### Required Core Courses (6 courses, 18 units)

**MATH 530A: Stochastic Calculus and Mathematical Finance (3.0 units)**

**MATH 530b: Stochastic Calculus and Mathematical Finance (3.0 units)**
Advanced topics in stochastic analysis, asset pricing in continuous time, stochastic control, Hamilton-Jacobi-Bellman equations, incomplete markets, American options, exotic options, term structure of interest rates. Duplicates credit in the former MATH-506. Prerequisite: MATH-530a

**MATH 512: Financial Informatics and Simulation (Computer Labs and Practitioner Seminar) (3.0 units)**
Experimental laboratory trading for financial markets using double auctions: handling statistical packages for data analysis. Practical training in virtual market environments, using financial trading system software.

**MATH 590: Directed Research (1.0-12.0 units)**
Research leading to the master's degree. Maximum units which may be applied to the degree to be determined by the department. Graded CR/NC.

**ECON 613: Economic and Financial Time Series I (4.0 units)**
Simultaneous equation models, dynamic structural econometric models, vector autoregressions, causality, forecasting, univariate and multivariate nonstationary time series, tests for unit roots, cointegration, autoregressive conditional heteroscedasticity models, time series models with changes in regime. (Student must apply for Departmental clearance to take this course)

**ECON 659: Economics of Financial Markets I (4.0 units)**
Equilibrium model of finance economy; absence of arbitrage; complete and incomplete markets; asset pricing theory: representative agent pricing, Capital Asset Pricing Model, martingale property of security prices. (Student must apply for Departmental clearance to take this course)

### Elective Courses (4 courses, 12 units)

**Computational and Empirical Finance (must take at least 2 courses)*

**FBE 535: Applied Finance in Fixed Income Securities (3.0 units)**
The basic principles underlying fixed income securities and how these principles apply to the practical aspects of fixed income management. Prerequisite: 1 from (GSBA 521 or GSBA 521b or GSBA 548)

*Note: Non-Business student applications are available at [www.marshall.usc.edu/registrationpolicies](http://www.marshall.usc.edu/registrationpolicies). Please complete and submit to registration@marshall.usc.edu.*

**FBE 554: Trading and Exchanges (3.0 units)**
Theories, practices, and technologies of trading at exchanges and in dealer networks. Sources of liquidity, volatility, profitability, and institutional change. Domestic and international public policy issues. Prerequisite: 1 from (GSBA 521 or GSBA 521b or GSBA 548)

*Note: Non-Business student applications are available at [www.marshall.usc.edu/registrationpolicies](http://www.marshall.usc.edu/registrationpolicies). Please complete and submit to registration@marshall.usc.edu.*
**FBE 555: Investment Analysis and Portfolio Management (3.0 units)**
Analysis and management of common stocks and fixed income securities; development of modern portfolio theory and the efficient market hypothesis; organization of securities markets.

**FBE 559: Management of Financial Risk (3.0 units)**
Analysis of commodity, futures, and options contracts; theoretical and empirical approaches; spot and futures price relationships, speculation and hedging strategies; market efficiency.

**FBE 589: Mortgages and Mortgage-Backed Securities and Markets (3.0 units)**
Valuation and analysis of residential and commercial mortgages and mortgage-backed securities and related markets.

**Statistics**

**MATH 541A: Introduction to Mathematical Statistics (3.0 units)**
Parametric families of distributions, sufficiency. Estimation: methods of moments, maximum likelihood, unbiased estimation. Comparison of estimators, optimality, information inequality, asymptotic efficiency. EM algorithm, jackknife and bootstrap. Prerequisite: 1 from (MATH 505A or MATH 407 or MATH 408)

**MATH 541B: Introduction to Mathematical Statistics (3.0 units)**
Hypotheses testing, Neyman-Pearson lemma, generalized likelihood ratio procedures, confidence intervals, consistency, power, jackknife and bootstrap. Monte Carlo Markov chain methods, hidden Markov models. Hypotheses testing, Neyman-Pearson lemma, generalized likelihood. Prerequisite: MATH 541A

**MATH 543L: Non Parametric Statistics**
No course description available.

**MATH 547: Methods of Statistical Inference**
No course description available.

**Numerical/Optimization/Other Methods**

**MATH 507: Numerical Analysis and Computation**
No course description available.

**MATH 502A: Numerical Analysis (3.0 units)**
Computational linear algebra; solution of general nonlinear systems of equations; approximation theory using functional analysis; numerical solution of ordinary and partial differential equations. Prerequisite: (MATH 425A and MATH 471)

**MATH 502B: Numerical Analysis (3.0 units)**
Computational linear algebra; solution of general nonlinear systems of equations; approximation theory using functional analysis; numerical solution of ordinary and partial differential equations. Prerequisite: MATH 502A

**MATH 504a: Numerical Solutions of Ordinary and Partial Differential Equations (3.0 units)**
a: Initial value problems; multistep methods, stability, convergence and error estimation, automatic stepsize control, higher order methods, systems of equations, stiff problems; boundary value problems; eigenproblems. b: Computationally efficient schemes for solving PDE numerically; stability and convergence of difference schemes, method of lines; fast direct and iterative methods for elliptic equations. Prerequisite: 501 or 502a or consent of instructor. Prerequisite: 1 from (MATH 501 or MATH 502A)

**MATH 505a: Applied Probability (3.0 units)**
Populations, permutations, combinations, random variables, distribution and density functions, conditional probability and expectation, binomial, poisson, and normal distributions; laws of large numbers, central limit theorem. Prerequisite: Consent of Instructor.
MATH 505b: Applied Probability (3.0 units)
Markov processes in discrete or continuous time; renewal processes; martingales; Brownian motion and diffusion theory; random walks, inventory models, population growth, queuing models, shot noise. Prerequisite: MATH 505A

MATH 508: Filtering Theory (3.0 units)
Theory of random differential equations and stochastic stability; optimum linear and nonlinear filtering, with discussion of asymptotic behavior of filter.

MATH 509: Stochastic Differential Equations (3.0 units)
Brownian motion, stochastic integrals, the Itô formula, stochastic differential equations, analysis of diffusion processes, Girsanov transformation, Feynmann-Kac formula, applications. Prerequisite: 1 from (MATH 505B or MATH 507B)

MATH 585: Mathematical Theory of Optimal Control (3.0 units)
Deterministic control: calculus of variations; optimal control; pontryagin principle; multiplier rules and abstract nonlinear programming; existence and continuity of controls; problems mayer; dynamic programming. Prerequisite: (MATH 570 and MATH 525A)

Computational and Financial Economics *
ECON 614: Economic and Financial Time Series II (4.0 units)
Stock returns, predictability and volatility, random walk and variance-bounds tests, estimation of capital asset, multifactor, and derivative pricing models, term structure of interest rates. Prerequisite: ECON 511

ECON 652: Economics of Financial Markets II (4.0 units)
Financial market equilibrium and partial equilibrium asset pricing in discrete and continuous time; properties of equilibria with and without complete markets: theory of option prices: Black-Scholes pricing formula; term structure of interest rates; hedging strategies and managing market risk using options, futures and swaps; hedging exchange-rates risks. Prerequisite: ECON 503

PM 511aL: Data Analysis (4.0 units)
Major parametric and non-parametric statistical tools used in biomedical research, computer packages including SAS. Includes laboratory. Lecture, 2 hours; laboratory, 2 hours. Prerequisite: PM 510

Pre-requisites for any of the above courses can be waived based on students' knowledge of the subject area. Approval from the program director is required.

*The elective courses in statistics/numerical/optimization/other methods and computational and empirical finance have to be approved for each student by the program directors. Other electives, not on this list, may sometimes be approved after consultation with program directors.