INSTRUCTORS

Dr. Ravindra Duddu

Associate Professor
Vanderbilt University
Nashville, TN, USA

Ravindra Duddu has a B.Tech in Civil Engineering from the Indian Institute of Technology Madras, and an M.S. and Ph.D. in Civil and Environmental Engineering from Northwestern University. He then worked as a postdoctoral researcher at the University of Texas at Austin and Columbia University before joining Vanderbilt University.

Prof. Duddu's research interests are in the general area of computational solid mechanics with an emphasis on fracture mechanics and multi-physics modeling of material damage evolution. He has 15+ years of experience in the application of the finite element method (FEM), including eXtended FEM, discontinuous Galerkin method, isogeometric analysis, and material point method. He is a recipient of the Fulbright Kalam-Climate Fellowship, which supported this short course offering.

Dr. Abhinav Gupta

Researcher
Vanderbilt University
Nashville, TN, USA

Abhinav Gupta holds a master's and Ph.D. in Civil Engineering from IIT Roorkee. He has five years of industrial experience analyzing and designing power plants at the Department of Atomic Energy in India. His research interests include large-scale finite element analysis, topology optimization, and fracture analysis. He has successfully scaled up his FEA code to handle 800 million variables on an HPC system. During his doctoral research, he has also worked with the core team of FEniCS under the Google Summer of Code program.

TARGET AUDIENCE

PG (M. Tech., M. Sc., or Ph. D.)

Faculties & Working Professionals using FEM.

BENEFITS

Gain a comprehensive understanding of solving PDE's using HPC capable FEM software, FEniCS.

Broad applicability across engineering disciplines, fostering interdisciplinary research.

Hands-on coding experience in solving elasticity, thermoelasticity and diffusive transport problems.

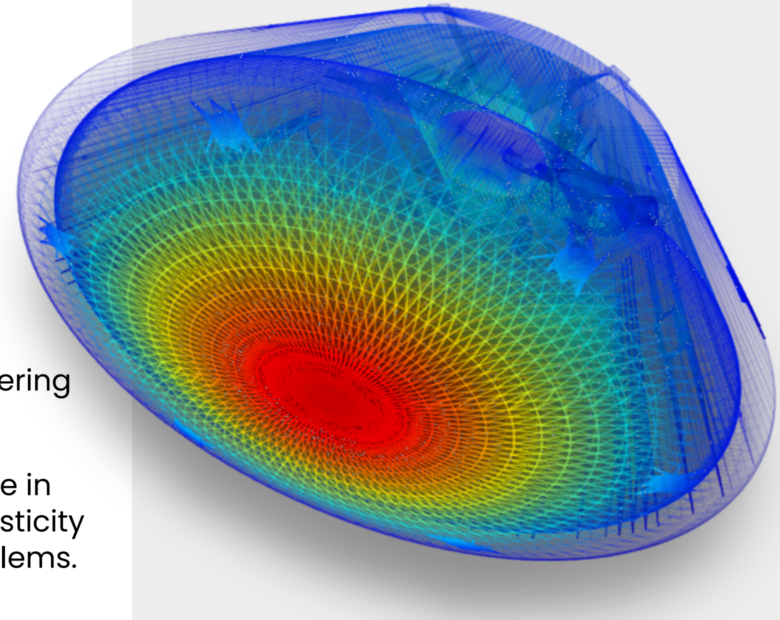
IMPORTANT DATES

Last date for receiving applications	**21 July 2023**
Intimation to participants	**22 July 2023**
Course Dates	**24-28 July 2023**

LOCATION

Department of Civil Engineering
IIT Madras, Chennai, TN,
600036, India

IIT Madras, India
Vanderbilt University, USA



A short course on

Introduction to FEniCS

Solution to elasticity, hyperelasticity and thermoelasticity problems in engineering sciences using the finite element method.

email: rduddu2023@gmail.com

COURSE OVERVIEW

This is a five-day course focused on solving partial differential equations (PDEs) using the FEniCS software package. The goal is to introduce the students to PDEs encountered in various engineering and science disciplines, such as solid mechanics, heat transfer, and mass transport. Therefore, this course is of broad interest to postgraduate students and early career researchers focusing on structural mechanics, materials and manufacturing, and geoscience applications. Each day covers different topics and PDEs, providing an understanding of the background physics, corresponding model equations and their finite element solution. Specifically, students will learn to derive the weak form from the strong form of various governing equations, linearization of nonlinear PDEs, best practices for coding, and using auto-differentiation in FEniCS for evaluating numerical tangents. Students will participate in hands-on computer lab sessions where they will develop the code for solving diffusive transport, elasticity and thermoelasticity problems.

REGISTRATION

To register for the course, students should fill this form (https://forms.gle/B9BF7WYSZi8qTAHA8) by 21 July 2023. The class size is capped at 25 students, and the admitted student will be notified on 22 July 2022 with the venue and class times.

The course is completely free, however, students are responsible for finding and paying for their own lodging and food.

CONTACT US

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COURSE CONTENTS

Day	Topic	Computer Lab
1	**Introduction and FEniCS installation** • Introduction to FEniCS • Installation and setup • Review of notation used • Solving linear Poisson equation	• Participants will utilize FEniCS to solve the linear Poisson equation, which is fundamental to defining heat transfer and diffusive mass transport phenomena.
2	**Solution to nonlinear problems** • Introduction to nonlinear Poisson • Linearization techniques • Auto-differentiation	• Participants will explore the numerical solution of nonlinear Poisson equations using FEniCS. They will learn how to implement appropriate iterative methods, including nonlinear functionals, nonlinear solvers, and convergence analysis.
3	**Linear elasticity** • Introduction to linear elasticity • Vector degrees of freedom (DOFs) • Shear locking and its implications • Beam bending using CST elements	• Participants will use FEniCS to solve linear elastic problems, including topics of strain-displacement relations, stress-strain constitutive models, and the finite element method for linear elasticity.
4	**Hyperelasticity** • Introduction to hyperelasticity • NeoHookean or nearly incompressible elasticity • Mathematical and computational aspects of hyperelasticity	• Participants will explore the solution of large deformation of hyperelastic materials using FEniCS. They will learn about the theory behind hyperelastic materials and their constitutive models.
5	**Thermoelasticity** • Introduction to coupled problems • Linear thermoelasticity: combining heat transfer and linear elasticity • Modeling temperature and deformation interactions	• Participants will solve linear thermo-elasticity problems using FEniCS, by coupling the heat and elasticity equations. Students will learn how to incorporate thermal effects into the linear elastic equations, define thermal boundary conditions, and use staggered approaches to solve the coupled problem.