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| **Course:** Time-varying nonlinear optimization | |
| **Course instructors:** Predrag S. Stanimirović | |
| **Course type:** elective | |
| **Credit points ECTS:** 12 | |
| **Prerequisites:** - | |

**Course objectives:**
Introduce gradient and Zhang dynamical systems for solving time-varying nonlinear optimization problems. Introduce students to the principles of modeling, interpretation and solving real problems by reducing them to the problems of linear and nonlinear optimization.

**Learning outcomes:**
Students trained in the application of nonlinear optimization methods in mathematics, computer science, practice as well as in scientific research and practical applications. Students are expected to recognize problems from science or engineering practice, define appropriate mathematical models as well as solve defined models using learned methods and software packages.

**Course description (outline):**
*Theoretical classes*
- Unconstrained optimization: One-dimensional optimization, non-gradient and gradient optimization methods, Newton method, quasi-Newton methods, convergence rate, conjugate gradient methods.
- Line search and trust-region methods for unconstrained optimization problems.
- Time-varying nonlinear optimization: gradient methods, dynamic system, asymptotic convergence, finite-time and fixed-time convergence in continuous-time optimization, gradient neural network, zeroing neural network.
- Gradient dynamical systems, Zhang dynamical systems, discretization of continuous models, connection with Newton's methods, scalar, vector and matrix models.
- Time-varying matrix inversion and generalized inversion of time-dependent matrices, square root of a matrix, calculation of matrix functions.
- Continuous-time nonlinear optimization with constraints, an approach based on recurrent neural networks.
- Overview of constraint optimization methods (active set methods, sequential quadratic programming, internal point methods, penalty function methods).
- Solving systems of nonlinear equations by methods of nonlinear programming.
- Application of nonlinear optimization in image restoration, robotics, signal processing, solving location problems, solving some problems in economy.
*Practice classes*
Имплементација теоријски обрађених метода

**References:**
1. Y. Zhang, D. Guo, Zhang Functions and Various Models, Springer, 2015.
2. Y. Zhang, L. Xiao, Z. Xiao, M. Mao, Zeroing Dynamics, Gradient Dynamics, and Newton Iterations, Taylor & Francis Group, 2016.
3. Y. Zhang, C. Yi, Zhang Neural Networks and Neural-dynamic Method, Nova Science Publishers, 2011.
4. Y. Wei, P.S. Stanimirović, M. Petković, Numerical and symbolic computations of generalized inverses, World Scientific Publishing Co. Pte. Ltd., Hackensack, NJ, 2018, September 2018, DOI 10.1142/10950

| Active teaching hours: 5 | Theoretical classes: 5 | Practice classes: |
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**Methods of teaching:** предавања и самостални рад студената на практичним часовима

**Grading structure (100 points):** 50 предиспитне обавезе, 50 испит