COURSE PROGRAMME

1. Information about the programme

1.1 University	**University “Alexandru Ioan Cuza” of Iaşi**
1.2 Faculty	**Faculty of Mathematics**
1.3 Department	**Mathematics**
1.4 Domain	**Mathematics**
1.5 Cycle	**Master**
1.6 Programme / Qualification	**Applied Mathematics**

2. Information about the course

2.1 Course Name			**Scientific calculus**				
2.2 Course taught by			**Associate Professor PhD Ionel-Dumitrel Ghiba**				
2.3 Seminary / laboratory taught by			**Associate Professor PhD Ionel-Dumitrel Ghiba**				
2.4 Year	**2**	**2.5** Semester	**3**	**2.6** Type of evaluation	**E**	**2.7** Course type	OP

** OB – Obligatory / OP – Optionally / F – Facultative*

3. Total Hours (estimated per semester and activities)

3.1 Number of hours per week	**4**	3.2 course	**2**	3.3. seminary/laboratory	**2**
3.4 Total number of hours	**56**	3.5 course	**28**	3.6. seminary/laboratory	**28**
Distribution					hours
Individual study using textbooks, course notes, bibliography items, etc.					**60**
Supplimentary study (library, on-line platforms, etc.)					**30**
Individual s tudy for seminary/laboratory, homeworks, projects, etc.					**25**
Tutoring					
Examination					**4**
Other activities.....					

3.7 Total hours of individual activity	**119**
3.8 Total hours per semester	**175**
3.9 Credit points	**7**

4. Pre-requisites

4.1 Curriculum	Mathematical Analysis, Linear Algebra
4.2 Competencies	Operation with basic notions of mathematical analysis and linear algebra. Basic knowledge of Computer Programming would be helpful.

5. Conditions (if necessary)

5.1 Course	Laboratory room (computers with MATLAB installed) Webex (if necessary)
5.2 Seminary / Laboratory	Laboratory room (computers with MATLAB installed) Webex (if necessary)

6. Specific competencies acquired

Professional competencies	C1 Manipulating notions, methods and mathematical models, specific techniques in scientific calculus and applications C2 Being able to construct and apply mathematical methods for analyzing and simulating some processes C3 Being able to develop, analyze and test algorithms and specific programming languages; being able to use them for solving problems in applied mathematics
Transversal competencies	CT1 Having a responsible attitude towards scientific research and teaching, being able to fully develop the personal potential in the professional career, respecting the principles of a rigorous and efficient work in order to fulfill complex tasks, respecting the ethical norms and principles in the professional activity. CT2 Being able to make a selection of information resources and to use them efficiently, in Romanian or other language of international circulation.

7. Course objectives

7.1. General objective	Using knowledge gained from previous courses taken (linear algebra, mathematical analysis, numerical analysis, optimization) in order to find and/or approximate the solutions of certain real problems, to obtain numerical algorithms, and to implement them in Matlab. Being able to generalize the results, when practice will demand.
7.2. Specific objectives	If successfull at the final examination, students will be able to: • Explain the basic methods used during the semester. • Describe the analitical methods of solving the studied problems. • Use the studied numerical algorithms and the basic optimization tehniques. • Analyze the solutions of the specific studied problems. • Use Matlab as a calculus tool.

8. Contents

8.1	**Course**	**Teaching methods**	**Remarks** (number oh hours, references)
1.	Short presentation of the topics. Evaluation details. Global and Local Optima for Unconstrained Optimization, Clasification of Matrices. Matrix norms. Second Order Optimality Conditions, Quadratic Functions	Questioning, dialogue, lecture, proof	4
2.	Least Squares: “Solution” of Overdeterminated Systems, Data Fitting. Regularized Least Squares and applications (Denoising and Circle Fitting)	Questioning, dialogue, lecture, proof	3
3.	Descent Directions Methods. The Gradient Method	dialogue, lecture, proof	2
4.	The Condition Number for Quadratic Minimization Problem, Diagonal Scaling	Questioning, dialogue, lecture, proof	2

5.	Convergence Analysis of the Gradient Method	Questioning, dialogue, lecture, proof	2
6.	The Gauss—Newton Method, Fermat-Weber Problem	Questioning, dialogue, lecture, proof	3
7.	Pure Newton's Method, Damped Newton's Method, The Cholesky Factorization, Hybrid Gradient-Newton Method	Questioning, dialogue, lecture, proof	4
8.	Linear Programming with Matlab: The Setup, Formulating the Problem and a Graphical Solution. Linear Algebra-A Constructive Approach: Jordan Exchange, Linear Independenc; Vertices and extreme points;	Questioning, dialogue, lecture, proof	4
9.	The Simplex Method: Example and discussion, the Phases of the algorithm, Finite Termination; Linear Programs in Nonstandard Form-Transforming Constraints and Variables	Questioning, dialogue, lecture, proof	4

Bibliography

Main references:

1. W. Gander, M.J. Gander, F. Kwok. Scientific computing-An introduction using Maple and MATLAB. Vol. 11. Springer Science & Business, 2014.
2. M. Ferris, C. Michael, O. L. Mangasarian, S.J. Wright. Linear programming with MATLAB. Vol. 7. SIAM, 2007.
3. Amir Beck, Introduction to nonlinear optimization-Theory, Algorithms, and Applications with MATLAB, SIAM, 2014.

4. Other references:

8.2	**Seminary / Laboratory**	**Teaching methods**	**Remarks** (number oh hours, references)
1.	Short presentation of the topics. Evaluation details. Global and Local Optima for Unconstrained Optimization, Clasification of Matrices. Matrix Norms. Second Order Optimality Conditions, Quadratic Functions	Questioning, dialogue, exercises	4
2.	Least Squares: "Solution" of Overdeterminated Systems, Data Fitting. Regularized Least Squares and applications (Denoising and Circle Fitting)	Questioning, dialogue, exercises	3
3.	Descent Directions Methods. The Gradient Method	Questioning, dialogue, exercises	2
4.	The Condition Number for Quadratic Minimization Problem, Diagonal Scaling	Questioning, dialogue, exercises	2
5.	Convergence Analysis of the Gradient Method	Questioning, dialogue, exercises	2
6.	The Gauss—Newton Method, Fermat-Weber Problem	Questioning, dialogue, exercises	3
7.	Pure Newton's Method, Damped Newton's Method, The Cholesky Factorization, Hybrid Gradient-Newton Method	Questioning, dialogue, exercises	4
8.	Linear Programming with Matlab: The Setup, Formulating the Problem and a Graphical Solution. Linear Algebra-A Constructive Approach: Jordan Exchange, Linear Independenc; Vertices and extreme points;	Questioning, dialogue, exercises	4

9.	The Simplex Method: Example and discussion, the Phases of the algorithm, Finite Termination; Linear Programs in Nonstandard Form-Transforming Constraints and Variables	Questioning, dialogue, exercises	4

Main references:

1. W. Gander, M.J. Gander, F. Kwok. Scientific computing-An introduction using Maple and MATLAB. Vol. 11. Springer Science & Business, 2014.
2. M. Ferris, C. Michael, O. L. Mangasarian, S.J. Wright. Linear programming with MATLAB. Vol. 7. SIAM, 2007.
3. Amir Beck, Introduction to nonlinear optimization-Theory, Algorithms, and Applications with MATLAB, SIAM, 2014.

9. Coordination of the contents with the expectations of the community representatives, professional associations and relevant employers in the corresponding domain

The aim of Scientific Calculus is to give students the oportunity to understand how they may use previously acquired theoretical knowledge in order to obtain solutions of some practical problems using some algorithms and some well known mathematical software.

10. Assessment and examination

Activity	**10.1 Criteria**	**10.2 Modes**	**10.3 Weight in the final grade (%)**
10.4 Course	Knowledge and correct use of fundamental concepts, results and algorithms	Written examination (WE) N1 Oral examination (OE) N2	75
10.5 Seminary/ Laboratory	Application of analytical and numerical methods for solving some optimization problems	Evaluation during the semester N3	25
10.6 Minimal requirements			
- Knowledge of the fundamental notions, understanding the main results - Development of algorithms for solving a problem of low-difficulty grade Final mark=(3*(N1+N2)/2+N3)/4>4.5			

Date
01.10.2023

Course coordinator
Associate Professor Ionel-Dumitrel Ghiba

Seminary coordinator
Associate Professor Ionel-Dumitrel Ghiba

Aproval date in the department

Head of the departament
Prof. PhD. Ioan Bucataru