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. |

Approved by the Head of the Department or an authorised person