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| **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** |