Course Description and Scope

Modern finance draws upon many fields of mathematics, in particular, algebra, econometrics, numerical analysis, optimization theory, partial differential equations, probability theory, statistics and stochastic calculus. The diversity of mathematical skills needed to master finance makes it a very challenging subject for students.

This BF212 course is for students in the banking and finance specialization. The course serves to equip students with basic mathematical knowledge and computational skills needed to solve problems related to finance. Furthermore, this course lays the foundation for more advanced topics, such as econometrics, stochastic calculus and optimal control theory, which make finance a very exciting subject.

The mathematical topics covered in this course include matrix algebra, calculus, difference equation, differential equation, optimization and portfolio mathematics (please refer to the proposed seminar schedule for details). The topics in the first five weeks of the course introduce students to the simplest financial market model and explain arbitrage pricing in a discrete time framework. The topics in the next three weeks lay the foundations for continuous time finance. The topics in the last four weeks introduce students to optimization and portfolio theory. These selected topics serve as an introduction to some of the fields of mathematics that modern finance draws upon.

Course Learning Objectives

Students will be able to use mathematical techniques to solve asset pricing and portfolio management problems.

Learning & Teaching Methods

3 hours of seminar per week commencing in Week 1 and ending in Week 13.
Course Assessments

<table>
<thead>
<tr>
<th>Components</th>
<th>Marks</th>
<th>Individual/Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coursework</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class Participations &amp; Presentations / Assignments / Quizzes</td>
<td>40</td>
<td>Individual / Group</td>
</tr>
<tr>
<td>Examination</td>
<td>60</td>
<td>Individual</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
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Assessment Plan

<table>
<thead>
<tr>
<th>Course Learning Objective</th>
<th>Assessment Method</th>
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</thead>
<tbody>
<tr>
<td>Ability to use mathematical techniques to solve asset pricing and portfolio management problems</td>
<td>Class Presentation, Assignment, Quiz, Written Exam</td>
</tr>
</tbody>
</table>

Readings & References

BBT  Jeffrey Baldani, James Bradfield and Robert Turner  
*Mathematical Economics*  
South-Western, 2nd Ed., 2005  
(Call No. HB135.B175)

C  Ales Cerny  
Mathematical Techniques in Finance  
Princeton University Press, 2004  
(Call No. HG106.C415)

K  Kamran Dadkhah  
*Foundations of Mathematical and Computational Economics*  
South-Western, 2006  
(Call No. HB135.D121)

LC  Hon Sing Lee and Gerald H. L. Cheang  
*Introduction to Calculus and Matrix Algebra with Applications in Finance*  
(Call No. QA303.L478)

SH  Knut Sydsaeter and Peter Hammond  
*Essential Mathematics for Economic Analysis*  
*(Library to order copies of this text)*

TH  John L. Teall and Iftekhar Hasan  
*Quantitative Methods for Finance and Investments*  
Blackwell Publishing, 2002  
(Call No. HG106.T253)
### Proposed Weekly Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Learning Objectives</th>
<th>Readings / Activity</th>
</tr>
</thead>
</table>
| 1    | Financial Basics | 1. Arithmetic & Geometric Series.  
2. Simple & Compound Interest.  
3. Limits & Exponential Function.  
4. Continuous Compounding of Interest.  
5. Present & Future Values.  
8. Annuity, Perpetuity & Amortization.  
11. Solving Problems with Excel. | BBT 15, 16  
K 2, 14  
LC* 2, 3  
SH 10  
TH* 4 |
2. One-Period Finite State Model.  
4. Securities as Vectors.  
5. Vector Space.  
7. Matrix as a Collection of Securities.  
8. Transposition.  
10. Working with Matrices in Excel. | BBT 3, 4  
C* 1  
K 4  
LC* 11, 12, 15  
SH 15, 16 |
2. Hedging.  
3. Linear Independence and Redundant Securities.  
4. The Structure of the Marketed Subspace.  
5. Identity Matrix and Arrow -Debreu Securities.  
6. Matrix Determinant & Inverse.  
7. Inverse Matrix and Replicating Portfolios.  
9. Solving Linear Systems of Equations in Excel. | BBT 15, 16  
K 2, 14  
LC* 2, 3  
SH 10  
TH* 4 |
<table>
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<th>Week</th>
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</table>
2. Asset Prices, Returns & Portfolio Units.  
3. Arbitrage.  
4. No-Arbitrage Pricing.  
5. State Prices & the Arbitrage Theorem.  
6. State Prices and Asset Returns.  
State Prices & No-Arbitrage Pricing. | C* 2  
K 4  
LC* 10, 17  
TH 10 |
| 5    | Arbitrage and Pricing of Securities II. | 8. One-Period Binomial Model.  
9. Multi-Period Binomial Model.  
Implementing the Binomial Model in Excel. | |
| 6    | Univariate Calculus.  
**Quiz 1 covering topics in week 1–5** | 1. Functions.  
2. Payoff Functions of Derivatives.  
5. Continuity & Differentiability.  
6. Differentiation.  
7. Product Rule, Quotient Rule & Chain Rule.  
8. Limits & L'Hospital Rule.  
10. Integration.  
Integration by Substitutions & by Parts. | BBT 5, 6  
K* 6, 7, 8, 11  
LC* 4, 5, 6, 8  
SH 6, 7, 9, 11, 12  
TH 8, 9 |
| 7    | Multivariate Calculus.  
Continuous Time Model | 11. Partial Derivatives.  
12. Total Differential.  
13. Implicit Differentiation.  
Working with Symbolic Math using Computer. | |
| 8    | Recess | |
| 9    | Black-Scholes Option Pricing Model. | 1. Differential Equation.  
Black-Scholes Option Pricing Model. | BBT 15, 16  
K* 13  
LC* 9  
TH 10 |
<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Learning Objectives</th>
<th>Readings / Activity</th>
</tr>
</thead>
</table>
| 10   | Unconstrained Optimization. | 1. Maxima & Minima of Univariate Functions.  
2. First & Second Order Conditions for Optimality.  
4. Unconstrained Optima of Multivariate Functions.  
Unconstrained Optimization using Excel. | BBT 7, 8, 9, 10  
K* 9, 10  
LC* 7  
SH 8, 13, 14 |
| 11   | Constrained Optimization. | 5. Optimization with Equality Constraints.  
6. The Lagrangian Function.  
8. The Second Order Conditions for Optimality.  
9. Optimization with Inequality Constraints.  
10. Inequality Constraints & Karush-Kuhn-Tucker Conditions  
Constrained Optimization using Excel | |
| 12   | Portfolio Mathematics I.  
**Quiz 2 covering topics in week 6–11** | 1. Returns of Securities.  
2. Expected Return & Variance-Covariance Matrix.  
3. Mean-Variance Framework.  
4. Portfolio Expected Return & Variance.  
5. Quadratic Forms.  
6. Basic Portfolio Problems  
7. Minimum Variance Portfolio.  
8. Minimizing Portfolio Risk for a Required Expected Return.  
Maximizing Portfolio Expected Return Given Tolerated Risk. | K 3, 5  
LC* 14  
TH* 6, 8 |

* The main reference.