



Innovative teaching and learning strategies in open modelling and simulation environment for student-centered engineering education
InMotion

Presentation of the textbook
Fundamentals of event-continuous systems simulation theory
(bachelor level)

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Rationale and objective

Rationale

- Produced within the Erasmus+ InMotion project.
- Bachelor's level course of 3 ECTS.
- Elaborated from teaching materials currently used in NSTU Bachelor and Master courses.

Learning objective

As a result of studying this textbook, students should be able to:

- Apply a systematic approach and mathematical methods in formalizing of solutions to applied problems.
- Construction of mathematical and computer models.
- Simulation of discrete-continuous systems in the workbench.
- Apply a numerical methods for solving of non-trivial Cauchy problems.



Book contents

1. Introduction

2. Theory of ordinary differential equations

- 2.1 Formulation of problem
- 2.2 Existence and uniqueness of solutions
- 2.3 Continuous dependence of solutions on initial conditions
- 2.4 Stability
- 2.5 Stiffness

Book contents (cont.)

3. Numerical methods for analysis of modes of HS

- 3.1 Basic definitions
- 3.2 Control of accuracy
- 3.3 Control of stability
- 3.4 Implementation of explicit methods
- 3.5 Detection of stiffness
- 3.6 Implicit methods with control of stiffness
- 3.7 Explicit method of variable order and step
- 3.8 Computer-aided analysis of highly stiff modes of HS

Book contents (cont.)

4. Hybrid systems

- 4.1 Discrete-continuous model
- 4.2 Zeno effect
- 4.3 Modes and events
- 4.4 Local and global behavior
- 4.5 Discontinuities
- 4.6 Analysis of event-continuous systems
- 4.7 Classification of events
- 4.8 Computer-aided analysis of HS

Book contents (cont.)

5. Event detection

- 5.1 Regions of uncertainty of hybrid model
- 5.2 Correct detection of discrete events
- 5.3 Linearization and method of establishing for localization of events
- 5.4 Ensuring asymptotic approaching to boundary surface for explicit schemes
- 5.5 Examples of the detection algorithm uses

Book contents (cont.)

6. Software

- 6.1 Visual computer models
- 6.2 Textual computer models
- 6.3 Block-textual computer models
- 6.4 Implementation of computer models
- 6.5 Graphical interpretation of computer experiment results
- 6.6 Features of HS programming

Book contents (cont.)

7. Domain-specific components of the software

- 7.1 Modeling and simulation of control systems
- 7.2 Solution of chemical kinetics problems
- 7.3 Modeling and simulation of electrical power systems
- 7.4 Modeling and simulation of hydraulic systems

8. Conclusion

9. References