SYLLABUS
NUMERICAL CALCULUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Automation and Computer Science
1.3	Department	Mathematics
1.4	Field of study	Systems Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Automation and Applied Informatics, English
1.7	Form of education	Full time
1.8	Subject code	16.00

2. Data about the subject

2.1	Subject name					Numerical Methods					
2.2	Subject area					Mathematics					
2.3	Course responsible/lecturer					Assist. Prof., PhD Math. Flavius-Olimpiu PATRULESCU					
2.4	Teachers in charge of applications					Assist. Prof., PhD Math. Flavius-Olimpiu PATRULESCU					
2.5	Year of Study	II	2.6	Semester	3	2.7	Assessment	exam	2.8	Subject category	DID/OB

3. Estimated total time

Sem.	Subject name	Lecture	Applications			Lecture	Applications			Individual study	TOTAL	Credit
		[hours/week.]				[hours / semester]						
			S	L	P		S	L	P			
3	**Numerical Calculus**	**2**	**-**	**2**	**-**	**28**	**-**	**28**	**-**	**72**	**128**	**5**

3.1	Number of hours per week	4	3.2	of which, course	2	3.3	applications	2
3.4	Total hours in the teaching plan	128	3.5	of which, course	28	3.6	applications	28

Individual study	Hours
Manual, lecture material and notes, bibliography	30
Supplementary study in the library, online and in the field	9
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	30
Tutoring	0
Exams and tests	3
Other activities	0

3.7	Total hours of individual study	72
3.8	Total hours per semester	128
3.9	Number of credit points	5

4. Pre-requisites (where appropriate)

4.1	Curriculum	Basic knowledge of Differential and Integral Calculus
4.2	Competence	Competences in elementary Differential and Integral Calculus: derivatives, integrals, series.

5. Requirements (where appropriate)

5.1	For the course	
5.2	For the applications	

6. Specific competences

Professional competences	**C1 –** Operating with basic Mathematical, Engineering and Computer Science concepts (5 credits) **C1.1 –** Recognizing and describing concepts that are specific to the fields of calculability, complexity, programming paradigms, and modeling computational and communication systems **C1.3 –** Building models for various components of computing systems **C1.5 –** Providing a theoretical background for the characteristics of the designed systems

Cross competences	N/A

7. Discipline objectives (as results from the *key competences gained*)

7.1	General objective	A presentation of the concepts, notions, methods and fundamental techniques used in differential calculus.
7.2	Specific objectives	Use of the differential calculus to solve problems in engineering.

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	**Elements of Error Theory.** Floating Point Arithmetic. Absolute and Relative Errors.	Explanation	2 hr.
2-3	**Numerical Methods in Linear Algebra.** Special Types of Matrices. Norms of Vectors and Matrices. Eigenvalues and Eigenvectors. Error Estimation. Matrix Equations. Pivoting Elimination. Improved Solutions of Matrix Equations. Partitioning Methods for Matrix Inversion. LU Factorization. Doolittle's Factorization. Cholesky's Factorization Method. Iterative Techniques for Solving Linear Systems. Jacobi Iterative Method. Gauss-Seidel Iterative Method. Relaxation Methods. Characteristic Polynomial: Leverrier Method. Characteristic Polynomial: Fadeev-Frame Method. Power Method.	Demonstration Collaboration Interactive activities	4 hr
4-5	**Solutions of Nonlinear Equations.** Method of Successive Approximation. The Bisection Method. The Newton-Raphson Method. The Secant Method. False Position Method. The Chebyshev Method. Numerical Solutions of Nonlinear Systems of Equations. Newton's Method for Systems of Nonlinear Equations. Steepest Descent Method.		4 hr
6-8	**Elements of Interpolation Theory.** Lagrange Interpolation. Divided Difference. Mean Value Properties in Lagrange Interpolation. Approximation by Interpolation. Hermite Interpolating Polynomial. Finite Differences. Interpolation of Multivariable Functions. Scattered Data Interpolation. Shepard's Method. Splines. B-splines.		6 hr
9-10	**Elements of Numerical Integration.** Richardson's Extrapolation. Numerical Quadrature. Error Bounds in the Quadrature Methods. Trapezoidal Rule. Richardson's Deferred Approach to the Limit. Romberg Integration. Newton-Cotes Formulas. Simpson's Rule. Gaussian Quadrature.		4 hr
11-12	**Elements of Approximation Theory.** Discrete Least Squares Approximation. Orthogonal Polynomials and Least Squares Approximation. Rational Function Approximation. Padé Approximation. Trigonometric Polynomial Approximation. Fast Fourier Transform. Bernstein Polynomial. Bézier Curves.		4 hr
13-14	**Integration of Ordinary/Partial Differential Equations.** The Euler Method. The Taylor Series Method. The Runge-Kutta Method. The Runge-Kutta Method for Systems of Equations. The Adams Method. **Integration of Partial Differential Equations** Parabolic Partial-Differential Equations. Hyperbolic Partial Differential Equations. Elliptic Partial Differential Equations.		4 hr

Bibliography

1. Dumitru Mircea Ivan. Calculus. Editura Mediamira, Cluj-Napoca, 2002. ISBN 973-9358-88-8.
2. Mircea Ivan and Kálmán Pusztai. Numerical Methods with Mathematica. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-41-5.
3. Ioan-Adrian Viorel, Dumitru Mircea Ivan, and Loránd Szabó. Metode numerice cu aplicaţii în ingineria electrică. Editura Universităţii din Oradea,
4. Mircea Ivan and Kálmán Pusztai. Mathematics by Computer. Comprex Publishing House, Cluj-Napoca, 1992.

8.2. Applications (Seminars, Laboratory, Projects)		Teaching methods	Notes
1	The applications follow the topics of the courses.	Explanation Demonstration	28 hr

		Collaboration Interactive activities	

Bibliography:

1. Mircea Ivan and Kálmán Pusztai. Numerical Methods with Mathematica. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-41-5.
2. Ioan-Adrian Viorel, Dumitru Mircea Ivan, and Loránd Szabó. Metode numerice cu aplicaţii în ingineria electrică. Editura Universităţii din Oradea,

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

Collaboration with engineers to identify and solve problems raised by the market.

10. Evaluation

Activity type	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Course		Abilities of understanding and using creatively the concepts and proofs		Written examination		30%
Applications		Abilities to solve problems and applying algorithms		Written examination		70%
10.4 Minimum standard of performance						
Ability to present coherently a theoretical subject and to solve problems with practical content.						

Date of filling in:		**Title First name NAME**	**Signature**
15.02.2025	Course	Assist. Prof., PhD Math. Flavius-Olimpiu PATRULESCU	
	Applications	Assist. Prof., PhD Math. Flavius-Olimpiu PATRULESCU	

Date of approval by the Department Board	Head of Departament of MATHEMATICS Professor, PhD Math. Dorian POPA
Date of approval by the Faculty Council _____	Dean Prof.Dr.Ing. Vlad Muresan