



ЮЖНЫЙ ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ  
Региональный математический центр  
SOUTHERN FEDERAL UNIVERSITY  
Regional Mathematical Center  
<https://rmc.sfedu.ru/>, Rostov-on-Don, Russia

## International scientific online seminar on Analysis, Differential Equations and Mathematical Physics

Coordinators: Prof. Alexey Karapetyants, Prof. Vladislav Kravchenko

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### Energy based modeling, simulation and optimization of multiphysics systems

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The next level of digitization will create digital twins of every product or process. To do this in a mathematical rigorous and risk and error-controlled way, a new modeling, simulation and optimization paradigm is needed. While automated modularized modeling is common in some technical domains like circuit design or multi-body dynamics, it becomes increasingly challenging when systems or numerical solvers from different physical domains are coupled, due to largely different scales or modeling accuracy, and very different software technologies.

A recent system theoretic approach to address these challenges is the use of network and energy based modeling via constrained port-Hamiltonian (pH) systems, where the coupling is done in a physically meaningful way via energy variables. Furthermore, for each subsystem a whole model hierarchy can be employed ranging from very fine grane models to highly reduced surrogate models arising from model reduction or data based modeling. The model hierarchy allows adaptivity not only in the discretization but also in the model selection.

We will present an overview over the hierarchical pH modeling approach and illustrate the advantages: Very robust models which are close to the real physics, invariance of the structure under Galerkin projection discretization or model reduction as well as state and time dependent coordinate changes.

The results are illustrated with numerical results at the hand of several real world applications.

\*Seminar website: <https://rmc.sfedu.ru/seminar>. The seminar uses Microsoft Teams online platform. To join the seminar, please send a request to [pichugina@sfedu.ru](mailto:pichugina@sfedu.ru) (Olga Pichugina, scientific secretary).

The seminar is organized by the Regional Mathematical Center of the Southern Federal University in collaboration with Institute of Mathematics, Mechanics and Computer Sciences of the Southern Federal University and the special Interest ISAAC-OTHA group in Operator Theory and Harmonic Analysis.

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