AME40541/60541: Finite Element Methods

Course logistics

AME40541/60541: Finite Element Methods, 3 units
Lecture: MWF 1p-1:50p, B34/36 Geddes Hall

This course is being offered as a combined undergraduate (AME40541) and graduate (AME60541) course. The lectures for both listings will be co-located; however, the workload and level of rigor will be higher for those enrolled in AME60541. Undergraduate students can enroll in AME60541 for graduate credit with instructor approval.

Course description

The finite element method is the industry-standard for solving a range of thermal, structural, and fluid flow problems that commonly arise in engineering practice and research. Commercial software is well-suited for solving such problems; however, having a fundamental understanding of the underlying methods is crucial to effectively use the software, develop methods/code tailored to the particular problems they face, or undertake cutting-edge research. This course introduces the fundamental concepts of finite element methods with applications to structural analysis, heat flow, fluid mechanics, and multiphysics problems. It covers the basic topics of linear and nonlinear finite element technology including weak formulations and error analysis, domain discretization on structured and unstructured meshes, assembly of global equations, the isoparametric concept, essential and natural boundary conditions, numerical quadrature, variational crimes, and the structure of a finite element program. Throughout the course, students will build their own finite element code that will be used to investigate fundamental properties of finite element methods. In addition, the course makes use of commercial software to explore more advanced capabilities, validate their own code, and gain experience with software commonly used in engineering industry.

Learning goals

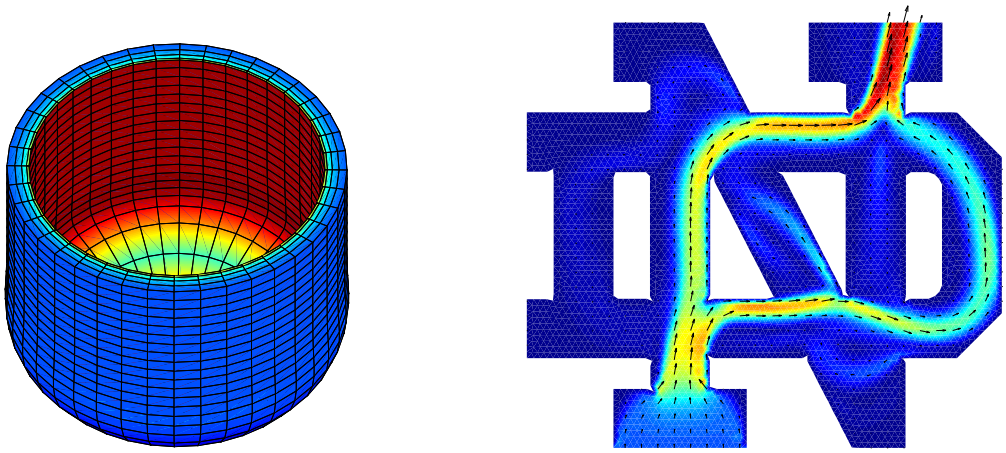
Upon successful completion of this course, you will be able to: (1) identify problems in engineering and science that can (and cannot) be solved with the finite element (FE) method, (2) apply the steps of the FE method to linear/nonlinear partial differential equations (PDEs) and engineering structures, (3) use commercial FE software to solve problems that arise in engineering and science, and (4) develop FE program from scratch that can be used/extended for research purposes.

Prerequisites

MATLAB programming, multivariable calculus, basic linear algebra

Instructor

Matthew J. Zahr (mzahr@nd.edu), 300B Cushing Hall



Deformation of a thin-walled structure and viscous flow through the Notre Dame logo; both problems were solved using the FEM code developed throughout the course.