Course: Numerical Linear Algebra

Course instructors: Marko Petković

Course type: elective

Credit points ECTS: 12

Prerequisites: -

Course objectives:
Introduction to the construction and implementation of main numerical methods in linear algebra, and their applications to the practical problems in natural, technical and social sciences.

Learning outcomes:
Students should be familiar with the basic and advanced numerical methods in linear algebra. Students should also be able to efficiently implement these methods on solving the concrete practical problems in natural and technical sciences, financial mathematics, etc.

Course description (outline):
Theoretical classes

- Basic matrix analysis: matrix multiplications, BLAS routines, fast matrix multiplication, parallel algorithms, matrix and vector norms, SVD, stability analysis.
- Linear systems: factorizations (LU, Cholesky, etc.), gaussian elimination, parallel algorithms, structured systems (tridiagonal, banded, Vandermonde, etc.)
- Orthogonalization and least squares: Householder and Givens transformations, QR factorization, regularization, least squares problems, updating matrix factorizations.
- Symmetric and non-symmetric eigenvalue problems: power iterations, QR algorithm, tridiagonal problems, computing SVD, Jacobi methods, sparse problems, Krylov subspace methods, Lanczos method.
- Large sparse linear systems: iterative methods, conjugate gradient, other CG-based methods, preconditioning

Practice classes
Implementation of the theoretically analysed methods.

References:
[1] G.H. Golub, C.F. Van Loan, Matrix Computations, 4th ed., The Johns Hopkins University Press, Baltimore, 2013.
[2] J. Kiusalaas, Numerical methods in engineering with Python 3, Cambridge University Press, 2013.

Active teaching hours: 5	Theoretical classes: 5	Practice classes:

Methods of teaching:
Theoretical lectures and independent work of students during practical hours.

Grading structure (100 points)
50 points on pre-exam and 50 points on oral exam