

FINANCIAL MATHEMATICS

Director: Tze Leung Lai

Steering Committee: A. Dembo, K. Giesecke, T. Lai, A. Owen, G. Papanicolaou, J. Primbs, K. Singleton, A. Toussaint

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Economics: T. Amemiya, P. Hansen, M. Kurz, J. Shoven

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Mathematics: S. Brendle, A. Dembo, P. Diaconis, G. Papanicolaou, A. Toussaint

Statistics: T. Cover, A. Dembo, P. Diaconis, T. Lai, A. Owen, B. Rajaratnam

This is an interdisciplinary program that provides 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 PROGRAM IN FINANCIAL MATHEMATICS

The department offers a Master of Science in Financial Mathematics. University requirements for the M.S. are described in the "Graduate Degrees" section of this bulletin.

MASTER OF SCIENCE IN FINANCIAL MATHEMATICS

Admission—To be eligible for admission, students are expected to have taken the following courses or their equivalent: Linear algebra at the level of MATH 103.

1. Advanced calculus (real analysis) at the level of MATH 115.
2. Basic ordinary and partial differential equations at the level of MATH 131 and 132 (basic partial differential equations).
3. Probability at the level of STATS 116; theory of statistics at the level of STATS 200; and stochastic processes at the level of STATS 217 or, preferably, MATH 136/STATS 219.
4. Computer programming at the level of CS 106A.

Some of these courses are offered as summer courses and may be taken by candidates lacking the required background.

Candidates for admission must take the general Graduate Record Examination and preferably the subject test in Mathematics as well. Information about these exams can be found at <http://www.grc.org>.

Requirements—The program requires that the student take 45 units of work. Of these 45 units, six courses must be taken from the list of required courses and six must be taken from the list of elective courses, available on the program web site at <http://finmath.stanford.edu/academics/required.html> and <http://finmath.stanford.edu/academics/electives.html>. These courses must be taken for a letter grade, but students may elect to take one of the 12 courses credit/no credit. An overall grade point average (GPA) of 2.75 is required. A seminar in Financial Mathematics is an integral part of the program and an opportunity to interact with leading academic and industry speakers (for credit, enroll in STATS 239AB). There is no thesis requirement.

Any remaining units required to complete the 45 total must be taken from the following options:

- from the approved list of electives with emphasis on computation, information technology, or finance
5. STATS 200, STATS 217, STATS 218, MATH 131, MATH 132, MATH 202 or ECON 140
 6. additional (practical) CS courses
 7. in the form of an industrial internship in the Bay Area or elsewhere, with the approval and supervision of a faculty member. A written report must be submitted upon completion of the internship. Students who choose to take

credit for practical training must sign up for Stats 297 (1-3 units).

Ordinarily, four quarters are needed to complete all requirements.

Required Courses—For the M.S. degree in Financial Mathematics, students must fulfill six of these required courses: In stochastic processes and statistics:

- a. MATH 236. Introduction to Stochastic Differential Equations
 - b. STATS 241. Statistical Modeling in Financial Markets
8. In differential equations, simulation, and computing:
 - c. MATH 227. Partial Differential Equations and Diffusion Processes
 - or STATS 362. Monte Carlo Sampling
 - d. MATH 239. Computation and Simulation in Finance
 9. In finance and economics:
 - e. MS&E 242H. Investment Science Honors
 - or MATH 240. Topics in Financial Mathematics: Fixed Income Models
 - f. MATH 238/STATS 250. Mathematical Finance

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.

The requirements must be met within two years of entering the program, or four academic quarters for those already at Stanford.

Elective Courses—Each candidate must take at least six approved elective courses from the list below.

At least two electives in Probability, Stochastic Processes or Statistics from:

Statistics:

- STATS 202. Data Analysis
- STATS 206. Applied Multivariate Analysis
- STATS 207. Introduction to Time Series Analysis
- STATS 219. Stochastic Processes (Same as MATH 136)
- STATS 220. Continuous Time Stochastic Control
- STATS 237. Time Series Modeling and Forecasting
- STATS 240. Statistical Methods in Finance
- STATS 252. Data Mining and Electronic Business
- STATS 305. Introduction to Statistical Modeling
- STATS 306A. Methods for Applied Statistics
- STATS 310A/B/C. Theory of Probability
- STATS 315A/B/C. Modern Applied Statistics
- STATS 317. Stochastic Processes
- STATS 318. Modern Markov Chains
- STATS 324. Multivariate and Random Matrix Theory
- STATS 343. Time Series Analysis
- EE 376A. Information Theory

Mathematics:

- MATH 136. Stochastic Processes (Same as STATS 219)
- MATH 205A/B. Real Analysis
- MATH 237. Stochastic Equations and Random Media

Economics:

- ECON 275. Time Series Econometrics

10. At least two electives in Differential Equations, Optimization, Simulation, or Computing from:

Mathematics:

- MATH 220. PDE of Applied Mathematics
- MATH 222A. Computational Methods for Fronts, Interfaces, and Waves
- MATH 256A,B. Partial Differential Equations
- MATH 261A,B. Functional Analysis
- MATH 266. Time Frequency Analysis and Wavelets

Statistics:

- STATS 212. Applied Statistics with SAS
- STATS 227. Statistical Computing
- STATS 235. Decision Making in Financial Services
- STATS 322. Function Estimation in White Noise

Computer Science:

- CS 106X. Programming Abstractions (Accelerated)
- CS 193D. C++

CS 229. Machine Learning
CS 249A. Object-Oriented Programming: A Modeling and
Simulation Perspective
CS 261. Optimization and Algorithmic Paradigms
CS 339. Topics in Numerical Analysis
CS 365. Randomized Algorithms

Management Science and Engineering:

MS&E310. Linear Programming
MS&E 311. Optimization
MS&E 312. Advanced Methods in Numerical Optimization
MS&E 313. Vector Space Optimization
MS&E 323. Simulation Theory
MS&E 339. Approximate Dynamic Programming
MS&E 347. Credit Risk: Modeling and Management
MS&E 348. Optimization of Uncertainty and Applications in
Finance
MS&E 351. Dynamic Programming and Stochastic Control

Graduate School of Business:

OIT 667. Revenue Management*

11. At least two electives in Economics or Finance from:

Economics:

ECON 202N-203N. Core Economics: Modules 1 and 2, 5
and 6 (for non-Economics Ph.D. students)
ECON 210. Core Economics: Modules 3 and 7
ECON 211. Core Economics: Modules 11 and 12
ECON 269. International Financial Markets and Monetary
Institutions
ECON 281. Economics of Uncertainty
ECON 284. Topics in Dynamic Economics

Mathematics:

MATH 180. Introduction to Financial Mathematics

Statistics:

STATS 243. Introduction to Mathematical Finance
(summer version of MATH 180)

Management Science and Engineering:

MS&E 247G. International Financial Management (Same
as FINANCE 323)*
MS&E 247S. International Investments
MS&E 341. Advanced Economic Analysis
MS&E 342. Advanced Investment Science
MS&E 345. Advanced Topics in Financial Engineering
MS&E 347. Credit Risk: Modeling and Management
MS&E 444. Investment Practice*

Graduate School of Business:

FINANCE 320. Debt Markets*
FINANCE 326. Derivative Securities*
FINANCE 328. Portfolio Management*
FINANCE 621. Financial Markets II
FINANCE 622. Dynamic Asset Pricing Theory
GSB 629. Tax and Finance Seminar
MGTECON 600. Microeconomic Analysis
MGTECON 604. Advanced Econometrics
MGTECON 609. Applied Econometric and Economics
Research

*Indicates courses of limited enrollment and/or the instructor's preapproval is needed for registration.

Other elective courses may be authorized by the program director if they provide skills relevant to financial mathematics and do not overlap with courses in the candidate's program.