DS 291 Jan 3:1

Finite elements: Theory and Algorithms

Instructor

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Teaching Assistant

Email:

Department: Department of Computational and Data Sciences

Course Time: 10-11.30 AM

Lecture venue: CDS 202

Detailed Course Page: cds.iisc.ac.in/faculty/sashi/teach/

Announcements

Brief description of the course

This course will provide an introduction to the finite element methods and their applications to the scalar convection diffusion equations and to the Navier-Stokes equations. The course will cover the basic mathematical theory of the finite element methods, and the development of fully practical finite element algorithms for solving partial differential equations elliptic and parabolic scalar PDES, linear elasticity, Mindlin-Reissner plate problem, Navier-Stokes equations. Further, the lab component will consists of programming assignments including the implementation of the finite element algorithms, solving scalar and Navier-Stokes equations using the in-house package ParMooN (cmg.cds.iisc.ac.in/parmoon/).

This four credit course will be offered every year in the January-April term as an elective in Department of Computational and Data Sciences. This course is aimed to be an introductory graduate level (200-series) course.

Prerequisites

Good knowledge of numerical analysis and/or consent from the instructor.

Syllabus

Generalized (weak) derivatives, Sobolev norms and associated spaces, inner-product spaces, Hilbert spaces, construction of finite element spaces, mapped finite elements, two- and three-dimensional finite elements, Interpolation and discretization error, variational formulation of second order elliptic boundary value problems, finite element algorithms and implementation for linear elasticity, Mindlin-Reissner plate problem, two-dimensional stationary incompressible Navier-Stokes equations systems in fluid mechanics.

Course outcomes

The students will learn the mathematical theory of finite element methods and fully practical finite element algorithms for solving partial differential equations elliptic and parabolic scalar PDES, linear elasticity, Mindlin-Reissner plate problem, Navier-Stokes equations.

Grading policy

25% for assignments, 25% for mid-term, 50% for final-term

Assignments

Resources

1. Sashikumaar Ganesan, Lutz Tobiska: Finite elements: Theory and Algorithms, Cambridge-IISc Series, Cambridge University Press, 2017

2. Dietrich Braess, Finite Elements: Theory, Fast Solvers, and Applications in Solid Mechanics, Cambridge University Press, 3rd ed., 2007

3. Susanne C. Brenner, Ridgway Scott, The Mathematical Theory of Finite Element Methods, Springer-Verlag, 3rd ed., 2008