KARSHI
STATE
UNIVERSITY

MINISTRY OF HIGHER EDUCATION, SCIENCE AND

INNOVATIONS OF THE REPUBLIC OF UZBEKISTAN

KARSHI STATE UNIVERSITY

MODULE HANDBOOK

Field of Knowledge: 500000 – Natural sciences, mathematics and statistics
Field of Education: 540000 – Mathematics and statistics
Field of Study: 70540101 – Mathematics

Module designation	*1. GN1206, Homology theory*
Semester(s) in which the module is taught	*2*
Person is responsible for the module	*Abdimajid Khurramov*
Language	*Uzbek language*
Relation to curriculum	*Mandatory.*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 6 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Credits* *Credit* *1. 6(1+1+4)* *6*
Required and recommended prerequisites for joining the module	*1. "The course on 'Homology Theory' in Abstract Algebra is logically closely related to the following subjects: Mathematical Analysis, Abstract Algebra, Fundamentals of Topology, and Differential Equations."*
Module objectives/intended learning outcomes	*1. "Purpose of the discipline — Homology is one of the important branches of mathematics, whose main objective is to study the structure of various mathematical objects, their equivalence relations, and invariants. This field is used in the analysis and solution of problems in algebra, topology, geometry, and physics."*
	2.
Content	*1.1. Introduction.* *1.2. Linear spaces.* *1.3. Euclidean spaces.* *1.4. Group theory.* *1.5. Normal and quotient (factor) groups.* *1.6. Abstract Algebra* *1.7 Homomorphism.* *1.8 Isomorphism.* *1.9 Covering.* *1.10 Simplicial homology* *1.11 Triangulation.* *1.12 Chain complex*
Examination forms	*Paper examination*
Study and examination requirements	*It is necessary to fully master the theoretical and methodological concepts of the subject, be able to accurately reflect the results of the analysis, conduct independent observations of the processes being studied, and complete the tasks and assignments given in the forms of current and intermediate control, and submit a test or written work for final control.*
Reading list	*1. Narmanov A.Ya. Vvedeniyu v teoriyu gomologii. Konspekt leksii. UzMU, 2024 g.*

	2.T.N.Fomenko. Elementi teorii gomologiy. Konspekt leksiy. MGU, 2018 g. *3. V.V.Prisolov. Elementi teorii gomologiy. M., Nauka,2006 g.* *4. L.S.Pontryagin. Osnovi kombinatornoy topologii. M.URSS,2004 g.* *5. A.Donald. Leksii po algebraicheskoy topologii. M.,Mir.1976 g.* *6. M.M.Postnikov.Leksii po algebraicheskoy topologii. M., Nauka, 2006 g.* *7. M.E.Kazaryan. Vvedeniye v teoriyu gomologiy. Moskva, MIAN, 2006 g.*

Module designation	*TTJ2304, Branching random processes*
Semester(s) in which the module is taught	*3-Semester*
Person is responsible for the module	*Imomov A`zam Abduraximovich*
Language	*Uzbek language*
Relation to curriculum	*Elective science*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 6 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Credits Cr ECTS* *1. 6(2+4) 6 2*
Required and recommended prerequisites for joining the module	Probability Theory,Calculus Linear Algebra, Stochastic Processes Mathematical Statistics Programming Skills
Module objectives/intended learning outcomes	*This module provides a solid understanding of branching random processes, focusing on their mathematical and statistical representation. It equips students with the skills to analyze these processes in real-world systems and simulate them computationally. Students will be able to understand key concepts and terminology, analyze simple branching models, interpret results in practical contexts, and perform computational simulations of branching processes*
	2.
Content	**Topics included in the course:** 1. Discrete-Time Branching Processes: Definition and Key Concepts (2 hours) 2. Generating Functions and Moments (2 hours) 3. Classification of States. Structure of the Galton-Watson Process (2 hours) 4. Probability of Process Continuation. Critical Processes (2 hours) 5. Probability of Continuation for Subcritical Processes (2 hours) 6. Limit Theorems (2 hours) 7. Immigrated Galton-Watson Processes: Definition and Structure (2 hours) 8. Generating Function and Moments of the Immigrated Galton-Watson Process (2 hours)

	9. Limit Theorems for the Immigrated Galton-Watson Process (6 hours) 10. Continuous-Time Markov Branching Processes: Definition and Key Concepts (4 hours) 11. Generating Functions and Classification of States (2 hours) 12 Probability of Process Continuation and Limit Theorems (2 hours)
Examination forms	*Paper examination*
Study and examination Requirements	*It is necessary to fully master the theoretical and methodological concepts of the subject, be able to accurately reflect the results of the analysis, conduct independent observations of the processes being studied, and complete the tasks and assignments given in the forms of current and intermediate control, and submit a test or written work for final control.*
Reading list	1.Blitzstein, J. K., & Hwang, J. *Introduction to Probability.* CRC Press, 2019. 2.DeGroot, M. H., & Schervish, M. J. *Probability and Statistics (5th Edition).* Pearson, 2018. 3.Wasserman, L. *All of Statistics: A Concise Course in Statistical Inference.* Springer, 2020 edition. 4. Grimmett, G., & Stirzaker, D. *Probability and Random Processes (4th Edition).* Oxford University Press, 2020. 5.Rice, J. A. *Mathematical Statistics and Data Analysis (3rd Edition).* Cengage Learning, 2018 edition 6. Borovkov A.A. «Teoriya veroyatnostey», «Lan», 2010 g. Str.705. 7.Robert B. Basic probability theory. Dover Publications, Inc.2008. 8.Vatutin V.A. Vetvyaщiesya protsessы i ix primeneniya. Moskva. MIAN. Vыpusk 8. 2008. 9.Vatutin V.A. Vetvyaщiesya protsessы i ix primeneniya. Moskva. MIAN. 2008.Vыpusk 12. 2009. 10.Vatutin V. A., Zubkov A. M. Vetvyaщiesya protsessы. I // Itogi nauki i texniki. Seriya «Teoriya veroyatnostey.

	Matematicheskaya statistika. Teoreticheskaya kibernetika». — M: VINITI, 1985. — T. 23. — S. 3–67. 11. Sevastyanov B.A. Vetvyaщiesya protsessы, Nauka, M., 1971. 12. Athreya K.B., Ney P. Branching processes, Springer-Verlag, New-York-Heidelberg, 1972.

Module designation	MFZU 1206**,** Modern Methods of Mathematical Physics
Semester(s) in which the module is taught	*1 semester*
Person is responsible for the module	*Yangiboyev Zoyir*
Language	*Uzbek language*
Relation to curriculum	*Elective Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Total Credits: 6* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Ordinary Differential Equations* • *Partial Differential Equations* • *Mathematical Analysis* • *Theory of Functions of a Complex Variable* • *Functional analysis*
Module objectives/intended learning outcomes	• *Educational and regulatory documents of a specialized subject teacher;* • *Credit-module system in teaching specialized subjects;* • *Knowledge assessment technology;* • *Information technologies in teaching specialized subjects;* • *Methodology of forming mathematical concepts;* • *Mathematical modeling and problem-based learning (PBL);* • *Pedagogical skills and "Micro-teaching" (Practical module).*
	1.
Content	• *Elements of functional spaces;* • *Trigonometric Fourier series;* • *Multiple Fourier series;* • *Fourier transforms;* • *The concept of generalized derivative;* • *Space of test functions (Space of fundamental functions);* • *Space of generalized functions (Space of distributions);* • *Derivative and integral of generalized functions;* • *Differential operators with constant coefficients;* • *Fundamental problems of mathematical physics*
Examination forms	*Paper examination*
Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets*

	and independent study tasks, at a high academic standard • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	1. *Wolter A.Stranss. Partial Differential Equations; An introduction. Birkhhauzer. Germany, 2005.* 2. *Davia D.Bleecker, George Csordes. Basic of Partial Differential Equations. Birkhhauzer. Germany, 2009.* 3. *Vladimirov V.S., Jarinov V.V. Uravneniya matematicheskoy fiziki. Uchebnik dlya VUZov. -M.: FIZMATLIT. 2004.* 4. *Vladimirov V.S., i dr. Sbornik zadach po uravneniyam matematicheskoy fiziki. -M.: FIZMATLIT. 2004. – 286 s.* 5. *Qosimov Sh.G‘., Aliqulov T.N., Otayev Sh.Q. Matematik fizikaning zamonaviy usullari. O‘quv qo‘llanma. Toshkent. 2016 y.* 6. *D.Q. Durdiyev. Xususiy hosilali differensial tenglamalar. Buxoro. 2019 y*

Module designation	TMLT2204 "Limit theorems for random variables"
Semester(s) in which the module is taught	*2*
Person is responsible for the module	*Imomov Azam Abduraximovich*
Language	*Uzbek language*
Relation to curriculum	*Elective science*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 5 ECTS (120 hours):* *Lectures: 30hours* *Practical training 30hours* *Self-Study and Independent Learning: 60 hours*
Credit points	*Credits Cr ECTS* *1. 4 4 2*
Required and recommended prerequisites for joining the module	*1 is pre-requisite for 5* *Algebra* *Analytical geometry* *Mathematical analysis* *Elements of combinatorics* *Mathematical Logic*
Module objectives/intended learning outcomes	*1. Active verb: What will be done/produced* *The aim of teaching this subject is to develop in master's students a theoretical probabilistic intuition, that is, the ability to construct and analyze mathematical models that reflect random events occurring in real statistical experiments; limit theorems for random variables constitute a broad field of study and serve as an important conceptual tool in scientific research, and their wide application in financial mathematics and insurance problems increases interest in the subject and demonstrates the necessity of studying it.*
	2.
Content	***1.*** *Sample space of elementary events. Axioms of probability theory. Properties of probability.* ***2.*** *Definitions and examples. Events defined by random variables. Properties of distribution functions.* ***3.*** *Probability density functions and their properties. Independence of random variables and events.* ***4.*** *Sequence of Bernoulli random variables. Law of large numbers.* ***5.*** *Local limit theorem. Moivre–Laplace theorem.* ***6.*** *Theorems on approximating the binomial distribution by the Poisson distribution.*

	7. *Convergence of random variables. Convergence of distributions.* ***8.*** *Weak dependence conditions for sequences of random variables; definitions, types, and classification of weak dependence.* ***9.*** *Sequence of independent random variables. Law of large numbers.* ***10.*** *Law of large numbers for a series of independent random variables.* ***11*** *Central limit theorem for sequences of independent and identically distributed random variables.* ***12*** *Strong law of large numbers.* ***13*** *Central limit theorem for sums of identically distributed random variables.* ***14*** *Central limit theorems under the Lindeberg condition.* ***15*** *Berry–Esseen inequality.*
Examination forms	*Paper examination*
Study and examination requirements	*It is necessary to fully master the theoretical and methodological concepts of the subject, be able to accurately reflect the results of the analysis, conduct independent observations of the processes being studied, and complete the tasks and assignments given in the forms of current and intermediate control, and submit a test or written work for final control.*
Reading list	*1.Borovkov A.A. «Teoriya veroyatnostey», «Lan», 2010 g. Str.705.* *2. Shiryaev A.N. «Veroyatnost» , M. str. 581.* *3. Formanov Sh.Q. "Ehtimolliklar nazariyasi", T.2014y.268 b.* *4. Robert B. Basic probability theory. Dover Publications, Inc.2008.* *5. Chistyakov V.P. Kurs teorii veroyatnostey. – Moskva: «Nauka», 2003 g.* *6.O'zbekiston Respublikasi oliy ta'limtizimini 2030 yilgacha rivojlantirish konsepsiyasi. O'zbekiston Respublikasi Prezidentining 2019 yil 8 oktabrdagiPF-5847-sonFarmoni.* *7.Mirziyoyev Sh.M. Tanqidiy tahlil, qat'iy tartib-intizom va shaxsiy javobgarlik – har bir rahbar faoliyatining kundalik qoidasi bo'lishi kerak. T.: "O'zbekiston" NMIU, 2017. 104 b.*

Module designation	*2.* O'IN1106, Theory of Measure and Integration
Semester(s) in which the module is taught	*1 semester*
Person is responsible for the module	*Khamrayev Akhror*
Language	*Uzbek language*
Relation to curriculum	*Elective Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Total Credits: 6* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Mathematical Analysis* • *Linear Algebra and Analytic Geometry* • *Functional analysis* • *Theory of functions of a complex variable*
Module objectives/intended learning outcomes	• *Upon successful completion of this module, students will be able to:* • *Explain fundamental concepts of measure theory, including σ-algebras, measures, and measurable spaces* • *Construct and analyze Lebesgue measure and its key properties* • *Apply methods for extending measures and work with measurable and non-measurable sets* • *Define and investigate measurable functions and their main properties* • *Distinguish and analyze different types of convergence (almost everywhere, in measure, uniform)* • *Develop and evaluate the Lebesgue integral and apply its main properties* • *Apply major convergence theorems, including the Monotone Convergence Theorem and Dominated Convergence Theorem* • *Compare Lebesgue and Riemann integrals and justify the advantages of the Lebesgue approach* • *Apply product measures and use Fubini's theorem in solving multidimensional integration problems* • *Demonstrate strong analytical thinking and rigorous mathematical reasoning*
	2.
Content	• *Sets and Mappings* • *Systems of Sets* • *Lebesgue Measure in the Plane* • *General Definition of Measure* • *Extension of Measures* • *Lebesgue Extension Scheme* • *Non-measurable Sets* • *Measurable Functions* • *Types of Convergence*

	• *Convergence in Measure* • *Simple Functions and Measurability Criteria* • *General Definition of the Lebesgue Integral* • *Limit Theorems under the Lebesgue Integral* • *Lebesgue Integral on Sets of Infinite Measure* • *Product Measures*
Examination forms	*Paper examination*
Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets and independent study tasks, at a high academic standard* • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	1. *Barbara D. Macluer. Elementary Functional analysis. Springer. 2009.* 2. *J.I. Abdullaev, R.N. G'anixo'jayev va b. Funksional analiz, Toshkent – Samarqand, 2009.* 3. *Sh. A. Ayupov va b. Funksional analizdan misol va masalalar, Nukus "Bilim", 2009* 4. *J.I.Abdullayev, R.N.G`anixo`jayev, M.H.Shermatov, O.I.Egamberdiyev "Funksional analiz va integral tenglamalar" Universitetlarning zika-matematika fakulteti talabalari uchun darslik. Toshkent. "EL PRESS", 2013. 458 b* 5. *Cohn, D.L.* Measure Theory. *Birkhäuser, 2013.* 6. *Tao, T.* An Introduction to Measure Theory. *American Mathematical Society, 2011.* 7. *Sarimsoqov T. A. Haqiqiy o'zgaruvchili funksiyalar nazariyasi. T.: «O'qituvchi», 1986.*

Module designation	*3.* MFTM2304, Inverse Problems of Mathematical Physics
Semester(s) in which the module is taught	*1 semester*
Person is responsible for the module	*Yangiboyev Zoyir*
Language	*Uzbek language*
Relation to curriculum	*Elective Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Total Credits: 6* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Ordinary Differential Equations* • *Partial Differential Equations* • *Mathematical Analysis* • *Theory of Functions of a Complex Variable* • *Functional analysis*
Module objectives/intended learning outcomes	• *Direct and inverse problems of mathematical physics;* • *Inverse problems for ordinary differential equations;* • *Inverse problems for linear differential equations and systems;* • *Linear inverse problems for partial differential equations;* • *Determining the coefficients of hyperbolic equations;* • *Inverse problems for equations of parabolic type;* • *A problem on finding functions based on integral values*; • *Inverse problem for the Laplace equation. Inverse problems for potential theory.*
	3.
Content	• *Introduction to the fundamental concepts of direct and inverse problems of mathematical physics*; • *Studying the formulation of direct and inverse problems and information regarding their solutions*; • *Learning methods for solving ill-posed problems*; • *Inverse problems for ordinary differential equations and equations of mathematical physics*; • *Constructing mathematical models of various processes using differential equations*; • *Studying methods for finding solutions to inverse problems of mathematical physics in functional spaces*; • *Theoretical analysis of the solutions to inverse problems of mathematical physics based on their formulations*; • *Studying inverse problems formulated using modern methods of mathematical physics*;
Examination forms	*Paper examination*

Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets and independent study tasks, at a high academic standard* • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	1. *Lavrentyev M.M., Romanov V.G., Shishatskiy S.P. Nekorrektniye zadachi matematicheskoy fiziki i analiza AN SSSR, Sib.otd-niye, VS .— M. : Nauka, 1980 .— 286 s.* 2. *Lavrentyev M.M., Romanov V.G., Vasilyev V.G. «Mnogomerniye obratniye zadachi dlya differensialnix uravneniy», Novosibirsk: Nauka, 1969.* 3. *Lavrentyev M.M., Savelyev L.Y. «Lineyniye operatori i nekorrektniye zadachi», Novosibirsk: Nauka, 1994.* 4. *Romanov V.G. «Obratniye zadachi matematicheskoy fiziki AN SSSR, Sib. otd-niye, VS .— M. : Nauka, 1984 .— 263 s. : il. — Bibliogr.:s.246-261.* 5. *Saloxiddinov, M, Matematik fizika tenglamalar: darslik \ M.Saloxiddinov-Toshkent; Uzbekiston, 2022*

Module designation	BFON1106, Operator theory in Banach spaces
Semester(s) in which the module is taught	*1 semester*
Person is responsible for the module	*Nodirov Shohruh*
Language	*Uzbek language*
Relation to curriculum	*Compulsory (Core) Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Total Credits: 6* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Mathematical Analysis* • *Linear Algebra and Analytic Geometry* • *Functional analysis* • *Theory of functions of a complex variable*
Module objectives/intended learning outcomes	*Upon successful completion of this module, students will be able to:* • *Solve advanced theoretical and applied problems in operator theory on Banach spaces, demonstrating a comprehensive understanding of linear operators and their properties* • *Analyze the structure of Banach spaces and the behavior of bounded and unbounded linear operators acting on them* • *Establish rigorous connections between fundamental concepts such as normed spaces, completeness, compactness, and operator spectra* • *Construct and present mathematically rigorous proofs of key theorems in operator theory, as well as develop analogous generalizations* • *Apply advanced methods of functional analysis, including spectral theory and compact operator techniques, to solve complex problems* • *Select and justify appropriate analytical tools and methods for investigating problems in both pure and applied contexts* • *Interpret and evaluate abstract operator-theoretic results with a high level of mathematical rigor and logical consistency* • *Demonstrate advanced competencies in independent research, critical thinking, and abstract mathematical reasoning in the context of Banach space theory*
	4.
Content	• *Normed Linear Spaces and Banach Spaces* • *Hilbert Spaces and Orthonormal Systems (Bessel's Inequality)* • *Linear Bounded Operators and Operator Norm*

	• *Linear Functionals and Dual Spaces* • *Spaces of Bounded Linear Operators* • *Types of Operator Convergence: Uniform, Strong, and Weak* • *Inverse Operators and the Banach Inverse Operator Theorem* • *Reflexivity of Banach Spaces* • *Adjoint Operators*
Examination forms	*Paper examination*
Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets and independent study tasks, at a high academic standard* • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	8. *Barbara D. Macluer. Elementary Functional analysis. Springer. 2009.* 9. *J.I. Abdullaev, R.N. G'anixo'jayev va b. Funksional analiz, Toshkent – Samarqand, 2009.* 10. *Sh. A. Ayupov va b. Funksional analizdan misol va masalalar, Nukus "Bilim", 2009* 11. *J.I.Abdullayev, R.N.G`anixo`jayev, M.H.Shermatov, O.I.Egamberdiyev "Funksional analiz va integral tenglamalar" Universitetlarning zika-matematika fakulteti talabalari uchun darslik. Toshkent. "EL PRESS", 2013. 458 b* 12. *Brayman, W., Chaikovskyi, I. Functional Analysis and Operator Theory. Springer, 2024.* 13. *Vaidyanathan, P. Functional Analysis: A Modern Approach. Cambridge University Press, 2023.* 14. *Malafosse, B., Malkowsky, E., Rakočević, V. Operators Between Sequence Spaces and Applications. Springer, 2021.*

Module designation	*4.* DDS2304, Discrete dynamic systems
Semester(s) in which the module is taught	*3 semester*
Person is responsible for the module	*Khamrayev Ahror*
Language	*Uzbek language*
Relation to curriculum	*Compulsory (Core) Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Total Credits: 4* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Mathematical Analysis* • *Linear Algebra and Analytic Geometry* • *Functional analysis* • *Theory of functions of a complex variable*
Module objectives/intended learning outcomes	*Upon successful completion of this module, students will be able to:* • *Solve advanced theoretical and applied problems in operator theory on Banach spaces, demonstrating a comprehensive understanding of linear operators and their properties* • *Analyze the structure of Banach spaces and the behavior of bounded and unbounded linear operators acting on them* • *Establish rigorous connections between fundamental concepts such as normed spaces, completeness, compactness, and operator spectra* • *Construct and present mathematically rigorous proofs of key theorems in operator theory, as well as develop analogous generalizations* • *Apply advanced methods of functional analysis, including spectral theory and compact operator techniques, to solve complex problems* • *Select and justify appropriate analytical tools and methods for investigating problems in both pure and applied contexts* • *Interpret and evaluate abstract operator-theoretic results with a high level of mathematical rigor and logical consistency* • *Demonstrate advanced competencies in independent research, critical thinking, and abstract mathematical reasoning in the context of Banach space theory*
	5.
Content	• *Normed Linear Spaces and Banach Spaces* • *Hilbert Spaces and Orthonormal Systems (Bessel's Inequality)* • *Linear Bounded Operators and Operator Norm*

	• *Linear Functionals and Dual Spaces* • *Spaces of Bounded Linear Operators* • *Types of Operator Convergence: Uniform, Strong, and Weak* • *Inverse Operators and the Banach Inverse Operator Theorem* • *Reflexivity of Banach Spaces* • *Adjoint Operators*
Examination forms	*Paper examination*
Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets and independent study tasks, at a high academic standard* • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	15. *Barbara D. Macluer. Elementary Functional analysis. Springer. 2009.* 16. *J.I. Abdullaev, R.N. G'anixo'jayev va b. Funksional analiz, Toshkent – Samarqand, 2009.* 17. *Sh. A. Ayupov va b. Funksional analizdan misol va masalalar, Nukus "Bilim", 2009* 18. *J.I.Abdullayev, R.N.G`anixo`jayev, M.H.Shermatov, O.I.Egamberdiyev "Funksional analiz va integral tenglamalar" Universitetlarning zika-matematika fakulteti talabalari uchun darslik. Toshkent. "EL PRESS", 2013. 458 b* 19. *Brayman, W., Chaikovskyi, I. Functional Analysis and Operator Theory. Springer, 2024.* 20. *Vaidyanathan, P. Functional Analysis: A Modern Approach. Cambridge University Press, 2023.* 21. *Malafosse, B., Malkowsky, E., Rakočević, V. Operators Between Sequence Spaces and Applications. Springer, 2021.*

Module designation	*ILTM1106, Scientific Research Methods*
Semester(s) in which the module is taught	*1*
Person is responsible for the module	*Boymurodov Sanjar Bekmurodovich*
Language	*Uzbek language*
Relation to curriculum	*Compulsory*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog*
Workload (incl. contact hours, self-study hours)	*120 hours* *Practical training 60 hours* *Self-Study and Independent Learning: 60 hours*
Credit points	*4 (2+2)*
Required and recommended prerequisites for joining the module	Philosophy Psychology History Political Science Sociology
Module objectives/intended learning outcomes	*Reinforces students understanding of research methods and Enhances students ability to conduct systematic research*
Content	1 Covers fundamental theoretical concepts in the field 2 Provides students with a solid theoretical foundation 3 Introduses key theories ans principles relevant to the subject 4 Focuses on the development of critical understanding of theories Multiple choice Questions ,Short answers questions , essay questions , practical assignments , oral presentation Project work.
Examination forms	*Paper examination*
Study and examination requirements	1. If detailed and complete answers are provided for all questions – 5

	2. If answers are provided for all questions (some of them partially) or complete answers are given for 2/3 of the questions – 4 (Good) 3. If answers are given to some of the questions or partial answers are provided for 2/3 of the questions – 4. If no answers are provided or the answers do not correspond to the questions – 2
Media Employed	1 Power Point Presentations with Slides 2Video lectures /tutorials 3.Online databases Science direct google scholar 4.SAurvery tools online questionary google forms 5.interactive simulations 6.Podcasts Webinars
Reading list	1. Davronov Z.D. Scientific research methodology. –T.:TMI, 2006. 267 p. 2. Soifnazarov I.S. NikitchenkoG.V. Scientific creativity methodology.–T.:TIU, 2004. 365 p. 3. Shermuhamedova N.A. Scientific research methodology.–T.:Information technologies. 2014. 450 p. 4. Shermuhamedova N.A. Scientific research methodology.-T.:Science and information technologies. 2014. 450 p. 5. Murray N. Pothbard Praxeoloey as a method of social sciences originally from phenomenology and social seionoos. Maurice Nathanson ed. (Evanston. U.: Northwestern Universite Press. 1973). Great Britain: Edward Elgar, 1977.

Module designation	OSNM2204, Spectral Theory of Operators
Semester(s) in which the module is taught	*2 semestr (cridet 6)*
Person is responsible for the module	*Nodirov Shohruh*
Language	*Uzbek language*
Relation to curriculum	*Compulsory (Core) Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (120 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 60 hours*
Credit points	*Total Credits: 4* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Mathematical Analysis* • *Linear Algebra and Analytic Geometry* • *Functional analysis* • *Theory of functions of a complex variable*
Module objectives/intended learning outcomes	*Upon successful completion of this module, students will be able to:* • *Solve advanced theoretical and applied problems in operator theory on Banach spaces, demonstrating a comprehensive understanding of linear operators and their properties* • *Analyze the structure of Banach spaces and the behavior of bounded and unbounded linear operators acting on them* • *Establish rigorous connections between fundamental concepts such as normed spaces, completeness, compactness, and operator spectra* • *Construct and present mathematically rigorous proofs of key theorems in operator theory, as well as develop analogous generalizations* • *Apply advanced methods of functional analysis, including spectral theory and compact operator techniques, to solve complex problems* • *Select and justify appropriate analytical tools and methods for investigating problems in both pure and applied contexts* • *Interpret and evaluate abstract operator-theoretic results with a high level of mathematical rigor and logical consistency* • *Demonstrate advanced competencies in independent research, critical thinking, and abstract mathematical reasoning in the context of Banach space theory*
	6.
Content	• *Normed Linear Spaces and Banach Spaces* • *Hilbert Spaces and Orthonormal Systems (Bessel's Inequality)* • *Linear Bounded Operators and Operator Norm*

	• *Linear Functionals and Dual Spaces* • *Spaces of Bounded Linear Operators* • *Types of Operator Convergence: Uniform, Strong, and Weak* • *Inverse Operators and the Banach Inverse Operator Theorem* • *Reflexivity of Banach Spaces* • *Adjoint Operators*
Examination forms	*Paper examination*
Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets and independent study tasks, at a high academic standard* • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	22. *Barbara D. Macluer. Elementary Functional analysis. Springer. 2009.* 23. *J.I. Abdullaev, R.N. G'anixo'jayev va b. Funksional analiz, Toshkent – Samarqand, 2009.* 24. *Sh. A. Ayupov va b. Funksional analizdan misol va masalalar, Nukus "Bilim", 2009* 25. *J.I.Abdullayev, R.N.G`anixo`jayev, M.H.Shermatov, O.I.Egamberdiyev "Funksional analiz va integral tenglamalar" Universitetlarning zika-matematika fakulteti talabalari uchun darslik. Toshkent. "EL PRESS", 2013. 458 b* 26. *Brayman, W., Chaikovskyi, I. Functional Analysis and Operator Theory. Springer, 2024.* 27. *Vaidyanathan, P. Functional Analysis: A Modern Approach. Cambridge University Press, 2023.* 28. *Malafosse, B., Malkowsky, E., Rakočević, V. Operators Between Sequence Spaces and Applications. Springer, 2021.*

Module designation	MFOM1106, Methodology of Teaching Specialized Subjects
Semester(s) in which the module is taught	*1 semestr (cridet 6)*
Person is responsible for the module	*Yangiboyev Zoyir*
Language	*Uzbek language*
Relation to curriculum	*Elective Course*
Teaching methods	*Lecture, discussion, problem solving, quizzes, peer-feedback, practice, dialog.*
Workload (incl. contact hours, self-study hours)	*Workload for 1 ECTS (180 hours):* *Lectures: 30 hours* *Practical training 30 hours* *Self-Study and Independent Learning: 120 hours*
Credit points	*Total Credits: 6* *ECTS: 1*
Required and recommended prerequisites for joining the module	• *Ordinary Differential Equations* • *Partial Differential Equations* • *Mathematical Analysis* • *Theory of Functions of a Complex Variable* • *Functional analysis*
Module objectives/intended learning outcomes	• *Direct and inverse problems of mathematical physics;* • *Inverse problems for ordinary differential equations;* • *Inverse problems for linear differential equations and systems;* • *Linear inverse problems for partial differential equations;* • *Determining the coefficients of hyperbolic equations;* • *Inverse problems for equations of parabolic type;* • *A problem on finding functions based on integral values*; • *Inverse problem for the Laplace equation. Inverse problems for potential theory.*
	7.
Content	• *Introduction to the fundamental concepts of direct and inverse problems of mathematical physics*; • *Studying the formulation of direct and inverse problems and information regarding their solutions*; • *Learning methods for solving ill-posed problems*; • *Inverse problems for ordinary differential equations and equations of mathematical physics*; • *Constructing mathematical models of various processes using differential equations*; • *Studying methods for finding solutions to inverse problems of mathematical physics in functional spaces*; • *Theoretical analysis of the solutions to inverse problems of mathematical physics based on their formulations*; • *Studying inverse problems formulated using modern methods of mathematical physics*;
Examination forms	*Paper examination*

Study and examination requirements	*Students are required to:* • *Attend lectures and practical sessions regularly and actively participate in advanced discussions and problem-solving activities* • *Demonstrate a deep understanding of theoretical concepts and the ability to apply advanced methods in solving complex problems* • *Complete all coursework assignments, including problem sets and independent study tasks, at a high academic standard* • *Successfully complete midterm assessments and demonstrate consistent academic progress* • *Achieve the minimum required score in continuous assessment to be admitted to the final examination* • *Demonstrate the ability to analyze, interpret, and rigorously justify mathematical results* • *Pass the final written examination by demonstrating advanced theoretical knowledge, independent thinking, and problem-solving skills*
Reading list	6. *Lavrentyev M.M., Romanov V.G., Shishatskiy S.P. Nekorrektniye zadachi matematicheskoy fiziki i analiza AN SSSR, Sib.otd-niye, VS .— M. : Nauka, 1980 .— 286 s.* 7. *Lavrentyev M.M., Romanov V.G., Vasilyev V.G. «Mnogomerniye obratniye zadachi dlya differensialnix uravneniy», Novosibirsk: Nauka, 1969.* 8. *Lavrentyev M.M., Savelyev L.Y. «Lineyniye operatori i nekorrektniye zadachi», Novosibirsk: Nauka, 1994.* 9. *Romanov V.G. «Obratniye zadachi matematicheskoy fiziki AN SSSR, Sib. otd-niye, VS .— M. : Nauka, 1984 .— 263 s. : il. — Bibliogr.:s.246-261.* 10. *Saloxiddinov, M, Matematik fizika tenglamalar: darslik \ M.Saloxiddinov-Toshkent; Uzbekiston, 2022*