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 | Calculus III and IV |
| 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  | First degree |
| Profile | *Academic* |
| Study mode | *Full-time* |
| Year and semester of studies | *2 Year, 1 and 2 semester* |
| Course type | *Basic* |
| Language of instruction | English |
| Coordinator | Ewa Rak, PhD |
| Course instructor | *Mirosława Zima, PhD, DSc* |

\* - 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**  |
| 1 |  | 30 |  |  |  |  |  |  | 5 |
| 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)

1st semester Exam

2nd semester Exam

2. Prerequisites

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|  Calculus I and II |

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

3.1. Course/Module objectives

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| --- | --- |
| O1 | To familiarize students with two and three dimensional space, set, vectors and metrics in a spaces. Definition of functions of several variables, implicit functions, vector functions.  |
| O2 | To familiarize students with definitions of limit and continuity, partial derivatives, derivative of implicit and vector functions. Gradient. |
| O3 | To familiarize students with the Taylor theorem, relative and absolute maxima and minima. Hessian. |
| O4 | To familiarize students with Multiple integrals, change of variables, polar, cylindrical and spherical integrals, techniques of integrations, numerical methods of integrations and applications.  |
| O5 | To familiarize students with parametrization of lines and surfaces, line and surface integrals, methods of integrations, Greene and Stokes theorems, and applications to mathematics and physical sciences. |
| O6 | To familiarize students with differential equations, separable equation, linear equations, ODEs with constant coefficients, systems of equations, applications, PDEs. |

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 | expands the knowledge and improves the competence in the field of differential calculus and its applications;  | K\_K01; K\_K02; K\_K03 |
| LO\_02 | can correctly formulate definitions and theorems in the field of differential calculus of the functions of several variables and use them to study the properties of functions of several variables; determining extremes and calculating approximate values of the functions; | K\_U05;K\_U02;K\_U01 |
| LO\_o3 | knows basic concepts and theorems of the differential function of several variables, proof technique and examples; | K\_W01; K\_W03 |
| LO\_04 | understands basic differences between differential calculus of functions of one and several variables; | K\_W04;K\_W02 |
| LO\_05 | expands the knowledge in the field of integral calculus and its applications; | K\_K01; K\_K02; K\_K03 |
| LO\_06 | can calculate multiple, line and surface integrals by use the appropriate theorems; | K\_U01; K\_U02 |
| LO\_07 | can use integral calculus of several variables in the geometrical and physical problems: for calculating the surface area of ​​the figure, the volume of solids; knows methods of integrations, Greene and Stokes theorems; | K\_U01; K\_U02; K\_U06;K\_W04;K\_W02;K\_W01;K\_W03  |
| LO\_08 | knows the basic concepts of differential equations, separable equation, linear equations, ODEs with constant coefficients, systems of equations, applications; PDEs. | K\_W01; K\_W02; K\_W03; K\_W04; K\_W07; K\_U01; K\_K01; K\_K02 |
| LO\_09 | knows the limitations of his own knowledge and own abilities; understands the need for further education; independently searches in the literature and on the Internet for information on calculus. | K\_K01; K\_K02; K\_K03;  |

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

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| --- |
| Content outline  |
| Description of two and three dimensional space, set, vectors and metrics in a spaces. Finding properties of functions of several variables, implicit functions, vector functions. Calculating limits and checking continuity functions of several variables. |
| Computations of partial derivatives, derivative of implicit and vector functions and gradient. Computation of Jacobian and Hessian. Expanding a function in the Taylor series, approximation using series. Seeking for the relative and absolute maxima and minima. |
| The calculation of multiple integrals. Change of variables, polar, cylindrical and spherical integrals, techniques of integrations. Calculations of the area of the surface, moments, etc. Calculations of the integrals numerically.  |
| Parametrization of lines and surfaces. Calculation of the line and surface integrals. Considering different methods of integrations; Greene and Stokes theorems. Applications to mathematics and physical sciences. |
| Solving differential equations, separable equation, linear equations, ODEs with constant coefficients, systems of equations. Applications of ODEs in several technical problems. Solving PDEs.  |

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; Distance learning.

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 | test, observation during classes | class |
| LO\_02 | test, observation during classes | class |
| LO\_03 | test, observation during classes | class |
| LO\_o4 | test, observation during classes | class |
| LO\_05 | test, exam, observation during classes | class |
| LO\_06 | test, exam, observation during classes | class |
| LO\_07 | test, exam, observation during classes | class |
| LO\_08 | test, exam, observation during classes | class |
| LO\_09 | observation during classes | class |

4.2 Course assessment criteria

|  |
| --- |
| students are Assessed regularly solving tasks writing.The examination of students' knowledge in an oral form.Grading score:  3.0 for 50 - 60%, 3.5 for 61 - 70 %, 4.0 for 71 – 80%, 4.5 for 81 – 90%; 5.0 for 91 – 100 % |

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 | 60 (30+30) |
| Non-contact hours - student's own work (preparation for classes or examinations, projects, etc.) | 140 (70+70) |
| Total number of hours | 200 (100+100) |
| Total number of ECTS credits | 10 (5+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:Vladimir A. Zorich, The Differential Calculus of Functions of Several Variables, in: Mathematical Analysis I, Universitext, Springer, Berlin-Heidelberg, 2015.1. David Perkinson, Differential Calculus of Several Variables, San Francisco, California, USA 2008.
2. C. H. Edwards Jr., Advanced Calculus of Several Variables , Dover Books on Mathematics, Academic Press, New York 1973.
3. Jeffrey R. Chasnov, Introduction to Differential Equations, Lecture notes for MATH 2351/2352.
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| Complementary literature: 1. Serge Lang, Calculus of several variables, Springer 1991.
2. Wendell Fleming, Functions of Several Variables, Springer 1977.
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Approved by the Head of the Department or an authorised person