CFRM 405: Mathematical Methods for Quantitative Finance

Mathematical Methods for Quantitative Finance provides a comprehensive review of the basic mathematical methods used in quantitative finance. The primary focus of the course is to prepare students to begin a master's level program in quantitative finance. Topics include multivariable calculus, linear algebra, Lagrange multipliers, Taylor series, and numerical methods.

Textbooks

Required:

- *A Primer for the Mathematics of Financial Engineering (Second Edition)*, Dan Stefanica, FE Press, 2011.

Recommended:

- *Solutions Manual - A Primer for the Mathematics of Financial Engineering (Second Edition)*, Dan Stefanica, FE Press, 2011.
- *Introduction to Linear Algebra*, Gilbert Strang, Wellesley-Cambridge, 1993.
- *Calculus Early Transcendentals*, James Stewart, Brooks/Cole, 2012.

Prerequisites

Single variable calculus (derivatives and integrals) and linear algebra (e.g., University of Washington courses: MATH 124, MATH 125, and MATH 308, or equivalents).

Homework

Homework will be given on a weekly basis. Assignments can be written on paper and submitted as a single scanned PDF file on the Canvas website, or typeset and submitted to the Canvas website before the designated time. Hard copies will not be accepted. Typically assignments will be assigned on Monday, and due the following Friday (11 days later) at 8pm Pacific Time. Homework will cover the material from that week. Students are encouraged to work together, but the submitted material should be your work alone. The lowest homework grade will be dropped, but *only if* every assignment is turned in with a good faith effort.

Grading

Homework (weekly)	40 Points
Exam 1	20 Points
Exam 2	20 Points
Exam 3	20 Points
Total	100 Points

Course Outline

We will use finance-motivated examples to investigate mathematical methods from a variety of fields. Emphasis will be placed on theoretical techniques and numerical techniques (using R). The course is organized into three parts. The first part uses the Black-Scholes formula and its partial derivatives (*"The Greeks"*) to motivate a review of topics from multivariable calculus. The second part of the course uses investment portfolio notation to motivate a review of topics from linear algebra. The third part of the course uses portfolio optimization to motivate a discuss of Taylor series, optimization, and numerical methods.

Module 1: Calculus

- Derivatives and partial derivatives.
- Integrals and multiple integrals.
- Differentiating improper integrals, changes of variables in multiple dimensions.
- The Greeks of the Black-Scholes formula.

Module 2: Linear Algebra

- Matrices and vectors, systems of linear equations.
- Matrix inverses, transposes, singular value decomposition.
- Orthogonal matrices, QR factorization, eignevalues and eigenvectors.
- Least squares problems.
- Lagrange's method.

Module 3: Numerical Methods

- Taylor series.
- Finite difference methods.
- Bisection method, Newton's method
- Application of Newton's method.
- Numerical integration.