MRM 1st Term 2018-2019 Mathematics

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Introduction

This course covers the basics of differential and integral calculus with an introduction to optimization methods, basics of vector and matrix algebra focusing on the application of linear algebra methods in Econometrics and Multivariate statistics. Familiarity with differential and integral calculus will provide a solid background for Probability and Mathematical Statistics, allowing the student to manage probability distributions and to understand how p-values are specifically obtained.

On the other hand, optimization methods play a relevant role in most fields of science. More specifically, in Statistics, estimation methods are based on optimizing the sum of squared residuals (least squares) or a likelihood function (maximum likelihood). Also, in Microeconomics, situations in which cost is minimized or utility is maximized are frequently considered.

Objectives

The objective of the Mathematics course is to refresh differential and integral calculus, matrix algebra, and to introduce optimization methods, which are going to appear in the Statistics and Microeconomics courses. The selection of the topics is driven by their later occurrence there. It also contains is a brief introduction to numerical methods.

Learning Outcomes

i. Calculate derivatives of functions of one variable.
ii. Find the local maxima and minima of functions of one variable.
iii. Identify the convexity of functions of one variable.
iv. Solve equations using numerical methods.
v. Calculate indefinite and definite integrals.
vi. Calculate partial derivatives.
vii. Solve unconstrained optimization problems.
viii. Solve constrained optimization problems.
ix. Identify the roots of a polynomial.
ii. Apply exponential and logarithmic transformations.
viii. Calculate the eigenvalues and eigenvectors of a square matrix.
iii. Verify linear independence and orthogonality and to identify quadratic forms

Competencies

General Competencies

- CG6: Use appropriate tools and techniques for problem solving, correction contrasting and decision validation.

Basic Competencies

- CB9: Students should be able to communicate clearly and concisely their conclusions, underlying knowledge and reasons to a specialized and non-specialized audience.
- CB 10: Students should possess the learning outcomes that enable them to continue studying in a way that will be largely self-directed or autonomous.

Specific Competencies

- CE2: Profound knowledge of tools in the fields of mathematics, statistics, econometrics and multivariable analyzes in order to carry out relevant research projects on a global level.
- CE8: Analyze business phenomena formal analysis tools (logic and mathematics) in order to develop consistent structural theories.
- CE9: Knowledge of and ability to use the tools of economic analysis and the classical theory of markets in the analysis of organizations.

Content

1. *Vectors*
2. *Matrices*
3. *Eigenvalues and eigenvectors*
4. *Quadratic forms*
5. *Differential and integral calculus with one variable*
6. *Numerical solution of equations*
7. *Convexity*
4. *Differential calculus with several variables*
5. *Lagrange method*
6. *Kuhn-Tucker method*

Methodology

The course is based on lectures, given in a traditional, professor-to-student way. The topics covered in the lectures are explained in a set of lecture notes.

Evaluation

Grading is based on the exercises proposed at the end of each session (50%) and the final exam (50%).

Course Outline

TITLE OF SESSION & MATERIAL

1	*Refreshing functions* Lecture notes: [MATH-01] Refreshing functions
2	*Vectors* Lecture notes: [MATH-02] Vectors
	Product of vectors Lecture notes: [MATH-03] Product of vectors
3	*Matrices* Lecture notes: [MATH-04] Matrices
4	*Determinants* Lecture notes: [MATH-05] Determinants
5	*The product of a matrix and a vector* Lecture notes: [MATH-06] The product of a matrix and a vector
	The product of two matrices Lecture notes: [MATH-07] The product of two matrices
6	*Eigenvalues and eigenvectors* Lecture notes: [MATH-08] Eigenvalues and eigenvectors
	Orthogonal matrices Lecture notes: [MATH-09] Orthogonal matrices
	Quadratic forms Lecture notes: [MATH-10] Quadratic forms

7	*Derivatives* Lecture notes: [MATH-11] Derivatives
8	*Differential calculus* Lecture notes: [MATH-12] Differential calculus
9	*Numerical solution of equations* Lecture notes: [MATH-13] Numerical solution of equations
10	*Convex functions* Lecture notes: [MATH-14] Convex functions
11	*Indefinite integrals* Lecture notes: [MATH-15] Indefinite integrals
12	*Definite integrals* Lecture notes: [MATH-16] Definite integrals
13	*Partial derivatives* Lecture notes: [MATH-17] Partial derivatives
14	*Local maxima and minima* Lecture notes: [MATH-18] Local maxima and minima
15	*The Lagrange method* Lecture notes: [MATH-19] The Lagrange method
16	*The Kuhn-Tucker method* Lecture notes: [MATH-20] The Kuhn-Tucker method
17	*Convex optimization* Lecture notes: [MATH-21] Convex optimization
	The least squares method Lecture notes: [MATH-22] The least squares method
118	*Practical applications*
19	*Practical applications*
20	*Final exam*

Bibliography

- TM Apostol (1967), *Calculus*, Wiley.