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| **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<br>**Phone** +41 (0) 58 934 51 16 and +41 (0) 58 934 58 82<br>**Email** nyfe@zhaw.ch and anis@zhaw.ch<br>**Address** ZHAW Zürcher Hochschule für Angewandte Wissenschaften<br>Life Sciences and Facility Management<br>Schloss 1<br>CH-8820 Wädenswil |
| **Lecturers** | • Dr. Matthias Nyfeler<br>• Dr. Maria Anisimova |
| **Entry Requirements** | The basics knowledge of the following topics:<br>• Mathematical analysis (particularly ordinary differential equations)<br>• Linear algebra basic knowledge<br>• Probability theory and statistical inference<br>• Programming (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:<br>• Describe a suitable model for the analysis of typical data from life sciences<br>• Formulate research questions from life sciences into formal mathematical models using differential equations or stochastic processes<br>• Practice simulation as an integral part of mathematical modelling process<br>• Validate a model and study its major properties<br>• Evaluate model fit to given data<br>• Formulate hypotheses and test them based on a specific model purpose<br>• Interpret the model estimates within the context of a given study<br>• Understand the limitations of each given model<br>• Know most frequent applications of modelling approaches in life sciences<br>• Recognize the opportunity for an application of standard models<br>• Describe a mathematical modelling study in a formal scientific report<br>• Critically review 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. |

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| | The course is structured in three sections:<br>A. Mechanistic Modelling (part I):<br>• Basic principles in modelling and simulation<br>• Modelling with ordinary and partial differential equations<br>• Multiphysics simulations (eg, computational fluid dynamics, heat transfer, diffusion, reaction)<br>• Reaction kinetics and process optimization<br>B. Stochastic Modelling (part II):<br>• 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<br>• Modelling evolutionary change in species and populations<br>• Computational genomics and –omics (eg, gene annotation)<br>C. Case studies<br>• Individual project work on pre-defined case studies on mechanistic and stochastic modelling.<br>• 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 Learning Outcome** | • Written exam on theory section A and B (40%)<br>• Individual written report for a case study (45%)<br>• Peer-review of one written report (15%) |
| **Bibliography** | Selected original papers and monographs depending on the individual case study.<br>• S. Karlin and H.M. Taylor. A First Course in Stochastic Processes, edition 3, Academic Press, New York, 1998<br>• E. Bodin, S. Lenhart, L. Gross, Mathematics for the Life Sciences, Princeton, 2014 |
| **Language** | English |
| **Comments** | |
| **Last Update** | 05.04.2024 |