Appendix No. 1.5 to the Resolution No. 7/2023

 of the Rector of the University of Rzeszów

**SYLLABUS**

**regarding the qualification cycle FROM 2024TO 2025**

1. Basic Course/Module Information

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| --- | --- |
| Course/Module title | REAL ANALYSIS |
| Course/Module code \* |  |
| Faculty (name of the unit offering the field of study) | *College of Natural Sciences* |
| Name of the unit running the course | *Institute of Mathematics* |
| Field of study | Mathematics |
| Qualification level  | Second degree |
| Profile | *Academic* |
| Study mode | *Full-time* |
| Year and semester of studies | *1 Year, 2 semester* |
| Course type | *Basic* |
| Language of instruction | English |
| Coordinator | Ewa Rak, PhD |
| Course instructor | *Svetlana Mincheva-Kamińska, PhD* |

\* - as agreed at the faculty

1.1.Learning format – number of hours and ECTS credits

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Semester(n0.) | Lectures | Classes | Colloquia | Lab classes | Seminars | Practical classes | Internships | others | **ECTS credits**  |
| 2 |  | 30 |  |  |  |  |  |  | 5 |

1.2. Course delivery methods

☒ conducted in a traditional way

☒ involving distance education methods and techniques

1.3. Course/Module assessment (exam, pass with a grade, pass without a grade)

Exam

2. Prerequisites

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| BASIC KNOWLEDGE OF CALCULUS, INTRODUCTION TO LOGIC AND SET THEORY, TOPOLOGY. |

3. Objectives, Learning Outcomes, Course Content, and Instructional Methods

3.1. Course/Module objectives

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| --- | --- |
| O1 | Presentation and assimilation by students of issues concerning: theory of space with measure; measurable functions; convergence in spaces with measure; integration theory of any measure. |
| O2 | Equipping students with the necessary tools for further mathematical education in the field of probability theory. |
| O3 | Equipping students with the necessary tools for further mathematical education in the field of functional analysis. |

3.2. Course/Module Learning Outcomes (to be completed by the coordinator)

|  |  |  |
| --- | --- | --- |
| Learning Outcome | The description of the learning outcome defined for the course/module | Relation to the degree programme outcomes |
| LO\_01 | The student has in-depth knowledge of real analysis, knows its most important theorems and knows how to place this knowledge in the development of mathematics. | K\_W01; K\_W03:  |
| LO\_02 | The student knows the basic methods of proof appropriate for real analysis. | K\_W05  |
| LO\_o3 | The student strengthens the role and importance of mathematical reasoning, knows the formal structure of real analysis. | K\_W02  |
| LO\_o4 | The student is able to construct mathematical reasoning in the field of real analysis, prove theorems and refute hypotheses through appropriate constructions and selection of counter-examples, he can check the correctness of inferences. | K\_U01; K\_U02  |
| LO\_o5 | The student knows the construction of the Lebesgue measure and integral, and their application in other theoretical and practical issues. | K\_U04 |
| LO\_o6 | The student knows how to use the literature on real analysis in English in the process of self-education. | K\_U19:  |
| LO\_o7 | The student is able to work in a team, formulate questions regarding real analysis, understands the need for continuous self-education. | K\_K01; K\_K02; K\_K03  |

**3.3. Course content (to be completed by the coordinator)**

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| Content outline  |
| Repetitory of algebra of sets, power theory, topology of metric spaces.Ring, σ-ring, field, σ-field, multiplicative and monotonic families -tasks. |
| Borel sets. Non-negative measure - tasks. Examination of finiteness, σ-finiteness and completeness of measures. External measure - tasks. |
| Caratheodory's theorem and its application for determining measurable sets in the Caratheodory sense.The Lebesgue external measure and Lebesgue measure - tasks. Measurable and non-measurable sets in the Lebesgue sense. |
| Measurable and Borel functions - tasks. |
| Examination of convergence of functional sequences (convergence everywhere, almost everywhere, uniform and by measure). |
| Calculation of integrals from characteristic and non-negative functions by any measure.Calculation of integrals from non-negative measurable functions by any measure. Application of Lebesgue theorem on monotonic convergence to calculate integrals.Calculation of real and complex integrals. Integrable functions in the sense of Riemann and Lebesgue - tasks.Product measure - tasks. Calculation of integrals in the Cartesian product. |

3.4. Methods of Instruction

e.g.

*Lecture: a problem-solving lecture/a lecture supported by a multimedia presentation/ distance learning*

*Classes: text analysis and discussion/project work (research project, implementation project, practical project)/ group work (problem solving, case study, discussion)/didactic games/ distance learning*

*Laboratory classes: designing and conducting experiments*

tutorials: working in groups and individual - task solving and proving theorems.

4. Assessment techniques and criteria

4.1 Methods of evaluating learning outcomes

|  |  |  |
| --- | --- | --- |
| Learning outcome | Methods of assessment of learning outcomes (e.g. test, oral exam, written exam, project, report, observation during classes) | Learning format (lectures, classes,…) |
| LO\_01 | oral exam | class |
| LO\_02 | oral exam, observation during classes | class |
| LO\_o3 | oral exam, discussion | class |
| LO\_o4 | oral exam | class |
| LO\_o5 | oral exam, observation during classes | class |
| LO\_o6 | oral exam, discussion | class |
| LO\_o7 | oral exam, discussion | class |

4.2 Course assessment criteria

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| --- |
| students are Assessed regularly solving tasks writing.The examination of students' knowledge in an oral form.Grading score: Denote by S the total number of points, then:[0,50%S] – 2.0 (F)(50%S,60%S] - 3.0 (E)(61%S,70%S] - 3.5 (D)(71%S,80%S] - 4.0 (C)(81%S,90%S] - 4.5 (B)(91%S,100%S] - 5.0 (A) |

5. Total student workload needed to achieve the intended learning outcomes

– number of hours and ECTS credits

|  |  |
| --- | --- |
| Activity | Number of hours |
| Scheduled course contact hours | 30 (10+20) |
| Non-contact hours - student's own work (preparation for classes or examinations, projects, etc.) | 95 |
| Total number of hours | 125 |
| Total number of ECTS credits | 5 ECTS |

\* One ECTS point corresponds to 25-30 hours of total student workload

6. Internships related to the course/module

|  |  |
| --- | --- |
| Number of hours |  |
| Internship regulations and procedures |  |

7. Instructional materials

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| Compulsory literature:1. W. Rudin, Real and complex analysis, McGraw-Hill, New. York, 1966. xi+412 pp.2. P. R. Halmos, Measure Theory, Van Nostrand Reinhold, New York 1950.3. A. E. Taylor, General Theory of Functions and Integration, Dover Publ INC, New York 1985. |
| Complementary literature: 1. A. G. Aksoy, m. a. Khamsi, A problem book in a real analysis, springer 2010.
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Approved by the Head of the Department or an authorised person