American University-Central Asia

SYLLABUS
NUMERICAL METHODS
(MAT 407, MAT 406)

Spring 2019 (January 14 – May3)

1. **Instructor:** Sklyar Sergey Nikolaevich - Professor, Doctor nauk in Physics and Mathematics. Office: 415, E-mail: sklyar_s@auca.kg
2. **Class meetings and Volume of academic load:** 2 lessons per week (one lesson = 75 minutes, lecture and laboratory practice). Total 6 credits, 15 working weeks.
3. **Consultations:** according to the preliminary arrangement with instructor.
4. **Brief course description:** course will focus on a base material of two classical sections of numerical mathematics: numerical methods of Algebra, Analysis and methods for solving of Ordinary Differential Equations. Students will familiarize with following topics: characteristics of computer arithmetic, polynomial and spline interpolation, direct and iterative methods for solving linear and nonlinear systems of equations, numerical integration, numerical methods for solving ordinary differential equations,
5. **Prerequisites:** Mathematical Analysis II, Programming-I.
6. **Textbooks:**
   - Richard L. Burden, J. Douglas Faires. Numerical Analysis. Brooks/Cole Cengage Learning, Ninth Edition, 2011.
   - Electronic Text Book (ETB) and additional materials are presented on electronic resource of AUCA: H:\Courses Information Support\Natural Sciences and Information Technologies\MAT 407 Numerical Methods.
7. **Objectives:** to give an introduction to modern numerical methods; to explain how, why, and when they can be expected to work; to provide a firm basis for future study of numerical analysis and scientific computing.
8. **Requirements and knowledge evaluation:**

   Grading
   Grades will be based on a total of 100 points, coming from**:**

   - Performance of original laboratory projects – 25*3=75 points (max),
   - Final Exam - theory and typical problems (Office of the Registrar sets day and time) – 25 points (max).

The final grade of the student will calculated in conformity with a following scale:

$$\mathbf{0 \le F \le 40 < D \le 45 < C- \le 50 < C \le 60 < C+ \le 65}$$
$$\mathbf{65 < B- \le 70 < B \le 80 < B+ \le 85 < A- \le 90 < A \le 100.}$$

Attendance and meaningful participation are expected. Policy and Schedule of projects delivery and defense is defined by the instructor additionally. Instructor reserves the right to change or modify this syllabus as needed; any changes will be announced during class.

9. <u>Course content and tentative academic calendar:</u>

I. Lectures

- ☞ ***Introduction.*** Mathematical modeling and numerical methods (Chapter I, ETB). Spaces of vectors and mesh functions, norms of vectors and mesh functions, equivalent norms (Chapter II, ETB). Round off errors and computer arithmetic (Chapter VII, ETB).
- ☞ ***Interpolation***. Lagrange interpolating polynomial, remainder term calculation. Optimal choice of the interpolation nodes, Chebyshev polynomials. Piecewise-linear interpolation, cubic spline interpolation. (Chapter III, ETB)
- ☞ ***Numerical integration.*** Composite rectangular, trapezoidal and Simpson's rules. Estimations of errors. (Chapter IV, ETB)
- ☞ ***Direct methods for solving linear systems.*** Gaussian elimination method. Marching method (factorization method) for tridiagonal linear systems, stability and correctness. (Chapter V, ETB)
- ☞ ***Numerical methods for solving initial-value problems for ordinary differential equations.*** Runge-Kutta methods of the first and second orders, analysis of convergence.
- ☞ ***Iterative techniques for nonlinear equations.*** Method of simple iterations, theorem of convergence. Newton's and quasi- Newton methods. Geometric interpretation of iterative methods (Chapter VI, ETB).

II. Laboratory practice

Performance of original laboratory projects (description on an electronic resource)

Project I (One of the following topics). Dates: 24.01-26.02

- ☞ Algebraic interpolation.
- ☞ Quadratic spline interpolation.
- ☞ Cubic spline interpolation.

Project II (One of the following topics). Dates: 26.02-26.03

- ☞ Composite quadrature formulas.
- ☞ Romberg integration (optional).
- ☞ Adaptive quadrature methods (optional).

Project III (One of the following topics). Dates: 26.03-25.04

- ☞ Runge-Kutta methods.
- ☞ Iterative methods for solving ordinary differential equations (optional).