Institut für
Angewandte Mathematik

Leibniz
Universität
Hannover

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Advanced numerical methods for stochastic and deterministic PDEs

The main aim of the course is to introduce efficient numerical techniques for solving different stochastic/deterministic PDEs. The course is designed to prepare the students to solve linear and nonlinear elliptic, parabolic and hyperbolic equations. The following topics are given in the course

1. Introduction of finite element, finite difference, and finite volume methods.
2. Existence and uniqueness of finite element solution.
3. Finite element error analysis, e.g., a-priori and a-posteriori error estimation.
4. Time discretization techniques, e.g., Euler and Euler-Maruyama methods.
5. Numerical methods for nonlinear stochastic PDEs.
6. Adaptive finite element methods.
7. Monte Carlo sampling techniques.

In the course, we consider the numerical methods for different elliptic and time-dependent PDEs, such as Poisson-Boltzmann equation, wave equation, Boltzmann-transport equation, drift-diffusion equation, Navier-Stokes and Cahn-Hilliard-Cook equation. In order to solve the equations, the efficient MATLAB programs will be explained in details.

The application of the equations in biology, physics, and engineering is another aspect of the course. The (system of) equations will be used in electromagnetic, semiconductor devices (e.g., field-effect transistors), fluid mechanics, phase segregation of binary alloys and polymers, simulation of ion channels and nanopores and etc. During the course, modeling these phenomena with PDE models will be explained. During the exercise, writing MATLAB codes for the simulations will be practiced.

Dates and place

Lecture: Wednesday, 12 - 14 h, c311 (1101)
Exercises: Wdnesday, 16 - 18 h, c311 (1101)

Prerequisites

1. Familiarity with MATLAB programming
2. Basic understating of theory and properties of PDEs

Examination

Oral exam

Language

The course and lecture notes will be given in English.

Contact

For any question about the course please write to amirreza.khodadadian@tuwien.ac.at