Module Description, available in: EN

Modelling Simulation and Optimisation

General Information

Number of ECTS Credits

3

Module code

FTP_ModSim

Valid for academic year

2020-21

Last modification

2019-12-16

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

FTP Fundamental theoretical principles

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of

- Calculus (differential and difference equations)
- Linear Algebra (vectors, matrices, change of basis, matrix inversion, computation of eigenvalues)

Brief course description of module objectives and content

Modelling, simulation and optimization are fundamental to solving problems in a number of fields of science, technology and life. Students will learn to design, implement, simulate, and optimize a model of dynamic system. Simulation, the exploration of the dynamic behavior of the model in time and space, is discussed for both continuous and discrete-event systems. Simulating a model allows the evaluation of indicators of the performance of the modelled system, improving our understanding of its behavior and dynamic complexity.

Aims, content, methods

Learning objectives and competencies to be acquired

The main aim of the course is to understand the pervasive feedback principles that rule the world we live in. Thanks to the acquired competencies, the successful student is expected to be able to tackle problems where temporal dynamics plays a major role. The student will learn about alternative and complementary modelling paradigms: from difference and differential equations for continuous time modelling to queuing systems and discrete event systems for discrete event modelling. The student will be then able to formalise the problem thanks to a dynamical model formulation, implement a simulation of the model, and explore the space of alternative behaviours of the system in order to synthesise a possibly optimal management and control strategy.

Module content with weighting of different components

- Tools for systems thinking: introduction to modelling with causal loop diagrams and stock and flows diagrams
- Models of feedback dynamics in dynamic systems: growth and collapse, delays and oscillations
- Elements of systems theory from linear and regular systems to non linear systems: analysis of equilibrium and stability
- Optimisation and control of continuous state and time systems: concept of feedback control, state estimation with the Kalman filter and Optimal Control
- Modelling with discrete event systems: elements of queuing systems.
- Building discrete event systems: modelling input data and analysing output of simulations
- Simulation as an optimisation design tool: design of experiments, metamodelling and the response surface methodology

Teaching and learning methods

Frontal lectures (3h/week) during which the students also perform hands-on exercises with modelling and simulation tools in order to acquire the key applications of the presented theory.

Literature

- Business Dynamics - Systems Thinking and Modeling for a Complex World, John D Sterman, McGraw-Hill, 2000. ISBN: 007238915X
- Introduction to Dynamic Systems, David G. Luenberger, John Wiley & Sons, 1979. ISBN: 0471025941
- Introduction to Discrete Event Systems - 2nd Edition. C.G. Cassandras and S. Lafortune.Springer 2008. ISBN 978-0-387-33332-8
- Simulation Modeling and Analysis 3rd Edition, Averill M Law and W David Kelton, McGraw-Hill, 2000. ISBN 0-07-116537-1
- *Simio and Simulation - Modeling, Analysis and Applications*, W.David Kelton, Jeffrey S. Smith, David T. Sturrock, Alexander Verbraeck. McGraw-Hill. 2010. ISBN 0-07-340888-3
- Simulation with ARENA - 4th Edition, W. David Kelton and Randall P. Sadowski and David T. Sturrock, McGraw-Hill International Edition 2007. ISBN 0-07-110685-5

Assessment

Certification requirements

Module does not use certification requirements

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

During each progress check the student may use one A5 note card (both sides) with whatever facts, formulas, or explanations you find helpful during the progress checks. Two A4 sheets may be brought to the final exam. No other material will be allowed.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted