Academic subject: Numerical Ecology				
Degree class: LM-40- Matematica		**Degree Course:** Mathematics	**Academic Year:** 2020/2021	
		Kind of class: mandatory	**Year:** 1	**Semester:** 2
			ECTS: 7 divided into **ECTS** lessons: 7	
Time management, hours, in–class study hours, out–of–class study hours lesson: 60 exe/lab/tutor: 0 in–class study: 60 out–of–class study: 115				
Language: Italian	**Mandatory Attendance:** no			
Subject Teacher Luciano Lopez	**Tel**: +39 080 5442678 **e-mail:** luciano.lopez@uniba.it	**Office:** Department of Mathematics Room 15 , Floor 2	**Office days and hours:** Wednesday 11-13	
Prerequisites: Basic knowledge of Algebra of matrices, numerical analysis, statistics, and Matlab programming language, knowledge acquired in the Bachelor of class L-35.				
Educational objectives: Acquiring methods and techniques of applied mathematics for the observation and analysis of data from an ecological/environmental study. Simulation of environmental models described by partial differential equations				
Expected learning outcomes (according to Dublin Descriptors)	**Knowledge and understanding:** Acquisition of basic concepts of ecological/environmental analysis of a problem. **Applying knowledge and understanding:** Acquisition of numerical methods for ecological data analysis and simulation of environmental models and interpretation of results **Making judgements:** Ability to evaluate the results from a study of an ecological problem through the tools of applied mathematics **Communication:** Acquisition of advanced mathematical language in describing a ecological problem and its simulation. **Lifelong learning skills:** Acquisition of appropriate learning methods, through the systematic use of texts, exercises and computer simulations of models			

Course program:

Data analysis in Ecology: objects and descriptors in ecology; the ecological matrix. Binding arrays of objects and descriptors.. Association measures: similarity and distance. Statistical dependence of descriptors in ecology. Scattering matrix for descriptors. Covariance matrix and correlation matrix. Multivariate normal distribution. Determination of the principal axes of ellipsoid. Analysis of type R.and type Q: similarity coefficients (symmetric and asymmetric) and coefficients of distance between pairs of objects. Distances: metrics and semi-metrics. Cluster analysis (cluster analysis). Clustering methods: the single link, complete link, average, weighted average, the centroid, centroid weighed, minimum variance or Wart. Sorting in smaller spaces. Principal component analysis (principal component analysis, PCA). Principal components of a correlation matrix.

Linear and non-linear least squares methods. Introduction to data assimilation.

Modelling and numerical solution of environmental problems of diffusion and transport. Objectives and contents: introducing some elementary partial differential equations for environmental problems and acquiring the basic knowledge for their numerical solution with finite difference methods. Strengthening of the knowledge through exercises and experiments. Topics covered: Introduction to some operators in differential equations: Diffusion and transport. Finite difference approximation of partial derivatives. Dirichlet and Neumann boundary conditions: physical meaning and numerics. Numerical schemes for PDEs: FTCS and Crank-Nicolson. Consistence, stability and converge.

Lax Theorems. Mathematical model for canal pollution and atmospheric pollution.

Teaching methods:
Lectures and exercise sessions in presence or at distance on MS Teams

Auxiliary teaching:
Tutorial activity

Assessment methods:
Oral exam and computer simulation of models

Bibliography:

P. Legendre, L.Legendre, Numerical Ecology, Elsevier 1998.

Holzbecher E, *Environmental Modeling,* Springer, Berlin, 2007

Thomas J.W., *Numerical partial differential equations: finite difference methods,* Springer, New York, 1995