I024	FIN- elective – Year 1 MR, IPM - obligatory – Semester 1	**Scientific Computing**	L+P+S 2+2+0	ECTS 5

Course objectives: Teach students how to use computers in science with emphasis on applications in numerical analysis (linear and nonlinear equations, integration, interpolation, simulation and optimization). In exercises, students will learn how to write sequential and parallel programs in Octave or Matlab and analyse algorithms with good numerical properties.

Course prerequisites. Undergraduate study programme in mathematics. (Differential Calculus, Integral Calculus, Linear Algebra I and II, Mathematical Tools)

Syllabus.
1. Models with applications in numerical linear algebra. Risk modelling and expected return on the portfolio. Heat dissipation of electronic components. Numerical methods for solving Poisson's equation. System of masses connected with elastic springs. Calculating the density of the material.
2. Solving of sparse systems. Direct and iterative methods. Preconditioning. Eigenvalues.
3. Models with differential equations. Approximation of boundary problems with finite differences, finite elements. Wave and heat-conduction.
4. Discrete Fourier transformation. Trigonometric interpolation. Fast Fourier transformation (FFT).
5. Analysis of several real models, including the image deblurring problem, the problem of data clustering and epidemiological models.

Expected learning outcomes.
After completing the course, students are expected to be able to:
- construct models that describe different real-world problems, such as risk modelling and expected return on the portfolio, heat dissipation of electronic components, systems of masses connected with elastic springs;
- use their knowledge, understanding and skills and apply them to solving sparse linear systems;
- fully understand and construct models using differential equations;
- apply basic concepts related to constrained optimization;
- apply discrete Fourier transformation, trigonometric interpolation and the fast Fourier transformation;
- apply their knowledge, understanding and skills in the analysis of realistic models;
- use mathematics literature of different sources.

Can the course be taught in English: Yes.

Teaching methods and student assessment. Lectures and exercises are obligatory. The exam consists of a written and an oral part, and it is taken after completion of lectures and exercises. Acceptable mid-term exam scores replace the written examination. Students can influence their final grade by doing homework throughout the semester.

Basic literature:

1. Dianne P. O'Leary, Scientific Computing with Case Studies, SIAM Press, 2009.
2. T. F. Comena, C. van Loan, Handbook for Matrix Computations, SIAM, Press, 1988.

Recommended literature:

1. Alfio Quarteroni, Fausto Saleri, Scientific Computing with MATLAB and Octave, 2nd Edition. Springer Verlag, Berlin, 2006.
2. F. Scheid, Schaum's Outline of Theory and Problems of Numerical Analysis, McGraw-Hill Professional, 1989.
3. J. L. Buchanan, P. R. Turner: Numerical Methods and Analysis, McGraw-Hill, Inc., New York, 1992.