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National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title : Numerical solutions and their convergence analysis for fractional differential and integro-differential equations involving weak singularities

Speaker : Sudarshan Santra (Rollno : 518ma1004)

Supervisor : Prof. Jugal Mohapatra

Venue : Seminar Room, Dept of Mathematics

Date & Time : 28 Sep 2022 (11.30AM)

Abstract : The study of fractional differential equations (FDEs) and fractional integro-differential equations (IDEs) has gained immense interest among many researchers due to its numerous applications in several fields of science and engineering. This helps in modeling many physical problems such as the control theory, fluid mechanics, the financial market, viscoelasticity, electrodynamics, bioengineering, etc. The analytical approximations of the FDEs and fractional order IDEs are not straightforward as the fractional differential operators are non-local defined by an integral over the entire region. Further, given smooth data in the governing equation involving fractional order derivatives may not guarantee the smooth solution of the problem. Due to this uncertain behavior, finding a solution for an FDE and fractional order IDE is not an easy task and there is a need for semi-analytical/numerical methods. The major objective of the present thesis is to analyze FDEs as well as fractional order IDEs and develop time-efficient, accurate, and computationally effective numerical methods such as the L1 scheme, the Adomian decomposition method, the homotopy perturbation method, and the modified Laplace decomposition method, etc., for solving them along with their stability and convergence analysis. This thesis is designed into two parts. The first part is devoted to the numerical simulation of differential equations (IVPs & IBVPs) involving fractional order derivatives, whereas the second part of the thesis shows the reliability of the present approach applying to fractional order IDEs as well as fractional order partial integro-differential equations of Volterra, Fredholm and also of mixed Volterra-Fredholm type. Several tests are performed on numerous extensive examples to show the efficiency and accuracy of the proposed methods and the results are presented in terms of tables and figures. The study of fractional differential equations (FDEs) and fractional integro-differential equations (IDEs) has gained immense interest among many researchers due to its numerous applications in several fields of science and engineering. This helps in modeling many physical problems such as the control theory, fluid mechanics, the financial market, viscoelasticity, electrodynamics, bioengineering, etc. The analytical approximations of the FDEs and fractional order IDEs are not straightforward as the fractional differential operators are non-local defined by an integral over the entire region. Further, given smooth data in the governing equation involving fractional order derivatives may not guarantee the smooth solution of the problem. Due to this uncertain behavior, finding a solution for an FDE and fractional order IDE is not an easy task and there is a need for semi-analytical/numerical methods. The major objective of the present thesis is to analyze FDEs as well as fractional order IDEs and develop time-efficient, accurate, and computationally effective numerical methods such as the L1 scheme, the Adomian decomposition method, the homotopy perturbation method, and the modified Laplace decomposition method, etc., for solving them along with their stability and convergence analysis. This thesis is designed into two parts. The first part is devoted to the numerical simulation of differential equations (IVPs & IBVPs) involving fractional order derivatives, whereas the second part of the thesis shows the reliability of the present approach applying to fractional order IDEs as well as fractional order partial integro-differential equations of Volterra, Fredholm and also of mixed Volterra-Fredholm type. Several tests are performed on numerous extensive examples to show the efficiency and accuracy of the proposed methods and the results are presented in terms of tables and figures.