

SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Civil Engineering
1.3	Department	Mecanica constructiilor
1.4	Field of study	Civil Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Civil, Industrial and Agricultural Buildings /Engineer (English language)
1.7	Form of education	Full time
1.8	Subject code	22.0

2. Data about the subject

2.1	Subject name				Metode numerice						
2.2	Course responsible/lecturer										
2.3	Teachers in charge of seminars										
2.4	Year of study	2	2.5	Semester	1	2.6	Assessment	E	2.7	Subject category	DF/DI

3. Estimated total time

3.1	Number of hours per week	4	3.2 of which, course:	2	3.3 applications:	
3.4	Total hours in the curriculum	56	3.5 of which, course:	28	3.6 applications:	
Individual study						hours
Manual, lecture material and notes, bibliography						20
Supplementary study in the library, online and in the field						5
Preparation for seminars/laboratory works, homework, reports, portfolios, essays						14
Tutoring						2
Exams and tests						3
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	Mathematical analysis; Special Mathematics;
4.2	Competence	Computer programming

5. Requirements (where appropriate)

5.1	For the course	Rooms with video-projector devices
5.2	For the applications	Computer Lab Rooms equipped with high performance computers and the following software applications (ANA library/Matlab, Octave, MS Office-Excel).

6. Specific competences

Professional competences	In-depth knowledge of the main numerical methods for solving nonlinear scalar and vectorial equations; problems of eigen values and eigen vectors and solving systems of linear and nonlinear equations with high dimensions. Knowledge of techniques for numerical implementation of an iterative process, control of error propagations, solving nonlinear equation by means of using an iterative approach. Theoretical knowledge regarding mathematical formulation of the numerical methods and to understand the terms used in the majority of the mathematical (numerical) software tools. The ability to use the specialized software codes and interpret the results obtained with the help of the analysis program.
Cross competences	Conception, development of a numerical model in scientific computation. Understanding of the mathematical and numerical apparatus in the formulation of scientific computation, the use of numerical methods in problems of eigen values and eigen vectors and solving large linear/nonlinear system of equations.

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

7.1	General objective	Development of competences regarding the development of advanced numerical models for scientific computation.
7.2	Specific objectives	Assimilation of theoretical and practical knowledge regarding the main numerical procedures used for solving nonlinear scalar and vectorial equations, problems of eigen values and eigen vectors.

8. Contents

8.1. Lecture (syllabus)	Teaching methods	Notes
Course 1 Notions of errors theory (Types of errors, Classification, Approximation, Errors, Absolute and Relative Error, Significant digits, propagation of errors in numerical procedures.	Theoretical presentation: Demonstrations and discussions at the “black-board”, discussions on the documents in electronic format (power-point slide, movies, internet, video, etc.	-
Course 2 – Nonlinear equations in real number set (R). Finding roots of nonlinear equation defined as $f(x)=0$. Bracketing methods: Bisection method.		
Course 3 - Nonlinear equations in real number set (R). Finding roots of nonlinear equation defined as $f(x)=0$. Secant and Regula Falsi method.		
Course 4: Nonlinear equations in real number set (R). Finding roots of nonlinear equation defined as $f(x)=0$. Newton method.		
Course 5. Nonlinear equations in real number set (R). Finding roots of nonlinear equation defined as $f(x)=0$. Finding roots of polynomial equations.		
Course 7. Nonlinear equations on real number set (R). Finding roots of nonlinear equation defined as $x=g(x)$. Fixed point theorems. Contractant applications (functions).		
Course 7. Nonlinear equations on real number set (R). Finding roots of nonlinear equation defined as $x=g(x)$. Fixed point theorems. Contractant applications (functions).		
Course 8. Nonlinear equations on real number set (R). Fixed point procedures. Modified Newton method. Convergence accelerators.		
Course 9. Nonlinear equations on real number set (R). Fixed point procedures. Modified Newton method. Convergence accelerators.		

Course 10. Nonlinear equations on R^n (Nonlinear vectorial equations). Newton method and descending (gradient) approach.		
Course 11. Linear system of equations. Gauss elimination technique.		
Course 12. Linear system of equations. Cholesky method. Ill and well-conditioned system of equations.		
Course 13. Eigen value and eigen vector problems		
Course 14. Polynomial interpolations.		
Bibliography Bibliography <ul style="list-style-type: none">• A. Chisalita, Numerical analysis, Editura UTPRES, Cluj-Napoca, 2002,• I Bors, Analiza numerica, Editura UTPRES, Cluj-Napoca, 2001• G. Coman, Analiza numerica, Ed. Libris, 1995• K. Atkinson, Elementary numerical analysis, John Willey&Sons, 1993• http://www.cfm.brown.edu/tutorials/Fortran.html• Chiorean, C.G., Analiza numerica. Note de curs (https://www.cosminchiorean.com/students.html)• S.C. Chapra, R.P. Canale – Numerical methods for engineerins, McGraw Hill Education, 2015• J.F. Epperson – An introduction to numerical methods and analysis, Wiley, 2013• R. K. Gupta – Numerical methods. Fundamentals and applications, Cambridge University Press, 2019		
Lab 1 Notions of errors theory (Types of errors, Classification, Approximation, Errors, Absolute and Relative Error, Significant digits, propagation of errors in numerical procedures. Graphical techniques to estimate the initial guesses of nonlinear equations.		
8.2. Applications/Seminars	Teaching methods	Notes
Lab 1 Notions of errors theory (Types of errors, Classification, Approximation, Errors, Absolute and Relative Error, Significant digits, propagation of errors in numerical procedures. Graphical techniques to estimate the initial guesses of nonlinear equations.	Presentations, discussions by means of using the software applications referenced at the bibliography.	-
Lab 2- Finding roots of nonlinear equation defined as $f(x)=0$. Bracketing methods: Bisection method.		
Lab 3 - Finding roots of nonlinear equation defined as $f(x)=0$. Secant and Regula Falsi method.		
Lab 4 - Finding roots of nonlinear equation defined as $f(x)=0$. Newton method. Comparative studies (Bisection, Secant, Newton)		
Lab 5 - Finding roots of nonlinear equation defined as $f(x)=0$. Newton method. Comparative studies (Bisection, Secant, Newton)		
Lab 6 - Finding roots of nonlinear equation defined as $x=g(x)$. Fixed point methods.		
Lab 7 - Finding roots of nonlinear equation defined as $x=g(x)$. Fixed point methods.		
Lab 8 – Explicit procedures of fixed point. Convergence accelerators (Aitken); Modified Newton method; Comparative studies (Newton, Modified Newton, accelerated fixed point method).		
Lab 9 – Explicit procedures of fixed point. Convergence accelerators (Aitken); Modified Newton method; Comparative studies (Newton, Modified Newton, accelerated fixed point method).		
Lab 10 - Nonlinear equations on R^n (Nonlinear vectorial equations). Newton method: iteration with constant and updated Jacobian.		

Course 11. Linear system of equations. Gauss elimination technique.		
Lab 12 – Linear system of equations: Jacobi method. Well and ill-conditioned system of equations		
Lab 13 – Evaluation		
Lab 14 - Evaluation		
Bibliography		
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9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The acquired skills will be necessary for the graduates who will carry out their activity within the design societies, and within the higher study cycles (MSc and PhD studies)

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Theoretical presentation of two problems (topics) from the list of topics discussed during the course (in both online and onsite scenarios)	Oral assessment (1 hour)	67 %
10.5 Applications	Solving problems received during laboratory hours	Oral assessment (10-15 minutes) during the last two laboratories.	33 %
10.6 Minimum standard of performance			
To obtain an overall mark of 50% in each component (course and laboratory) of assessment.			

Date of filling in:		Title Surname Name	Signature
	Lecturer		
	Teachers in charge of application		

Date of approval in the department	Head of department conf.dr.ing. Anca-Gabriela POPA
19/06/2025	
Date of approval in the faculty	Dean prof.dr.ing Daniela MANEA
25/06/2025	