M067	Obligatory - Semester 6	**Numerical Mathematics**	L+P+S 2+2+0	ECTS 5

Course objectives. Students will become familiar with the basic ideas and methods of numerical mathematics. We will thereby try to avoid theorems proving theorems, except in the case of constructive proofs that refer to generating ideas or creating methods themselves.

Course prerequisites. Differential Calculus, Integral Calculus, Functions of Several Variables, Linear Algebra I and II.

Syllabus.
1. Introduction. Error analysis. Significant digits. Floating point arithmetic. Error of the function. Inverse problem in error analysis.
2. Interpolation. Spline interpolation. Interpolation problem. Lagrange form of the interpolation polynomial. Newton form of the interpolation polynomial. Error estimation. Linear spline interpolation. Cubic spline interpolation.
3. Solving linear systems. Triangular systems. Gaussian elimination. LU - factorization - Cholesky–factorization. QR – factorization. Iterative methods. Singular value decomposition. Eigenvalue decomposition.
4. Solving nonlinear equations. Bisection method. Method of simple iteration. Newton method and modifications. Solving systems of nonlinear equations: Newton method, quasi-Newton methods.
5. Approximation of functions. Best L_2 approximation. Orthogonal polynomial. Chebyshev's polynomial. Best L_∞ approximation.
6. Linear and nonlinear least squares problem.
7. Numerical integration. Trapezoidal rule. Newton-Cotes formula. Simpson rule.
8. Numerical methods for solving ordinary differential equations. Euler method. Runge – Kutta method. Difference methods for solving boundary value problems.

Expected learning outcomes.
After the completion of this course, students are expected to:
*   understand basic ideas and methods of numerical mathematics;
*   adopt ideas and methods for solving the interpolation problem and basic methods for solving the system of linear equations;
*   adopt the main principles, ideas and methods for solving a nonlinear equation and ideas and methods for solving the system of nonlinear equations;
*   adopt the idea of approximation of function, especially in case of a discrete (by least squares problem) and a continuous function (especially Fourier, Chebyshev and other orthogonal polynomial);
*   adopt the basic principle and methods of numerical integration and numerical method for solving ordinary differential equations;
*   be able to apply these principles and methods to solving simpler problems.

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 an 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, reviewed course materials available on the course website.

Recommended literature:

1. J. E. Dennis, Jr.R.B. Schnabel, Numerical Methods for Unconstrained Optimization and Nonlinear Equations, SIAM, Philadelphia, 1996.
2. D. Kincaid, W. Cheney, Numerical Analysis, Brooks/Cole Publishing Company, New York, 1996.
3. J. Stoer, R. Bulirsch, Introduction to Numerical Analysis, Springer Verlag, New York, 1993.
4. R. Plato, Concise Numerical Mathematics, American Mathematical Society, Providence, 2003.
5. W. H. Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling, Numerical Recipes, Cambridge University Press, Cambridge, 1989.