

Identification	Subject	CSH 521, Numerical Methods for Scientific Computing, 6 ECTS
	Department	Mathematics
	Program	Graduate
	Term	Fall, 2026
	Instructor	Rza Mustafayev
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	Classroom/hours	Tuesday 18:40-20:10, 20:20-21:00
Prerequisites	None	
Language	English	
Compulsory/Elective	Compulsory	
Description	Numerical analysis focuses on finding approximate solutions to complex problems by breaking them down into simpler arithmetic operations that computers can efficiently execute. Essentially, it involves solving challenging mathematical problems by performing a sequence of basic, manageable steps. The problems addressed in numerical analysis often originate from diverse areas of mathematics, especially algebra and analysis. Moreover, numerical analysis does not just produce raw numerical results; it also contributes significantly to the development of algebraic and analytic theories, enhancing our overall understanding of these disciplines.	
Required textbooks and course materials	1. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 8th Edition. 2. Francis Scheid, Schaum's Outline of Theory and Problems of Numerical Analysis, 2nd Edition.	
Course website		
Course outline	The course outline typically covers error analysis, interpolation, function approximation, solving non-linear equations, solving systems of linear equations, numerical differentiation, numerical integration, and the numerical solution of ordinary differential equations. The course aims to provide an understanding of computational techniques, their theoretical basis, and their application in solving practical mathematical problems.	
Course objectives	Upon completion students should have a comprehensive understanding of major concepts of the Numerical Analysis. Namely students should be able to: • Understand the fundamental concepts of machine numbers. • Work with the basic notions of error measurement. • Find approximate solutions of wide range of nonlinear equations on the real line by different methods. • Use the concept of interpolation polynomial to approximate a function. • Apply an interpolation polynomials to numerical differentiation and integration. • Learn to find numerical solutions to initial value problems for ordinary differential equations. • Solve linear systems by iterative methods.	

Learning outcomes	The learning outcomes of a numerical analysis course typically focus on the student's ability to understand the concepts of errors and computer arithmetic, apply various numerical methods to solve mathematical problems such as nonlinear equations and linear systems, implement these methods in software, and analyze and interpret the results and limitations of these techniques.		
Teaching methods	Lecture		x
	Experiential exercise		
	Assisted work		x
	Assisted lab work		x
	Others		
Evaluation	Methods	Date/deadlines	Percentage (%)
	Midterm Exam		30
	Class Participation		5
	Quizzes		20 (2 quizzes)
	Activity		5
	Project (3 phases)		-
	Final Exam		40
	Total		100
Policy	▪ Use of Generative AI Tools The use of generative artificial intelligence (GAI) tools is strictly prohibited in this course. The primary aim of the course is to develop students' independent mathematical reasoning, problem-solving skills, and creative thinking. Students are therefore expected to complete all assignments and assessments independently without the use of GAI tools. If it is determined that a student has used generative artificial intelligence (GenAI) tools while completing assignments, one of the following measures may be applied: • Issuing an oral or written warning; • Requiring the resubmission of the assignment; • Reducing the grade for the assignment or assigning a zero (0). • Cell phones are not allowed during class time. PLEASE turn them off before lecture! (Not silent or vibrating mode). This is a university policy and violators will be reprimanded accordingly. • No late assignments will be accepted without prior arrangement with the instructor for acceptable excuses. Medical and family emergency will be considered on case-by-case basis. • No late homework will be accepted. Homework is to be completed on an individual basis. Students may discuss homework with classmates, but students are responsible for your own work. If students have consulted classmates, please note the individuals name on the top of students' assignment. • If students should miss class due to personal emergency or medical reasons, please notify the instructor by email immediately. A doctor's note will be required for make-up work. • University policy on academic honesty concerning exams and individual work will be strictly enforced. • BE ON TIME!		

Week	Date/Day (Tentative)	Topics	Textbook/Assignments
1	15.09.2026 15.09.2026	Mathematical Preliminaries. Review of Calculus.	BF, Ch. 1: 1.1
2	22.09.2026 22.09.2026	Machine numbers: a model of floating point numbers, properties, special numbers. The input function and the input error theorem. Anomalies in computer arithmetic and their explanations.	BF, Ch. 1: 1.2
3	29.09.2026 29.09.2026	Nonlinear equations. The Bisection Method. Fixed-Point Iteration.	BF, Ch. 2: 2.1-2.2
4	06.10.2026 06.10.2026	Newton's method. False position method and secant method. Error Analysis for Iterative Methods. Accelerating Convergence.	BF, Ch. 2: 2.3-2.5
5	13.10.2026 13.10.2026	Estimates for the roots of polynomials. Horner's method for the calculation of function values of polynomials. Operation count. Horner's method and the derivative. Higher derivatives.	BF, Ch. 2: 2.6 Quiz-1 (10 pts)
6	20.10.2026 20.10.2026	Interpolation and the Lagrange Polynomial. Polynomial interpolation. Lagrange base polynomials, Lagrange form.	BF, Ch. 3: 3.1
7	27.10.2026 27.10.2026	Divided differences, Newton form. Error of the interpolating polynomial.	BF, Ch. 3: 3.2
8	03.11.2026 03.11.2026	Midterm Exam Divided differences, Newton form. Error of the interpolating polynomial.	BF, Ch. 3: 3.2
9	10.11.2026 10.11.2026	Holiday	
9	17.11.2026 17.11.2026	Numerical Differentiation. Richardson's Extrapolation.	BF, Ch. 4: 4.1-4.2
10	24.11.2026 24.11.2026	Quadrature formulas. Interpolatory quadrature formulas, exactness. Midpoint, trapezoid and Simpson's formulas. Error of basic quadrature formulas. Composite formulas: quadrature rules and their error bounds.	BF, Ch. 4: 4.3-4.4 Quiz-2 (10 pts)
11	01.12.2026 01.12.2026	The Elementary Theory of Initial-Value Problems. Euler's Method.	BF, Ch. 5: 5.1-5.2

12	08.12.2026 08.12.2026	Runge–Kutta Methods. Error Control and the The Runge–Kutta–Fehlberg Method.	BF, Ch. 5: 5.4-5.5
13	15.12.2026 15.12.2026	Norms of Vectors and Matrices. Norms of Vectors and Matrices. Iterative Techniques for Solving Linear Systems.	BF, Ch. 7: 7.1-7.3
14	22.12.2026 22.12.2026	Error Bounds and Iterative Refinement. The Conjugate Gradient Method.	BF, Ch. 7: 7.4-7.5
	TBA	FINAL EXAM	

This syllabus is a guide for the course and any modifications to it will be announced in advance.