FINANCIAL MATHEMATICS

Director: George Papanicolaou

Core Faculty:

Business: D. Duffie, J. M. Harrison, K. Singleton
Economics: T. Amemiya, F. Kubler, M. Kurz, F. Wolak
Electrical Engineering: T. Cover
Management, Science and Engineering: P. Glynn, D. Iglehart (emeritus), D. Luenberger
Mathematics: A. Dembo, P. Diaconis, G. Papanicolaou
Statistics: T. Cover, A. Dembo, P. Diaconis, T. Lai, A. Owen

Steering Committee:

A. Dembo, P. Glynn, F. Kubler, T. Lai, A. Owen, G. Papanicolaou, K. Singleton

This is an interdisciplinary program that aims to provide a master's level education in applied and computational mathematics, statistics, and financial applications to individuals with strong mathematical skills.

The departments of Mathematics and Statistics, in close cooperation with the departments of Economics, and Management Science and Engineering, as well as the Graduate School of Business, provide many of the basic courses.

GRADUATE PROGRAMS

MASTER OF SCIENCE

The program requires that the student take 45 units of work, or twelve courses of 3 units each, from the list of offerings provided below. Ordinarily, four or five quarters are needed to complete all requirements.

Admission—To be eligible for admission, students are expected to have taken the following courses or their equivalent:

1. Linear algebra at the level of Mathematics 103.
2. Advanced calculus (Real Analysis) at the level of Mathematics 115.
3. Basic ordinary and partial differential equations at the level of Mathematics 131 and 132 (Basic Partial Differential Equations).
4. Probability and statistics at the level of Statistics 116, 200, and preferably 217 (Introduction to Stochastic Processes).
5. Computer programming at the level of Computer Science 106A.

Some of these courses, for example, Statistics 217-218, are offered as summer courses and can be taken by candidates lacking the required background. Additional information about summer courses is posted on the program web site at http://cartan.stanford.edu/finmath.

Candidates for admission must take the general Graduate Record Examination and preferably the subject test in Mathematics. Information about this exam can be found at http://www.gre.org.

Requirements—For the M.S. degree in Financial Mathematics, students must fulfill the following six required courses:

1. In stochastic processes and statistics:
   a) Mathematics 236 (Introduction to Stochastic Differential Equations)
   b) Statistics 240 (Statistical Methods in Finance) *or* Economics 275 (Time Series)
2. In differential equations, simulation, and computing:
   a) Mathematics 220B (Applied Partial Differential Equations B)
   b) Mathematics 240 (cross-listed with Statistics 245) (Computation and Simulation in Finance)
3. In finance and economics:
   a) Mathematics 180 (Introduction to Financial Mathematics) *or* Management Science and Engineering 242 (Investment Science) *or* Business F620 (Introduction to Financial Economics)
   b) Mathematics 241 (cross-listed with Statistics 250 and Economics 289) (Mathematical Finance)

These courses must be taken for letter grades where available, and an overall 2.75 grade point average (GPA) is required. There is no thesis requirement.

Courses that are equivalent to the above and have been taken previously may be waived by the adviser, in which case they must be replaced by elective courses in the same subject area.

In addition, students must take at least six approved elective courses from a list that can be found on the web site at http://cartan.stanford.edu/finmath. With the approval of the instructor, credit can be obtained for practical training in industry. Students must sign up for Mathematics 201 and write a detailed report in order to receive credit.

The requirements must be met within three years of entering the program.

COURSES

The following are required core courses.

MATHEMATICS

180. Introduction to Financial Mathematics—Financial derivatives: contracts and options. Hedging and risk management. Arbitrage, interest rate and discounted value. Geometric random walk and Brownian motion as models of risky assets. Initial boundary value problems for the heat and related partial differential equations. Self-financing replicating portfolio. Black-Scholes pricing of European options. Dividends. Implied volatility. Optimal stopping and American options. Prerequisite: Mathematics 53. Corequisites: Mathematics 131, 151, or Statistics 116.
3 units, Aut (Dembo)

220B. Partial Differential Equations of Applied Mathematics—Greens functions, integral transforms, variational and distribution theoretic methods for the analysis of differential and integral equations, with illustrative examples. Prerequisite: some familiarity with differential equations and functions of a complex variable.
3 units, Win (J. Levandosky)

236. Introduction to Stochastic Differential Equations—Brownian motion, stochastic integrals, and diffusions as solutions of stochastic differential equations. Functionals of diffusions and their connection with partial differential equations. Random walk approximation of diffusions. Prerequisite: basic probability and differential equations.
3 units, Win (Papanicolaou)

240. Computation and Simulation in Finance—Monte Carlo, finite difference, tree, and transform methods for the numerical solution of partial differential equations in finance. Emphasis is on derivative security pricing.
3 units, Spr (Lee)

241. Mathematical Finance—(Enroll in Statistics 250.)
3 units, Win (Papanicolaou)

STATISTICS

240. Statistical Methods in Finance—Regression analysis and applications to the Capital Asset Pricing Model and multifactor pricing models. Smoothing techniques and estimation of yield curves. Classification and credit risk. Statistical analysis and econometric modeling of financial time series. Forecasting problem sets, hands-on experience with real data.
3 units, Spr (Lai)

245. Computation and Simulation in Finance—(Enroll in Mathematics 240.)
3 units, Spr (Lee)

250. Mathematical Finance—Stochastic models of financial markets. Forward and futures contracts. European options and equivalent martingale measures. Hedging strategies and management of risk. Term structure models and interest rate derivatives. Optimal stopping and American options.
3 units, Win (Papanicolaou)