Generalized Cauchy type problems for linear and nonlinear fractional differential equations with composite fractional derivative operator

Prof. Dr. Živorad Tomovski (Sts. Cyril and Methodius University, Institute of Mathematics, Skopje, Republic of Macedonia)

This talk is devoted to proving the existence and uniqueness of solutions to Cauchy type problems for fractional differential equations with composite fractional derivative operator on a finite interval of the real axis in spaces of summable functions. An approach based on the equivalence of the nonlinear Cauchy type problem to a nonlinear Volterra integral equation of the second kind and applying a variant of the Banachs fixed point theorem to prove uniqueness and existence of the solution is presented. The Cauchy type problems for integro-differential equations of Volterra type with composite fractional derivative operator, which contain the generalized Mittag-Leffler function in the kernel, are considered. Using the method of successive approximation, and the Laplace transform method, explicit solutions of some open problems proposed by Srivastava and Tomovski (2009) are established in terms of the multinomial Mittag-Leffler function. Some fractional diffusion equations with Caputo time fractional derivative are considered in a bounded domain, with different boundary conditions. Given the successful application of the generalized composite fractional (Hilfer) derivative for the modeling of highly non-trivial dielectric data by Hilfer, and modeling with generalized fractional diffusion equations by Sandev et al. and with generalized space-time fractional diffusion equations by Tomovski et al., we believe that the fractional nonlinear models, extended Laplace transform formula and fractional integro-differential equations of Volterra type discussed here will be useful in many problems in science and engineering.