M104	**Methods of numerical mathematics**	L	S	P	ECTS
		3	0	2	7

Course objectives: Through this course students will be introduced to the basic ideas and methods of numerical mathematics. In lectures we will not insist on a formal proofs of results but on their understanding and application, except in the case of constructive proofs which themselves refer to the construction of ideas or methods.

Prerequisites. Linear algebra I, Linear algebra II, Differential Calculus, Numerical Mathematics.

Course Outline.

1. **Vector norms and inner product.**
2. **Solving systems of linear equations (direct methods)** Gaussian elimination, numerical properties of Gaussian elimination, error analysis of Gaussian elimination, Gaussian elimination with partial pivoting (GEPP), error analysis of GEDP.
3. **QR decomposition** Household QR decomposition (Householder's reflectors), operation count (operation costs), error analysis.
4. **Iterative methods for solving linear system.** Linear methods, Jacobi method, Gauss-Seidel method, steepest descent method and conjugate gradient method.
5. **Linear least squares (LS) problem (methods for solving LS problems)**. Solving LS problems using SVD, solving LS problems using QR, conditioning of LS problems.
6. **Eigenvalues and eigenvectors.** Eigenvalue problem, iterative methods for symmetric matrices, QR (Francis algorithm).
7. **Optimization methods.** Basics of linear programming, nonlinear 1-D optimiztion problems and methods (Newton method with or without step regulation).
8. **Numerical solution of ordinary differential equations (ODE).** Numerical methods for 1st order ODE (Euler method, Runge-Kutta method), systems of ODE, computation of matrix functions.

Learning outcomes

No.	Learning outcomes
1.	Understanding of basic ideas and methods of numerical linear algebra and numerical analysis
2.	Adopting of ideas and methods for solving linear systems and basic iterative methods for solving systems of linear equations
3.	Adopting of the main principles, ideas and methods for solving linear least square problems
4.	Understanding and application of the main principles and methods for solving eigenvalue problems.
5.	Adopting of main ideas of optimization and understanding and application of basic linear and non-linear optimization methods.
6.	Adopting ideas and methods for solving systems of ordinary differential equations.

7.	Apply acquired learning skills on lifelong learning in the considered mathematical area.
8.	Clearly and unambiguously explain own conclusions to the experts and /or to laypersons, based on knowledge and arguments.

COUPLING OF THE EXPECTED LEARNING OUTCOMES, TEACHING PROCESS ORGANIZATION AND THE EVALUATION OF THE TEACHING OUTCOMES

TEACHING PROCESS ORGANIZATION	ECTS	EXPECTED LEARNING OUTCOMES **	STUDENT ACTIVITY *	EVALUATION METHOD	SCORE	
					min	max
Lecture attendance	0.5	1-7	Attending lectures, discussions, teamwork and individual work on tasks	Participant lists, monitoring activities on class	0	4
Homework	1	1-7	Independent problem solving	Checking the correctness of solutions of the given pieces of homework	12	20
Repeated exams	2	1-7	Preparation for midterms	Checking the correctness of solution	19	38
Final exam	3.5	1-7	Recapitulation of the subject matter	Checking the correctness of answers on the final exam	19	38
TOTAL	7				50	100

Teaching methods and student assessment. Exercises are partially auditory and partially laboratory with computer use. Lectures and exercises are obligatory. The exam is taken after the completion of lectures and exercises, and it consists of a written and oral part. Acceptable results achieved in mid-term exams taken during the semester replace the written part of the exam. Students may influence their grade by doing extra-credit assignments or writing a seminar paper.

Can the course be taught in English: Yes.

Basic literature:

1. R. Scitovski, Numerička matematika, Odjel za matematiku, Sveučilište u Osijeku, 2004.
2. R. Scitovski, Recenzirani nastavni materijali dostupni na web stranici predmeta.
3. N. Truhar; Numerička linearna algebra; Odjel za matematiku, Svučilišta u Osijeku, 2010.

Recommended literature:

1. Stuart and J. Voss, Matrix Analysis and Algorithms, http://seehuhn.de/media/papers/numlinalg.pdf, 2009.
2. J. E. Dennis,, Jr.R.B,Schnabel, Numerical Methods for Unconstreined Optimization and Nonlinear Equations, SIAM, Philadelphia, 1996.
3. D. Kincaid, W. Cheney, Numerical Analysis, Brooks/Cole Publishing Company, New York, 1996.
4. J. Stoer, R. Bulirsch, Introduction to Numerical Analysis, Springer Verlag, New York, 1993.
5. R. Plato, Concise Numerical Mathematics, American Mathematical Society, Providence, 2003.