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Seminar of Analysis

Speaker: Prof. Arbaz Khan (Department of Mathematics, Indian Institute of Technology Roorkee, India).

Date/Time: 30/04/2025 (Wednesday), from 14:15 to 15:15 Lisbon time (18:45pm to 19:45pm IST)

Location: Online via Zoom. Please find the details below:

Link: https://videoconf-colibri.zoom.us/j/91434648600?pwd=xhjPqgsVnEEQSQqMa6VYWkRFe6KJIl.1

Meeting ID: 914 3464 8600

Passcode: 418037

Title: Uncertainty Quantification in Poroelasticity: Methods and Error Control

Abstract: Linear poroelasticity models play a crucial role in various applications across biology and geophysics. A prominent example is the Biot consolidation model, which captures the coupled behavior between the elastic deformation of a fluid-saturated porous medium and the diffusive flow of the fluid within it, under the assumption of small deformations. This model forms a foundational framework for computational simulations in medicine (e.g., organ modeling) and geomechanics (e.g., deformation of permeable rocks). In the first part of this talk, we present a novel **locking-free stochas-**

tic Galerkin mixed finite element method (SG-MFEM) for the Biot consolidation model incorporating uncertainties in the Young's modulus and hydraulic conductivity fields. Starting from a five-field mixed variational formulation, we describe the stochastic Galerkin approximation and establish the well-posedness of the resulting system. Emphasis is placed on the development of efficient linear algebra techniques, including a new preconditioner for the MINRES algorithm, for which we derive spectral bounds. Numerical experiments illustrate the robustness and efficiency of the proposed solver. The second part of the talk focuses on the development of **a posteriori error estimators** for the SG-MFEM applied to the Biot model with uncertain parameters. These estimators form the basis for adaptive refinement strategies that enhance computational efficiency while preserving accuracy.