Co-funded by the
Erasmus+ Programme
of the European Union

SUBJECT: General Numerical Method	
ECTS CREDITS\КРЕДИТЫ ECTS:	5 ECTS
TEACHERS, UNIVERSITY AND EMAILS:	1. Nurlan Medetov, medetov@rambler.ru
LANGUAGE OF INSTRUCTION:	Russian (Nurlan Medetov)
ACADEMIC COURSE:	2016—2017.
NAME OF THE MASTER'S DEGREE	Master's in Mathematical Engineering\

COURSE AIMS:

Aim:
- studying the numerical methods for solving problems, mastering of methodological approaches of numerical calculations development;
- studying the methods for solving research and applied tasks;
- studying of the problem solving methods based on the application of special software (MatLab)

Objectives:
- to understand the idea about the basics of numerical methods for the analysis of experimental results;
- to be aware of the basic methods for solving linear and nonlinear problems of algebra;
- to develop practical skills in the use of numerical methods, including using software

LEARNING OUTCOMES\ Результаты обучения:

to know:
- the basics of the theory of error and the approximation theory;
- the fundamental principles of mathematical modeling;
- the numerical methods for solving problems of algebra;
- the methods of numerical integration and differentiation;
- the algorithms for numerical methods implementations

be able to:
- formulate the problem and find the ways to solve it;
- classify and select the numerical methods;
-develop the algorithms of numerical methods and implement them in practice by means of software products;
- analyze and evaluate the problem solutions;
- find numerically the required solutions of mathematical models for various technological processes;
- perform calculations to solve problems with the help of the software package

apply:
- computational methods and software resources to solve different tasks of industry;
- skills to evaluate in practice the accuracy of the results;
- the major techniques of using computational methods in solving various problems of professional activity

COURSE SYLLABUS:

1. The theory of errors.

1.1 The sources and classification of errors. Approximate numbers. Absolute and relative errors.

1.2 Errors in arithmetic. Features of calculations done with the computer technology. Types of errors. The error of the numerical solution of the problem. The convergence problem. The convergence of a numerical method.

2. Numerical methods of linear algebra.

2.1 Direct methods for solving systems of linear algebraic equations. Gauss method for solving systems of linear algebraic equations. Features of numerical implementation of the Gauss method.

2.2 Linear one-step iterative methods. One-step iterative methods for variational type. Two-step iterative methods for variational type. Seidel method. Jacobi method.

3. Numerical methods for solving nonlinear equations.

3.1 Statement of the problem. Methods for separating the roots. Conditionality nonlinear problem. bisection method for solving a nonlinear equation.

3.2 Newton's Method. Conditions for the convergence of Newton's method. Secant method. The method of chords. Geometric interpretation.

3.3 Method of iterations. Convergence conditions. Geometric interpretation. Simplified Newton's method. Method of simple iteration for solving systems of nonlinear equations. Seidel method.

3. Numerical methods for solving nonlinear equations.

3.1 Statement of the problem. Methods for locating the roots. Conditionality of nonlinear problem. Bisection method for solving a nonlinear equation.

3.2 Newton's Method. Conditions for the convergence of Newton's method. Secant method. The method of chords. Geometric interpretation.

3.3 Method of iterations. Convergence conditions. Geometric interpretation. Simplified Newton's method. Method of simple iteration for solving systems of nonlinear equations. Seidel method.

4. Interpolation and extrapolation.

2.1 2.1 Setting the interpolation problem. The interpolation with power polynomials. Lagrange and Newton Interpolation polynomials. Linear interpolation. Interpolation accuracy. Factors determining the interpolation accuracy: numerical differentiation and integration. Formula for rectangles, trapezoids.

2.2 Approximation of functions. The concepts of approximation, stability and convergence. approximation criteria.

5. The numerical solution of optimization problems.

5.1 Unconditional optimization. One-dimensional optimization. Local and global methods. Gradient methods. Newton's method.

5.2 Non-linear optimization with constraints. The method of penalty functions. Multicriteria tasks.

LITERATURE:

Basic literature

[1]Амосов А.А., Дубинский Ю.А., Копченова Н.В. Вычислительные методы для инженеров. – М.: Высшая школа, 1994

[2]Бахвалов Н.С., Жидков Н.П., Кобельков Г.Н. Численные методы. – 6-е изд.- М.: БИНОМ. Лаборатория знаний, 2008

[3]Самарский А.А. , Гулин А.В. Численные методы. – М.: Наука, 1989

[4]Деммель Дж. Вычислительная линейная алгебра. – М.: Мир, 2001

Further reading:

[5]Демидович Б.П., Марон И.А. Основы вычислительной математики. – М.: Наука, 1970

[6]Каханер Д., Моулер К., Нэш С. Численные методы и программное обеспечение. – М.: Мир, 1998

[7]Susanne Brenner, Ridgway Scott. The mathematical Theory of Finite Element Methods (Text in Applied Mathematics) 3rd Edition

[8]R.W.Hamming. Numerical Methods for Scientists and Engineers (Dover Books on Mathematics) 2nd Revise ed.Edition

TEACHING METHOD:

Lectures, problem lectures, dialogical methods, practical exercises, demonstration, online training, video conferencing in all Central Asian partners

METHOD OF ASSESSMENT:

60% assessment of the theoretical knowledge:
- theoretical questions on the course content

40% assessment of practical abilities:
- to solve problems on the course content;
- computer implementation of specialized tasks solutions with MatLab

STUDENT WORKLOAD:

Classroom work (attending all kinds of classes) = 45 hours
Lecture - 1 per week (15 weeks)
Practical classes – 1 hour per week (15 weeks)
Independent work of a student = 90 hours
Total hours – 135 hours.

RECOMMENDATIONS:

-

OTHER COMMENTS:

-