

## RTU Course "Fundamentals of Computer Simulation and Modelling"

12111 Department of Modelling and Simulation

### General data

Code	DMI201
Course title	Fundamentals of Computer Simulation and Modelling
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Jelena Pečerska
Academic staff	Gaļina Merkurjeva Juris Merkurjevs Vitālijs Boļšakovs Nadežda Zeņina Jana Bikovska Raisa Smirnova Maksims Žigunovs
Volume of the course: parts and credits points	1 part, 4.5 credits
Language of instruction	LV, EN
Annotation	The study course considers fundamental concepts of system modelling, i.e. the concept of computer modelling and standard procedure, modelling motivation and main principles, and model development and application aspects. The module discusses the essential principles of analytical modelling and types of analytical models used in practice, such as differential equations, difference equations, Boolean functions, logical expressions, finite automats, network models and Petri nets. The fundamentals and applications of system statistical modelling are considered. The structure of a computer simulation model and its main components are defined. Discrete event simulation methods for input modelling, time handling and process simulation, simulation on spreadsheets and simulation output analysis are considered. The systems dynamics approach is discussed. Main principles and methods for model testing and validation are given. Software modelling and add-on tools are reviewed.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to provide the basics of system modelling and simulation. The aims of the study course are: - to acquaint with the basic concepts of system modelling, theoretical and practical aspects of model design and application, a model taxonomy, analytical models, main principles and methods of system computer simulation; - to teach to formulate the purpose of modelling and requirements for the system model, to choose the most appropriate type of model; - to teach to design a simulation model of the system with the general simulation modelling software and to apply it for the analysis and optimisation of the system operation.
Structure and tasks of independent studies	Self-dependent work/course project and practical/ laboratory works organized individually and in groups are intended for the practical implementation and application of the modeling and simulation methods, techniques and principles, which included in the subject, with modern modelling software.
Recommended literature	Obligātā/Obligatory: 1. Cassandras C. G., Lafortune S. Introduction to Discrete Event Systems (3rd ed.), Springer, 2021. 2. Merkurjevs J., Merkurjeva G., Pečerska J., Tolujevs J, Sistēmu imitācijas modelēšanas tehnoloģija. Rīga: RTU, 2008. – 120 lpp. 3. Averil M. Law. Simulation Modeling and Analysis, 5th ed., McGraw-Hill, 2015, 804 p. 4. Pidd M. Tools for thinking. Modelling in Management Science, 3d ed., John Wiley & Sons, Ltd., 2012, 292 p. 5. Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. (2015). Discrete-Event System Simulation. (5th ed.) Prentice Hall. Papildu/Additional: 1. Robinson S. Simulation: The Practice of Model Development and Use. Macmillan Education UK, 2014, 392 p. 2. Gianni, D., D'Ambrogio, A., & Tolk, A. Modeling and Simulation-Based Systems Engineering Handbook. CRC Press, Taylor & Francis Group, 2014. 3. Borshchev A. The Big Book of Simulation Modeling: Multimethod Modeling with AnyLogic 6. AnyLogic North America, 2013, 614 p. 4. Greasley A. Simulating Business Processes for Descriptive, Predictive, and Prescriptive Analytics. DeG PRESS, 2019, 250 p. 5. Frolova L. Matemātiskā modelēšana ekonomikā un menedžmentā. Teorija un prakse. Izglītības soli, Rīga, 2005.
Course prerequisites	Basic knowledge in mathematics, discrete mathematics, probability theory and mathematical statistics.

### Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Course introduction.	2	0	0	0
Basic concepts of systems modelling.	6	4	0	0

System analytical modelling.	4	2	0	0
System statistical (computer simulation) modelling. The Monte Carlo method.	2	2	0	0
Discrete event simulation.	6	4	0	0
Simulation on time-based diagrams and spreadsheets.	2	24	0	0
Visual interactive modelling and simulation.	2	2	0	0
System dynamics.	4	2	0	0
Model testing and validation.	2	2	0	0
Modelling software and add-on tools.	2	2	0	0
Laboratory: creating models with modern simulation software for modelling, analysis and optimization of various systems (computer systems, control systems; transport, production and logistics).	16	16	0	0
Examination.	3	0	0	0
Consultations.	9	0	0	0
Total:	60	60	0	0

### ***Learning outcomes and assessment***

Learning outcomes	Assessment methods
Is able to interpret and use system modelling terminology.	Successfully passed e-test on system modelling basic concepts.
Is able to interpret and use analytical models of complex systems.	Successfully passed e-test on analytical modelling. Using MATLAB, demonstrated ability to apply analytical models to modelling and analysis of a control system.
Is able to interpret and use system statistical (simulation) techniques.	Successfully passed e-test on application aspects of system statistical modelling. Demonstrated ability to use simulation techniques (Course project).
Is able to develop simple simulation models and use them in order to analyse and improve system behaviour.	Using general purpose simulation software, demonstrated ability to develop simulation models and apply them to system analysis and optimisation.
Is able to identify an appropriate model type for a specific problem.	Successfully passed e-test based on problem analysis and selection of an appropriate model.
Is able to describe different analytical and algorithmic models and their application aspects in system modelling, analysis and optimisation.	Demonstrated ability to identify a specific subject and provide a reasoned explanation (Course exam).

### ***Evaluation criteria of study results***

Criterion	%
Laboratory works	40
E-tests	20
Course exam	40
Total:	100

### ***Study subject structure***

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	2.0	0.0	1.0		*	