UNIVERSITÀ CATTOLICA del Sacro Cuore

# Mathematics for management

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## Course aims and intended learning outcomes

The course has the objective of introducing quantitative and numerical instruments for the formalization and the study of dynamic problems in a wide range of fields: Industrial Organization, Finance, Research & Development Decision Making, Supply Chains and, more in particular, Management.

At the end of the course students should:

1. Have acquired the knowledge and understanding of the main parts of the program and be able to apply the mathematical methods described in the program in order to solve problems and exercises.
2. Be able to understand the translation of a real world situation into a mathematical model.
3. Be able to deal with complex problems by using the mathematical tools.
4. Have learned a rigorous and essential language that allows them to communicate the knowledge clearly and effectively.
5. Have developed good learning skills that allow them to continue their plan of studies.

## Course content

The course in organized in two parts.

FIRST PART: *Continuous-time models*

- Basic Definitions of Dynamical Systems Theory (fixed point, local stability, global stability).
- One-Dimensional systems: from linear to nonlinear differential equations.
- Local bifurcations: Saddle-Node, Transcritical, Pitchfork, Flip.
- Two-dimensional systems: from linear to nonlinear systems of differential equations.
- Local bifurcations: Andronov-Hopf bifurcation.
- N-dimensional systems: from linear to nonlinear systems of differential equations.
- Deterministic Chaos and the Butterfly Effect.
- Applications to Industrial Organization, Finance, R&D problems and other fields.

SECOND PART: *Discrete-time models*

- Difference between continuous-time and discrete-time formulation of dynamic models.
- One-Dimensional maps: from linear to nonlinear difference equations.
- The Logistic map and Deterministic Chaos in discrete time.
- Local bifurcations: Saddle-Node, Transcritical, Pitchfork, Flip.
- Two-dimensional maps: from linear to nonlinear systems of difference equations.
- Local bifurcations: Neimark-Sacker bifurcation.
- Piecewise-linear maps and Border-Collision Bifurcations.
- Applications to Industrial Organization, Finance, R&D problems and other fields.

## Reading list

Lecture Notes, Exercise Sets and additional materials available on the e-learning platform *Blackboard*.

The material on Blackboard is self-contained and covers all the topics of the course.

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## Teaching method

Lectures, assignments, exercises with software for numerical simulations, instructional materials published on the *Blackboard*.

## Assessment method and criteria

The exam is subdivided into two parts: for the first part (during the period of lessons) attending students, organized in groups, must analyze and discuss a case study by using the software for numerical simulations. Non Attending students may replace this part with an evaluation of the skills in using the software and the end of the course. The second part is a final written exam. Further information can be found on the *Blackboard*.

## Notes and prerequisites

It is required to have a basic knowledge of the typical topics of an undergraduate course in Mathematics for Economics, such as the study of a real-valued functions, derivatives, partial derivatives and linear algebra.