MINISTERUL EDUCAŢIEI ŞI CERCETĂRII
UNIVERSITATEA „AUREL VLAICU“ DIN ARAD
310130 Arad, B-dul Revoluției nr. 77, P.O. BOX 2/158 AR
Tel : 0040-257- 283010; fax. 0040-257- 280070
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Operator de date cu caracter personal nr.2929

SYLLABUS

1. Program data

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Study program	**Mathematical modeling in science and technology**
1.8. Form of education	**Full-time education (FT)**

2. Data about Discipline

2.1. Name of the discipline	**GmEA3O01 Mathematical optimization**
2.2. Education Plan Holder	**Prof. Dr. Nădăban Sorin Florin**
2.3. Assistant	**Lect. Dr. Sida Lavinia Elisabeta**
2.4. Year of study	**2**
2.5. Semester	**1**
2.6. Type of evaluation	**ES**
2.7. Discipline regime	**OB**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**2**
3.2. Class hours per week	**1**
3.3. Seminar/laboratory/project hours per week	**1**
3.4. Total hours in the curriculum	**28**
3.5. Course hours per semester	**14**
3.6. Seminar/laboratory/project hours per semester	**14**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**30**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**34**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**30**
3.4.4. Tutoring	**0**
3.4.5. Examinations	**3**
3.4.6. Other activities ...	**0**

3.7. Total hours of individual study	**97**
3.8. Total hours per semester	**125**
3.9. Number of credits	**5**

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	
4.2. Competence prerequisites	

5. Necessary conditions (where applicable)

5.1. Course conditions	
5.2. Conditions for holding the seminar	
5.3. Laboratory conditions	
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional competencies	**C2 Statistical processing of data, analysis and interpretation of phenomena and processes with random character.** **C4. Design and application of mathematical models for the analysis of phenomena and processes.**
6.2. Transversal competencies	**CT2. Efficient coordination and management of activities organized in a team or group interdisciplinary** **CT3. Selection of information resources, efficient use of training sources professional,** **developing the ability to correlate professional activity with the requirements of a dynamic society**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**Developing students' skills in building mathematical models.** **Developing students' abilities to correctly apply the acquired knowledge and develop their analytical capacity.**
7.2. Specific objectives	**Students will be able to demonstrate that they have acquired knowledge regarding use of modeling and optimization techniques;**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
Chapter 1. What is a mathematical model? 1.1. Models mathematics in engineering, economics, computer science, ecology; 1.2. Methods for mathematical modeling	exposure interaction exemplification problematization modeling	2 hours
Chapter 2. Optimization algorithms in directed graphs	exposure interaction exemplification problematization modeling	2 hours
Chapter 3. Optimization techniques using derivatives 4.1. The case functions of one variable 4.2. The case of functions of more than one many variables - without constraints - with constraints and the rule Lagrange's multipliers	exposure interaction exemplification problematization modeling	2 hours
Chapter 4. Mathematical modeling of preferences consumer. Maximization of utility functions 5.1. The relationship of preference 5.2. Utility function 5.3. Consumption set 5.4. Budget set 5.5. Fundamental properties of preference relations 5.6. Preference and utility 5.7. The problem maximizing utility	exposure interaction exemplifying	2 hours

Chapter 5. Mathematical models applicable to distribution of goods 5.1. Mathematical modeling in marketing 5.2. The use of mathematical models in process optimization Decision-making for distribution of goods 5.3. Mathematical models based on strategic game theory	exposure interactive exemplification problematization modeling	2 hours
Chapter 6. Mathematical modeling in ecology 6.1. Models population growth 6.2. Models for multiple species	exposure interaction exemplification problematization modeling	2 hours
Chapter 7. Mathematical Modeling in Computer Science 7.1. Spaces quasi-pseudo-metrics and their applications in the field of words, in the study of algorithm complexity, etc. 7.2. Normed linear spaces fuzzy and their applications in image processing, wavelet analysis, data compression, data mining, etc.	exposure interaction exemplification problematization modeling	2 hours

8.2 Course Bibliography

1. R.S. Cantrell, C. Cosner, On the Dynamics of Predator–Prey Models with the Beddington–DeAngelis Functional Response, Journal of Mathematical Analysis and Applications 257, 206–222 (2001).
2. P.D. Cha, J.J. Rosenberg, C.L. Dym, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge University Press, New York, 2000.
3. A. Mas-Colell, M.D. Whinston, J. Green, Microeconomic Theory, Oxford University Press, 1995.
4. S. Nădăban, I. Dzitac, Some properties and applications of fuzzy quasi-pseudo-metric spaces, Informatica, 27 (1) (2016), 141-159.
5. S. Nădăban, Fuzzy euclidean normed spaces for data mining applications, International Journal of Computers Communications & Control, 10 (1) (2015), 70-77.
6. S. Nădăban, I. Dzitac, Atomic decompositions of fuzzy normed linear spaces for wavelet applications, Informatica, 25 (2014), 643-662.
7. C. Neuhauser, Mathematical challenges in spatial ecology, Notices of the AMS, Vol. 48, No. 11, 2001. 1304 -1314.
8. R. Diestel, Graph Theory, Springer - Verlag, Graduated texts in Mathematics, vol 173, 2000.
9. C. Giumale, Introducere în analiza algoritmilor: teorie şi aplicaţii, Polirom Publishing House, Iaşi, 2004.
10. B. Korte, J. Vygen, Combinatorial Optimization: Theory and Algorithms, Springer, 2000
11. S. Nădăban, A. Şandru, Algoritmica grafurilor. Sinteze de curs şi aplicaţii, Mirton Publishing House, Timişoara, 2007.
12. D. Opris, G. Silberberg, Linear, Discrete, Convex Optimizations, Mirton Publishing House, Timisoara, 1999.

8.3 Seminar Content	Teaching methods	Observations
Chapter 1. What is a mathematical model? 1.1. Models mathematics in engineering, economics, computer science, ecology; 1.2. Methods for mathematical modeling	exposure interactive exemplification problematization modeling	2 hours
Chapter 2. Optimization algorithms in directed graphs	exposure interactive exemplification problematization modeling	2 hours
Chapter 3. Optimization techniques using derivatives 4.1. The case functions of one variable 4.2. The case of functions of more than one many variables - without constraints - with constraints rule Lagrange's multipliers	interactive exhibition exemplification problematization modeling	2 hours
Chapter 4. Mathematical modeling of preferences consumer. Maximization of utility functions 5.1. The relationship of preference 5.2. Utility function 5.3. Consumption set 5.4. Budget set 5.5. Fundamental properties of preference relations 5.6. Preference and utility 5.7. The problem maximizing utility	interactive exhibition exemplification	2 hours
Chapter 5. Mathematical models applicable to distribution of goods 6.1. Mathematical modeling in marketing 6.2. The use of mathematical models in process optimization decision-making for the distribution of goods 6.3. Mathematical models based on strategic game theory	interactive exhibition exemplification	2 hours
Chapter 6. Mathematical modeling in ecology 7.1. Models population growth 7.2. Models for multiple species	exposure interaction exemplification problematization modeling	2 hours

Chapter 7. Mathematical modeling in computer science 8.1. Quasi-pseudo-metric spaces and their applications in the field of words, in the study of algorithm complexity, etc. 8.2. Fuzzy normed linear spaces and their applications in image processing, wavelet analysis, data compression, data mining, etc.	interactive exposure exemplification problematization modeling	2 hours

8.4 Seminar Bibliography

1. **R. Diestel, Graph Theory, Springer - Verlag, Graduated texts in Mathematics, vol 173, 2000.**
2. **S. Nădăban, A. Șandru, Algoritmica grafurilor. Sinteze de curs și aplicații, Mirton Publishing House, Timișoara, 2007.**
3. **D. Opris, G. Silberberg, Optimizari liniare, discrete, convexe, Mirton Publishing House, Timisoara, 1999.**
4. **A. Mas-Colell, MD Whinston, J. Green, Microeconomic Theory, Oxford University Press, 1995.**

8.5 Laboratory Content	Teaching methods	Observations

8.6 Laboratory Bibliography

8.7 Project Content	Teaching methods	Observations

8.8 Project Bibliography

9. Corroboration/validation of the content of the discipline (where applicable)

The content of the discipline is consistent with the content of similar disciplines from other university centers in the country and abroad. In order to better adapt the content of the discipline to the requirements of the labor market, meetings were held with employers - representatives of the business environment.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight of the grade final
10.1. Course	**correctness and completeness of knowledge logical coherence degree of assimilation of specialized language conscientiousness, interest in study**	Oral evaluation (final in the exam session): Presentation of a final project student's free presentation Evaluation conversation Oral questionnaire. Active participation in courses.	30% 10%
10.2. Seminar	**the ability to operate with knowledge assimilated; the ability to apply in practice conscientiousness, interest in study**	Oral evaluation (final in the exam session): Completion and presentation of the final project Topics, projects completed along the way Active participation in the seminar	30% 10% 20%
10.3. Laboratory			
10.4. Design			

10.5 Minimum performance standard

Mastering fundamental concepts, using specialized language, creating a simple application.

11. Learning outcomes

1. The graduate knows and applies the appropriate methods and techniques for solving problems in algebra, geometry, mathematical analysis, functional analysis, linear programming, differential equations, statistics, etc. 2. The graduate can apply the appropriate analytical methods for modeling and solving real-life problems, based on the acquired knowledge and fundamental principles.

Course holder	Assistant	Director of the Department	Dean
Prof. Nădăban Sorin Florin	Lect. Sida Lavinia Elisabeta	Assoc. Prof. Popa Lorena Camelia	Prof. Nădaban Sorin Florin

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DISCIPLINE SHEET

1. Program Data

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Study program	**Mathematical modeling in science and technology**
1.8. Form of education	**Part-time education (FI)**

2. Data about Discipline

2.1. Name of the discipline	**GmEU3O02 Stochastic systems and prediction**
2.2. Education Plan Holder	**Associate Professor Dr. Gaspar Octavian Pastorel**
2.3. Assistant	**Associate Professor Dr. Gaspar Octavian Pastorel**
2.4. Year of study	**2**
2.5. Semester	**1**
2.6. Type of evaluation	**IS**
2.7. Discipline regime	**On**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**
3.2. Class hours per week	**2**
3.3. Seminar/laboratory/project hours per week	**1**
3.4. Total hours in the curriculum	**42**
3.5. Course hours per semester	**28**
3.6. Seminar/laboratory/project hours per semester	**14**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**50**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**20**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**30**
3.4.4. Tutoring	**4**
3.4.5. Examinations	**4**
3.4.6. Other activities ...	**0**

3.7. Total hours of individual study	**108**
3.8. Total hours per semester	**150**
3.9. Number of credits	**6**

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	**Real and complex analysis, Functional analysis, Probability theory**
4.2. Competence prerequisites	**the ability to extract relevant information from international specialized literature**

5. Necessary conditions (where applicable)

5.1. Course conditions	**classroom equipped with blackboard and video projector**
5.2. Conditions for holding the seminar	**seminar room equipped with a whiteboard and video projector**
5.3. Laboratory conditions	
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C1. Analysis of real systems and development of mathematical models for processes and systems with application in engineering and economics.** **C5. Process modeling, design and implementation of numerical and symbolic calculation methods.**
6.2. Transversal skills	**CT2. Ability to communicate verbally and in writing on professional topics with computer scientists, engineers and economists and to draft technical reports or scientific articles.** **CT4. The ability to work individually and in a team in an interdisciplinary environment and to respect the professional ethics norms specific to the field**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**-The student should know the basic concepts related to stochastic systems and prediction theory.** **- The student should develop the skills to correctly apply the acquired knowledge to solve different classes of problems.** **- The student must train and develop his analytical ability.** **-The student should know the basic concepts related to stochastic systems and prediction theory.**
7.2. Specific objectives	**- The student should acquire the definitions and properties of harmonic analysis applied in the study of the structure of scalar and abstract stochastic processes.** **- The student is able to correctly apply basic methods and principles in solving complex problems.** **- The student can carry out projects for the mathematical modeling of a concrete problem.**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
1. Operator Theory Complements. 1.1 Hilbert Spaces. Orthonormal Bases 1.2 Operators on Hilbert Spaces. Invariant Subspaces 1.3 Isometric Operators. Unitary Operators. Projectors 1.4 Wold Decomposition of an Isometric Operator	Interactive exhibition	4 ore
2. Hardy spaces on torus. 2.1 Lebesgue spaces on R. 2.2 Hardy spaces H1(D), H2(T). 2.3 Characterization of invariant subspaces 2.4 F. and M. Riesz theorem 2.5 Szego-Krein-Kolmogorov theorem	Interactive exhibition	4 ore
3. One-dimensional stationary processes. 3.1 Definitions and examples 3.2 Time spaces of a stationary process 3.3 Wold structure of a stationary process 3.4 Elements of prediction of a stationary process	Interactive exhibition	4 ore

4. Natural bi-shifts and Wold decompositions for biisometries. 4.1 The notion of a pair of operators. 4.2 Bishift. Natural bi-shift 4.3 Wold decomposition for doubly commutative biisometries 4.4 Wold decomposition for general biisometries	Interactive exhibition	6 ore
5. Stationary processes with two time parameters. 5.1 The notion of stationarity in two parameters. 5.2 Definition of the notions of past in two parameters 5.3 Structure of stationary processes with two time parameters 5.4 Wold and Cramer decompositions for stationary processes with two time parameters	Interactive exhibition	6 ore
6. Numerical examples 6.1 AR models 6.2 ARMA models 6.3 ARCH and GARCH models	Interactive exhibition	4 ore

8.2 Course Bibliography

1. Pÿstorel Gaÿpar, Harmonic Analysis of Stochastic Processes, Ed. Univ. De Vest, Timisoara, 2008 2. Yu. Kakihara, Multidimensional Second Order Stochastic Processes, World Scientific publ.Comp. River Edge, NI, 1997.
3. Y. Kozachenko, O. Pogorilyak, I. Rozora, A. Tegza, Similation of Stochastic Processes with Given Accuracy and Reliability, ISTEPreess, Elsevier, Oxford, 2016.
4. Ruey S. Tsay, Analysis of Financial Time Series, Wiley&Sons, 2nd Edition, 2005.
5. M. Pourahmadi, Foundations of Time Series Analysis and Prediction Theory, Wiley&Sons, 2001.

8.3 Seminar Content	Teaching methods	Observations
The topic of the seminar hours closely follows that of the course.	Exemplification, problematization, interactive exposition	

8.4 Seminar Bibliography

1. Pÿstorel Gaÿpar, Harmonic Analysis of Stochastic Processes, Ed. Univ. De Vest, Timisoara, 2008 2. Yu. Kakihara, Multidimensional Second Order Stochastic Processes, World Scientific publ.Comp. River Edge, NI, 1997.
3. Y. Kozachenko, O. Pogorilyak, I. Rozora, A. Tegza, Similation of Stochastic Processes with Given Accuracy and Reliability, ISTEPreess, Elsevier, Oxford, 2016.
4. Ruey S. Tsay, Analysis of Financial Time Series, Wiley&Sons, 2nd Edition, 2005.
5. M. Pourahmadi, Foundations of Time Series Analysis and Prediction Theory, Wiley&Sons, 2001.

8.5 Laboratory Content	Teaching methods	Observations

8.6 Laboratory Bibliography

8.7 Project Content	Teaching methods	Observations

8.8 Project Bibliography

9. Corroboration/validation of the content of the discipline (where applicable)

The content of the discipline is corroborated with similar disciplines offered at universities abroad and with the requirements of the Arad labor market (e.g. the risk department of Intesa San Paolo Bank)

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight of the grade final
10.1. Course	**- correctness and completeness of knowledge; - logical coherence; - degree of assimilation of specialized language; - criteria targeting attitudinal aspects: conscientiousness, interest in individual study.**	Oral assessment: free student presentation; oral questionnaire; evaluation conversation; active participation in the course	55% 5%
10.2. Seminar	**- the ability to operate with the acquired knowledge; - the ability to apply it in practice; - criteria targeting attitudinal aspects: conscientiousness, interest in individual study.**	individual project active participation in the seminar	35% 5%
10.3. Laboratory			

10.4. Design			

10.5 Minimum performance standard **Knowledge of the fundamental elements of theory, logical coherence in exposition, solving a simple application.**

11. Learning outcomes

The student can perform the analysis of real systems and the development of mathematical models for processes and systems with application in engineering and economics. The student can contribute to the modeling of processes, the design and implementation of numerical and symbolic calculation methods. The student should develop the skills to correctly apply the accumulated knowledge to solve different classes of problems. The student must form and develop his analytical capacity. The student is able to correctly apply the basic methods and principles in solving complex problems. The student can carry out projects for the mathematical modeling of a concrete problem.

Professor	Assistant	Director Department	DEAN
Associate Professor Dr. Gaspar Octavian Pastorel	Gaspar Octavian Pastorel, PhD	Conf.univ.dr. Lorena Camelia Popa	Prof. Sorin-Florin NADABAN, PhD

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SYLLABUS

1. Program Data

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Study program	**Mathematical modeling in science and technology**
1.8. Form of education	**Full-time education (FT)**

2. Data about Discipline

2.1. Name of the discipline	**GmEU3O03 Fuzzy functional analysis**
2.2. Education Plan Holder	**Prof. Dr. Nădăban Sorin Florin**
2.3. Assistant	**Prof. Dr. Nădăban Sorin Florin**
2.4. Year of study	**2**
2.5. Semester	**1**
2.6. Type of evaluation	**ES**
2.7. Discipline regime	**OB**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**
3.2. Class hours per week	**2**
3.3. Seminar/laboratory/project hours per week	**1**
3.4. Total hours in the curriculum	**42**
3.5. Course hours per semester	**28**
3.6. Seminar/laboratory/project hours per semester	**14**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**30**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**50**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**24**
3.4.4. Tutoring	**0**
3.4.5. Examinations	**4**
3.4.6. Other activities ...	**0**

3.7. Total hours of individual study	**108**
3.8. Total hours per semester	**150**
3.9. Number of credits	**6**

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	**That's not the case.** **That's not the case.** **That's not the case.**
4.2. Competence prerequisites	**That's not the case.**

5. Necessary conditions (where applicable)

5.1. Course conditions	**That's not the case.**
5.2. Conditions for holding the seminar	**That's not the case.**
5.3. Laboratory conditions	
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C1. Operating with advanced notions and methods of functional and numerical analysis.** **C4. Design and application of mathematical models for the analysis of phenomena and processes.**
6.2. Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own professional potential, respecting rigorous and efficient work rules for the execution of complex professional tasks.** **CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group** **CT3. Selection of information resources, efficient use of professional training sources, development of the capacity to correlate professional activity with the requirements of a dynamic society**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**Students should have fundamental notions of fuzzy functional analysis**
7.2. Specific objectives	**Students should master important notions such as -fuzzy** **sets -fuzzy** **topological spaces -fuzzy** **metric spaces -fuzzy** **normed vector spaces**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
Chapter 1. Fuzzy sets Chapter 2. Fuzzy metric spaces Chapter 3. Fuzzy normed vector spaces 3.1. Topology of these spaces 3.2. Convergent sequences and fundamental sequences 3.3. Fuzzy bounded linear operators	Lecture, dialogue, exposition, problematization	

8.2 Course Bibliography

1. R. Saadati, C. Park, D. O'Regan, S. Nădăban, n-Expansively super-homogeneous and (n, k)-contractively sub-homogeneous fuzzy control functions and stability results with numerical examples, Advances in Difference Equations, 2021:153, 2021. https://doi.org/10.1186/s13662-021-03287-y

2. S. Nădăban, From Classical Logic to Fuzzy Logic and Quantum Logic: A General View, International Journal of Computers Communications & Control, [SI], 16(1) 2021. https://doi.org/10.15837/ijccc.2021.1.4125.

3. T. Binzar, F. Pater, S. Nădăban, Fuzzy bounded operators with application to Radon transform, Chaos, Solitons & Fractals, 141, Article number: 110359, 2020, https://doi.org/10.1016/j.chaos.2020.110359.

4. T. Binzar, F. Pater, S. Nădăban, A study of boundedness in fuzzy normed linear spaces, Symmetry- Basel, 11(7), Article number: 923, 2019. https://doi.org/10.3390/sym11070923

5. S. Nădăban, Some fundamental properties of fuzzy linear relations between vector spaces, Filomat, 30(1) (2016), 41-53.
6. S. Nădăban, Fuzzy b-metric spaces, International Journal of Computers Communications & Control, 11(2) (2016), 273-281.
7. S. Nădăban, I. Dzitac, Some properties and applications of fuzzy quasi-pseudo-metric spaces, Informatica, 27 (1) (2016), 141-159.
8. S. Nădăban, Fuzzy pseudo-norms and fuzzy F-spaces, Fuzzy Sets and Systems, 282 (2016), 99–114.
9. T. Bînzar, F. Pater, S. Nădăban, On fuzzy normed algebras, Journal of Nonlinear Sciences & Applications (JNSA), 9(9) (2016), 5488-5496. IF: 1.34
10. S. Nădăban, Fuzzy continuous mappings in fuzzy normed linear spaces, International Journal of Computers Communications & Control, 10 (6) (2015), 834-842.
11. S. Nădăban, Fuzzy euclidean normed spaces for data mining applications, International Journal of Computers Communications & Control, 10 (1) (2015), 70-77.
12. S. Nădăban, I. Dzitac, Atomic decompositions of fuzzy normed linear spaces for wavelet applications, Informatica, 25 (2014), 643-662.

8.3 Seminar Content	Teaching methods	Observations
Chapter 1. Fuzzy sets Chapter 2. Fuzzy metric spaces Chapter 3. Fuzzy normed vector spaces 3.1. Topology of these spaces 3.2. Convergent sequences and fundamental sequences 3.3. Fuzzy bounded linear operators	Dialogue, exemplification, problematization	

8.4 Seminar Bibliography

1. R. Saadati, C. Park, D. O'Regan, S. Nădăban, n-Expansively super-homogeneous and (n, k)-contractively sub-homogeneous fuzzy control functions and stability results with numerical examples, Advances in Difference Equations, 2021:153, 2021. https://doi.org/10.1186/s13662-021-03287-y
2. S. Nÿdÿban, From Classical Logic to Fuzzy Logic and Quantum Logic: A General View, International Journal of Computers Communications & Control, [SI], 16(1) 2021. https://doi.org/10.15837/ijccc.2021.1.4125.
3. T. Binzar, F. Pater, S. Nădăban, Fuzzy bounded operators with application to Radon transform, Chaos, Solitons & Fractals, 141, Article number: 110359, 2020, https://doi.org/10.1016/j.chaos.2020.110359.
4. T. Binzar, F. Pater, S. Nădăban, A study of boundedness in fuzzy normed linear spaces, Symmetry- Basel, 11(7), Article number: 923, 2019. https://doi.org/10.3390/sym11070923
5. S. Nădăban, Some fundamental properties of fuzzy linear relations between vector spaces, Filomat, 30(1) (2016), 41-53.
6. S. Nădăban, Fuzzy b-metric spaces, International Journal of Computers Communications & Control, 11(2) (2016), 273-281.
7. S. Nădăban, I. Dzitac, Some properties and applications of fuzzy quasi-pseudo-metric spaces, Informatica, 27 (1) (2016), 141-159.
8. S. Nădăban, Fuzzy pseudo-norms and fuzzy F-spaces, Fuzzy Sets and Systems, 282 (2016), 99–114.
9. T. Bînzar, F. Pater, S. Nădăban, On fuzzy normed algebras, Journal of Nonlinear Sciences & Applications (JNSA), 9(9) (2016), 5488-5496. IF: 1.34
10. S. Nădăban, Fuzzy continuous mappings in fuzzy normed linear spaces, International Journal of Computers Communications & Control, 10 (6) (2015), 834-842.
11. S. Nădăban, Fuzzy euclidean normed spaces for data mining applications, International Journal of Computers Communications & Control, 10 (1) (2015), 70-77.
12. S. Nădăban, I. Dzitac, Atomic decompositions of fuzzy normed linear spaces for wavelet applications, Informatica, 25 (2014), 643-662.

8.5 Laboratory Content	Teaching methods	Observations
8.6 Laboratory Bibliography		
8.7 Project Content	Teaching methods	Observations
8.8 Project Bibliography		

9. Corroboration/validation of the content of the discipline (where applicable)

The content of the discipline is consistent with the content of similar disciplines from other university centers in the country and abroad. For a better adaptation of the content of the discipline to the requirements of the labor market, meetings were held with both employers - representatives of the business environment and with mathematics and computer science teachers from the pre-university education in Arad.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight from the final grade
10.1. Course	**Preparing and presenting a report**	Oral evaluation (final in the exam session): Presentation of a final project Student's free presentation Evaluation conversation Oral questionnaire.	50%

10.2. Seminar	**The ability to operate with the acquired knowledge; the ability to apply it in practice, conscientiousness, interest in studying. Oral assessment (final in the exam session)**	Oral evaluation (final in the exam session): Completion and presentation of the final project Homework, projects completed along the way Active participation in the seminar	50%
10.3. Laboratory			
10.4. Design			
10.5 Minimum performance standard **Mastering fundamental concepts, using specialized language.**			

11. Learning outcomes

1. The graduate correctly explains and interprets mathematical concepts, using specific language. 2. The graduate is able to abstract, formalize and generalize mathematical material. 3. The graduate knows the rules for writing a mathematical text

Course holder	Assistant	Director of the Department	Dean
Prof. Sorin Florin NĂDĂBAN	Prof. Sorin Florin NĂDĂBAN	Assoc. Prof. Lorena Camelia POPA	Prof. Sorin Florin NĂDĂBAN

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SYLLABUS

Academic year 2025-2026

Study Year 2 / Semester 1

Legend:
- written in black - standard format of the subject sheet
- written in blue - operational suggestions for developing the sheet.

1. Program data

1.1 Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2 Faculty	**of Exact Sciences**
1.3 Department	**Department of Mathematics-Informatics**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Master's degree**
1.6 COR/ESCO core group study/qualification program *	**Mathematical modeling in science and technology**

* according to the Curriculum

2. Data about the discipline

2.1. Name of the discipline		**Scientific research methodology**				2.2 Discipline code	**GmET3O04**
2.3. Course activity holder			**Assoc. Prof. Bogosel Benjamin**				
2.4 Seminar/laboratory activity holder			**Assoc. Prof. Bogosel Benjamin**				
2.5 Year of study	**2**	2.6 Semester	**1**	2.7 Evaluation type (E/C/VP)	**ES**	2.8 Discipline regime (**A**-mandatory,**Op**-optional,**F**-optional)	**OB**

3. Total estimated time

3.1 Number of hours per week	**2**	of which: 3.2 course	**1**	3.3 seminar/laboratory	**1**
3.4 Total hours in the curriculum	**28**	of which: 3.5 course	**14**	3.6 seminar/laboratory	**14**
Time distribution					**hours**
a. Study according to the textbook, course material, bibliography and notes					**72**
b. Additional documentation in the library, on specialized electronic platforms and in the field					**0**

c. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**0**
d. Tutoring	**0**
e. Examinations	**0**
f. Other university activities (study visits, project consultations, etc.)	**0**

3.7 Total hours of individual study (a+b+c)	**72**
3.8 Total hours of university activities (d+e+f+3.4)	**28**
3.9 Total hours per semester (3.7+3.8)	**100**
3.10 Number of credits **	**4**

* 1 credit = 25 hours
** It is recommended that 3.7 be greater than or equal to 3.8

4. Preconditions(where applicable)

4.1 curriculum	-
4.2 competencies	-

5. Conditions(where applicable)

5.1 Course schedule	Classroom, video projector and appropriate software, Internet access - accounts in the SUMS platform
5.2 Seminar schedule	-
5.3 Laboratory conduct	Classroom, video projector and appropriate software, Internet access - accounts in the SUMS platform
5.4 Project implementation	-

6. Specific skills acquired

6.1 Professional skills	C1. Operating with advanced notions and methods of functional and numerical analysis. C4. Design and application of mathematical models for the analysis of phenomena and processes.

6.2 Transversal skills	CT2. Ability to communicate verbally and in writing on professional topics with computer scientists, engineers and economists and to draft technical reports or scientific articles. CT3. The ability to educate and train at the level of high school and higher education in the field of computer science and related disciplines CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own professional potential, respecting rigorous and efficient work rules for the execution of complex professional tasks. performing complex professional tasks.

7. Discipline objectives(based on the grid of specific skills acquired)

7.1 General objective of the discipline	Acquiring the methodological principles of scientific research and developing the capacity to apply them for the development and public support of scientific works.
7.2 Specific objectives	Knowledge of the component parts of a research paper Efficient use of bibliographic and documentation sources Use of research tools and methods for the publication process of a scientific paper: from writing to submission for publication

8. Contents *

8.1 Course	**Teaching methods**	**Observations**
1. Theory of scientific knowledge 2. Principles of scientific research 3. Organization of scientific research activity 4. Scientometrics and the evaluation of research results 5. Stages of writing a scientific paper 6. Case studies	The presentation, the debate, the conversation The presentation, the debate, the conversation The presentation, the debate, the conversation The presentation, the debate, the conversation The presentation, the debate, the conversation The presentation, the debate, the conversation	2 hours 2 hours 2 hours 2 hours 2 hours 4 hours
8.2 Bibliography 1. W. Booth, G. Colomb, J. Williams, J. Bizup, W. Fitzgerald, The Craft of Research, The University of Chicago Press, 2016 2. Ristea AL, Ioan-Franc V, Popescu C, Methodology in scientific research, 2017, Bucharest, Expert Publishing House 3. B. Bogosel - Course support on the SUMS platform		
8.3 Seminar	**Teaching methods**	**Observations**

1. Theory of scientific knowledge	Exercise, discussions and debate, modeling, the project.	2 hours
2. Principles of scientific research	Exercise, discussions and debate, modeling, the project.	2 hours
3. Organization of scientific research activity	Exercise, discussions and debate, modeling, the project.	2 hours
4. Scientometrics and the evaluation of research results	Exercise, discussions and debate, modeling, the project.	2 hours
5. Stages of writing a scientific paper	Exercise, discussions and debate, modeling, the project.	2 hours
6. Case studies	Exercise, discussions and debate, modeling, the project.	4 hours

8.4 Bibliography

1. W. Booth, G. Colomb, J. Williams, J. Bizup, W. Fitzgerald, The Craft of Research, The University of Chicago Press, 2016
2. Ristea AL, Ioan-Franc V, Popescu C, Methodology in scientific research, 2017, Bucharest, Expert Publishing House
3. B. Bogosel - Course support on the SUMS platform

8.5 Laboratory	Teaching methods	Observations
-	-	-

8.6 Bibliography

-

8.7 Project	Teaching methods	Observations
-	-	-

8.8 Bibliography

-

* course and seminar/laboratory assignments must fully cover the specific objectives formulated in section 7.2.
* the topics addressed in the course and those in the seminar can be designed both in a complementary relationship and/or in a deeper understanding of the topic.
* it is advisable that the development of the subject sheet be done as a team by the course and seminar/laboratory lecturers, possibly by all lecturers of the same subject, where several people teach the same subject.

9. Correlating the content of the discipline with the expectations of representatives of the epistemic community, professional associations and representative employers in the field related to the program

The content of the discipline is consistent with what is done in other university centers in the country and abroad.

10. Evaluation

Activity type	Evaluation criteria	Evaluation methods	Weight of final grade
10.1 Course	- correctness and completeness of knowledge; - logical coherence; - degree of assimilation of specialized language; - conscientiousness, interest in individual study.	Written exam/Project	80%
10.2 Seminar	- the ability to operate with the acquired knowledge; - the ability to apply it in practice; - conscientiousness, interest in individual and team study.	active participation	20%
10.3 Laboratory	-	-	-
10.4 Project	-	-	-
10.5 Minimum performance standard -			

11. Learning outcomes

The graduate knows the basic principles of scientific research. The graduate is able to use electronic resources to conduct a bibliographic study. The graduate knows the components of a scientific paper. The graduate develops his critical spirit and applies scientific research methods for the correct interpretation of the information received.

Date of completion	Signature of the course holder	Signature of the seminar holder
2025-10-09 10:50:39		
Date of approval in the department	Signature of the department director	

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Annex to the Course Sheet (optional)

ANNEX TO THE DISCIPLINE SHEET

12. Evaluation - grade increase

Activity type	Evaluation criteria	Evaluation methods	Weight of final grade
12.1 Course	-	-	-
12.2 Seminar	-	-	-
12.3 Laboratory	-	-	-
12.4 Project	-	-	-
12.5 Minimum performance standard -			
Participation in 50% of teaching activities and mastery of basic concepts.*			
Date of completion		Signature of the course holder	Signature of the seminar holder
2025-10-09 10:50:39			

13. Evaluation - arrears

Activity type	Evaluation criteria	Evaluation methods	Weight of final grade
13.1 Course	-	-	-
13.2 Seminar	-	-	-
13.3 Laboratory	-	-	-
13.4 Project	-	-	-
13.5 Minimum performance standard -			
Participation in 50% of teaching activities and mastery of basic concepts.*, **			
Date of completion		Signature of the course holder	Signature of the seminar holder
2025-10-09 10:50:39			

* Indicative wording
* * If the discipline has laboratory hours, the methods for recovering them must be provided.

SYLLABUS

1. Study Programme

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Program studied	**Mathematical modeling in science and technology**
1.8. Form of education	**Full – Time Study**

2. Course Details

2.1. Name of the discipline	**GmET3O05 Research project**
2.2. Education Plan Holder	**Prof. Dr. Stoica Codruța Simona**
2.3. Assistant	**Prof. Dr. Stoica Codruța Simona**
2.4. Year of study	**2**
2.5. Semester	**1**
2.6. Type of evaluation	**C**
2.7. Discipline regime	**DT**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**2**
3.2. Class hours per week	**0**
3.3. Seminar/laboratory/project hours per week	**2**
3.4. Total hours in the curriculum	**28**
3.5. Course hours per semester	**0**
3.6. Seminar/laboratory/project hours per semester	**28**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**30**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**20**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**20**
3.4.4. Tutoring	**0**
3.4.5. Examinations	**2**

3.4.6. Other activities ...	0
3.7. Total hours of individual study	**72**
3.8. Total hours per semester	**100**
3.9. Number of credits	4

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	
4.2. Competence prerequisites	

5. Necessary conditions (where applicable)

5.1. Course conditions	
5.2. Conditions for conducting the Seminary	
5.3. Laboratory conditions	
5.4. Project implementation conditions	**Seminar room, properly equipped with a whiteboard and video projector, internet connection.**

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C1. Operating with advanced notions and methods of functional and numerical analysis C4. Designing and applying mathematical models for the analysis of phenomena and processes.**
6.2. Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own potential on a professional level, respecting rigorous and efficient work rules for the execution of complex professional tasks CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group CT3. Selecting information resources, efficient use of professional training sources, developing the capacity to correlate professional activity with the requirements of a dynamic society.**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**- Initiating the student in scientific research methods** **- The student should develop the ability to correctly apply the skills and knowledge acquired**
7.2. Specific objectives	**-Presentation of results obtained in a chosen research area in mathematics** **- Writing reports on a given topic** **- Learning scientific research skills and writing a scientific paper**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
8.2 Course Bibliography		
8.3 Seminar Content	Teaching methods	Observations
8.4 Seminar Bibliography		
8.5 Laboratory Content	Teaching methods	Observations
8.6 Laboratory Bibliography		

8.7 Project Content	Teaching methods	Observations
Romanian school of mathematics	Participatory lecture, debate, exposure	4 ore
2. Mathematical models for optimizing systems of differential equations with applications in economics.	Participatory lecture, debate, presentation	6 ore
3. Stochastic processes in mathematical modeling	Participatory lecture, debate, exposure	6 ore
4. Extremum problems with applications to optimal control systems.	Participatory lecture, debate, presentation	6 ore
5. Elements of control theory in mathematical modeling	Participatory lecture, debate, presentation	6 ore

8.8 Project Bibliography

1. V. Capasso, D. Bakstein, An Introduction to Continuous – Time Stochastic Processes, Theory, Models and Applications to Finance, Biology and Medicine, Birkhauser Boston, 2005 2. M. Capiÿski, T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer, 2nd Edition, 2011 3. S. Salsa, A. Squellati, Dynamical Systems and Optimal Control, EGEA Spa - Bocconi University Press, 2018 4. D.A. Sanchez, Ordinary Differential Equations and Stability Theory, Courier Dover Publications, 2019 5. G. Schneider, H. Uecker, Nonlinear PDEs: A Dynamical Systems Approach, American Mathematical Society, 2017 6. C. Stoica, Uniform Asymptotic Behaviors for Skew-Evolution Semiflows on Banach Spaces, Ed. Mirton, 2010 7. R. J. Williams,

Introduction to the Mathematics of Finance, American Mathematical Society, 2006 8. J. Zabczyk, Mathematical Control Theory: An Introduction, Birkhauser, 1992

9. C. Stoica, Project Support, SUMS, 2025

9. Corroboration/validation of the course contents (where applicable)

The content of the discipline is consistent with what is done in other university centers in the country and abroad. For a better adaptation of the content of the discipline to the requirements of the labor market, meetings were held with both representatives of the business environment and with mathematics and computer science teachers from pre-university education.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight from the note final
10.1. Course			
10.2. Seminar			
10.3. Laboratory			
10.4. Design	**- correctness and completeness of knowledge; - logical coherence; - degree of assimilation of specialized language; -** **conscientiousness, interest in individual study -** **the ability to operate with the acquired knowledge; - the ability**	Oral evaluation (final in the exam session): - Student's free presentation; - Evaluation conversation; Oral questionnaire. Active participation in courses. Oral assessment (final exam period): - project completion	30 % 20 % 30% 20%

	of application in practice;	necessary -homework	

10.5 Minimum performance standard

Minimum performance standard: The student must demonstrate that he/she is able to document and produce a scientific paper.

11. Learning outcomes

C. The graduate: a) documents himself/herself in relation to a given topic b) knows how to collect, classify and evaluate information from various sources c) critically summarizes new and complex information in relation to a given topic A. The graduate: a) correctly interprets the information collected on a given topic b) classifies the information available according to the context c) selects the information necessary to solve a specific problem d) uses digital tools to support information synthesis. RA. The graduate: a) uses the information at his disposal coherently b) demonstrates professionalism in managing the information at his disposal c) can work autonomously or in multidisciplinary teams C. The graduate: a) defines the concepts Understands the fundamental concepts that underlie abstract thinking: axioms, theorems, demonstrations, structures, functions, relations, abstract data types b) Knows the principles of mathematical and formal logic, as well as demonstration methods c) formulates observations and differentiates notions, properties and assertions from the basic disciplines of mathematics through examples and counterexamples A. The graduate: a) provides examples of the use of basic theoretical concepts and results when solving exercises and problems formulated in relation to the topics covered in the disciplines in the curriculum. b) represents and formulates concepts and problems in abstract, symbolic or formal terms RA. The graduate: a) Demonstrates intellectual autonomy in exploring and manipulating abstract concepts b) Finds solutions to practical, operational or conceptual problems, in a wide range of contexts c) Generates argumentative procedures in support of solutions C. The graduate: a) Knows advanced mathematical terminology, in Romanian and English b) Knows the conventions of notation, symbolization and formal presentation of mathematical content c) Transposes various practical problems into mathematical language d) Is able to express mathematical problems/theorems with practical implications in ordinary language. A. The graduate: a) Writes rigorous demonstrations, logical arguments and detailed explanations, using specific language b) Develops the solution to a problem in the field using appropriate mathematical symbols, language and tools c) Interprets and explains graphs, tables, mathematical models, numerical or symbolic results RA. The graduate: a) Communicate Presents ideas and processes using appropriate mathematical symbols, language and tools d) Demonstrates rigor and intellectual discipline in writing and presenting one's own mathematical results

Course Coordinator
Prof. Stoica Codruța Simona, PhD

Seminar Coordinator
Prof. Stoica Codruța Simona, PhD

Head of the Department
Assoc. Prof. Lorena Camelia Popa, PhD

DEAN
Prof. Sorin-Florin Nădăban, PhD

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SYLLABUS

1. Study Programme

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Program studied	**Mathematical modeling in science and technology**
1.8. Form of education	**Full – Time Study**

2. Course Details

2.1. Name of the discipline	**GmEU3A31 Dynamic systems and optimal**
2.2. Education Plan Holder	**control Prof. Dr. Stoica Codruța Simona**
2.3. Assistant	**Prof. Dr. Stoica Codruța Simona**
2.4. Year of study	**2**
2.5. Semester	**1**
2.6. Type of evaluation	**Exam**
2.7. Discipline regime	**DA - Imposed compulsory discipline**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**2**
3.2. Class hours per week	**1**
3.3. Seminar/laboratory/project hours per week	**1**
3.4. Total hours in the curriculum	**28**
3.5. Course hours per semester	**14**
3.6. Seminar/laboratory/project hours per semester	**14**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**23**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**25**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**25**
3.4.4. Tutoring	**20**
3.4.5. Examinations	**4**

3.4.6. Other activities ...	0
3.7. Total hours of individual study	**97**
3.8. Total hours per semester	**125**
3.9. Number of credits	5

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	
4.2. Competence prerequisites	

5. Necessary conditions (where applicable)

5.1. Course conditions	**Classroom, equipped with a blackboard, laptop and video projector**
5.2. Conditions for holding the seminar	**Laboratory room, properly equipped with blackboard, computers, network, Internet connection**
5.3. Laboratory conditions	
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C3. Solving problems of dynamic systems, optimal control and operational research.** **C4. Design and application of mathematical models for the analysis of phenomena and processes.**
6.2. Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own potential on a professional level, respecting rigorous and efficient work rules for the execution of complex professional tasks CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group CT3. Selecting information resources, efficient use of professional training sources, developing the capacity to correlate professional activity with the requirements of a dynamic society**

7. Discipline objectives (where applicable)

7.1. The objective general of the discipline	**- The student is able to apply the theory of optimal control so that the qualitative study of the optimum leads to the effective solution of problems - The student can use mathematical models in solving a concrete problem.** **- The student should be aware of the importance of studying dynamic systems due to applications in computer science, mechanics, biology and economics - The student should understand that in studying phenomena that occur in the real world, often complex, it is necessary to achieve a schematization of them, called modeling, which involves mathematical methods** **- The student should develop the ability to correctly apply the skills and knowledge acquired**
7.2. Specific objectives	**- The student is able to demonstrate that he/she has understood the basic notions: control systems, semigroups of operators** **- The student can apply the notions of controllability and observability in examples** **- The student demonstrates that he has mastered the notions of stability for controlled systems** **- The student is able to _apply the acquired notions to the study of dynamic systems that model phenomena in computer science, physics, engineering or economics**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
	Participatory lecture,	

1. Revisiting the ODEs and PDEs	debate, exposition, problematization, exemplification, demonstration.	2 ore
2. Real world phenomena modelled by ODEs and PDEs	Participatory lecture, debate, exposition, problematization, exemplification, demonstration.	4 ore
3. Dynamical systems	Participatory lecture, debate, exposition, problematization, exemplification, demonstration.	4 ore
4. Optimal control issues	Participatory lecture, debate, exposure, problematization, exemplification, demonstration.	4 ore

8.2 Course Bibliography

1. M. Megan, Megan, A.L. Sasu, B. Sasu, Asymptotic Behaviours of Evolution Families, Mirton Publishing House, 2003 2. S. Salsa, A. Squellati, Dynamical Systems and Optimal Control, EGEA Spa - Bocconi University Press, 2018 3. G. Schneider, H. Uecker, Nonlinear PDEs: A Dynamical Systems Approach, American Mathematical Society, 2017 4. C. Stoica, Uniform Asymptotic Behaviors for Skew-EvolutionSemiflows on Banach Spaces, Mirton Publishing House, Timisoara, 2010 5. J. Zabczyk, Mathematical Control Theory: An Introduction, Birkhauser, 1992 6 C. Stoica, Course and seminar support, SUMS, 2025

8.3 Seminar Content	Teaching methods	Observations
1. Revisiting the ODEs and PDEs	Participatory lecture, debate, exposition, problematization, exemplification.	4 ore
2. Real world phenomena modelled by ODEs and PDEs	Participatory lecture, debate, exposition, problematization, exemplification.	4 ore
3. Dynamical systems	Participatory lecture, debate, exposure, problematization, exemplification.	4 ore
4. Optimal control issues	Participatory lecture, debate, exposure, problematization, exemplification.	2 ore

8.4 Seminar Bibliography

1. M. Megan, Megan, A.L. Sasu, B. Sasu, Asymptotic Behaviours of Evolution Families, Mirton Publishing House, 2003 2. S. Salsa, A. Squellati, Dynamical Systems and Optimal Control, EGEA Spa - Bocconi University Press, 2018 3. G. Schneider, H. Uecker, Nonlinear PDEs: A Dynamical Systems Approach, American Mathematical Society, 2017 4. C. Stoica, Uniform Asymptotic Behaviors for Skew-Evolution Semiflows on Banach Spaces, Mirton Publishing House, Timisoara, 2010 5. J. Zabczyk, Mathematical Control Theory: An Introduction, Birkhauser, 1992 6. C. Stoica, Course and seminar support, SUMS, 2025

8.5 Laboratory Content	Teaching methods	Observations

8.6 Laboratory Bibliography

8.7 Project Content	Teaching methods	Observations

8.8 Project Bibliography

9. Corroboration/validation of the course contents (where applicable)

The content of the course is in line with what is done in other university centers abroad. In order to adapt the content of the course to the requirements of the labor market, meetings were held with representatives of the business environment.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight from the final grade
10.1. Course	**- correctness and completeness of knowledge; - logical coherence; - degree of assimilation of specialized language; - conscientiousness, interest in individual study.**	Oral evaluation (final in the exam session): - Student's free presentation; - Evaluation conversation; Oral questionnaire. Active participation in courses.	30% 10%
10.2. Seminar	**- the ability to operate with the acquired knowledge; - the ability to apply it in practice; - conscientiousness, interest in individual study.**	Oral assessment (final exam period): - project completion necessary - homework Active participation in seminars.	30% 10% 20%
10.3. Laboratory			
10.4. Design			

10.5 Minimum performance standard

Adequate acquisition of basic theoretical concepts and the ability to apply them in the study of mathematical models and control systems.

11. Learning outcomes

C. The graduate: a) documents himself/herself in relation to a given topic b) knows ways of collecting, classifying and evaluating information from various sources c) critically summarizes new and complex information in relation to a given topic A. The graduate: a) correctly interprets the information collected on a given topic b) classifies the information available according to the context c) selects the information necessary to solve a specific problem d) uses digital tools to support information synthesis. RA. The graduate: a) coherently uses the information available b) demonstrates professionalism in managing the information available c) can work autonomously or in multidisciplinary teams

C. The graduate: a) defines concepts Understands the fundamental concepts underlying abstract thinking: axioms, theorems, proofs, structures, functions, relations, abstract data types b) Knows the principles of mathematical and formal logic, as well as methods of proof c) formulates observations and differentiates notions, properties and assertions from the basic disciplines of mathematics through examples and counterexamples A. The graduate: a) provides examples of the use of basic theoretical concepts and results when solving exercises and problems

formulated in relation to the topics covered in the curriculum subjects. b) represents and formulates concepts and problems in abstract, symbolic or formal terms RA. The graduate: a) Demonstrates intellectual autonomy in exploring and manipulating abstract concepts b) finds solutions to practical, operational or conceptual problems, in a wide range of contexts c) generates argumentative procedures in support of solutions C. The graduate: a) Knows advanced mathematical terminology, in Romanian and English b)

Knows the conventions of notation, symbolization and formal presentation of mathematical content c) Transposes various practical problems into mathematical language d) Is able to express mathematical problems/theorems with practical implications in ordinary language. A. The graduate: a) Writes rigorous demonstrations, logical arguments and detailed explanations, using specific language b) Develops the solution to a problem in the field using appropriate symbols, language and mathematical tools c) Interprets and explains graphs, tables, mathematical models, numerical or symbolic results RA. The graduate: a) Communicates and interprets the solution to a problem b) Compares using specific mathematical language, alternative solutions c) Presents ideas and processes using appropriate symbols, language and mathematical tools d) Demonstrates rigor and intellectual discipline in writing and presenting their own mathematical results

Course Coordinator	Seminar Coordinator	Head of the Department	DEAN
Prof. Dr. Stoica Codruța Simona, PhD	Prof. Dr. Stoica Codruța Simona, PhD	Assoc. Prof. Lorena Camelia Popa, PhD	Prof. Sorin-Florin NĂDĂBAN, PhD

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SYLLABUS

1. Study programme

1.1. Higher education institution	**„Aurel Vlaicu" University of Arad**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics and Computer Science**
1.4. Field of study	**Mathematics**
1.5. Study level	**2025-2026**
1.6. Ciclul de studii	**Master**
1.7. Study programme / Qualification	**Mathematical Modeling in Science and Technology**
1.8. Form of education	**Full-time study**

2. Course details

2.1. Name of the course	**GmEU3A32 Statistical data analysis and processing**
2.2. Course coordinator	**dr. Nagy Mariana**
2.3. Seminar/laboratory/project coordinator	**dr. Nagy Mariana**
2.4. Study year	**2**
2.5. Semester	**1**
2.6. Evaluation type	**ES**
2.7. Course type	**OP**

3. Estimated total time (hours per semester)

3.1. Hours per week	**2**
3.2. Lecture hours per week	**1**
3.3. Seminar/laboratory/project hours per week	**1**
3.4. Total hours per curriculum	**28**
3.5. Lecture hours per semester	**14**
3.6. Seminar/laboratory/project hours per semester	**14**
	Time division [hrs]
3.4.1. Independent study from textbooks, course support, bibliography and notes	**30**
3.4.2. Additional reading (libraries, specialized electronic platforms and field research)	**30**
3.4.3. Preparing of seminars/laboratories/projects, homework, papers, portfolios and essays	**26**
3.4.4. Tutorial coaching	**7**
3.4.5. Examinations	**4**
3.4.6. Other activities	**0**
3.7. Total individual study hours	**97**
3.8. Total hours per semester	**125**
3.9. Number of ECTS credits	**5**

4. Prerequisites (if applicable)

4.1. Curriculum related	Probability and mathematical statistics - basic course
4.2. Competence related	

5. Conditions (if applicable)

5.1. for the lecture	**Lecture room, equipped with laptop, video projector/smartboard and appropriate software**
5.2. for the seminar	
5.3. for the laboratory	**Laboratory room, appropriately equipped: computers, network, Internet connection, MS Office, SPSS, Fast Statistics, Clusterseer**
5.4. for the project	

6. Specific educational objectives (competences to be acquired)

6.1. Competenţe profesionale	**C2. Statistical processing of data, analysis and interpretation of results** **C4. Design and application of mathematical models for the analysis of phenomena and processes**
6.2. Competenţe transversale	**CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group**

7. Course outcomes (resulting from the specific educational objectives to be acquired)

7.1. General outcomes	**Training students' skills in using data processing techniques in order to obtain aggregated, statistical information. Developing students' abilities to correctly apply the acquired knowledge and developing their analytical capacity.**
7.2. Specific outcomes	**Students will be able to demonstrate that they have acquired knowledge regarding: -** **The use of data processing techniques based on statistical methods.** **Familiarity with elements of interpreting results in various fields, in order to facilitate collaboration with the beneficiary of the analyses. - The use of general-purpose spreadsheet environments and specialized programs for the application areas.**

8. Outline (if applicable)

8.1 Lecture Outline	Teaching methods	Remarks
Statistical approach to data sets - Information classification. Information processes. - Data. Information. Knowledge. Interpretation. Decision. - Statistical variable. Probability. Frequency. Relative frequency. - Statistical distribution. - Sample. Sampling techniques. - Examples Descriptive analysis - Numerical characteristics: - discrete values, range, amplitude - mean, mode, median, quantile, moving average - dispersion, variance, standard error, standard deviation - skewness coefficient, asymmetry coefficient - confidence level - Use of computing techniques: applications - Examples and interpretations Graphical representation of statistical distributions - Basic elements regarding the choice of graphic representation – Types of graphic representations - Histograms. - Use of the calculation technique: applications Statistical forecasts - Elements of estimation theory - Use of numerical characteristics for forecasting: mean, moving average, standard deviation - Forecasts using graphical representation: extrapolation, trendline, coefficient of determination - Use of the calculation technique: applications Comparative analysis of data sets - Normal distribution - Correlation. Covariance. - Regression. Regression curve + equation and graphical representation. - Use of the calculation technique: applications Probability distributions. Statistical hypotheses. - Classical statistical distributions: - binomial distribution - normal distribution - exponential distribution - distribution - Student distribution - Fischer - Snedecor distribution - Verification of statistical hypotheses: - Analysis of variance. - Tests of independence. Tests of agreement. - T-test, Z-test, F-test - concordance test - Use of computing: applications - Use of clusters for data processing - Definition and typology of clusters - Spatial clusters: identification methods - Besag-Newell method - Kulldorff method - Use of computing: Clusterseer - Approaching a problem with real data - Choosing a statistical analysis methodology - Data sampling - Data analysis - Use of computing: application	interactive exposition heuristic conversation exemplification interactive exposition exemplification problematization modeling interactive exposition exemplification problematization modeling interactive exposition exemplification problematization modeling interactive exposition exemplification problematization modeling interactive exposition exemplification problematization modeling interactive exposition exemplification problematization modeling interactive exposition exemplification problematization	1 hour 2 hours 1 hour 2 hours 1 hour 3 hours 2 hours 2 hours

8.**2 Lecture References**

1. Nagy M, Suport de curs, Platforma SUMS, 2024
2. Babucea AG, Analiza datelor – Metode statistice avansate , Ed. Universitaria, Craiova, 2010
3. Besag J., Newell J. (1991). The detection of clusters in rare diseases, Journal of the Royal Statistical Society, Series A,154, 143-155;
4. Brownley C.W., Foundations for Analytics with Python, O'Reilly, 2016
5. Kulldorff, M. (1997). A spatial scan statistic. Statistics–Theory and Methods, 26, 1481-96;
6. Nagy M., Vizental M., Asistarea deciziei folosind mediul Excel, Ed. Albastră, Cluj-Napoca, 2008
7. Nussbaumer Knaflic C., Storytelling with Data, Wiley, 2015
8. Oleksik M., Rosca L., Analiza datelor cu Microsoft Excel, Ed. Pro Universitaria, 2023
8. Pintilescu C., Analiza statistică multivariată, Ed. Universitatii „Alexandru Ioan Cuza", Iasi, 2007
10. Spircu L., Calciu M., Spircu T., Analiza datelor de marketing., Seria Oeconomica, ed. All, Bucureşti,1994/2000
11. *** User manual of: MS-Excel, SPSS, Fast statistics, ClusterSeer, Python

8.3 Seminar Outline	Teaching methods	Remarks

8.4 Seminar References

8.5 Laboratory Outline	Teaching methods	Remarks
Statistical approach to data sets - Information classification. Information processes. - Data. Information. Knowledge. Interpretation. Decision. - Statistical variable. Probability. Frequency. Relative frequency. - Statistical distribution. - Sample. Sampling techniques. - Examples Descriptive analysis - Numerical characteristics: - discrete values, range, amplitude - mean, mode, median, quantile, moving average - dispersion, variance, standard error, standard deviation - skewness coefficient, asymmetry coefficient - confidence level - Use of computing techniques: applications - Examples and interpretations Graphical representation of statistical distributions - Basic elements regarding the choice of graphic representation – Types of graphic representations - Histograms. - Use of the calculation technique: applications Statistical forecasts - Elements of estimation theory - Use of numerical characteristics for forecasting: mean, moving average, standard deviation - Forecasts using graphical representation: extrapolation, trendline, coefficient of determination - Use of the calculation technique: applications Comparative analysis of data sets - Normal distribution - Correlation, types of correlation, calculation method. Covariance. - Regression. Regression curve + equation and graphical representation. - Use of the calculation technique: applications Probability distributions. Statistical hypotheses. - Classical statistical distributions: - binomial distribution - normal distribution - exponential distribution - distribution - Student distribution - Fischer - Snedecor distribution - Verification of statistical hypotheses: - Analysis of variance. - Tests of independence. Tests of agreement. - T-test, Z-test, F-test - concordance test - Use of computing: applications - Use of clusters for data processing - Definition and typology of clusters - Spatial clusters: identification methods - Besag-Newell method - Kulldorff method - Use of computing: Clusterseer - Approaching a problem with real data - Choosing a statistical analysis methodology - Data sampling - Data analysis - Use of computing: application	analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea analiza studiu individual documentare pe web problematizarea modelarea Documentation onthe Web Modeling	1 hour 2 hours 1 hour 1 hour 1 hour 3 hours 2 hours 3 hours

8.6 Laboratory References
1. Nagy M, Suport de curs, Platforma SUMS, 2024 2. Babucea AG, Analiza datelor – Metode statistice avansate , Ed. Universitaria, Craiova, 2010 3. Besag J., Newell J. (1991). The detection of clusters in rare diseases, Journal of the Royal Statistical Society, Series A,154, 143- 155; 4. Brownley C.W., Foundations for Analytics with Python, O'Reilly, 2016 5. Kulldorff, M. (1997). A spatial scan statistic. Statistics–Theory and Methods, 26, 1481-96; 6. Nagy M., Vizental M., Asistarea deciziei folosind mediul Excel, Ed. Albastră, Cluj-Napoca, 2008 7. Nussbaumer Knaflic C., Storytelling with Data, Wiley, 2015 8. Oleksik M., Rosca L., Analiza datelor cu Microsoft Excel, Ed. Pro Universitaria, 2023 8. Pintilescu C., Analiza statistică multivariată, Ed. Universitatii „Alexandru Ioan Cuza", Iasi, 2007 10. Spircu L., Calciu M., Spircu T., Analiza datelor de marketing., Seria Oeconomica, ed. All, Bucureşti,1994/2000 11. *** Documentaţia programelor folosite: MS-Excel, SPSS, Fast statistics, ClusterSeer, Python 12 *** Applied data science with Python, https://cognitiveclass.ai/learn/data-science-withpython/?fbclid=IwAR31wSPOuz27WYmc6N1DIRcZiG9U-v2SP4WAC3GhG9yq9jWdiFXQN1Fi3J8**8.7**

8.7 Project Outline	Teaching methods	Remarks

9. Correlation of course outline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

The content of the discipline is consistent with the content of similar disciplines in other university centers in the country and abroad. **For a better adaptation of the content of the discipline to the requirements of the labor market, meetings were held with both employers - representatives of the business environment and with mathematics and computer science teachers from the pre-university education in Arad.**

10. Evaluation / Grading (if applicable)

Activity type	Evaluation criteria	Evaluation methods	Percentage of the final grade
10.1. Lecture	correctness and completeness of knowledge logical coherence degree of assimilation of the specialized language conscientiousness, interest in study	Oral evaluation (final in the exam session) Active participation in courses.	40% 10%

10.2. Seminar			
10.3. Laboratory	**the ability to operate with the acquired knowledge;** **the ability to apply it in practice;** **conscientiousness and interest in studies**	Homework, projects completed during the course Completion and presentation of the final project, active participation in the laboratory	40% 10%
10.4. Project			
10.5 Minimal performance standard **Mastering fundamental concepts, using specialized language, carrying out the project.**			

11. Learning results

Graduates will be able to use statistical data processing techniques based on statistical methods: Graduates will know elements of interpreting results in various fields, in order to facilitate collaboration with the beneficiary of the analyses. Graduates will be able to use general-purpose spreadsheet environments and specialized programs by application field.

Course coordinator	Seminar/laboratory/project coordina	Head of the Department	Dean
Prof. Nagy Mariana	Prof. Nagy Mariana	Assoc.Prof. Popa Lorena	Prof. Nădăban Sorin

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Operator de date cu caracter personal nr. 2929

SYLLABUS

1. Study programme

1.1. Higher education institution	**„Aurel Vlaicu” University of Arad**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics and Computer Science**
1.4. Field of study	**Mathematics**
1.5. Study level	**2025-2026**
1.6. Ciclul de studii	**Master**
1.7. Study programme / Qualification	**Mathematical modeling in science and technology**
1.8. Form of education	**Full – Time study**

2. Course details

2.1. Name of the course	**Advanced modeling and simulation techniques**
2.2. Course coordinator	**Dragoi Vlad-Florin**
2.3. Seminar/laboratory/project coordinator	**Dragoi Vlad-Florin**
2.4. Study year	**2**
2.5. Semester	**2**
2.6. Evaluation type	**Exam**
2.7. Course type	**Mandatory**

3. Estimated total time (hours per semester)

3.1. Hours per week	**3**
3.2. Lecture hours per week	**2**
3.3. Seminar/laboratory/project hours per week	**1**
3.4. Total hours per curriculum	**42**
3.5. Lecture hours per semester	**28**
3.6. Seminar/laboratory/project hours per semester	**14**
	Time division [hrs]
3.4.1. Independent study from textbooks, course support, bibliography and notes	**45**
3.4.2. Additional reading (libraries, specialized electronic platforms and field research)	**40**
3.4.3. Preparing of seminars/laboratories/projects, homework, papers, portfolios and essays	**40**
3.4.4. Tutorial coaching	**4**
3.4.5. Examinations	**4**
3.4.6. Other activities	**0**
3.7. Total individual study hours	**133**
3.8. Total hours per semester	**175**
3.9. Number of ECTS credits	**7**

4. Prerequisites (if applicable)

4.1. Curriculum related	
4.2. Competence related	

5. Conditions (if applicable)

5.1. for the lecture	**Lecture room equipped with video projector, internet connection and software tools**
5.2. for the seminar	
5.3. for the laboratory	Laboratory room equipped with networked computers, internet connection and adequate software
5.4. for the project	

6. Specific educational objectives (competences to be acquired)

6.1. Profesional skills	**C2. Statistical processing of data, analysis and interpretation of random phenomena and processes.** **C3. Solving problems of dynamic systems, optimal control and operational research.** **C4. Design and application of mathematical models for the analysis of phenomena and processes.** **C5. Solving financial and actuarial mathematics problems.**
6.2 Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and teaching field, one's own professional potential, respecting rigorous work rules and effectively capitalizing on them to perform complex professional tasks.** **CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group** **CT3. Selection of information resources, efficient use of professional training sources, development of the capacity to correlate professional activity to the requirements of a dynamic society development of the capacity to correlate professional activity to the requirements of a dynamic society**

7. Course outcomes (resulting from the specific educational objectives to be acquired)

7.1. General outcomes	**The main objective of this discipline is the acquisition and development of techniques for modeling physical processes and simulating them.** **All of these will allow them to increase their chances of being hired and integrate multidisciplinary teams.**
7.2. Specific outcomes	**Description and simulation of stocastic processes such as Brownian motion.** **Understanding and simulating randomness.** **Understanding and manipulating in difference use cases of Monte Carlo methods.**

8. Outline (if applicable)

8.1 Lecture Outline	Teaching methods	Remarks
1. How to generate IID random variables 2. Monte Carlo method 3. Variance reduction 4. Case studies: Brownian Motion, Reliability, PRNG testing	Presentation Lecture using video projector and the internet Web search Interactive discussions Examples	

8.2 Lecture References

1. **A. Benveniste, M. Métivier, P.Priouret, Adaptive Algorithms and Stochastic Approximations, Springer-Verlag, 1990.**
2. **L. Breiman, Probability, Addison-Wesley,1968.**
3. **T.M. Cover, J.A. Thomas, Elements of Information Theory, 2nd edition, Wiley, 2006.**
4. **G.S. Fishman, Monte Carlo, Springer 1997.**
5. **W. Härdle, Applied nonparametric regression, Cambridge University Press, 1990.**
6. **I. Karatzas, S. Shreve, Brownian Motion and Stochastic Calculus, 2d edition, Springer 1991.**

8.3 Seminar Outline	Teaching methods	Remarks
1. How to generate IID random variables 2. Monte Carlo method 3. Variance reduction 4. Case studies: Brownian Motion, Reliability, PRNG testing	Case studies Examples Individual study Brainstorming Practical challenges	

8.4 Seminar References

1. **A. Benveniste, M. Métivier, P.Priouret, Adaptive Algorithms and Stochastic Approximations, Springer-Verlag, 1990.**
2. **L. Breiman, Probability, Addison-Wesley,1968.**
3. **T.M. Cover, J.A. Thomas, Elements of Information Theory, 2nd edition, Wiley, 2006.**
4. **G.S. Fishman, Monte Carlo, Springer 1997.**
5. **W. Härdle, Applied nonparametric regression, Cambridge University Press, 1990.**

6. I. Karatzas, S. Shreve, Brownian Motion and Stochastic Calculus, 2d edition, Springer 1991.

8.5 Laboratory Outline	Teaching methods	Remarks

8.6 Laboratory Outline

8.7 Project Outline	Teaching methods	Remarks
8.8 Project Outline		

9. Correlation of course outline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

This course is taught in similar programs at many universities, both in Romania and abroad. For a better matching with the demands of the labor market, meetings with employers' representatives, business representatives, and specialty teachers from the pre-university education system have been organized. Using English brings and added value to the program, enabling the hiring of graduates by multinational companies (both abroad and in Romania).

10. Evaluation / Grading (if applicable)

Activity type	Evaluation criteria	Evaluation methods	Percentage of the final grade
10.1. Lecture	Level of mastering the domain-specific vocabulary Logical consistency Extent of correctness and completeness of knowledge Responsibility Commitment Resolution	Final written exam at the end of the semester Active participation	40% 10%
10.2. Seminar	Ability to use the knowledge Ability to apply theoretical knowledge to practical cases Responsibility Commitment Resolution	Partial written exam during the semester Independent work, homework Active participating	30% 10% 10%
10.3. Laboratory			
10.4. Project			
10.5 Minimal performance standard **Proper mastering of the basics, understanding the fundamental notions/concepts, fluent with the domain-specific vocabulary, and able to analyze and explain simple cases.**			

11. Learning outcomes

Knowledge:
The graduate documents himself/herself in relation to a given topic.
The graduate knows ways of collecting, classifying and evaluating information from various sources.
The graduate critically summarizes new and complex information in relation to a given topic.
The graduate defines concepts, understands the fundamental concepts underlying abstract thinking: axioms, theorems, proofs, structures, functions, relations, abstract data types.
The graduate knows the principles of mathematical and formal logic.
The graduate formulates observations and differentiates notions, properties and assertions from the basic disciplines of mathematics through examples and counterexamples.
The graduate knows advanced mathematical terminology, in Romanian and English.
The graduate knows the conventions of notation, symbolization and formal presentation of mathematical content.
The graduate translates various practical problems into mathematical language.
The graduate is able to express mathematical problems/theorems with practical implications in ordinary language.
The graduate knows advanced methodologies for modeling and verifying relationships between quantities.
The graduate integrates statistical knowledge with the foundations of scientific research and data analysis, in interdisciplinary and applied contexts.
The graduate demonstrates advanced knowledge of the concepts and models of analytical thinking, including logical reasoning, causal analysis, critical evaluation of information and evidence-based decision-making.
The graduate understands methods for structuring complex problems, such as SWOT analysis, decision analysis, logic modeling and systemic approaches.
The graduate knows techniques for assessing the validity and coherence of arguments, in academic and professional contexts.
The graduate understands the psychological and social mechanisms of reaction to stress and uncertainty, as well as effective adaptation strategies.
The graduate knows models of positive leadership and change management, relevant for constructively addressing challenges in teams and organizations.
The graduate knows the importance of accuracy and precision in academic and professional activities, especially in writing, analysis, research and decision-making.

Skills:
The graduate uses various computing technologies to perform analytical mathematical calculations and determine solutions to a problem in the field.
The graduate classifies the information available to him/her according to the context.
The graduate provides examples of the use of basic theoretical concepts and results when solving exercises and problems formulated in relation to the topics covered in the subjects in the curriculum.
The graduate interprets and explains graphs, tables, mathematical models, numerical or symbolic results.
Can examine and interpret relationships between variables in advanced mathematical, economic, scientific or social problems
The graduate can write reports, presentations or scientific publications that highlight and interpret the relationships between variables.
The graduate collects, processes and analyzes relevant data and information.
The graduate creates relevant graphic visualizations to support the interpretation of data.
Visualize and communicate results effectively, adapting their presentation to the target audience.
The graduate applies estimation and validation techniques for models, using specialized software tools.
Compares and selects alternative models, justifying the choice based on statistical criteria and the application context.
The graduate formulates rational and well-argued solutions, based on data, facts, and logical principles.
The graduate encourages a positive attitude in the team, contributing to maintaining a collaborative and motivating work climate.

Responsibility and autonomy:
The graduate verifies and validates the results obtained through critical analysis.
The graduate assumes responsibility for choosing the correct calculation methods.
The graduate applies effective working techniques in multidisciplinary teams.
The graduate can work autonomously or in multidisciplinary teams.
The graduate finds solutions to practical, operational or conceptual problems in a wide range of contexts. He/she assumes responsibility for the validity and accuracy of the interpretation of data and identified relationships.
Interprets and communicates the results of data processing responsibly.
Plans and autonomously conducts statistical analysis processes, assuming responsibility for the correctness and relevance of the results.
Critically evaluates the quality of data and the validity of the methods used, respecting scientific and ethical standards.
Makes independent decisions regarding the selection of statistical techniques and the interpretation of results in complex contexts.
Plans and autonomously manages data analysis processes, from defining analytical questions to communicating results.
Critically evaluates the quality of data and the validity of the methods used, assuming responsibility for the rigor and ethics of the analytical process.
Promotes the responsible use of statistical modeling, respecting ethical principles and good practices in research and analysis.
Analyzes and interprets the results of scientific research carried out responsibly.
Assumes responsibility for the quality of the analysis process, demonstrating rigor, objectivity and coherence in reasoning.
Makes autonomous decisions in complex situations, based on a critical assessment of alternatives and consequences.
Promotes analytical thinking in teams and organizations, contributing to the development of a culture of reflection and informed decision-making.

Course coordinator	Seminar/laboratory/project coordina	Head of the Department	Dean
Assoc.Prof. Drăgoi Vlad	Assoc.Prof. Drăgoi Vlad	Assoc.Prof. Popa Lorena	Prof. Nădăban Sorin

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Operator de date cu caracter personal nr.2929

SYLLABUS

1. Study Programme

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Program studied	**Mathematical modeling in science and technology**
1.8. Form of education	**Full – Time Study**

2. Course Details

2.1. Name of the discipline	**GmET4O08 Practice Project B**
2.2. Education Plan Holder	**Prof. Dr. Stoica Codruța Simona**
2.3. Assistant	**Prof. Dr. Stoica Codruța Simona**
2.4. Year of study	**2**
2.5. Semester	**2**
2.6. Type of evaluation	**C**
2.7. Discipline regime	**DT**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**2**
3.2. Class hours per week	**0**
3.3. Seminar/laboratory/project hours per week	**2**
3.4. Total hours in the curriculum	**28**
3.5. Course hours per semester	**0**
3.6. Seminar/laboratory/project hours per semester	**28**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**40**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**50**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**40**
3.4.4. Tutoring	**13**
3.4.5. Examinations	**4**

3.4.6. Other activities ...	0
3.7. Total hours of individual study	**147**
3.8. Total hours per semester	**175**
3.9. Number of credits	7

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	
4.2. Competence prerequisites	

5. Necessary conditions (where applicable)

5.1. Course conditions	
5.2. Conditions for conducting the Seminary	
5.3. Laboratory conditions	
5.4. Project implementation conditions	**Seminar room, properly equipped with a whiteboard and video projector, internet connection.**

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C1. Operating with advanced notions and methods of functional and numerical analysis C4. Designing and applying mathematical models for the analysis of phenomena and processes.**
6.2. Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own potential on a professional level, respecting rigorous and efficient work rules for the execution of complex professional tasks CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group CT3. Selecting information resources, efficient use of professional training sources, developing the capacity to correlate professional activity with the requirements of a dynamic society.**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**- Initiating the student in scientific research methods** **- The student should develop the ability to correctly apply the skills and knowledge acquired**
7.2. Specific objectives	**Presentation of results obtained in a research field chosen from mathematics** **- Writing reports on a given topic** **- Learning scientific research skills and writing a scientific paper**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
8.2 Course Bibliography		
8.3 Seminar Content	Teaching methods	Observations
8.4 Seminar Bibliography		
8.5 Laboratory Content	Teaching methods	Observations
8.6 Laboratory Bibliography		

8.7 Project Content	Teaching methods	Observations
1. Mathematics - essence and importance	Participatory lecture, debate, exposure	4 ore
2. Evolution operators in the study of differential equations	Participatory lecture, debate, presentation	6 ore
3. Recent approaches to evolution equations	Participatory lecture, debate, exposure	6 ore
4. Scientific research of excellence	Participatory lecture, debate, presentation	6 ore
5. Unsolved problems of mathematics	Participatory lecture, debate, presentation	6 ore

8.8 Project Bibliography

1. S. Salsa, A. Squellati, Dynamical Systems and Optimal Control, EGEA Spa - Bocconi University Press, 2018 2. D.A. Sanchez, Ordinary Differential Equations and Stability Theory, Courier Dover Publications, 2019 3. G. Schneider, H. Uecker, Nonlinear PDEs: A Dynamical Systems Approach, American Mathematical Society, 2017 4. C. Stoica, Uniform Asymptotic Behaviors for Skew-Evolution Semiflows on Banach Spaces, Ed. Mirton, 2010 5. J. Zabczyk, Mathematical Control Theory: An Introduction, Birkhauser, 1992 6. C. Stoica, Project Support, SUMS, 2025

9. Corroboration/validation of the content of the discipline (where applicable)

The content of the discipline is consistent with what is done in other university centers in the country and abroad.
For a better adaptation of the content of the discipline to the requirements of the labor market, meetings were held with both representatives of the business environment and with mathematics and computer science teachers from pre-university education.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight from the note final
10.1. Course			
10.2. Seminar			
10.3. Laboratory			
10.4. Design	**- correctness and completeness of knowledge; - logical coherence; - degree of assimilation of specialized language; - conscientiousness, interest in individual study. - ability to operate with the assimilated knowledge; - ability to apply in practice;**	Oral evaluation (final in the exam session): - Student's free presentation; - Evaluation conversation; Oral questionnaire. Active participation in courses. Oral assessment (final exam period): - completion of the required project - homework	30% 20% 30% 20%

10.5 Minimum performance standard

The student must demonstrate that he or she is able to document and produce a scientific paper.

11. Learning outcomes

C. The graduate: a) documents himself/herself in relation to a given topic b) knows how to collect, classify and evaluate information from various sources c) critically summarizes new and complex information in relation to a given topic A. The graduate: a) correctly interprets the information collected on a given topic b) classifies the information available according to the context c) selects the information necessary to solve a specific problem d) uses digital tools to support information synthesis. RA. The graduate: a) uses the information at his disposal coherently b) demonstrates professionalism in managing the information at his disposal c) can work autonomously or in multidisciplinary teams C. The graduate: a) defines the concepts Understands the fundamental concepts that underlie abstract thinking: axioms, theorems, demonstrations, structures, functions, relations, abstract data types b) Knows the principles of mathematical and formal logic, as well as demonstration methods c) formulates observations and differentiates notions, properties and assertions from the basic disciplines of mathematics through examples and counterexamples A. The graduate: a) provides examples of the use of basic theoretical concepts and results when solving exercises and problems formulated in relation to the topics covered in the disciplines in the curriculum. b) represents and formulates concepts and problems in abstract, symbolic or formal terms RA. The graduate: a) Demonstrates intellectual autonomy in exploring and manipulating abstract concepts b) Finds solutions to practical, operational or conceptual problems, in a wide range of contexts c) Generates argumentative procedures in support of solutions C. The graduate: a) Knows advanced mathematical terminology, in Romanian and English b) Knows the conventions of notation, symbolization and formal presentation of mathematical content c) Transposes various practical problems into mathematical language d) Is able to express mathematical problems/theorems with practical implications in ordinary language. A. The graduate: a) Writes rigorous demonstrations, logical arguments and detailed explanations, using specific language b) Develops the solution to a problem in the field using appropriate mathematical symbols, language and tools c) Interprets and explains graphs, tables, mathematical models, numerical or symbolic results RA. The graduate: a) Communicates and interprets the solution to a problem b) Compares using specific mathematical language, alternative solutions c)

Presents ideas and processes using appropriate mathematical symbols, language and tools d) Demonstrates rigor and intellectual discipline in writing and presenting one's own mathematical results

Course Coordinator	Seminar Coordinator	Head of the Department	DEAN
Prof. Stoica Codruța Simona, PhD	Prof. Stoica Codruța Simona, PhD	Assoc. Prof. Lorena Camelia Popa, PhD	Prof. Sorin-Florin NĂDĂBAN, PhD

MINISTERUL EDUCAŢIEI ȘI CERCETĂRII
UNIVERSITATEA „AUREL VLAICU“ DIN ARAD
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http://www.uav.ro; e-mail: rectorat@uav.ro
Operator de date cu caracter personal nr.2929

SYLLABUS

1. Study Programme

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master**
1.7. Specialization / Program studied	**Mathematical modeling in science and technology**
1.8. Form of education	**Full – Time Study**

2. Course Details

2.1. Name of the discipline	**GmET4O09 Elaboration of the dissertation**
2.2. Education Plan Holder	**Prof. Dr. Stoica Codruța Simona**
2.3. Assistant	**Prof. Dr. Stoica Codruța Simona**
2.4. Year of study	**2**
2.5. Semester	**2**
2.6. Type of evaluation	**C**
2.7. Discipline regime	**DT**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**5**
3.2. Class hours per week	**0**
3.3. Seminar/laboratory/project hours per week	**5**
3.4. Total hours in the curriculum	**70**
3.5. Course hours per semester	**0**
3.6. Seminar/laboratory/project hours per semester	**70**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**105**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**0**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**0**
3.4.4. Tutoring	**0**
3.4.5. Examinations	**0**

3.4.6. Other activities ...	0
3.7. Total hours of individual study	**105**
3.8. Total hours per semester	**175**
3.9. Number of credits	7

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	**Completion of the mandatory subjects provided for in the curriculum.**
4.2. Competence prerequisites	**Skills for analyzing and synthesizing knowledge in the field of the dissertation topic.**

5. Necessary conditions (where applicable)

5.1. Course conditions	
5.2. Conditions for holding the seminar	
5.3. Laboratory conditions	**The laboratories are conducted in the form of a meeting between the student and the dissertation coordinator.**
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C1. Operating with advanced notions and methods of functional and numerical analysis.** **C2. Statistical processing of data, analysis and interpretation of random phenomena and processes.** **C3. Solving problems of dynamic systems, optimal control and operational research.** **C4. Design and application of mathematical models for the analysis of phenomena and process.** **C5. Solving financial and actuarial mathematics problems.**
6.2. Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own potential on a professional level, respecting rigorous and efficient work rules for the execution of complex professional tasks** **CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group CT3. Selecting information resources, efficient use of professional training sources, developing the capacity to correlate professional activity with the requirements of a society dynamic.**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**Synthesizing the information accumulated during studies and the ability to apply it in practice in the form of a dissertation.**
7.2. Specific objectives	**1. Familiarizing students with the substantive requirements of a dissertation. 2. Guiding students in developing a work that contains a theoretical and an applied part; that is innovative, interdisciplinary and original.** **3. Monitoring the correct application of specific analysis methods in the field of the dissertation topic and compliance with the model agreed at the university level for the development of the dissertation work.**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
8.2 Course Bibliography		
8.3 Seminar Content	Teaching methods	Observations
8.4 Seminar Bibliography		
8.5 Laboratory Content	Teaching methods	Observations
Establishing the thematic universe of dissertation works.	The topics are proposed by the teachers of the Department- Mathematics Computer Science, but can be supplemented with student proposals.	Dissertation topics are posted on the noticeboard, respectively on the faculty website, until the 5th. oct.
2. Establishing the indicative title, structure and bibliography of the work as a result of the study of specialized literature	Individual work, consultations	
3. Establishing the timetable for completing the dissertation.	Individual or group discussions group	December 1
4. Discussions on how to prepare the dissertation: structure of the work, technical editing conditions of the work, use of bibliographical references, use of figures, graphs, etc.	Individual and group discussions, independent reading and consultations	
5. Discussions regarding the theoretical and methodological aspects of the paper depending on the chosen topic.	Individual discussions	March 15
6. Coordination of the applied part of the dissertation work and correct establishment of conclusions	Individual discussions, independent work	May 1
Finalization of the dissertation and anti-plagiarism check of each work	Individual discussions, independent work	June 1
8. Preparing the presentation for public support	Individual discussions, independent work	June 15
8.6 Laboratory Bibliography **In addition to the bibliography recommended by the coordinating teacher and that chosen by the student, it is recommended to consider the guide for developing dissertations, agreed at the university level http://www.uav.ro/ro/academic/finalizare-studii**		
8.7 Project Content	Teaching methods	Observations
8.8 Project Bibliography		

9. Corroboration/validation of the course contents (where applicable)

The content of the discipline is consistent with that of similar disciplines taught in university centers in the country and abroad and provides the methodological universe for students to prepare and defend their dissertation.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight of final grade

10.1. Course			
10.2. Seminar			
10.3. Laboratory	**-choosing the topic and proof of studying the appropriate specialized literature - carrying out the thesis dissertation (content plus form)**	-motivation of the chosen topic, bibliographic additions made to the bibliography proposed by the coordinator supported by a consistent synthesis of the studied material -the chosen methodology is consistent with achieving the objectives -the work is consistent and well structured -the conclusions are logical and relevant to the topic of the work -respects the model agreed at university level	30% 70%
10.4. Design			

10.5 Minimum performance standard

The paper must meet the writing requirements, the bibliographic references must be made correctly, the theoretical part must be complete and the applied part must be completed in a proportion of 75%.

11. Learning outcomes

1. Knows advanced mathematical terminology, in Romanian and English 2. Develops the solution to a problem in the field using appropriate mathematical symbols, language and tools 3. Interprets and explains graphs, tables, mathematical models, numerical or symbolic results 4. Can use statistical, mathematical or computational techniques to build and validate models involving relationships between variables. 5. Uses specialized computer tools to perform complex statistical analyses.

Course Coordinator Prof. Stoica Codruța Simona, PhD	Seminar Coordinator Prof. Stoica Codruța Simona, PhD	Head of the Department Assoc. Prof. Lorena Camelia Popa, PhD	DEAN Prof. Sorin-Florin NĂDĂBAN, PhD

SYLLABUS

1. Program Data

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master's degree**
1.7. Specialization / Study program	**Mathematical modeling in science and technology**
1.8. Form of education	**Part-time education (FI)**

2. Data about Discipline

2.1. Name of the discipline	**GmEU4A41 Special chapters in geometry**
2.2. Education Plan Holder	**Associate Professor, PhD Popa Lorena Camelia**
2.3. Assistant	**Associate Professor, PhD Popa Lorena Camelia**
2.4. Year of study	**2**
2.5. Semester	**2**
2.6. Type of evaluation	**ES**
2.7. Discipline regime	**OP**

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**
3.2. Class hours per week	**1**
3.3. Seminar/laboratory/project hours per week	**2**
3.4. Total hours in the curriculum	**42**
3.5. Course hours per semester	**14**
3.6. Seminar/laboratory/project hours per semester	**28**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**40**
3.4.2. Additional documentation in the library, on specialized electronic platforms and on the ground	**40**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**45**
3.4.4. Tutoring	**4**
3.4.5. Examinations	**4**
3.4.6. Other activities ...	**0**
3.7. Total hours of individual study	**133**

3.8. Total hours per semester	**175**
3.9. Number of credits	**7**

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	
4.2. Competence prerequisites	

5. Necessary conditions (where applicable)

5.1. Course conditions	**Writing board** **Smart board or video projector and appropriate software – Power Point, Excel, Mathcad**
5.2. Conditions for holding the seminar	
5.3. Laboratory conditions	**Room equipped with laptop, video projector and appropriate software** **Power Point, Excel, Mathcad, Internet access - accounts in the SUMS platform**
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C1. Operating with advanced notions and methods of functional and numerical analysis.** **C4. Design and application of mathematical models for the analysis of phenomena and processes.** **C5. Solving financial and actuarial mathematics problems.**
6.2. Transversal skills	**CT1. Manifesting a responsible attitude towards the scientific and didactic field, capitalizing on one's own professional potential, respecting rigorous and efficient work rules for the execution of complex professional tasks.** **CT2. Efficient coordination and management of activities organized in a team or in an interdisciplinary group.**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**- The student deepens the knowledge of geometry already acquired.** **- The student develops the skills to correctly apply the acquired knowledge to solve different classes of problems.**
7.2. Specific objectives	**- The student is able to correctly apply basic methods and principles in solving complex problems.** **- The student is able to select appropriate methods and techniques for solving geometry problems.**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
Chapter 1. Vector geometry in the space of free vectors. Geometric vectors, the space of free vectors, projections, the scalar product, the vector product and products of three vectors (mixed and double vector product). Orthonormal references in the plane and space, polar coordinates in the plane and space, semi-polar coordinates in space.	Lecture, debate, demonstration, exemplification	2 hours
Chapter 2. Analytical geometry of the plane and the line. Geometry of the plane in space, geometry of the line in the plane and of the line in space, problems related to the relative position of lines and planes and the notion of distance.	Lecture, debate, demonstration, exemplification	2 hours
Chapter 3 Second-order algebraic curves and surfaces. Second-order algebraic curves in the plane (conics), centers, reduction to canonical form, classification of conics on the general equation, unitary (geometric) definition of conics. Second-order algebraic surfaces (quadriques), study of quadrics on reduced equations, sphere. Reduction to canonical form of quadrics on general equation and their classification.	Lecture, debate, demonstration, exemplification	2 hours
Chapter 4. Differential geometry of curves. Parameterized curves. Definition of curves. Analytical methods for representing curves. Tangent line and osculating plane to a curve. Curvature of the curve. Orientation of curves. Frenet reference. Frenet formulas. Torsion.	Lecture, debate, demonstration, exemplification	2 hours

Fundamental theorems of the differential theory of curves. Singular points.		
Chapter 5. Differential geometry of surfaces. Parameterized surfaces. Analytical representations. Curves on surfaces. Special classes of surfaces. Tangent and normal to a surface. Orientation of surfaces. The fundamental operator. Bilinear forms associated with a surface. Calculation of the matrix of the fundamental operator. Normal curvature. Asymptotic curves. Principal directions. Curvature lines. Total curvature and mean curvature. Equations of motion of the natural reference point. Gauss's theorem. Fundamental theorems of the differential theory of surfaces. Geodesic curves.	Lecture, debate, demonstration, exemplification	2 hours
Chapter 6. Differential varieties and differential applications. Differential varieties-definitions: topological varieties, parametrizations, maps, atlases, coordinate transformations. Examples of differential varieties: spheres, projective spaces, tori. Differentiable applications, diffeomorphisms.	Lecture, debate, demonstration, exemplification	2 hours
Chapter 7. Tangent space on a differentiable manifold. Tangent vectors at a point of a differentiable manifold. Tangent space at a point of a differentiable manifold. Tangent map at a point associated with a differentiable map. [illegible]	Lecture, debate, demonstration, exemplification	2 hours

8.2 Course Bibliography

1. **Bar, C., Elementary Differential Geometry, Cambridge Univ. Press, 2010.**
2. **Do Carmo Manfredo, P., Differential Geometry of Curves and Surfaces: Second Edition, Dover Pub., 2016.**
3. **Popa, L., Seminar and course notes-Special chapters of geometry, SUMS.**
4. **Munteanu, MI, Differentiable Varieties - course notes, Alexandru Ioan Cuza University of Iasi, 2020.**
5. **Papuc, D., Differential Geometry, EDP, Bucharest, 1982.**
6. **Pressley, AN, Elementary Differential Geometry, Springer, 2014.**

8.3 Seminar Content	Teaching methods	Observations

8.4 Seminar Bibliography

8.5 Laboratory Content	Teaching methods	Observations
Chapter 1. Vector geometry in the space of free vectors. Geometric vectors, the space of free vectors, projections, the scalar product, the vector product and products of three vectors (mixed and double vector product). Orthonormal references in the plane and space, polar coordinates in the plane and space, semi-polar coordinates in space.		4 hours
Chapter 2. Analytical geometry of the plane and the line. Geometry of the plane in space, geometry of the line in the plane and of the line in space, problems related to the relative position of lines and planes and the notion of distance.		4 hours
Chapter 3 Second-order algebraic curves and surfaces. Second-order algebraic curves in the plane (conics), centers, reduction to canonical form, classification of conics on the general equation, unitary (geometric) definition of conics. Second-order algebraic surfaces (quadriques), study of quadrics on reduced equations, sphere. Reduction to canonical form of quadrics on general equation and their classification.		4 hours
Chapter 4. Differential geometry of curves. Parameterized curves. Definition of curves. Analytical methods for representing curves. Tangent line and osculating plane to a curve. Curvature of the curve. Orientation of curves. Frenet reference. Frenet formulas. Torsion. Fundamental theorems of the differential theory of curves. Singular points.	Exercise, discussion and debate, modeling, project	4 hours
Chapter 5. Differential geometry of surfaces. Parameterized surfaces. Analytical representations. Curves on surfaces. Special classes of surfaces. Tangent and normal to a surface. Orientation of surfaces. The fundamental operator. Bilinear forms associated with a surface. Calculation of the matrix of the fundamental operator. Normal curvature. Asymptotic curves. Principal directions. Curvature lines. Total curvature and mean curvature. Equations of motion of the natural reference point. Gauss's theorem. Fundamental theorems of the differential theory of surfaces. Geodesic curves.		4 hours
Chapter 6. Differential manifolds and differential applications. Differential manifolds-definitions: topological manifolds, parametrizations, maps, atlases, coordinate transformations. Examples of differential manifolds:		4 hours

Spheres, projective spaces, tori. Differentiable maps, diffeomorphisms.		
Chapter 7. Tangent space on a differentiable manifold. Tangent vectors at a point of a differentiable manifold. Tangent space at a point of a differentiable manifold. Tangent map at a point associated with a differentiable map.		4 hours

8.6 Laboratory Bibliography

1. **Bar, C., Elementary Differential Geometry, Cambridge Univ. Press, 2010.**
2. **Do Carmo Manfredo, P., Differential Geometry of Curves and Surfaces: Second Edition, Dover Pub., 2016.**
3. **Popa, L., Seminar and course notes-Special chapters of geometry, SUMS.**
4. **Munteanu, MI, Differentiable Varieties - course notes, Alexandru Ioan Cuza University of Iasi, 2020.**
5. **Papuc, D., Differential Geometry, EDP, Bucharest, 1982.**
6. **Pressley, AN, Elementary Differential Geometry, Springer, 2014.**

8.7 Project Content	Teaching methods	Observations

8.8 Project Bibliography

9. Corroboration/validation of the course contents (where applicable)

This course is taught in similar programs at several universities, both in the country and abroad. In order to better match the demands of the labor market, meetings were organized with representatives of employers and with specialized teachers from the pre-university education system. The use of English brings and adds value to the program, allowing the employment of graduates by multinational companies (both from abroad and from Romania).

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight of final grade
10.1. Course	**knowledge; logical coherence; acquisition of specialized language; criteria targeting attitudinal aspects: seriousness, conscientiousness, interest in the topic addressed.**	Oral assessment (final exam period): presentation of a final project. Active participation in the course	40% 10%
10.2. Seminar			
10.3. Laboratory	**the ability to operate with the acquired knowledge; the ability to apply it in practice; conscientiousness and interest in study.**	Oral assessment (final exam period): preparation and presentation of the final project. Active participation in the laboratory	40% 10%
10.4. Design			

10.5 Minimum performance standard

Using basic concepts using specialized language in solving a simple application.

11. Learning outcomes

The graduate knows and applies the appropriate methods and techniques for solving geometry problems. The graduate can apply appropriate methods for modeling and solving real-life problems, based on the acquired fundamental knowledge and principles.

Course coordinator	Seminar/laboratory/project coordinator	Head of the Department	Dean
Assoc. Prof. Lorena Camelia POPA	Assoc. Prof. Lorena Camelia POPA	Assoc.Prof. Lorena Camelia POPA	Prof.Sorin-Florin NĂDĂBAN

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SYLLABUS

1. Program Data

1.1. Higher education institution	**"AUREL VLAICU" UNIVERSITY OF ARAD**
1.2. Faculty	**of Exact Sciences**
1.3. Department	**Department of Mathematics-Informatics**
1.4. Field of study	**Mathematics**
1.5. Academic year	**2025-2026**
1.6. Study cycle	**Master's degree**
1.7. Specialization / Study program	**Mathematical modeling in science and technology**
1.8. Form of education	**Part-time education (FI)**

2. Data about Discipline

2.1. Name of the discipline	**GmEU4A42 Decision Modeling and Optimization**
2.2. Education Plan Holder	**Associate Professor, PhD Popa Lorena Camelia**
2.3. Assistant	**Associate Professor, PhD Popa Lorena Camelia**
2.4. Year of study	**2**
2.5. Semester	**2**
2.6. Type of evaluation	**ES**
2.7. Discipline regime	~~**OP**~~

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**
3.2. Class hours per week	**1**
3.3. Seminar/laboratory/project hours per week	**2**
3.4. Total hours in the curriculum	**42**
3.5. Course hours per semester	**14**
3.6. Seminar/laboratory/project hours per semester	**28**
	Time distribution [Hours]
3.4.1. Studying according to the textbook, course material, bibliography and notes	**30**
3.4.2. Additional documentation in the library, on electronic platforms specialty and on the ground	**60**
3.4.3. Preparation of seminars/laboratories, assignments, papers, portfolios and essays	**40**
3.4.4. Tutoring	**0**
3.4.5. Examinations	**3**

3.4.6. Other activities ...	**0**
3.7. Total hours of individual study	**133**
3.8. Total hours per semester	**175**
3.9. Number of credits	**7**

4. Preconditions (where applicable)

4.1. Curriculum prerequisites	**Mathematical analysis on R, Linear algebra**
4.2. Competence prerequisites	**Calculating derivatives and integrals for functions of one variable**

5. Necessary conditions (where applicable)

5.1. Course conditions	**Classroom, equipped with laptop, video projector and appropriate software – Power Point, Excel, Mathcad, Internet access-accounts in the SUMS platform**
5.2. Conditions for holding the seminar	
5.3. Laboratory conditions	**Laboratory room, equipped with laptop, video projector and appropriate software – Power Point, Excel, Mathcad, Internet access - accounts in the SUMS platform**
5.4. Project implementation conditions	

6. Specific skills acquired (where applicable)

6.1. Professional skills	**C2. Statistical processing of data, analysis and interpretation of random phenomena and processes.** **C3. Solving problems of dynamic systems, optimal control and operational research.** **C4. Design and application of mathematical models for the analysis of phenomena and processes.**
6.2. Transversal skills	**CT3. Selection of information resources, efficient use of professional training sources, development of the capacity to correlate professional activity with the requirements of a dynamic society.**

7. Discipline objectives (where applicable)

7.1. General objective of the discipline	**- solving optimization problems using analytical and computational methods - modeling and analyzing real situations through specific mathematical techniques**
7.2. Specific objectives	**- familiarizing students with the fundamental concepts specific to decision-making problems** **- developing mathematical modeling skills for practical problems. - applying multi-criteria analysis methods in complex decision-making situations.**

8. Contents (where applicable)

8.1 Course Content	Teaching methods	Observations
Chapter 1. The issue of modeling and simulating decision-making problems. Decision. Stages of the decision-making process. The importance of simulating decision-making processes, as a process through which a model of a real system is built.	interactive exposition, exemplification, problematization	1 hour
Chapter 2. Solving decision-making problems using the linear programming method. General features of a linear programming problem. Modeling the decision-making problem: identifying the objective and constraints; defining decision variables; identifying the objective function using decision variables. Solving PL problems using MS_Excel (using the Solver tool).		2 hours
Chapter 3. Modeling and optimizing multi-attribute decisions. Characteristics of multi-attribute decision problems. Expression		4 hours

multi-attribute decision problem in a matrix form, using MS-Excel. Analysis of decision-making situations using multi-attribute decision models and using mathematical functions. Normalization. Normalization methods. Criteria weights. Weighting methods (objective, subjective, aggregate) Multi-attribute decision-making methods. -MADM: Dominance method, Max-min method, Conjunctive method, Disjunctive method, TOPSIS method ("Technique for Order Preference by Similarity to Ideal Solution"), ELECTRE method ("Elimination and Choice Translating Reality"), Analytic Hierarchical Process (AHP) method		
Chapter 4. Fuzzy linear programming. Basic concepts of fuzzy logic. Fuzzy mathematical modeling. Methods for classifying fuzzy numbers. Simplex algorithm in a fuzzy context.		4 hours
Chapter 5. Multi-attribute decision-making methods in a fuzzy context. Fuzzy TOPSIS method. Fuzzy ELECTRE method. Fuzzy AHP method.		3 hours

8.2 Course Bibliography

1. S. Dinu, G.Raicu, R.Zÿgan, Modern multicriteria analysis methods in cyber security management, Ed. Nautical, Constanta 2023.
2. E. Boroÿ, D. Opriÿ, Introduction to linear optimization and applications, Ed. Facla, Timiÿoara, 1979.
3. HA Taha, Operations Research: An Introduction. Pearson, 2017.
4. F. Hillier, G. Lieberman, Introduction to Operations Research, Publisher, Edition 11, McGraw-Hill, 2024.
5. L.Popa - course support and applications - SUMS Platform, 2025.
6. Chiranjibe Jana, Madhumangal Pal, Valentina Emilia Balas, Ronald R. Yager, Picture Fuzzy Logic and Its Applications in Decision Making Problems, Elsevier, 2023, ISBN: 9780443220241, https://shop.elsevier.com/books/picture-fuzzy-logic-and-its-applications-in-decision-makingproblems/jana/978-0-443-22024-1

8.3 Seminar Content	Teaching methods	Observations

8.4 Seminar Bibliography

8.5 Laboratory Content	Teaching methods	Observations
Practical modeling and optimization problems. Examples.	Case study, discussions and debate, modeling, exercise, project.	2 hours
Linear programming.		4 hours
Modeling and optimizing multi-attribute decisions.		8 hours
Fuzzy linear programming.		8 hours
Multi-attribute decision-making methods in fuzzy context.		6 hours

8.6 Laboratory Bibliography

1. L.Popa - course support and applications - SUMS Platform, 2025.
2. S. Dinu, G. Raicu, R. Zÿgan, Modern multicriteria analysis methods in cyber security management, Ed. Nautical, Constanta 2023.
3. F. Hillier, G. Lieberman, Introduction to Operations Research, Publisher, Edition 11, McGraw-Hill, 2024.
4. L. POPA, A new ranking method for trapezoidal intuitionistic fuzzy numbers and its application to multi-criteria decision making, International Journal of Computers Communications & Control, 18(2), 5118, 2023.
5. L. POPA, Centroid-Induced Ranking of Triangular Picture Fuzzy Numbers and Applications in Decision-Making, Symmetry, 16 (11), 1492, 2024.

8.7 Project Content	Teaching methods	Observations

8.8 Project Bibliography

9. Corroboration/validation of the content of the discipline (where applicable)

The content of the discipline is in line with what is done in other university centers in the country and abroad. For a better adaptation of the content of the discipline to the requirements of the labor market, meetings were held with both representatives of the business environment and with teaching staff from the Mathematics-Informatics department.

10. Evaluation (where applicable)

Activity type	Evaluation criteria	Evaluation methods	Weight from the final grade
10.1. Course	**- correctness and completeness of knowledge; - logical coherence; - degree of assimilation of specialized language; - criteria targeting attitudinal aspects: conscientiousness, interest in individual study.**	Summative assessment 20% Active participation in courses 10%	30%
10.2. Seminar			
10.3. Laboratory	**- the ability to operate with the acquired knowledge; - the ability to apply it in practice; - criteria targeting attitudinal aspects: conscientiousness, interest in individual and team study.**	Team/individual project /Written paper - summative assessment 60% Active participation in laboratories 10%	70%
10.4. Design			

10.5 Minimum performance standard
Knowledge of the fundamental elements of theory, solving a simple application.

11. Learning outcomes

The graduate: - is able to mathematically model some concrete problems and apply optimization methods - understands the optimization of resource allocation in the prototype development process - is familiar with the decision-making process based on feedback and multi-attribute analysis - interprets the results and formulates recommendations for making optimal decisions

Holder	Assistant	Head of the Department	DEAN
Associate Professor, PhD Lorena Camelia Popa	Associate Professor, PhD Lorena Camelia Popa	Associate Professor, PhD Lorena Camelia Popa	Prof. PhD Sorin-Florin NADABAN