Tárgytematika / Course Description

Digital twins

GKNM_MSTA035

Tárgyfelelős neve / Teacher's name: dr. Horváth Zoltán

Félév / Semester: 2022/23/1

Beszámolási forma / Assesment: Vizsga

Tárgy heti óraszáma / Teaching hours(week): 2/4/0

Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

The main goal of the course is to introduce, practice and deepen the necessary mathematical tools for the curriculum and provide the students with a detailed overview of all components of the model based digital twins and construct one actual digital twin at the end of the course.

TANTÁRGY TARTALMA / DESCRIPTION

1.hét	The concept of digital twins with examples from industry and global challenges.
2.hét	Vector spaces, norms, scalar product, Hilbert spaces. Function spaces.
3.hét	Ordinary differential equations, initial and boundary value problems, linearization.
4.hét	Linear ordinary differential equations, exact and numerical solutions in the state space
5.hét	Linear input-output systems, control systems.
6.hét	Laplace transformation, transfer function; approximation with the transfer function.
7.hét	Model order reduction with the balanced truncation method.
8.hét	Model order reduction wth the proper orthogonal decomposition for linear input-output systems.
9.hét	Parameter dependent problems and their model reduction methods.
10.hét	Introduction to data assimilation to linear dynamical systems.
11.hét	The variational data assimilation to linear dynamical systems (4DVAR).
12.hét	Construction of a model based digital twin: thermal predictive maintenance of a simplified motor (modelling, simulations, systems).
13.hét	Construction of a model based digital twin: thermal predictive maintenance of a simplified motor (model reduction, data assimilation).
14.hét	Conceptual overview.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

A kollokvium írásbeli és szóbeli részből áll, súlyuk az értékelésben rendre 60-40%. Az írásbeli rész a félév anyagából való számítógépes problémamegoldás, a szóbeli elsősorban az elméleti ismeretek ellenőrzésére szolgál.

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

Kötelező irodalom:

[1] Athanasios C. Antoulas, Approximation of large-scale dynamical systems. Society for Industrial and Applied Mathematics (SIAM)}, Philadelphia, PA. ISBN: 0-89871-529-6/hbk; 978-0-89871-871-3/ebook, pp. 493. 2005.

Ajánlott irodalom:

[2] Peter Benner, Albert Cohen, Mario Ohlberger, and Karen Willcox (Eds.): Model Reduction and Approximation: Theory and Algorithms. Computational Science and Engineering Vol. 15, SIAM Publications, Philadelphia, PA, 2017. ISBN: 978-1-611974-81-2

[3] Varga, Andreas: Solving Fault Diagnosis Problems - Linear Synthesis Techniques. Springer, 2018. ISBN 978-3-319-51559-5

[4] EU-MATHS-IN: Modeling, Simulation and Optimization in a Data-rich Environment. https://www.eu-maths-in.eu/EUMATHSIN/wp-content/uploads/2018/05/MSO-vision.pdf