MRM 1st Term 2019 1 - Mathematics

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Introduction

This course covers the basics of differential and integral calculus, with an introduction to optimization methods. 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 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.

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. *Differential and integral calculus with one variable*
2. *Numerical solution of equations*
3. *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	*Derivatives* Lecture notes: [MATH-11] Derivatives
2	*Differential calculus* Lecture notes: [MATH-12] Differential calculus
3	*Numerical solution of equations* Lecture notes: [MATH-13] Numerical solution of equations
4	*Computer session*
5	*Convex functions* Lecture notes: [MATH-14] Convex functions
6	*Indefinite integrals* Lecture notes: [MATH-15] Indefinite integrals
7	*Definite integrals* Lecture notes: [MATH-16] Definite integrals
8	*Partial derivatives* Lecture notes: [MATH-17] Partial derivatives
9	*Local maxima and minima* Lecture notes: [MATH-18] Local maxima and minima
10	*The Lagrange method* Lecture notes: [MATH-19] The Lagrange method
11	*The Kuhn-Tucker method* Lecture notes: [MATH-20] The Kuhn-Tucker method
12	*Convex optimization* Lecture notes: [MATH-21] Convex optimization
13	*The least squares method* Lecture notes: [MATH-22] The least squares method
14	*Computer session*
15/16	*Final exam*

Bibliography

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

Professor's Biography

Prof. Miguel-Angel Canela

Associate Professor of Managerial Decision Sciences

Prof. Canela holds a Ph. D. degree in Mathematics from the Universitat de Barcelona (1980). Before joining IESE in 2009, he was a professor at the Department of Applied Mathematics and Analysis of that university and a part-time professor of the Ph. D. Program at IESE. He also worked many years as a consultant at the Institut Català de Tecnologia.

His Ph. D. Dissertation and first research papers were concerned with various problems of Functional Analysis. Later, his interest switched towards interdisciplinary research, entering diverse fields, such as Management Science, Nutrition, Botany, Toxicology and Biochemistry. He has coauthored several research papers with IESE professors and students. Nowadays, his attention is focused on the application of Data Science to various aspects of management.