SYLLABUS

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / qualification	Computer Science / Engineer
1.7 Form of education	Full time
1.8 Subject code	24.0

2. Data about the subject

2.1 Subject name					***Numerical Methods***		
2.2 Course responsible / lecturer					Prof. dr. Dumitru-Mircea Ivan - mircea.ivan@math.utcluj.ro		
2.3 Teachers in charge of applications					Prof. dr. Daniela Rosca - daniela.rosca@math.utcluj.ro		
2.4 Year of Study	II	2.5	Semester	4	2.6 Type of assessment (E - exam, C - colloquium, V - verification)		E
2.7 Subject category	*DF – fundamentală, DD – în domeniu, DS – de specialitate, DC – complementară*						DF/DI
	DI – Impusă, DOp – opțională, DFac – facultativă						

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 Methods**	**2**	**-**	**2**	**-**	**28**	**-**	**28**	**-**	**44**	**100**	**4**

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

Individual study	
Manual, lecture material and notes, bibliography	20
Supplementary study in the library, online and in the field	4
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	15
Tutoring	0
Exams and tests	5
Other activities	0

3.7	Total hours of individual study	44
3.8	Total hours per semester	100
3.9	Number of credit points	4

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 competencies gained*)

7.1	General objective	A presentation of the concepts, notions, methods, and fundamental techniques used in Numerical methods.
7.2	Specific objectives	Use of numerical algorithms in order 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 Demonstration Collaboration Interactive activities	2 hrs
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. Choleski'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.		4 hrs
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 hrs
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 hrs
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 hrs
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. *METAFONT.*		4 hrs
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. **Integration of Partial Differential Equations** Parabolic Partial-Differential Equations. Hyperbolic Partial Differential Equations. Elliptic Partial Differential Equations.		4 hrs

Bibliography

1. Mircea Ivan and Kálmán Pusztai. Numerical Methods with Mathematica. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-41-5.
2. Mircea Ivan and Kálmán Pusztai. Mathematics by Computer. Comprex Publishing House, Cluj-Napoca, 1992.
3. Ioan Gavrea & Mircea Ivan, ML. Numerical Methods, POSDRU/86/1.2/S/62485, 2013

8.2. Applications (Seminars, Laboratory, Projects)	Teaching methods	Notes

1	The applications follow the topics of the courses.	Explanation Demonstration Collaboration Interactive activities	28 hrs

Bibliography:

1. Mircea Ivan and Kálmán Pusztai. Numerical Methods with Mathematica. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-41-5.

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

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

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Ability to understand and use the concepts and proofs creatively	Written examination	40%
Applications	Ability to solve problems and apply algorithms	Written examination	60%
Minimum standard of performance:			
Ability to present a theoretical subject coherently and to solve problems with practical content.			

Date of filling in: 06.06.2023	**Teachers**	**Title First name Last name**	**Signature**
	Lectures	Prof. Mircea Ivan	
	Applications	Prof. Daniela Rosca	

Date of approval by the Department Board 08.06.2023	Head of Department of Mathematics, Prof. PhD. Dorian Popa
Date of approval by the Faculty Council	Dean, Prof. PhD. eng. Liviu Miclea