PH. D. PROGRAM IN ECONOMICS

MSQE PROGRAM

JOHANN WOLFGANG GOETHE UNIVERSITÄT FRANKFURT AM MAIN

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Mathematics and Statistics Pre-Semester Course 2008

Ph.D. Program in Economics and MSQE Program

Syllabus

(*Version September 1, 2008*)

Note: The course "Mathematical Methods" of the Ph.D. Program in Economics and the MSQE Program in the academic year 2008/2009 will have two components: an entrance examination based on the contents of the Mathematics and Statistics Pre-Semester course (the entrance examination will be given on October 18, 2008 from 11:00 am to 1:00 pm, counting 25% towards the overall course grade); and a course component taught during the fall semester (counting 75% towards the overall course grade).

Instructors: Sabine Eschenhof (Part 1) (eschenhof@vwl.tu-darmstadt.de), Adrian Buss (Part 2) (buss@finance.uni-frankfurt.de), Cristian Badarinza (Part 3) (badarinza@web.de) and Georgios Georgiadis (Part 4) (jorgo@georgiadis.de).

Time: September 15 to September 19 (Part 1), September 22 to September 26 (Part 2), September 29 to October 4 (Public Holiday on October 3) (Part 3) and October 6 to October 10 (Part 4); for all parts 10:00 am to 12:00 pm and 1:00 pm to 3:00 pm.

Location: House of Finance, DZ Room.

Prerequisites: Students are expected to have a solid undergraduate background in mathematics and statistics/econometrics. Students missing some of this background are expected to have worked through the following references *prior* to the beginning of the course:

- Chiang, A.C. and K. Wainwright (2005): *Fundamental Methods of Mathematical Economics*, Boston: Mc Graw-Hill Irwin, Chapters 1 through 13.
- Stock, J.H. and M.W. Watson (2006): *Introduction to Econometrics*, 2nd Ed., Boston: Addison Wesley, Chapters 1 through 9.

Course Outline:

Linear Algebra and Introduction to MATLAB (Week 1)

1. Introduction to *MATLAB*
2. Matrix Algebra (Theory and Numerical Illustration in *MATLAB*)
    - Elementary Operations
    - Rank, Determinant and Inverse
    - Eigenvalues and Eigenvectors
    - Similarity Transformations
    - Special Matrices
3. Systems of Linear Equations (Theory and Numerical Illustration in *MATLAB*)
4. Vector and Matrix Differentiation (Theory and Numerical Illustration in *MATLAB*)

Real Analysis and Calculus (Week 2)

1. Notions of Logic and Set Theory
    - Logical Connectives
    - Quantifiers
    - Proof
    - Sets and Functions
    - Mathematical Induction
2. Sequences and Series of Real Numbers and of Functions
    - Convergence
    - Special Sequences and Series
3. Metric Spaces
    - Open/Closed Sets; Compact/Convex Sets
    - Convergence and Continuity in Metric Spaces
4. Functions
    - Continuity and Limits
    - Concavity
    - Homogeneity
    - Special Properties
    - Differentiation
    - Integration
    - Approximation by Taylor Polynomials
5. Static Models
    - Implicit Function Theorem
    - Intermediate Value Theorem
    - Fixed Point Theorems

Static Optimization (Week 3)

1. Canonical Programming Problem
2. Unconstrained Maximization
    - Necessary and Sufficient Conditions
    - Concave and Generalized Concave Problems
3. Maximization with Equality Constraints
    - Necessary and Sufficient Conditions
    - Concave and Generalized Concave Problems
4. Maximization with Equality and Inequality Constraints
    - Necessary and Sufficient Conditions
    - Concave and Generalized Concave Problems
5. Comparative Statics and Value Functions
6. Numerical Illustration in *MATLAB*: Newton's Method and Quasi-Newton Methods

Statistics (Week 4)

1. Probability
2. Distribution of Random Variables
    - Bernoulli and Poisson Distributions
    - Exponential Distribution
    - Normal Distribution
    - Transformations of Normal Random Variables: Chi Square, *t* and *F* Distributions
3. Multivariate Random Variables
    - Multivariate Normal Distribution
    - Expectations
    - Covariances and Correlation
    - Conditional Distributions
4. Moment Generating Functions and Transformations of Distributions
5. Elements of Asymptotic Modes of Convergence
    - Modes of Convergence
    - Laws of Large Numbers
    - Central Limit Theorems
6. The Linear Regression with Multiple Regressors: Ordinary Least Squares Estimation
7. Monte Carlo Experiments in Econometrics: Key Ideas and Numerical Illustration in *MATLAB*

Texts:

Avriel, M. (1976): *Nonlinear Programming: Analysis and Methods*, Englewood Cliffs: Prentice Hall.

Clark, C.W. (1982): *Elementary Mathematical Analysis*, Belmont: Wadsworth Publishers.

De La Fuente, A. (2000): *Mathematical Methods and Models for Economists*, Cambridge: Cambridge University Press.

Dixit, A. (1990): *Optimization in Economic Theory*, 2nd Ed., New York: Oxford University Press.

Drhymes, P. (2000): *Mathematics for Econometrics*, 3rd Ed., Berlin: Springer Verlag.

Fitzpatrick, P.M. (1995): *Advanced Calculus*, Boston: PWS Publishing.

Gallant, A.R. (1997): *An Introduction to Econometric Theory*, Princeton: Princeton University Press.

Higham, D.J. and N.J. Higham (2005): *MATLAB Guide*, 2nd Ed., Philadelphia: SIAM Press.

MathWorks Inc. (2006): *Getting Started with MATLAB* (Online Documentation and Tutorial), http://www.mathworks.com/access/helpdesk/help/techdoc/learn_matlab/.

Miranda, M.J. and P.L. Fackler (2002): *Applied Computational Economics and Finance*, Cambridge (MA): MIT Press.

Mittelhammer, R.C. (1996): *Mathematical Statistics for Economics and Business*, Berlin: Springer Verlag.

Simon, C.P. and L. Blume (1994): *Mathematics for Economists*, New York: W.W. Norton.

Sundaram, R.K. (1996): *A First Course in Optimization*, Cambridge: Cambridge University Press.

Takayama, A. (1985): *Mathematical Economics*, 2nd Ed., New York: W.W. Norton.