University *of Ljubljana*
Faculty *of Mechanical Engineering*

Mechanics of Light-weight Structures 5 ECTS

Lecturer: **Assoc. Prof. Dr. Miha Brojan**

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

Objectives

The objectives of this course are to learn the basics of nonlinear mechanics of structural elements, to learn to take advantage of instabilities for advanced functionality and to learn to design light-weight structures for efficient material use. With this course student will get the following competences:

- ability to understand the basics of nonlinear mechanics of structural elements,
- ability to take advantage of instabilities for advanced functionality,
- ability to design light-weight structures for efficient material use.

Programme

Obligations for following and completing the course; Presentation of relevant study literature; Overview of course topics; Basic properties of lightweight structures, Efficient material use, favourable stress distribution in lightweight structures; Review of slender (thin-walled) structural elements: beams, plates, shells; Composite structures; Problems of slender element application (discontinuities, nonlinearities, imperfections, interactions of interconnected elements, stability); Basic concepts of stability of structures, determination of stability conditions in slender structures; Limit load buckling (snap-through), bifurcation buckling; Physically correct equilibrium on a (deformed) beam; Euler's buckling; Influence of imperfections; Buckling of a bar under self-weight; Beams on discrete elastic supports; Beam on an elastic foundation, wrinkling; Buckling of real-life (elastic-plastic) beam; Torsional buckling (buckling of an I-beam); Improving load-carrying capacity by optimization; Definition of an optimization problem (objective function, equality and inequality conditions, Karush-Kuhn-Tucker theorem); Simple cases in optimization; Optimization of load-carrying capacity of a composite beam (e.g. a composite aircraft wing); Physically correct equilibrium on a (deformed) plate; Föppl-von-Karman plate theory; Bending of an elastic plate; Bending of a composite plate; Wrinkling of composite plates

Prerequisites

Meeting the enrolment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.

Learning outcomes

Thorough professional theoretical and practical knowledge in a selected field of expertise that is supported with a broad theoretical and methodological basis.

- In-depth knowledge of nonlinear response of structural elements
- In-depth understanding of mechanics of composite structures
- In-depth understanding of solution methods of nonlinear problems for the design of light-weight structures

Assessment

20 % Examination (lectures - theory)
60 % Examination (exercises – design calculations)
10 % Laboratory exercises
10 % Homework

Literature

- S.P. Timoshenko, J.M. Gere: Theory of Elastic Stability
- G. Simitses & D.H. Hodges: Fundamentals of Structural Stability
- J.M.T. Thompson & G. W. Hunt: General Theory of Elastic Stability
- J. Singer, J. Arbocz, T. Weller: Basic Concepts, Columns, Beams and Plates (Volume 1 & 2)
- D. Bigoni: Nonlinear Solid Mechanics - Bifurcation Theory and Material
- Z.P. Bazant, L. Cedolin: Stability of Structures: Elastic, Inelastic, Fracture, and Damage Theories
- N.R.G. Iyengar: Elastic Stability of Structural Elements
- T.V. Galambos & A.E. Surovek: Structural Stability of Steel