UNIVERSITY OF NIŠ

Course Unit Descriptor	Faculty	Faculty of Mechanical Engineering

GENERAL INFORMATION	
Study Program	Mechanical Engineering
Study Module (if applicable)	-
Course Title	Nonlinear FEM structural analysis in transport engineering
Level of Study	☐Bachelor ☐ Master's ☒ Doctoral
Type of Course	☐ Obligatory ☒ Elective
Semester	☐ Autumn ☒ Spring
Year of Study	I
Number of ECTS Allocated	10
Name of Lecturer/Lecturers	Dragan Z. Marinković
Teaching Mode	☒ Lectures ☐ Group tutorials ☐ Individual tutorials ☒ Laboratory work ☒ Project work ☒ Seminar ☐ Distance learning ☐ Blended learning ☐ Other

Purpose and Overview (max. 5 sentences)

Expanding the knowledge acquired at undergraduate studies related to the structural analysis of carrying structures in the field of transport technique; understanding the causes of nonlinear deformational behaviour and, accordingly, the distinction between different types of nonlinear analysis; FEM formulations for nonlinear structural analysis and algorithms for solving nonlinear problems; identification of the cases from the field of transport technique that require nonlinear structural analysis.

Syllabus (brief outline and summary of topics, max. 10 sentences)

1) The basics of linear FEM structural analysis, applied assumptions and their consequences. 2) Steps in performing linear and nonlinear FEM structural analysis and their comparison. Causes and types of nonlinearities – geometrical, material, contact. 3) Algorithms for solving nonlinear FEM problems. Tangential stiffness matrix. Incremental approach. Linearization of the problem and iterative solution procedure – Newton-Raphson method, modified Newton-Raphson method, arc/line search method. 4) Geometrically nonlinear analysis. Formulations of nonlinear FEM analysis – total Lagrange, updated Lagrange, co-rotational formulation. Strain and stress measures. The effect of stress state – geometric stiffness matrix. Structural stability, post-buckling deformational behaviour. Follower forces. Examples from the field of transport technique. 5) Materially nonlinear analysis. Description of material properties dependent on strain and strain rate. Elastic-plastic material behaviour. Examples from the field of transport technique. 6) Combination of the approaches based on Multi-Body System (MBS) and FEM to resolve nonlinear problems in the field of transport technique. Decomposition of overall motion into the rigid-body motion and deformable motion. 7) Local nonlinearities. Model sub-structuring. Examples from the field of transport technique.

Language of Instruction

☒Serbian (complete course) ☐ English (complete course) ☐ Other _____ (complete course)

☒Serbian with English mentoring ☐Serbian with other mentoring _____			
Assessment Methods and Criteria			
Pre exam Duties	**Points**	**Final Exam**	**Points**
Activity During Lectures	**5**	**Written Examination**	**40**
Practical Teaching	**5**	**Oral Examination**	**50 (project presentation)**
Teaching Colloquia	**0**	**Overall Sum**	**100**
***Final examination mark is formed in accordance with the Institutional documents**			