MG2817
Applications of the Finite Element Method

Professor: Andrea Barbarulo

Language of instruction: English – **Number of hours**: 36 – **ECTS**: 3

Prerequisites: Some knowledge of functional analysis

Period: S8   Elective 12   March to June   IN28IE5, SEP8IE5

Course Objectives

The finite element method has become a method of choice for computational engineering and science simulations. The main objective of the course is to develop skills to effectively use the finite element method for the analysis of problems in solid and fluid mechanics. Students will learn the basic principles of the method, how to develop suitable finite element models, and how to interpret the numerical results. A second objective is to familiarize students with the COMSOL Multiphysics software. The skills acquired in this course will be useful for the supervision of conception and design projects.

On completion of the course, students should be able to

- derive the weak formulation of any initial- and boundary- value problem
- write the corresponding finite element formulation
- implement the model in COMSOL Multiphysics and solve the problem
- assess the accuracy of the finite element solution

Course Contents

The course will present the main theoretical aspects of the finite element method and its application to engineering problems using COMSOL Multiphysics. Topics will include:
- Variational formulation of classical 1D BVPs
- Finite element space and solution procedures
- Variational formulation of classical 2D BVPs
- Finite elements in 2D and in 3D
- Matrix assembly
- Mesh generation, convergence analysis, and discretization errors
- Adjoint problems
- Initial and boundary-value problems
- Multimodel/multiphysics applications

The theory will be illustrated by the development of COMSOL models drawn from applications in solid and fluid mechanics such as: linear elastic stress analysis, large deformations, thin plate and shell modeling, heat transfer, incompresible flows, etc.

Course Organization

Lectures: 15 hr, Labwork: 18 hr, Exam: 3 hr

Teaching Material and Textbooks

Lecture notes in English

Evaluation

3-hr written final exam (no document allowed, but computer allowed for the practical part). The project reports may count as up to 4 bonus points added to the mark of the final exam

Mechanical and Civil Engineering