY 6311. Co-Requisite: None. Notes: None.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6803 Financial Engineering (research course) (3 Credits)***Typically offered Fall and Spring*

This course is a research/case effort and can be handled in different ways at the discretion of the faculty supervisor. The course may involve a series of cases that are dissected and analyzed. It may involve teaming students with industry personnel for proprietary or non-proprietary research projects. Or it may involve thesis-type research. Generally, students work under faculty supervision, but the course is intended to be largely self-directed within 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 vary depending on the student's track and the nature of the chosen project.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6811 FINANCIAL SOFTWARE LABORATORY (1.5 Credits)***Typically offered Fall, Spring, and Summer terms*

This course teaches students to use financial software tools commonly employed in industry. Examples include: @Risk, Yieldbook, Excel, R, and C++. | Prerequisites: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6821 FINANCIAL ECONOMETRIC LABORATORY (1.5 Credits)***Typically offered Fall and Spring*

This course teaches students to use Eviews and Stata. | Prerequisites: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6831 COMPUTATIONAL FINANCE LABORATORY (1.5 Credits)***Typically offered Fall and Spring*

The course introduces programming applications in financial modelling. Topics include variables, data types, input/output, plotting, selection statements, loop statements, functions, and classes, and implementation for Black-Scholes option pricing partial differential equation, Monte Carlo simulation, numerical methods for solving partial differential equations, and option pricing by Fourier transform.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6841 COMPUTATIONAL FINANCE LAB – MATLAB (1.5 Credits)***Typically offered occasionally*

This course uses MATLAB to explore applications of Computational Finance. | Prerequisites: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6851 Financial Lab 5: C++ (1.5 Credits)***Typically offered occasionally*

This course teaches students to use C++.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6861 FINANCIAL SOFTWARE ENGINEERING LABORATORY (1.5 Credits)***Typically offered occasionally*

This financial lab requires students to publicly participate in a large software project. This participation could take the form of contributing to an open-source financial software project with the contributions being accepted and committed to the main branch, or publishing a stand-alone library or package for a programming language commonly used in financial applications, or the development or updating of a brand-new industrial strength financial software application. As the students work on their project, this course will focus on important software engineering considerations specifically as they apply to the fast-paced world of financial projects, such as formalized procedures for revision control and bug tracking and other proven methods of software management in a fast-paced financial environment. | Prerequisite: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6871 R in Finance (1.5 Credits)***Typically offered Fall, Spring, and Summer terms*

This course introduces the free programming language R and its many applications to finance including risk management, portfolio construction, strategy development and testing, and trading and execution. Topics covered include financial time series analysis, advanced risk tools, applied econometrics, portfolio management, and derivatives valuation. Students will be required to write some code in R every week. | Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the Department & FRE-GY 6123 and FRE-GY 6083

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6883 Financial Computing (3 Credits)***Typically offered Fall, Spring, and Summer terms*

This course covers programming applications to financial engineering, including C++ and Java and the various common development environments for them. Topics include structured and object-oriented programming in C++ with applications to binomial options pricing, multi-threaded programming in Java with applets and graphical interfaces with applications to risk measurement tools, data-based manipulation and programming in SQL and standard database access libraries with applications to historical financial data series retrieval and management, and other advanced programming concepts important for financial engineering such as numerical techniques, trading systems, and large-scale software design. | Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the Department.

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 6901 SELECTED TOPICS IN FINANCIAL ENGINEERING (1.5 Credits)*Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include infrastructure and projects finance, international and global finance, economics and finance in developing countries, global finance in a global world, international investment strategies, finance and taxes, among others.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6911 Financial Regulation (1.5 Credits)***Typically offered occasionally*

The course provides an overview of the legal and institutional framework of regulations for capital markets, with a strong emphasis on the United States with some discussion of the financial regulation of banks, insurance firms and financial services in general. In addition, attention is given to regulation in global and emerging markets. The goal is to develop a practical understanding for application in business decision making. The course explores the interplay of regulation (both intended and unintended effects), risk management and the evolution of global modern banking. In light of current market developments, the course develops a critical perspective and discusses potential approaches to the structure of financial regulation. | Prerequisite: None. Co-requisite: None. Notes: None.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 6921 Selected Topics in Financial Engineering (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include infrastructure and projects finance, international and global finance, economics and finance in developing countries, global finance in a global world, international investment strategies, finance and taxes, among others. | Prerequisites: advanced standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6931 SELECTED TOPICS IN FINANCIAL ENGINEERING (1.5 Credits)***Typically offered occasionally*

Prerequisite: Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6951 SELECTED TOPICS IN FINANCIAL ENGINEERING (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include infrastructure and projects finance, international and global finance, economics and finance in developing countries, global finance in a global world, international investment strategies, finance and taxes, among others. | Prerequisites: advanced standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6961 SELECTED TOPICS IN FINANCIAL ENGINEERING (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include infrastructure and projects finance, international and global finance, economics and finance in developing countries, global finance in a global world, international investment strategies, finance and taxes, among others. | Prerequisites: advanced standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6971 SEL TOPICS IN FINANCIAL ENGR (1.5 Credits)***Typically offered occasionally*

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: advanced standing and instructor's permission and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**Prerequisites:** FRE-GY 6411.**FRE-GY 6981 SEL TOPICS IN FINANCIAL ENGR (1.5 Credits)***Typically offered occasionally*

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: advanced standing and instructor's permission and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 6991 SEL TPCS IN FINANCIAL ENGINEERING (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include infrastructure and projects finance, international and global finance, economics and finance in developing countries, global finance in a global world, international investment strategies, finance and taxes, among others. Prerequisites: advanced standing and instructor's permission and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 7003 FINANCIAL ACCOUNTING AND ANALYSIS (3 Credits)***Typically offered Fall*

This course provides a solid understanding of the creation and interpretation of modern financial statements. Topics include the reasons for financial statements, U.S. accounting principles and how they differ abroad, quality of financial information, financial ratios and their uses, cash-flow analysis, measurement of corporate performance. The course will also cover various methods of forecasting statements and a discussion of valuation. | Prerequisite: Graduate Standing or permission of FRE department.

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 7021 Financial Engineering Capstone: Internship (1.5 Credits)*Typically offered Fall, Spring, and Summer terms*

In this course, the Career Development Office helps the student secure an internship. Students work under faculty supervision. However, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A paper based on the internship work is required. | Prerequisites: This course should be taken after the student has successfully completed two Semesters and earned at least 18 credits. Prerequisites vary depending on the student's track, the nature of the internship and Graduate Standing.

Grading: Grad Poly Pass/Fail**Repeatable for additional credit:** Yes**FRE-GY 7023 Financial Engineering Capstone: Internship (1.5 Credits)**

In this course, the Career Development Office helps the student secure an internship. Students work under faculty supervision. However, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A paper based on the internship work is required. | Prerequisites: This course should be taken after the student has successfully completed two Semesters and earned at least 18 credits. Prerequisites vary depending on the student's track, the nature of the internship and Graduate Standing.

Grading: Grad Poly Pass/Fail**Repeatable for additional credit:** Yes**FRE-GY 7043 Financial Engineering Capstone: Project (3 Credits)***Typically offered Fall, Spring, and Summer terms*

In this project course, students work with faculty on proprietary or non-proprietary research projects. Generally, students work under faculty supervision. 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 after the student has successfully completed two Semesters and has earned at least 18 credits. Prerequisites vary depending on the student's track, the nature of the project to be undertaken, and Graduate Standing.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7103 MACROECONOMICS (3 Credits)**

Macroeconomics deals with the performance, structure and behavior of a national or regional economy as a whole. This course provides the basic tools for analyzing macroeconomic phenomena. Economic models are developed that explain the relationship between factors such as national income, output, consumption, unemployment, inflation, savings, investment, international trade and international finance. Applications investigate the causes and consequences of short-run fluctuations in national income and attempts at predicting long-run economic growth. | Prerequisite: None.

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7121 Statistical Arbitrage (1.5 Credits)***Typically offered Fall and Spring*

Statistical arbitrage refers to strategies that combine many relatively independent positive expected value trades so that profit, while not guaranteed, becomes very likely. This course prepares students to research and practice in this area by providing the tools and techniques to generate and evaluate individual trading strategies, combine them into a coherent portfolio, manage the resulting risks, and monitor for excess deviations from expected performance. It introduces theoretical concepts such as cointegration, risk capital allocation, proper backtesting, and factor analysis, as well as practical considerations such as data mining, automated systems, and trade execution. Programming languages such as R, Python, or C++ will be used to present applications to data at low, intermediate and high frequency. | Prerequisites: Matriculation into a graduate program sponsored by the Department of Finance & Risk Engineering, or permission of the Department & FRE-GY 6123 and FRE-GY 6083

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7211 FORENSIC FINANCIAL TECHNOLOGY AND REGULATORY SYSTEMS (1.5 Credits)***Typically offered Fall and Spring*

The goal of this course is to understand the technology behind financial forensics and regulatory systems. These include innovative database techniques ("dataveillance"), artificial intelligence, data mining, and non-parametric outlier methods used by the Securities Exchange Commission (SEC), the Financial Industry Regulatory Authority (FINRA), as well as the FBI, and other federal and state agencies. Student teams will prepare and present projects or case studies applying the concepts covered in class. | Prerequisite: FRE-GY 6153 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7221 BIG DATA IN FINANCE (1.5 Credits)***Typically offered Fall and Spring*

This is an advanced course on practical computer science and database topics most relevant to financial applications. As such it covers fundamental concepts such as financial database design, use, and maintenance, distributed financial computing and associated storage, grid and cloud computing, modeling unstructured financial data, and data mining for risk management. | Prerequisite: FRE-GY 6153 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7241 ALGORITHMIC PORTFOLIO MANAGEMENT (1.5 Credits)***Typically offered Fall, Spring, and Summer terms*

This course focuses on portfolio construction and rebalancing strategies such as momentum, value, and size strategies, among others. The course emphasizes backtesting and risk factor analysis as well as optimization to reduce tracking error. It will also address how a quantitative investment approach can help both individual and institutional investors make sound long-term investment decisions. | Prerequisite: FRE-GY 6123 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No

FRE-GY 7251 ALGORITHMIC TRADING & HIGH-FREQUENCY FINANCE (1.5 Credits)*Typically offered Fall and Spring*

Algorithmic trading refers to the utilization of special computer programs in an order management system that restructure an order into a sequence of sub-orders based on the dimensions of submission time, price, size, and side. The goal of this course is to survey several algorithmic strategies used by financial institutions and to understand their implementation in the context of order management systems and standard financial protocols (such as FIX and FIXatdl). Student teams will prepare and present projects or case studies applying the concepts covered in class. | Prerequisites: FRE-GY 6153 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7261 NEWS ANALYTICS & STRATEGIES (1.5 Credits)***Typically offered Spring*

The fast-growing field of news analytics requires large databases, fast computation, and robust statistics. This course introduces the tools and techniques of analyzing news, how to quantify textual items based on, for example, positive or negative sentiment, relevance to each stock, and the amount of novelty in the content. Applications to trading strategies are discussed, including both absolute and relative return strategies, and risk management strategies. Students will be exposed to leading software in this cutting-edge space. | Prerequisites: FRE-GY 6153 and FRE-GY 7221 and Graduate Standing

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7703 DATA SCIENCE FOR FINANCIAL ENGINEERING (3 Credits)***Typically offered Fall and Spring*

This is an on-line quantitative course especially geared toward Master of Science in Financial Engineering students. The course covers the statistical tools needed to model and estimate the joint dynamics of markets. Included are: - topics in multivariate statistics that are relevant for risk management and portfolio management - machine learning models as generalizations of linear factor models, omnipresent across finance - the connection between the estimation/calibration of machine learning models and classical and Bayesian econometrics - backtesting and model/estimation risk in the context of decision theory - distributional stress-testing for risk management and portfolio/business construction for portfolio management. The final exam may be administered on-line or in-person. | Prerequisite: Matriculation into MS Financial Engineering or permission of FRE department

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7773 MACHINE LEARNING IN FINANCIAL ENGINEERING (3 Credits)***Typically offered Fall and Spring*

This course covers the theory of Machine Learning and its fundamental applications in the field of Financial Engineering. Supervised, unsupervised, and reinforcement learning paradigms are discussed. | Prerequisites: Matriculation into MS Financial Engineering or permission of the FRE department

Grading: Grad Poly Graded**Repeatable for additional credit:** No**FRE-GY 7801 TOPICS IN FINANCE AND FINANCIAL MARKETS I (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include Financial Economics, Macroeconomics and Finance, the Bond market, the securities markets, Derivatives markets, Contract Theory, Credit and Counterparty Risks, Banking Finance and others. | Prerequisites: Graduate standing and instructor's permission

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 7811 Topics in Finance and Financial Markets 2 (1.5 Credits)***Typically offered occasionally*

The course analyzes and discusses current topics of particular importance in finance and risk engineering. Selected topics are emphasized and provide focus for further study. Examples can include Behavioral Finance, Personal Finance, Investment Theories and Alternative Finance, Corporate and Financial Responsibility, Financial Ethics, Hedge Funds Investment Strategies and their Management and macro hedge funds management, among others. | Prerequisites: Graduate standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 7821 TOPICS IN RISK FINANCE I (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in Actuarial Science are analyzed and discussed. Course topics may include for example: Pension Funds management, Actuarial Science and Social Security, Life Insurance, Insurance and Financial Products design and management. | Prerequisite: Advanced standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 7831 TOPICS IN FINANCIAL AND RISK ENGINEERING I (1.5 Credits)***Typically offered occasionally*

Current and selected topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide a focus for further study. Topics include Credit Risk and Credit Derivatives, Quantitative Methods in Rare Events, Energy, Oil and Water Finance as well as advanced topics in financial econometrics and computational finance. | Prerequisites: Graduate standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 7841 TOPICS IN RISK FINANCE II (1.5 Credits)***Typically offered occasionally*

Current and selected topics of particular importance in Actuarial Science and in the insurance-finance convergence are analyzed and discussed. Course topics may include Risk Engineering and the Insurance Business, Principles of Insurance Management in a Dynamic and Global Setting, Finance-insurance convergence. | Prerequisite: Advanced standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes

FRE-GY 7851 TOPICS IN FINANCIAL AND RISK ENGINEERING 2 (1.5 Credits)*Typically offered occasionally*

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics are emphasized and provide a focus for further study. Examples can include urban finance engineering, environmental finance, infrastructure and projects finance, real-estate finance, insurance finance and derivatives, and macro hedge funds management. | Prerequisites: Graduate standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 7871 TOPICS IN FINANCIAL INFORMATION SERVICES AND TECHNOLOGY (1.5 Credits)***Typically offered occasionally*

Current topics of particular importance in financial information services and technology are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include, natural language processing, sentiment analysis, alternative data, advanced deep learning techniques, and others. | Prerequisites: Graduate Standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 9713 SPECIAL TOPICS IN ASSET PRICING (3 Credits)***Typically offered occasionally*

Current topics of particular importance in asset pricing are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include, financial modeling, financial statement analysis, portfolio optimization with dynamic programming, market microstructure, and others. | Prerequisites: Graduate Standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 9733 SPEC TOPCS IN FIN ENGR (3 Credits)***Typically offered occasionally*

Current topics of particular importance in financial engineering are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include machine learning with big data, fixed income securities, quantitative investing strategies, and others. | Prerequisites: Graduate Standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 9743 SPEC TOPCS IN RISK MANAGEMENT (3 Credits)**

Current topics of particular importance in risk management are analyzed and discussed. Selected topics are emphasized and provide focus for further study. Examples might include climate change risk, event driven finance, mathematics of machine learning, Markov chains, and others. | Prerequisites: Graduate Standing and instructor's permission.

Grading: Grad Poly Graded**Repeatable for additional credit:** Yes**FRE-GY 9973 MS THESIS IN FINANCE & RISK ENGINEERING (3 Credits)***Typically offered Fall and Spring*

In this research course, students undertake proprietary or non-proprietary research and write a thesis-type research paper. Generally, students work under faculty supervision. However, the course is intended to be largely self-directed within guidelines established by the supervising faculty member. | Prerequisites: Graduate Standing. This course should be taken during the student's final semester. Prerequisites vary depending on the student's track and the nature of the thesis project.

Grading: Grad Poly Graded**Repeatable for additional credit:** No