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| O imagine care conține siglă, simbol, Font, Grafică  Descriere generată automat | MINISTERUL EDUCAŢIEI **UNIVERSITATEA „AUREL VLAICU“ DIN ARAD**310130 Arad, B-dul Revolutiei nr. 77, P.O. BOX 2/158 AR *Tel.: 0040-257- 283010; fax. 0040-257- 280070*  [http://www.uav.ro](http://www.uav-arad.go.ro)*;* e-mail: rectorat@uav.ro |

**Operator de date cu caracter personal nr. 2929**

**SYLLABUS**

1. **Study programme**

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| 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 | **2024-2025** |
| 1.6. Ciclul de studii | **Bachelor** |
| 1.7. Study programme / Qualification | **Mathematics informatics** |
| 1.8. Form of education | **Full – Time study** |

1. **Course details**

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| 2.1. Name of the course | **Functional Analysis 1** |
| 2.2. Course coordinator | **Gașpar Octavian-Păstorel, Ph. D.** |
| 2.3. Seminar/laboratory/project coordinator | **Gașpar Octavian-Păstorel, Ph. D.** |
| 2.4. Study year | **3** |
| 2.5. Semester | **1** |
| 2.6. Evaluation type | **summative** |
| 2.7. Course type | **compulsory** |

1. **Estimated total time (hours per semester)**

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| 3.1. Hours per week | **4** |
| 3.2. Lecture hours per week | **2** |
| 3.3. Seminar/laboratory/project hours per week | **2** |
| 3.4. Total hours per curriculum | **56** |
| 3.5. Lecture hours per semester | **28** |
| 3.6. Seminar/laboratory/project hours per semester | **28** |
| Time division [hrs] | |
| 3.4.1. Independent study from textbooks, course support, bibliography and notes | **25** |
| 3.4.2. Additional reading (libraries, specialized electronic platforms and field research) | **15** |
| 3.4.3. Preparing of seminars/laboratories/projects, homework, papers, portfolios and essays | **25** |
| 3.4.4. Tutorial coaching | **0** |
| 3.4.5. Examinations | **4** |
| 3.4.6. Other activities | **0** |
| 3.7. Total individual study hours | **69** |
| 3.8. Total hours per semester | **125** |
| 3.9. Number of ECTS credits | **5** |

1. **Prerequisites** (if applicable)

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| 4.1. Curriculum related | Calculus in R and R^n;  Real and complex Analyisis |
| 4.2. Competence related | C1. Working with mathematical concepts and methods.  CT3. Efficient use of information, communication resources and assisted education both in romanian and in an internationally widespread language. |

1. **Conditions** (if applicable)

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| 5.1. for the lecture | **Lecture room with black (or white) board and beamer** |
| 5.2. for the seminar | **Seminar room with black (or white) board and beamer** |
| 5.3. for the laboratory |  |
| 5.4. for the project |  |

1. **Specific educational objectives (competences to be acquired)**

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| 6.1. Competenţe profesionale | **C1.** Working with mathematical concepts and methods.  **C2.** Mathematical processing of data, analysis of phenomena and processes.  **C4.** Conceiving models for describing phenomena. |
| 6.2. Competenţe transversale | **CT1.** Applying the rules of organized and efficient work, of responsibie attitudes towards teaching-scientific field, to value the own creative potential, while respecting the principles and norms of professional ethics.  **CT3.** Efficient use of information, communication resources and assisted education both in romanian and in an internationally widespread language. |

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

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| 7.1. General outcomes | **Using of theoretical fundaments of mathematics and of formal models** |
| 7.2. Specific outcomes | 1. **Knowing the analytical structure of Banach spaces and duality concepts** 2. **Assimilating fundamental principles from operator theory on Banach and Hilbert spaces and spectral theory** 3. **Gaining abstract reasoning ability with respect to the analyis and geometry of Hilbert spaces** 4. **Applying basic priciples of duality and operator theory to certain functional models** |

1. **Outline** (if applicable)

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| 8.1 Lecture Outline | Teaching methods | Remarks |
| 1. Complementary notions of set theory and general topology: Odreder sets and the Zorn Lemma; Abstract topological spaces; Open, closed sets, neighbouhoods; Closure adn interior of a set, boundary sets; Separation axioms, separability, Baire’s theorem; Metric spaces, completion. | Interactive presentation. Exemplification | 6 hrs |
| 2. Linear space: linear subspaces; Hamel basis; Complementary subspaces; Linear operators and linear functionals; the algebraic dual. | Interactive presentation. Exemplification | 4 hrs |
| 3. Normed spaces: Norm, semi-norm, sublinear functionals; Normed and Banach spaces; Subspaces; Extending linear functionals – The Hahn-Banach theorem; Linear operators on normed spaces; the operator norm. | Interactive presentation. Exemplification | 4 hrs |
| 4. Principles of functional anaysis: Open mapping theorem; Closed graph theorem; Uniform bpundedness principle; Banach-Steinhaus theorem | Interactive presentation. Exemplification | 4 hrs |
| 5. Hilbert spaces: Inner product and Hilbert spaces; Orthogonality and orthonormal systems; Linear and continuous functionals – the Riesz representation; Linear, bounded operators and the Hilbert space adjoint; Fourier coefficients and the Gram-Schmidt orthogonalization. | Interactive presentation. Exemplification | 6 hrs |
| 6. Spectral theory: special classes of Hilbert space operators; Spectrum and resolvent set; spectra of certain classes of operators. | Interactive presentation. Exemplification | 4 hrs |
| 8.2 Lecture References  1. D. Farenick, Fundamentals of Functional Analysis, Springer International Publishing, 2016.  2. D. Gaspar, P. Gașpar : Analiză funcțională, ediția a 2-a, Editura de Vest, Timișoara, 2009.  3. C. Goffman, G. Pedrick : First Course in Functional Analysis, Prentice Hall, 1965.  4. W. Rudin : Functional Analysis, 2nd edition, McGraw-Hill, 1991.  5. V. Sunder : Functional Analysis. Spectral Theory, Birkhäuser, 1997 | | |

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| 8.3 Seminar Outline | Teaching methods | Remarks |
| 1. Complementary notions of set theory and general topology: Odreder sets and the Zorn Lemma; Abstract topological spaces; Open, closed sets, neighbouhoods; Closure adn interior of a set, boundary sets; Separation axioms, separability, Baire’s theorem; Metric spaces, completion. | Interactive presentation. Exemplification | 6 hrs |
| 2. Linear space: linear subspaces; Hamel basis; Complementary subspaces; Linear operators and linear functionals; the algebraic dual. | Interactive presentation. Exemplification | 4 hrs |
| 3. Normed spaces: Norm, semi-norm, sublinear functionals; Normed and Banach spaces; Subspaces; Extending linear functionals – The Hahn-Banach theorem; Linear operators on normed spaces; the operator norm. | Interactive presentation. Exemplification | 4 hrs |
| 4. Principles of functional anaysis: Open mapping theorem; Closed graph theorem; Uniform bpundedness principle; Banach-Steinhaus theorem | Interactive presentation. Exemplification | 4 hrs |
| 5. Hilbert spaces: Inner product and Hilbert spaces; Orthogonality and orthonormal systems; Linear and continuous functionals – the Riesz representation; Linear, bounded operators and the Hilbert space adjoint; Fourier coefficients and the Gram-Schmidt orthogonalization. | Interactive presentation. Exemplification | 6 hrs |
| 6. Spectral theory: special classes of Hilbert space operators; Spectrum and resolvent set; spectra of certain classes of operators. | Interactive presentation. Exemplification | 4 hrs |
| 8.4 Seminar References  1. D. Farenick, Fundamentals of Functional Analysis, Springer International Publishing, 2016.  2. D. Gaspar, P. Gașpar : Analiză funcțională, ediția a 2-a, Editura de Vest, Timișoara, 2009.  3. C. Goffman, G. Pedrick : First Course in Functional Analysis, Prentice Hall, 1965.  4. W. Rudin : Functional Analysis, 2nd edition, McGraw-Hill, 1991.  5. V. Sunder : Functional Analysis. Spectral Theory, Birkhäuser, 1997 | | |
| 8.5 Laboratory Outline | Teaching methods | Remarks |
| 8.6 Laboratory Outline | | |
| 8.7 Project Outline | Teaching methods | Remarks |
| 8.8 Project Outline | | |

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

**The contents of the course is according to the ones in other similar universities both inland and abroad. For a better tailoring to the needs of the labor market, meetings were held with both business and education representatives.**

1. **Evaluation / Grading** (if applicable)

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| Activity type | Evaluation criteria | Evaluation methods | Percentage of the final grade |
| 10.1. Lecture | * **Correctness and completion of gained knowledge;** * **Logical coherence;** * **Degree of assimilation of specific terms.**   **Criteria concerning attitude aspects: thoroughness, interst for individual study** | Oral evaluation  Active participations at lectures | 30%  5% |
| 10.2.  Seminar | * **Capacity of operating with gained notions;** * **Capacity of practical application.**   **Criteria concerning attitude aspects: thoroughness, interst for individual study** | Regular homework assignments  Written exam (within the exam session)  Active participation at seminars | 25%  35%  5% |
| 10.3.  Laboratory |  |  |  |
| 10.4. Project |  |  |  |
| 10.5 Minimal performance standard  **Knowing fundamental notions, logical coherence in presentation, solving an easy exercise** | | | |

Course coordinator

Conf. univ. Dr. Octavian-Pastorel GASPAR

Seminar/laboratory/project coordinator

Conf.uinv. Dr. Octavian-Pastorel GASPAR

Head of the Department

Lect.univ.dr. Lorena Camelia POPA

Dean

Prof.univ.dr. Sorin-Florin NĂDĂBAN