UCLouvain	**linma2510** *2022*	**Mathematical ecology**

5.00 credits	30.0 h + 22.5 h	Q2

⚠️ **This biannual learning unit is not being organized in 2022-2023 !**

Teacher(s)	Deleersnijder Eric ;Hanert Emmanuel ;Van Effelterre Thierry ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	This course requires prior training in ordinary and partial differential equations (ODEs and PDEs).
Main themes	This course covers the mathematical modelling of ecological and epidemiological processes in the context of systems theory. It aims to analyse the properties of key ecological and epidemiological models, particularly population models. Basically, the models studied refer to the laws of physics, and in particular the concepts of conservation of matter. This course aims to introduce basic tools for understanding and, if possible predicting, the spatio-temporal evolution of ecological and epidemiological systems. These tools include ordinary differential equations, partial differential equations and numerical methods to approximate these equations.

Learning outcomes	**At the end of this learning unit, the student is able to :**
	
	    Contribution of the course to the program objectives
	
	    • 1.1, 1.2, 1.3
	    • 2.2, 2.4
	    • 3.1, 3.2, 3.3
	    • 5.3, 5.5, 5.6
	
	    Specific learning outcomes of the course
	    At the end of the course LMAPR2510, students will be able to:
	
	1 • Identify, describe and explain the theoretical concepts of mathematical modeling of ecological and epidemiological processes in the context of systems theory ;
	    • Explain mathematical concepts and computer tools to model the spatio-temporal dynamics of these processes ;
	    • Activate and mobilize these concepts and tools in an operational manner in order to model the processes governing an ecological or epidemiological application, through an individual project ;
	    • Justify and defend the methodological choices that were made for the complete analysis of the case study, integrating into the discussion the underlying theoretical concepts presented in the course and illustrated in practical work ;
	    • Write a brief report, argued on the basis of results and appropriately illustrated with graphs and charts, using accurate and appropriate scientific vocabulary

Evaluation methods	Individual report based on a project and oral defense during the exam session.
Teaching methods	The course is taught through lectures that include many examples. Practicals and larger-scale individual projects are also proposed to the students so that they can implement the theoretical concepts covered in the lectures.
Content	The course covers the following elements, in particular through a detailed presentation of examples made using Matlab and/or Python: 1. Single-species population models: logistic growth model - microbial growth models - age distribution models. 2. Populations interactions and biodiversity models: predator-prey Lotka-Volterra models - competitive exclusion principle - coexistence. 3. Key elements of mathematical modeling in epidemiology of infectious diseases: compartmental models - dynamics at the population level (epidemics, endemic states) - basic reproduction ratio (R0) - infectious disease control. 4. Random walks, diffusion and characteristic time scales. 5. Population dynamics in space : advection-diffusion-reaction equations - dynamics of a species in the presence of dispersion - dynamics of several species with dispersion - nonlinear progressive waves - effect of dispersion on populations in competition ' pattern formation.
Inline resources	Lecture notes and Matlab/Python scripts available on Moodle : https://moodleucl.uclouvain.be/course/view.php?id=9201

Bibliography	1. Supports de cours : Notes de cours et programmes Matlab disponibles sur iCampus.
	2. Ouvrages de référence : May R.M., 1973, Stability and Complexity in Model Ecosystems, Princeton University Press - Murray J.D., 2002 (3rd ed.), Mathematical Biology (Vol. I & II), Springer - Okubo A., 1980, Diffusion and Ecological Problems: Mathematical Models, Springer-Verlag - Keeling M.J. & Rohani P., 2007, Modeling Infectious Diseases in Humans and Animals, Princeton University Press - Brauer F., van den Driessche P. & Wu J., 2008, Mathematical Epidemiology, Springer.
Other infos	The notes are written in English. Lectures are given in English.
	This course requires prior training in ordinary and partial differential equations (ODEs and PDEs).
Faculty or entity in charge	MAP

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Environmental Science and Management	ENVI2M	5		🔍
Interdisciplinary Advanced Master in Science and Management of the Environment and Sustainable Development	ENVI2MC	5		🔍
Master [120] in Electro-mechanical Engineering	ELME2M	5		🔍
Master [120] in Mathematical Engineering	MAP2M	5		🔍
Master [120] in Physics	PHYS2M	5		🔍