|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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** | | | | | | | | |