# Mathematical methods for economics and environment

## Prof. Nicolò pecora

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

### The course aims at providing the formalism, the terminology and the logical tools of mathematics, which constitute a necessary prerequisite for an adequate understanding of the economic and statistical disciplines at the core of the undergraduate program in Management for Sustainability. The course also aims at making the topic of sustainability as much concrete as possible and, at the same time, students will be endowed by concepts that allow them to critically interpret the relevant phenomena in the field of sustainability. Besides the mere mathematical calculus, the goal of this course is to introduce students to the mathematical concepts that are necessary to formalize and analyze dynamical systems that describe the evolution of relevant phenomena within the economic and environmental area.

At the end of the course, students will be able to:

* Quantitatively and qualitatively analyze the behavior of one and two real variables functions, also through the use of an appropriate software.
* Discuss and solve unconstrained and constrained optimization problems.
* Analyze the dynamic behavior of the economic and environmental variables through the study of dynamic models that are employed to describe the evolution of real variables.
* Understand the interconnections between the mathematical and economic notions, and address the environmental topics in a critical way.

Moreover, the course has the objective of developing an autonomous capability of judging and communicative abilities. The definition of a mathematical model requires the detection and the comprehension of a problem, the identification of the relevant aspects and its quantitative formalization. Once the outcomes of the model are obtained, the goal is to interpret such results and communicate them in an appropriate way.

***COURSE CONTENT***

***Decision theory***

1. One and two real variable functions: definitions and economic examples, domain, graphic, level curves, global and local maxima and minima, monotonous functions, inverse function. Limits: definition, examples and calculus.
2. Continuous functions: definition, Weierstrass theorem, Bolzano theorem. Derivatives: definition and geometrical interpretation, calculus, Lagrange theorem, concavity/convexity.
3. Local and global maxima and minima of a one variable function. Linear programming.
4. Two variables functions: partial derivatives, implicit function theorem.
5. Constrained and unconstrained optimized. Lagrange multipliers.

***Dynamical systems and formalization of economic and environmental phenomena.***

1. Integral calculus: basic definitions, Riemann integration, indefinite integrals, improper integrals.
2. Vectors and matrices: determinant of a square matrix, rank, inverse matrix, linear systems.
3. Eigenvalues and eigenvectors.
4. Introduction to dynamical systems: difference and differential equations.
5. Dynamical models: prey-predator model, competitive market model, population models.

***READING LIST***

Required:

A. Guerraggio, *Matematica,* Pearson Paravia Bruno Mondatori S.p.A., 2020.

Additional readings:

F. Brega-G. Messineo, *Esercizi di Matematica generale,* G. Giappichelli, Torino, 2013.

S. SALSA-A. SQUELLATI. *Modelli dinamici e controllo ottimo. Un’introduzione elementare*. Egea, Milano, 2006

M. Bianchi-L. Scaglianti, *Precorso di matematica,* CEDAM, Padova, 2010.

Further material (slides, exercises, assignments, research papers, exam samples) will be made available on the Blackboard platform.

***TEACHING METHOD***

Theoretical and practical lessons with the use of a mathematical software. During classes an active participation is expected. Students may be required to discuss and solve, individually or in small groups, simple problems that are addressed during the lectures.

Teaching also makes use of the Blackboard platform, where additional teaching material will be made available.

***ASSESSMENT METHOD AND CRITERIA***

The exam is designed to assess both reasoning skills and analytical rigour on the topics covered by the course. Through the exam, students have to demonstrate their knowledge of the notions addressed during the classes and apply them to solve the mathematical problems by using a computational software. The comprehension capabilities will be valued, as well as the utilization of the most appropriate quantitative tools among those presented throughout the course. At the same time, the rigorous application of the method aims at solving the problem will be a relevant aspect of the grading.

Grading will be based on an exam which is delivered through the software adopted during classes, and it covers all the arguments of the course. It consists in three problems. The three questions bear equal weight, and they will be graded in a range from 0 (in case of no answer) to 10 (if the answer is faultless). The maximum grade of the exam is 30/30. The exam lasts 1,5 hours.

During the course, two assignments will be delivered, to be addressed individually or in pair. A maximum of 4 points for each assignment can be obtained. Such points will contribute to the 25% of the final grade and replace one problem of the exam.

#### NOTES AND PREREQUISITES

Attending classes is highly recommended.

Preliminary topics (General information on sets and on logic. Exponentials and logarithms. Algebraic expressions. Rational, irrational, exponential and logarithmic equations and inequalities. Analytic geometry of the plane: lines and conics. Overview of trigonometry) are fundamental requirements for a successful attendance of the course and for passing the exam. An overview will be presented during the General Mathematics Pre-Course whose attendance is strongly advised.

Further details on course syllabus, textbooks to be used and additional references, if any, will be provided by the lecturer.

Information on office hours available on the teacher's personal page at <http://docenti.unicatt.it/>.