



UNIVERSITY OF NIŠ

Course Unit Descriptor**Faculty**

Faculty of Mechanical Engineering

GENERAL INFORMATION

Study Program	Mechanical Engineering		
Study Module (if applicable)	-		
Course Title	NUMERICAL METHODS		
Level of Study	<input type="checkbox"/> Bachelor	<input type="checkbox"/> Master's	<input checked="" type="checkbox"/> Doctoral
Type of Course	<input checked="" type="checkbox"/> Obligatory	<input type="checkbox"/> Elective	
Semester	<input checked="" type="checkbox"/> Autumn	<input type="checkbox"/> Spring	
Year of Study	I		
Number of ECTS Allocated	10		
Name of Lecturer/Lecturers	Petković D. Ljiljana, Rajković M. Predrag, Živković S. Dragan, Ilić S. Gradimir, Vukić V. Mića, Jovanović M. Miloš		
Teaching Mode	<input checked="" type="checkbox"/> Lectures	<input type="checkbox"/> Group tutorials	<input type="checkbox"/> Individual tutorials
	<input type="checkbox"/> Laboratory work	<input type="checkbox"/> Project work	<input checked="" type="checkbox"/> Seminar
	<input type="checkbox"/> Distance learning	<input type="checkbox"/> Blended learning	<input type="checkbox"/> Other

Purpose and Overview (max. 5 sentences)

Students are introduced to the numerical methods for solving mathematical models which describe some physical phenomena in the field of mechanical engineering and to the methods of optimization. Students first gain knowledge in the field of numerical analysis (which is compulsory) and then choose one of the fields: Finite Element Method, Methods of Optimization, Numerical Methods in Energetics and Process Engineering.

Students get ability to solve: practical scientific and technical problems in the field of mechanical engineering described by ordinary or partial differential equations; optimization problems.

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

Numerical Analysis: Systems of linear equations. Factorization methods. Iterative methods. Jacobi and Gauss-Seidel iteration. Polynomial interpolation. Trigonometric interpolation and fast Fourier transform. Spline interpolation and B-splines. Theory of the best approximations. Chebyshev mini-max approximation. Numerical differentiation and integration. Gaussian quadrature. Numerical solution of ordinary differential equations. Predictor-corrector methods. Convergence analysis. Systems of differential equations. Finite difference method for boundary value problems. Eigenvalue problem for differential equations. Partial differential equations. Difference methods for solving elliptic, parabolic and hyperbolic equations.

Finite Element Method: Functional spaces. Linear operators and functionals. Dual spaces. Polynomial approximations. L^2 projections. Variational and projection methods. Classical and weak formulation. Ritz-Galerkin method. Cea lemma. Finite element method. 2D and 3D triangulation. Test and trial functions. Construction of finite elements. Mesh generation and refinement. Error estimation. One dimensional and two dimensional boundary value problems. Galerkin discretization. Assembling of the stiffness matrix and the mass matrix. Computer implementation.

Optimization Algorithms: Linear optimization problems and algorithms. Nonlinear optimization problems and algorithms. Multicriteria optimization problems and algorithms. Vector objective function and constraints. Perfect (ideal) and marginal solutions. Pareto optimum. Global criteria method. Method of weighted coefficients. Dynamical and global optimization problems and algorithms. Genetic algorithms. Simulation statistical methods. Monte-Carlo method and its applications. Numerical optimization methods for picture reconstruction.

Numerical Methods in Energy and Process Engineering: Importance of fluid flow and heat transfer. The need to understand and predict. Differential equation of unsteady thermal conduction in solid bodies. Conduction – numerical methods of solution. Finite difference method. Finite volume method. Finite difference approximation for steady and unsteady problems of heat conduction. Explicit method. Implicit method. Analysis of numerical scheme stability. Consistency of difference equations obtained by finite differences discretization.. Limitations from the point of the second principle of thermodynamics.

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		Written Examination	50
Practical Teaching		Oral Examination	Max. 50
Teaching Colloquia		Overall Sum	100

*Final examination mark is formed in accordance with the Institutional documents