

## Tárgytematika / Course Description

### Model order reduction

GKNM\_MSTA047

Tárgyfelelős neve /

Teacher's name: dr. Lotfi Abdelhakim

Félév / Semester: 2022/23/1

Beszámolási forma /

Assesment: Vizsga

Tárgy heti óraszám /

Teaching hours(week): 2/2/0

Tárgy féléves óraszám /

Teaching hours(sem.): 0/0/0

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### OKTATÁS CÉLJA / AIM OF THE COURSE

The main goal of the course is to introduce and get learned the most recent and effective methods of the model order reduction technology, including their numerical implementation.

Topics: The model order reduction concept and terminology. Model order reduction for linear input-output systems: modal truncation, balanced truncation and comparison with the substructuring method. Simplification of parametric systems and application for optimization. The proper orthogonal decomposition (POD). Methods improving efficiency of POD (balanced POD, EIM, DEIM). Combination of POD and clustering. The reduced basis method for the finite element methods. Applications using computational software FEniCS and Feel++.

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### TANTÁRGY TARTALMA / DESCRIPTION

#### 1. Introduction and Motivation

- What is Model Reduction?

#### 2. Linear Time-Invariant (LTI) Systems

- State-space(Notation, Continuous-time, Discrete-time) SISO, MIMO
- Laplace transform / Inverse Laplace transform - Transfer function
- Similarity transformation  $\rightarrow$  Transfer function
- System response
- Controllability Matrix, Controllability Gramian, Lyapunov Equation
- Observability Matrix, Observability Gramian, Lyapunov Equation

#### 3. Model order reduction for linear input-output systems:

- modal truncation, balanced truncation, moment matching, Krylov subspace methods
- Applications, Examples, Comparison of results
- Parametric model order reduction and applications

#### 4. Model Reduction of Nonlinear Systems

- Proper orthogonal decomposition (POD)
- Discrete Empirical Interpolation Method (DEIM)
- Applications

#### 5. The reduced basis method for the finite element methods

- Applications of Reduced basis (RB) methods for parametrized Partial Differential Equations
  - Applications
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### **SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD**

To pass this course the student should

- pass 2 tests, the exact date for the two test will be announced on the first lecture. In this two tests the student must score at least 51% or better in order to pass final exam.
- pass final exam, the grades are set according to the table below:

50%-ig (1)

51-70% (2)

71-82% (3)

83-93% (4)

94-100% (5)

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### **KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL**

#### **Model Order Reduction: Theory, Research Aspects and Applications**

Editors: **Schilders**, Wilhelmus H., **van der Vorst**, Henk A., **Rommes**, Joost (Eds.)