

King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics
Math 690 - Term 171 - Syllabus
Instructor: Kassem Mustapha

Title Fractional diffusion models, theory and computations

References

- Podlubny, Fractional Differential Equations, Academic Press, San Diego, 1999.
- McLean, Regularity of solutions to a time-fractional diffusion equation, ANZIAM J., 2010.
- McLean & Mustapha, Convergence analysis of a discontinuous Galerkin method for a fractional diffusion equation, Numer. Algo., 2009.
- Mustapha, An implicit finite difference time-stepping method for a sub-diffusion equation, with spatial discretization by finite elements, IMA JNA, 2011.
- Mustapha & McLean, Superconvergence of a discontinuous Galerkin method for fractional order diffusion and wave equations, SINUM, 2013

Description Introduction to fractional integrals/derivatives, anomalous diffusion, fractional subdiffusion models, regularity properties, time-stepping backward Euler and Crank-Nicolson schemes, finite elements for the spatial discretization, discontinuous Galerkin methods, stability and convergence analysis, implementations of the numerical schemes.

Topics
1- Fractional integrals and derivatives
2- Useful tools: Laplace transforms, Mittag-Leffler and Wright functions
3- Anomalous diffusion
4- Fractional diffusion: continuous solutions, stability and regularity properties
5- Time-stepping finite difference schemes: backward Euler and Crank-Nicolson methods
6- Finite elements in space
7- High-order time-stepping discontinuous Galerkin methods

Grading policy:

Assignments: 35 %

Exam I: 30 %

Final Exam (Comprehensive): 35 %