Master in Life Sciences

A cooperation between BFH, FHNW, HES-SO, ZFH

Module	Mathematical Modelling		
Code	MSLS_V5_2		
Degree Programme	Master of Science in Life Sciences (MSLS)		
ECTS Credits	5		
Workload	150 h: Contact and exercises 60 h; Self-study 90 h		
Module Coordinator	Name	Part I: Dr. Matthias Nyfeler; Part II: Dr. Maria Anisimova	
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	Address	ZHAW Zurcher Hochschule für Angewandte Wissenschaften	
		Life Sciences and Facility Management	
Lecturers	Dr. Matthias Nyfeler Dr. Maria Apisimova		
Entry Requirements	The basics knowledge of the following topics:		
	 Iviatnematical analysis (particularly ordinary differential equations) Linear algebra basic knowledge 		
	 Probability 	theory and statistical inference	
	Programm	ing (preferably R and Python)	
Learning Outcomes and Competences	After completing the module students should have a solid grasp of basic theoretical concepts in mathematical modelling and a good understanding of its role in life sciences. Precisely, at the end of the course students are able to:		
	 Describe a suitable model for the analysis of typical data from life sciences Formulate research questions from life sciences into formal mathematical models using differential equations or stochastic processes Practice simulation as an integral part of mathematical modelling process Validate a model and study its major properties Evaluate model fit to given data Formulate hypotheses and test them based on a specific model purpose Interpret the model estimates within the centext of a given study. 		
	 Interpret u Understan Know mos Recognize Describe a Critically r 	d the limitations of each given model of frequent applications of modelling approaches in life sciences the opportunity for an application of standard models a mathematical modelling study in a formal scientific report eview a scientific publication regarding the applied modelling methods	
Module Content	The module focuses on two major mathematical modelling strategies: based on differential equations (part I) and using stochastic processes (part II) and then applied in case studies.		

	The course is structured in three sections:		
	 A. Mechanistic Modelling (part I): Basic principles in modelling and simulation Modelling with ordinary and partial differential equations 		
	 Multiphysics simulations (eg, computational fluid dynamics, heat transfer, 		
	diffusion, reaction)		
	 Reaction kinetics and process optimization B. Stochastic Modelling (part II): 		
	Fundamental classes of stochastic processes: continuous /discrete-time Markov		
	chains and processes over continuous/discrete state space, Poisson processes, Brownian motion and general Random Walk		
	 Modelling evolutionary change in species and populations 		
	 Computational genomics and –omics (eg, gene annotation) 		
	C. Case studies		
	 Individual project work on pre-defined case studies on mechanistic and 		
	stochastic modelling.		
	• Written reports and code are submitted in the format of a scientific publication.		
Teaching / Learning Methods	Basic knowledge is acquired through a combination of lectures, exercise sessions and group work/discussions. In order to apply and extend the acquired knowledge, students carry out individual assignments developing a solution for a case study. Throughout the course students are required to read and discuss relevant scientific literature in groups and as individual self-study.		
Assessment of	Written exam on theory section A and B (40%)		
Learning Outcome	 Individual written report for a case study (45%) 		
5	Peer-review of one written report (15%)		
Bibliography	Selected original papers and monographs depending on the individual case study		
Bibliography	 S Karlin and H M Taylor. A First Course in Stochastic Processes, edition 3 		
	Δcademic Press, New York, 1998		
	 E. Bodin, S. Lenhart, L. Gross, Mathematics for the Life Sciences, Princeton, 		
	2014		
Language	English		
Comments			
Last Update	17.04.2025		