Course title	**Numerical methods**
Course code	Mate3015
Branch of science	Mathematics
Sub-branch	Numerical analysis
Credit points	4
ECTS credit points	6
Total contact hours Lectures Seminars	64 32 32

Course author
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Prerequisites (course title, part of the program)
Mate1009, Mate1011, Mate1012, Mate1014, Mate2008

Course abstract
This course is designed for Bachelor study program "Mathematics" students. The course aims to introduce students to foundations of numerical methods. It includes the numerical solving methods of an equation with one unknown, numerical solving of a system of nonlinear equations, direct and iterative solving methods for systems of linear equations, matrix eigenvalues and eigenvectors problems, function interpolation and extrapolation, numerical differentiation and integration.

Results
• understand the essence of the numerical experiment; • be able to estimate the resulting precision of operations with approximate numbers; • know numerical solving methods of linear and nonlinear equations and their systems; • get an idea of basic techniques of numerical solving to the matrix eigenvalues and eigenvectors problems; • get an idea to the different types of approximation of data; • know basic methods of numerical differentiation and integration; • be able to use mathematical software packages for numerical solving of mentioned tasks.

Course content:
Lectures – 32 contact hours, seminars – 32 contact hours Introduction to mathematical modeling and numerical analysis. Foundations of error theory. Solving methods of an equation with one unknown. Bisection method. Secant method. Newton's method. Simple iteration method. Numerical solving of a system of nonlinear equations. Direct and iterative solving methods to the systems of linear equations. Matrix eigenvalues and eigenvectors problem. Function interpolation and extrapolation. Lagrange interpolation polynomial. Divided and finite differences. Newton interpolation polynomials. Spline interpolation. Least squares method. Numerical differentiation. Numerical integration. Using of mathematical software Derive and Mathematica for numerical tasks.

Course plan:
Lecture topics 1. Mathematical modeling and numerical analysis. Foundations of error theory. 2-3. Solving methods of an equation with one unknown. Bisection method. Secant method. Newton's method.

4. Simple iteration method for an equation with one unknown.
5. Solving of a system of nonlinear equations with two unknowns.
6-7. Direct and iterative solving methods to the systems of linear equations.
8. Matrix eigenvalues and eigenvectors problem.
9. Function interpolation and extrapolation. Lagrange interpolation polynomial.
10-11. Divided and finite differences. Newton interpolation polynomials.
12. Spline interpolation.
13. Least squares method.
14. Numerical differentiation.
15-16. Numerical integration. Rectangle rule. Trapezoidal rule. Simpson's rule.

Seminar topics

1. Approximate numbers and operations with them.
2. Bisection method.
3. Secant method. Newton's method.
4. Simple iteration method for an equation with one unknown.
5. Solving of a system of nonlinear equations with two unknowns.
6. Simple iteration method for a system of linear equations.
7. Seidel method.
8. Matrix eigenvalues and eigenvectors problem. Krylov method.
9. Lagrange interpolation polynomial.
10. Divided differences. Function interpolation.
11. Finite differences. Newton interpolation polynomials.
12. Spline interpolation.
13. Least squares method.
14. Numerical differentiation.
15. Numerical integration. Rectangle rule. Trapezoidal rule. Simpson's rule.
16. Richardson's extrapolation formula.

Independent work of students:

During semester students must complete 8 independent works. For each student tasks are individual.

Course requirements:

Acquisition and presentation of knowledge and skills described within the course.
Final evaluation form for the course – pass and examination.
Course requirements:

test – regular attendance and active work in 20%, independent work execution of 80%;

exam – successful implementation of independent works is a prerequisite for taking the exam, students are offered two theoretical questions and one practical task. Study methods and forms – lectures, seminars, independent works.

Main literature:

1. R. V. Dukkipati. Numerical Methods, New Age International, 2010.
2. H. Kalis . Skaitliskās metodes ar datorprogrammu MAPLE, MATHEMATICA lietošanu, Rīga, 2001.
3. R. Bulirsch, J. Stoer. Introduction to numerical analysis, Springer-Verlag, 1992.
4. R. L. Burden, J. D. Faires. Numerical Analysis, Brooks Cole, 2000.
5. S.R.K. Iyengar, R. K. Jain, Numerical Methods, New Age International, 2009.
6. Бахвалов Н.С., Жидков Х.П., Кобельков Г.Х. Численные методы. – М.: Наука, 2000.
7. Поршнев С.В. Численная математика, Санкт-Петербург, 2004.
8. Самарский А.А., Гулин А.В. Численные методы, М., 1989.

Auxiliary literature:

1. J. M. McNamee. Numerical Methods for Roots of Polynomials, Elsevier Science, 2007.
2. I. Pagodkina. Tuvinātās metodes. Skaitliskā integrēšana. - R.:LVU, 1982.

3. B. Kutzler, V. Kokol-Voljc. Ievads datoralgebras sistēmā Derive 5, Rīga, 2003.
4. S. Veģere, I. Volodko, A. Koliškins, V. Kremeņeckis. Matemātikas uzdevumu risināšana ar Mathematica 5, Rīga, RTU, 2009.
5. E. Isaacson, H. B. Keller. Analysis of Numerical Methods, Dover Publications, 1994.
6. M.K. Jain, S.R.K. Iyengar, R.K. Jain. Numerical Methods: Prorblems and Solutions, New Age, 2008.
7. C.T. Kelley. Iterative Methods for Linear and Nonlinear Equations, SIAM, 1995.
8. D. Kressner. Numerical Methods for General and Structured Eigenvalue Problems, Springer, 2005.
9. Воробьева Г.Н., Данилова А.Н. Практикум по численным методам. – М.: Высшая школа, 1979.
10. Корнейчук Н.П. Сплайны в теории приближения, М., Наука, 1984.
11. Лоусон Ч., Хенсон Р. Численное решение задач методом наименьших квадратов, Наука, 1986.
12. Турчак Л.И., Плотников П.В. Основы численных методов, М.,Физматлит, 2005.

Periodical and other sources of information:

http://www.numerical-recipes.com/
http://ads.harvard.edu/books/1990fnmd.book/

Relevant study programs and their parts (A, B, C, D):

Bachelor study program „Mathematics” , part A.