# Dynamical systems in finance

## Prof. Alessandro Musesti

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

The course aims at introducing the students to the analysis of deterministic dynamical systems, both continuous and discrete, and to the modeling of some phenomena in finance. Moreover, an overview of probability theory and of stochastic dynamical systems will be provided. Some applied models will be studied also by the use of a computer.

The students will be able to understand the basic mathematical models in finance given by discrete dynamical systems and by simple ordinary differential equations; they will be able to establish if a financial market is in equilibrium and if it is stable; they will learn to use specific software in order to study the main features of financial models.

***COURSE CONTENT***

Discrete dynamical systems. Equilibrium and stability. Periodic orbits. One-dimensional maps. Tent map and chaos. A survey on fractals.

Ordinary differential equations. Equilibrium solutions and stability. Stability of linear systems. The two-dimensional case. Isoclines. Stability by linearization. Lyapunov function. Equilibrium instability.

Analysis of models in economy and in finance. The cobweb model. Options and pricing. Financial time series. Chaos in finance.

Topics on stochastic dynamical systems.

***READING LIST***

S. N. Elaydi, *An introduction to difference equations*, Springer, 2005

R. L. Devaney, *A First course in chaotic dynamical systems*, Addison-Wesley, 1992

***TEACHING METHOD***

Classroom lectures, computer simulations, revision of individual and group assignments.

***ASSESSMENT METHOD AND CRITERIA***

There will be both a written and an oral examination. The written examination lasts 60 minutes and will test the expertise of the students in studying continuous and discrete dynamical systems. The oral examination will evaluate the knowledge of the student about the theoretical topics of the course and the analysis of specific financial models. The relevance of the answers, the appropriate use of specific terminology and the coherent structuring of the exposition will contribute to the assessment. There is a unique final mark, assessing the written test for 40% and the oral test for the remaining.

***NOTES AND PREREQUISITES***

Basic notions in linear algebra (matrices, determinants, eigenvalues) and in calculus (limits, elementary derivatives and integrals).