# Mathematical and statistical methods for decision-making

## Prof. Michele Longo (Modulo Matematico); Prof. Davide zurlo (Modulo Statistico)

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

The main aim of this two-module course (mathematics and statistics), is to present mathematics and statistics methods and techniques needed for the analysis of problems in the field of economics, statistics and finance. The exploration of these topics has the dual purpose of teaching students general theory and suggesting and analysing concrete application.

At the end of the course students:

1. Will have learned theoretical concepts presented during the course and be able to solve theoretical problems and exercises;
2. Will be able to represent situations from the real world using mathematical statistics language and symbology presented during the course, especially in the fields of economics, statistics and finance;
3. Will have developed good learning skills, which will allow them to adopt a more independent approach to later, more advanced, study.

***COURSE CONTENT***

The course is organised into two modules:

Mathematics module (Prof. Michele Longo)*.*

*Linear algebra.* Vector spaces RN. Subspaces. Linear dependence and independence. Basis and dimension. Internal product and norm. Linear functions. Eigenvalues and eigenvectors. Quadratic forms.

*Differential calculus for functions with multiple variables and optimisation.* Review of differential calculus for functions with multiple real variables. Derivative of compound functions. Implicit functions. Concave/convex functions. Free and constrained optimisation. Comparative statics and envelope theorem.

*Review of probability.* Probability space. Conditioned probability and *Bayes*’ *theorem* Uniform space and combination mathematics. Discrete and continuous random variables. Distribution and density functions. Mean, variance and covariance.

*Decisions in uncertain conditions.* Lotteries. Preferences regarding lotteries. Von-Neumann-Morgenstern axioms. Expected utility. Behaviour towards risk. Certainty equivalent and risk premiums. Absolute and relative risk aversìon coefficients. First and second-degree stochastic dominance. Insurance contracts. Portfolio decisions. The mean-variance model and introduction to CAPM.

Statistics module (Prof. Davide Zurlo).

*Linear regression.* Review of simple and multiple linear regression analysis. Regression with dichotomous variables.

*Classic approach to the analysis of time series.* Methods for identifying the components of a time series: trend, seasonal and irregular components.

*Modern approach to the analysis of time series.* Auto-covariance and auto correlation function. White noise and auto-regressive models. Non-stationarity in mean and variance. Integrated processes. Arima models.

***READING LIST***

*Mathematics module*

Lecture notes from the lecturer posted on Blackboard. In addition, lecture topics can be studied in more detail with the help of the following textbooks:

1. M.E.De Giuli-G. Giorgi-M. Maggi-U. Magnani, Matematica per l’economia e la finanza, Zanichelli, 2008.

2. P. Baldi, Introduzione alla probabilità con elementi di statistica, McGraw-Hill, 2003.

3. C. Huang-R. Litzenberger, Foundations of Financial Economics, Prentice Hall, 1998.

*Statistics module*

Lecture notes from the lecturer posted on Blackboard. In addition, lecture topics can be studied in more detail with the help of the following textbooks:

4. Lucchetti, Appunti di analisi delle serie storiche, 2015.

5. R. Carter Hill-W.E. Griffiths-G.C. Lim, Principi di Econometria, Zanichelli, 2013.

***TEACHING METHOD***

Frontal lectures.

***ASSESSMENT METHOD AND CRITERIA***

The examination consists of two written papers, one for each module, containing both theory questions and numerical exercises regarding the entire course programme. The two examination modules may be taken during different sessions, providing they are in the same academic year, otherwise the pass result will no longer be deemed valid.

Further information regarding the examination will be provided at the beginning of the course and posted on the Blackboard platform.

***NOTES AND PREREQUISITES***

Prior knowledge of Basic General Mathematics and Statistics from a three-year degree course in Economics would be useful.

The first six weeks of the course will be devoted to the mathematics module, the following six, after the mid-term tests, will be devoted to statistics.

The online *Blackboard* platform will be used to distribute course material, announce marks and provide information regarding the course.

In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out following procedures that will be promptly notified to students.

Further information can be found on the lecturers' webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.