UCLouvain

linma2510

2018

Mathematical ecology

5 credits	30.0 h + 22.5 h	Q2

This biannual learning unit is not being organized in 2018-2019 !

Teacher(s)	Deleersnijder Eric coordinator ;Hanert Emmanuel ;Van Effelterre Thierry ;
Language :	English
Place of the course	Louvain-la-Neuve
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.
Aims	**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 - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
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: 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: types of natural history of infections, types of transmission (e.g. direct contact or contact through a vector), socio-demographic aspects (e.g. contacts between individuals) - stratification of the population ' compartmental models ' dynamics at the population level (epidemics, endemic states) - basic reproduction ratio (R0) - infectious disease control - indirect protection - deterministic models (ODEs and PDEs) and stochastic models (Markov models, network model). Illustration by examples of different models addressing public-health issues: understanding the population dynamics, assessing of the potential impact of various interventions such as vaccinations, antibiotics/antivirals, behavioral changes (e.g. quarantine) 4. Application of modeling to understanding the biology of infectious diseases in an individual: dynamics of immune cells and their interaction with a pathogen illustrated by simple models based on the mathematical immunology. 5. Random walks, diffusion and characteristic time scales.

	6. 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 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 can be given in French or English according to the wishes of the students. 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	Aims
Master [120] in Electro-mechanical Engineering	ELME2M	5		
Master [120] in Environmental Science and Management	ENVI2M	5		
Master [120] in Physics	PHYS2M	5		
Master [120] in Mathematical Engineering	MAP2M	5		