RIGA TECHNICAL UNIVERSITY

ONLINE COURSE

SYSTEM DYNAMICS

MODEL-BASED ANALYSIS OF COMPLEX, DYNAMIC SYSTEMS

24 January–5 May | 2023

This course offers an introduction to System Dynamics modeling and model-based analysis of complex, dynamic systems. Its emphasis is on the relationship between system structure and dynamic behaviour, and on policy design. After an introduction to system dynamics, techniques and tools, the students are presented with three case studies and challenged to make use of system dynamics to recognize, identify, analyze and solve a variety of dynamic problems by means of modeling and simulation.

Intended audience

This course is introductory and intended for Master students as well as practitioners in the private and public domain, who:

- face the task of understanding complex, dynamic systems and may be challenged to manage such systems.
- see the benefit of developing and making use of simulation models to understand and manage such systems.
- will prepare for a Ph D education in the field.

Period	**24 January–5 May 2023** On Tuesdays and Thursdays at 13.00–17.00 Riga Time (12.00–16.00 ECT Time)
Volume of the course	12 ECTS
Participation fee	800 EUR
Language	English
Simulation Software	Stella Architect (will be provided during the course)
Obligatory literature	• John D. Sterman: Business Dynamics • Misc. journal articles, and the content of presentations made available during the course

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Academic staff

Pål I. Davidsen

- Professor Emeritus at the University of Bergen, Norway
- Professor at Riga Technical University
- Co-founder of the European Masters Programme in SD
- More than 50 years of experience in the field of the system dynamics

Armands Grāvelsiņš

- PhD, researcher and docent at the Riga Technical University

Course contents

The fundamentals of System Dynamics & Modeling with Stella A. I

Week	
1	**The Fundamentals of System Dynamics & Modeling with Stella A. I & II** (History, Method, Complexity, Causal Loops)
2	**The Fundamentals of System Dynamics & Modeling with Stella A. III & IV** (Stock & Flow, First order positive and negative loops, Feedback Loop Dominance)
3	**The Fundamentals of System Dynamics & Modeling with Stella A. V & VI** (Delays, Arrays)
4 | 5	**The Candide Case study** (Supply & Production Chain Dynamics (Oscillation), Aging Chains and Co-flows)
6 | 7	**The Mr. Wang Case study** (Labor Supply Chain Dynamics, Oscillation Trends, Expectation Formation and Decision Making in Complex Domains, Shifting the Burden)
8 | 9	**The Maibab Case study** (Predator Prey Dynamics Under Constraints, S-Shaped Growth from Shifts in Feedback Loop Dominance, Oscillations, Policy Robustness, Shifting the Burden)
10 | 11	**Diffusion Dynamics** (S-Shaped Growth from shifts in feedback loop dominance, Epidemics and Word-of-Mouth) Causal Loop Diagramming
12 | 13	**Equation formulation** Non-linear graph representation Story telling
14	**Summary, data-import & export**
15 | 16	**The Project Case study** (Modeling, Reporting Orally and In-writing)

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Learning outcome

Express knowledge and understanding

Students gain extended knowledge about the System Dynamics method with particular emphasis on model based problem identification and analysis. They also gain knowledge about the intimate relationship that exists between structure and behaviour (dynamics) in non-linear systems. They gain knowledge about robust strategy development, policy design and decision making (i.e. management). The students will know of the basic concepts of systems dynamics methods, techniques and tools.

Apply knowledge and understanding

Students will apply their knowledge in a series of comprehensive case studies, presented in class. They are challenged to investigate the dynamics arising from an underlying, non-linear structure by way of computer based modelling and simulation. Particular emphasis will be placed on their recognition of dynamic patterns of problem behaviour, as well as their ability to evaluate policies to address such problems

Make judgements

Students learn to make judgements about how well a model structure contributes to the explanation of an observed or hypothesised dynamic behaviour.

Communicate

Students are encouraged to participate actively in class and will be trained in writing presentations explain the relationship between structure and dynamic behaviour in complex systems.

Develop learning skills

The course is preparing the student for becoming a modeller, a problem identifier and a policy designer. It equips the student with the basic skills and tools to progress in the investigation of systems in ever more complex domains.

APPLY