University *of Ljubljana*
Faculty *of Mechanical Engineering*

FEM Structural Analysis 5 ECTS

Lecturer: **Assoc. Prof. Dr. Miroslav Halilovič, Assoc. Prof. Dr. Nikolaj Mole**

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

Objectives

The objectives of this course are to acquire knowledge about the theoretical background of the individual types of finite elements used in the computer analysis of structures, to acquire knowledge to prepare a numerical model of structure, mastering the determination of loading conditions and acquire competencies to display and evaluate the results of numerical analysis. With this course student will get the following competences:

- mastering the theoretical background of the FEM with the aim of developing your own program code,
- the ability for preparing the optimal numerical model of the structures,
- presentation and analysis of results considering the specifics of the used 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 theoretical and methodological knowledge of the application of finite element method and its implementation into own computer codes for modelling complex physical problems.

- Mastering efficient computer-aided FE analysis of structures, and critical analysis and interpretation of results.
- Ability to develop a specific software tool for structural analysis.

Assessment

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

Literature

- O.C. Zienkiewicz, R.L. Tayler, D.D. Fox: The Finite Element Method for Solid and Structural Mechanics, Elsevier, seventh ed., 2014
- G.R. Liu, S.S. Quek: The Finite Element Method: A practical course, Elsevier, sec. ed., 2014
- E. Onate: Structural Analysis with the Finite Element Method Linear Statics – Vol. 2. Beams, Plates and Shells, Springer, 2013