FEM Structural Analysis (6037-M) 5 ECTS

Lecturer: **M. Halilovič, B. Starman**

Lectures: 30h | Tutorials: 10h | Labs: 20h | Project: 65h | Lang. :

Objectives

The objectives of this course are to provide students with a solid understanding of the theoretical background of various types of finite elements used in the computer-based structural analysis. The course also develops student's ability to create appropriate numerical models of structures and to define relevant loading conditions. Furthermore, students acquire the skills needed to present and critically evaluate the results of numerical analysis. Upon completion of this course, students will be able to:

- understand the theoretical foundation of FEM and develop own program codes;
- create optimal numerical models of structures,
- present and analyse of results, considering the characteristics of the finite elements and the physical problem.

Programme

- Fundamentals of modelling of structures.
- Numerical modelling: comparison of numerical methods in terms of suitability for structural analysis, fulfilment of boundary conditions, basic steps in FE analysis.
- Steps in FE analysis.
- Properties of FEs, determination of initial, boundary and loading conditions.
- Isoparametric FE: interpolation functions, mapping to a natural coordinate system, mapping to a volume coordinate system, Gaussian quadrature rule.
- 3D FE to solve thermal or mechanical problems: determination of the number of FE DOF, point load, area distributed load, volume distributed load, analysis of the results.
- Axisymmetric FE to solve thermal or mechanical problems: mapping from Cartesian to cylindrical coordinate system, conditions for use of axisymmetric Fes.
- 2D FE to solve thermal or mechanical problems: conditions for the use of 2D FEs.
- Shell FE to solve shell structure problems; conditions for the use of shell FEs.
- 1D FE: matrix form of the system of linear equations in case of axial loaded construction elements, matrix form of the system of linear equations in case of Euler-Bernoulli theory and Timoshenko beam theory of bending beams, types of loads, visualization and analysis of the results.
- Advanced use of FEM: mirror symmetry, antisymmetry, cyclic symmetry, periodic boundary conditions, connection of different types of FEs

Prerequisites

- No conditions.

Learning outcomes

- In-depth knowledge of FEM theory and methodology, with ability to implement it in custom program codes for modelling complex physical problems.
- Mastering efficient computer-aided FEM of structures, with the ability to critically analyse and interpret results.

Assessment

- 50% Theory; 30% Practical work; 20% Coursework

Literature

- "The Finite Element Method for Solid and Structural Mechanics" - Elsevier - O.C. Zienkiewicz, R.L. Tayler, D.D. Fox, 2014
- "The Finite Element Method: A practical course" - Elsevier - G.R. Liu, S.S. Quek, 2014
- "Structural Analysis with the Finite Element Method Linear Statics", Springer - E. Onate, 2013