Karlstad Applied Analysis Seminar (2025)

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Fractional Boundary Value Problems: Analysis, Approximations and Applications

Abstract

Fractional calculus is a powerful tool in mathematical modeling, that gets more attention of applied mathematicians and natural scientists since the past decades. Dynamical systems involving fractional order derivatives are able to incorporate the so-called 'memory effects', and due to the non- local nature of fractional differential operators they are usually used in modeling of the flows through porous media (e.g., the groundwater flows), sub- and super-diffusion processes etc. Additionally, a large choice of fractional derivatives and variations in their order gives more flexibility in comparison to the classical integer-order models. Since most physical processes are nonlinear and the exact solution of such models is, in general, impossible to find, we are interested in construction of reliable iterative methods that enable us to deal with this task. In my talk I will present one of such approaches, that is based on analysis of a system of fractional differential equations, subject to periodic boundary conditions. A proper perturbation of the studied system allows us to reduce analysis of the boundary value problem to an equivalent initial value problem, whose solutions are approximated using the numerical-analytic scheme. I will also demonstrate the applicability and effectiveness of this method on a real-world problem.