**偏微分方程数值计算专题短期课程**

**课程名称：Numerical Methodology for Moving Interface Problems and Applications to Fluid-Structure Interactions (FSI)**

**主 讲 人：**孙澎涛 教授（美国内华达大学拉斯维加斯分校）

**时 间：**

2024 年 7 月 1 日(星期一)上午 9:00-11:00 下午 15:00--17:00

2024 年 7 月 2 日(星期二) 上午 9:00-11:00

2024 年 7 月 3 日(星期三) 上午 9:00-11:00 下午 15:00--17:00

2024 年 7 月 4 日(星期四)上午 9:00-11:00

2024 年 7 月 5 日(星期五)上午 9:00-11:00 下午 15:00--17:00

**授课地点：**数学院西楼112教室

**课程简介：**

In this series of lectures, I will present our recent numerical methodology studies for unsteady moving interface problems and applications to dynamic fluid-structure interaction (FSI) problems. Numerical methodologies to be discussed include the body-fitted mesh method — arbitrary Lagrangian−Eulerian (ALE) method and the body-unfitted mesh method — fictitious domain (FD) method. Both methods are popular and practical in applications to realistic FSI problems with moving interfaces and jump coefficients, and take different effects due to their significantly distinct features in the theoretical background as well as in the numerical implementations. In my lectures, both the numerical analysis and the algorithm development will be emphasized in terms of a monolithic mixed finite element method, where, the numerical analysis will focus on analyzing properties of the well-posedness, the stability and the convergence of the developed finite element approximation in both semi- and fully discrete schemes; and the algorithm development will concentrate in the implementation of ALE method and FD method in the finite element frame for unsteady interface problems with distinct governing equations on either side of the moving interface such as FSI problems.

**课程内容安排：**

My lectures will be grouped into the following four topics and given in four sessions, respectively, as displayed below.

1. Introduction to the arbitrary Lagrangian Eulerian (ALE) - finite element method (FEM)

1.1 The ALE approach in conservative and non-conservative formulation

1.2 A linear advection diffusion problem and Geometric Conservation Law (GCL)

1.3 Stability analysis of the conservative ALE scheme

1.4 Stability analysis of the non-conservative ALE scheme

2. ALE-FEM for a unsteady Stokes/parabolic interface problem

2.1 A novel elliptic projection approach

2.2 Stability and convergence analyses for the semi-discrete scheme

2.3 Stability and convergence analyses for the fully discrete scheme

3. Distributed Lagrange multiplier/fictitious domain (DLM/FD)-FEM for unsteady Stokes/parabolic interface problem

3.1 DLM/FD formulation with finite elements

3.2 DLM/FD finite element analysis for a semi-discrete scheme

3.3 DLM/FD finite element analysis for a fully discrete scheme

4. Applications to FSI problems in hydrodynamics and hemodynamics

4.1 ALE-FEM for a dynamic FSI problem

4.2 Algorithm development for a hydrodynamic FSI problem involving a rotating elastic turbine

4.3 Algorithm development for a hemodynamic FSI problem involving multiple structure materials in the cardiovascular environment底端

**授课教师简介：**

孙澎涛博士，现任美国内华达大学拉斯维加斯分校（University of Nevada Las Vegas, UNLV）数学系的终身正教授，博士生导师。1997年在中国科学院数学研究所获博士学位。在2007年入职美国内华达大学（UNLV）之前，曾先后在中国科学院、香港理工大学、美国宾夕法尼亚州立大学、加拿大西蒙弗雷泽大学担任博士后、副研究员、助理教授等职位。主要研究方向：偏微分方程数值解，有限元/有限体积方法的数值分析，自适应有限元方法，区域分解方法，相场方法，以及对流体动力学、固体力学、流─固耦合动力学、燃料电池动力学、血液动力学、电流体动力学等多物理场问题的建模、科学与工程计算的算法、分析、实现等研究。在著名的科学期刊上发表学术论文100余篇。2008年以来的研究课题连续被美国国家科学基金会（NSF），西蒙斯基金会（Simons Foundation）和内华达大学的教授研究奖励基金所资助。于2016年获得内华达大学理学院颁发的杰出研究奖。

欢迎相关方向研究生和高年级本科生参加！

华南师范大学数学科学学院

2024年 6月 3日