NAO «L.N. GUMILYOV EURASIAN NATIONAL UNIVERSITY»

**Module Handbook**
**Educational program**
**7M05401- Mathematics**

**Nur-Sultan**
**2022**

**Module 1**

| | |
|---|---|
| Module code and name | EDUC 52003 Higher School Pedagogy |
| Semester(s) in which the module is taught | 2 |
| Persons responsible for the module | Kalkeeva K.R |
| Language of instruction | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (university component). |
| Credit points | 4 ECTS |
| Type of teaching, contact hours | Total workload: 120 hours. Lectures: 15 hours, practical: 22 hours, independent work of students: 83 hours. |
| Workload | Traditional. Active and interactive teaching methods |
| Requirements according to the examination regulations | Methods of studying private methods", Technologies of teaching at the university. |
| Recommended prerequisites | The development of professional and pedagogical thinking of teachers, the formation of scientific and pedagogical knowledge and skills necessary both for teaching and for improving general professional competence and pedagogical culture. |
| Module objectives/intended learning outcomes | The proposed course is aimed at familiarizing undergraduates with scientific and pedagogical approaches in the organization of the pedagogical process, as well as with the principles of pedagogical activity carried out in the system of vocational education. The sphere of professional pedagogical activity of a teacher is: - higher educational institutions; - colleges and other educational institutions; - organizations and enterprises whose activities are related to various aspects of teaching. The presented discipline assumes the creation of pedagogical conditions that ensure the development of the pedagogical position of masters, the formation of which determines the manifestation of the subjective characteristics of the teacher's personality in the system of professional education. |
| Content | Matrix test |
| Study and examination requirements and forms of examination | Visiting the MOE platform. The study of materials offered on the basis of the MOE and PLATONUS, timely completion of tasks and according to the test schedule to pass tests on the main course and SRO. |
| Media employed | Recording a video lecture accompanied by slides and movies. The study and feedback is carried out on the basis of the MOE and PLATONUS. |
| Reading list | 1. Akhmetova G.K., Isaeva Z.A. Pedagogy: Textbook for master's degree of universities. – Almaty: Kazakh University, 2018 – 328 p. 2. Pedagogical technologies: a textbook for students of pedagogical specialties / edited by V. S. Kukushin. — Rostov n/A: March, 2017. — 320 p. 3. Pedagogy of higher school: Textbook / Okolelov O.P. – M.:SIC INFRA-M, 2017. – 176 p. 4.Pedagogy of higher school: Textbook / K.R.Kalkeeva et al. – Astana-Master PO LLP, 2017. – 253 p. 5. Pedagogy of higher school: textbook / Sholpakulova G. K., Kalkeeva K.R., Nur-Sultan, 2021 -288 |

**Module 2**

| | |
|---|---|
| Module code and name | PSYC 52004 Management psychology |
| Semester(s) in which the module is taught | 1 |
| Persons responsible for the module | Mambetalina |
| Language of instruction | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (university component). |
| Credit points | 4 ECTS |

| | |
|---|---|
| Type of teaching, contact hours | Total workload: 120 hours. Lectures: 15 hours, practical: 22 hours, independent work of students: 83 hours. |
| Workload | Group work. Problematic discussion. Search method. Construction. Essay. Situational modeling. Text analysis. Creative writing. |
| Recommended prerequisites | Psychology, Rukhani zhangyru. |
| Module objectives/intended learning outcomes | Objectives: to teach undergraduates the management basics that ensure the preservation of a certain structure, organized systems; maintaining the regime of management activities, program implementation and management goals in professional activities. Expected learning outcomes: To know: the essence of the subject management psychology; basic theories and concepts of management psychology in modern domestic and foreign science; methodological and technological features of management in the professional sphere. Skills: be able to: analyze the processes of managerial activity; identify psychological management schemes; develop management schemes taking into account psychological patterns; determine the features of psychological interaction in management to possess: modern methods of socio-psychological analysis and diagnostics of the content and forms of managerial activity; methods of implementation of basic management approaches in the field of public procurement. |
| Content | Introduction to Management psychology. The personality of the manager. Management styles, delegation, and the business career of a manager. Psychology of staff motivation. Socialization of personality as a social phenomenon. Characteristics of the process of adaptation of the subordinate to the conditions of the organization. The system of regulation of behavior and activity of the individual in the organization. Communication as a social phenomenon. Features of managerial communication. Communication of the manager with subordinates as information exchange, interaction and impact. Problems of interpersonal perception in managerial communication. Features of communication of the head in a modern organization. Social organization as an object of management. Psychology of conflict management in the activities of the head. Social intelligence in the activities of the head. The health of the manager. Prevention and overcoming of stresses and life crises. |
| Study and examination requirements and forms of examination | It is necessary to participate in all types of control: current, intermediate, final, control of independent work of students. According to the discipline, the final score is determined, which consists of the results of the rating control and the exam, with 60% of the rating control, 40% of the exam result. The exam must score at least 50% to successfully complete the course. |
| Media employed | Recording a video lecture accompanied by slides and movies. The study and feedback is carried out on the basis of the MOE and PLATONUS. |
| Reading list | 1. Bazarov, T.Y. Psychology of personnel management: Textbook and workshop for academic undergraduate / T.Y. Bazarov. - Lyubertsy: Yurayt, 2016. - 381 p.<br>2. Kozlov, V.V. Psychology of management: Textbook / V.V. Kozlov. - M.: Academy, 2016. - 240 p.<br>3. Maltseva Yu. A., Yatsenko O. Yu. Psychology of management. Yekaterinburg : Ural Publishing House. un-ta, 2016.— 92 p.<br>4. Litvak, M.E. To command or obey? Psychology of management / M.E. Litvak. - Ph.D.: Phoenix, 2018. - 384 p.<br>5. Konovalenko, V. A. Psychology of personnel management: textbook for academic bachelor's degree / V. A. Konovalenko, M. Yu. Konovalenko, A. A. Solomatin. — M.: Yurayt Publishing House, 2015. — 477 p. — (Series: Bachelor. Academic course). |

| | |
|---|---|
| | 6. Bazarov T.Y. Psychology of personnel management: textbook and workshop for academic bachelor's degree.2015, Publishing House Yurayt M. - 381 p.<br>7. Kozlov, V.V. Psychology of management / V.V. Kozlov. - M.: Academia, 2017. - 48 p.<br>8. Konovalenko, V.A. Psychology of personnel management: Textbook for academic |

**Module 3**

| | |
|---|---|
| Module code and name | MATH53005 Methods of functional analysis |
| Semester(s) in which the module is taught | Semester 1 |
| Persons responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language of instruction | Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points | 8 ECTS |
| Type of teaching, contact hours | Traditional. Active and interactive teaching methods |
| Workload | Total workload: 240 hours. Lectures: 45 hours, practical: 30 hours, independent work of students: 165 hours. |
| Requirements according to the examination regulations | Formation of theoretical and practical knowledge in functional analysis, development of skills development and execution of scientific experiments.<br>Perform all kinds of work (participation in lectures, active work at seminars, perform SIW, to hand in all kinds of control etc.) provided by the module, the positive rating for the exam. |
| Recommended prerequisites | Mathematical Analysis III |
| Module objectives/intended learning outcomes | To master theoretical knowledge on the theory of metric, linear, normalized, Euclidean, Hilbert spaces, be able to analyse, prove, draw conclusions and apply the knowledge gained in research work. To be able to prove theorems and solve problems |
| Content | Discipline "Methods of functional analysis" is aimed at studying the basic methods of functional analysis. The subject of studing are the general theory of infinite-dimensional metric spaces, linear normed spaces, Euclidean, Hilbert spaces, functionals and operators on them; the theory of measure and integration in general spaces with measure, the establishment of generalizing connections between different branches of mathematics. In the process of learning, students should master the basic methods of functional analysis and acquire skills in research and problem solving. |
| Study and examination requirements and forms of examination | combined exam |
| Media employed | Syllabus, educational guide, computer, projector, interactive whiteboard |
| Reading list | 1. Kolmogorov A.N., Fomin S.V. Elements of the theory of function and functional analysis. M.: Science, 2008.<br>2. Trenogin V.A. Functional analysis, Moscow: FIZMATLIT, 2002.<br>3. R.A. Adams. Sobolev spaces // Pure and applied mathematics. -Vol. 65. Academic Press., New York-London 2005, 268pp. |

**Module 4**

| | |
|---|---|
| Course code and name | MATH53006 Application of Trigonometric Fourier series and Fourier transform in information compression problems |
| Semester(s) when the course is taught | 1 |

| | |
|---|---|
| Persons responsible for the module | N.T. Tleukhanova,<br>G.K.Mussabayeva<br>A.A. Jumabayeva |
| Language of instruction | Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 8 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 240<br>Lectures 45 / Practical training 30 / Self-study hours 165 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis III. |
| Module objectives/intended learning outcomes | The discipline is aimed at studying the basic properties of trigonometric series and Fourier transforms of functions from various functional spaces and their applications in information technology. Using the filtration properties of the Fourier transform, the construction of operators for compression and restoration of 2D and 3D video information is considered. |
| Content of the course | Discipline "Trigonometric Fourier series and Fourier transforms" is a subject aimed at teaching important methods of harmonic analysis. The object of learning is orthogonal series, trigonometric Fourier series, properties, Dirichlet derivative, Fayer summit, sufficient conditions of convergence. In addition, Fourier series complex types and multiple trigonometric Fourier series are studied. In the process of learning, master students should master the trigonometric Fourier series and acquire skills in research and problem solving. |
| Examination forms | combined exam |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1.Trenogin VA Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002.<br>2. H. Triebel Function Spaces. Basel; Boston: Birkhäuser Verlag, 2010 (in Russian).<br>3.G. K. Mussabayeva, N. T. Tleukhanova/Bochkarev inequality for the Fourier transform of functions in the Lorentz spaces L2,r(R)/ EurasianMath. J., 2015, V6, N1, p. 76–84. http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=9176 |

**Module 5**

| | |
|---|---|
| Course code and name | MATH 52105 Integrability and summability of orthogonal series |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | Bokayev N.A. |
| Language of instruction | Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 8 ECTS |

| | |
|---|---|
| Teaching methods | Classical teaching method: lecturing and solving problems in the classroom. |
| Workload (incl. contact hours, self-study hours) | Total workload: 240 hours.<br>Lectures: 45 hours, practical: 30 hours, independent work of students: 165 hours. |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis |
| Module objectives/intended learning outcomes | Mastering by students the necessary mathematical apparatus of orthogonal series, which helps to analyze, model and solve applied problems using modern technologies. / Mastering the apparatus of orthogonal series by students, the ability to analyze and apply the knowledge gained to solve problems of mathematical modeling. |
| Content of the course | The course covers the following areas of mathematics: Orthogonal systems: trigonometric system, Walsh system, multiplicative systems, trigonometric series, Walsh series, series over multiplicative systems, generalized monotone sequences, integrability of orthogonal series, summability of orthogonal series by the Fejér method and the Abel-Poisson method . |
| Examination forms | verbal |
| Study and examination requirements | Mandatory attendance by students of all classes according to the schedule; Preliminary preparation for classes; Timely completion and submission of SROs; Preparation for all types of classes should be independent, creative; Active work and manifestation of creativity during classes; Participation in all types of control; Commitment to the University's Academic Integrity Policy. |
| Technical and electronic learning tools | Interactive whiteboard, interactive whiteboard projector, computer. |
| Reading list | 1. Bari N.K. trigonometric series. M.: Fizmatgiz, 1961 – 960p.<br>2. Zygmund A. Trigonometric series. M.: Mir, 1965 -520p.<br>3. Kashin B.S., Sahakyan A.A. Orthogonal series . M.: Nauka, 2015 - 315p.<br>4. Edwards R. Fourier series in modern presentation. M.: Mir, 1985. T. 1-2, 530p. |

**Module 6**

| | |
|---|---|
| Course code and name | MATH 53008 The theory of groups |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language of instruction | Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 8 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |
| Workload (incl. contact hours, self-study hours) | Total workload: 240 hours.<br>Lectures: 45 hours, practical: 30 hours, independent work of students: 165 hours. |
| Required and recommended prerequisites for joining the course | No |
| Module objectives/intended learning outcomes | To acquaint with the basic concepts and classical facts and results of group theory, the development of methods for solving problems on this theory.<br>As a result of the course, students will know the basic definitions and statements of group theory, be able to prove the main results and solve problems in the discipline. |

| | |
|---|---|
| Content of the course | Groups. Subgroups. Cyclic groups. Homomorphism and isomorphism of groups. Kernel and image of a homomorphism. normal subgroups. Factor-group. Theorems on group homomorphisms. The action of a group on a set. p-groups. Sylow's theorems. Solvable and simple groups. External, internal direct product of groups. Decomposable groups. Free groups. Specifying a group by generators and defining relations. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |
| Reading list | 1. Gorodentsev A.P. Algebra, textbook for mathematics students, Part 1, 2013. - 485 p.<br>2. Kurosh A.G. - Theory of groups - Publishing house "Fizmatlit" - 2011 - 808s. - ISBN: 978-5-9221-1349-6<br>3. Lyapin E.S., Aizenshtat A.Ya., Lesokhin M.M. - Exercises on group theory - Publishing house "Lan" - 2010 - 272s. - ISBN: 978-5-8114-1015-6. |

**Module 7**

| | |
|---|---|
| Module code and name | MATH53009 The basic computational aggregates of numerical analysis |
| Semester(s) in which the discipline is taught | 1 |
| Persons responsible for the module(s) | N. Temirgaliyev, N. Nauryzbaev, G. Taugynbaeva, A. Zh. Zhubanysheva |
| Language of instruction | Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit scores (by discipline) | 8 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, self-employment hours) contact hours | Total workload: 240 hours.<br>Lectures: 45 hours, practical: 30 hours, independent work of students: 165 hours. |
| Required and recommended prerequisites for attaching to the module | Mathematical analysis, Theory of functions of a real variable (Real analysis), Functional analysis, Mathematical physics |
| The purpose of the discipline / expected learning outcomes | Acquaintance with the main computational aggregates of approximation theory and their applications in solving specific problems of approximation theory in the context of International Mathematics |
| The content of the discipline | Widths as formulations of various optimization problems of approximation theory, the most important examples of functionals and operators, the structure of sets of computational aggregates, the informative possibilities of the set of all polynomials with respect to a given system of linearly independent functions, computational aggregates constructed by the trigonometric Fourier coefficients of the function, from the values of the function at points, from the Radon transform, for all kinds of linear functionals and non-linear functionals (not for all) |
| Exam Forms | Oral exam |
| Tuition and Exam Requirements | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |

| | |
|---|---|
| Технические и электронные средства обучения | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e[Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series. ], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2 Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV [Electronic edition. IThMandSC], Astana, 1-259(2012).<br>3. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. (postojanno dopolnjaemyj po novym rezul'tatam i sootvetstvenno po novym i utochnjaemym postanovkam zadach – iz-za laviny rezul'tatov poslednih let vse vremja otodvigaemyj) [Electronic edition. IThMandSC. (constantly supplemented by new results and accordingly on new and more refined statements of problems - because of the avalanche of the results of recent years)], Astana, 2018.<br>4. Traub J.F, Wozniakowski H. A General Theory of Optimal Algorithms//Academic Press, New York, 1980.<br>1. 5. Vasilkovskii G. V., Voznyakovskii G. A survey of average case complexity for linear multivariate problems//Kazakh/Russian Mathematics. -2009. 53:4, 1–14<br>6. Temlyakov V. Multivariate Approximation. Cambridge University Press, 2018.<br>7. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p. |

**Module 8**

| | | | |
|---|---|---|---|
| Course code and name | MATH53010 The compact operators | | |
| Semester(s) when the course is taught | 1 | | |
| Persons responsible for the module | 1. K.N. Ospanov | | |
| Language of instruction | Russian | | |
| Connection with the curriculum (cycle, component) | Basic (Optional component) | | |
| Credit points (total by discipline) | 8 ECTS | | |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 240<br>Lectures<br>45 | Practical training<br>30 | Self-study hours<br>165 |
| Required and recommended prerequisites for joining the course | Functional analysis | | |

| | |
|---|---|
| Module objectives/intended learning outcomes | - know the methods of the theory of closed linear operators in Hilbert space, functional equations of the second kind, and elements of the theory of generalized functions.<br>- to own the skills to represent boundary value problems with nonsmooth data in the form of an operator equation and study by functional methods.<br>- be able to represent boundary value problems with nonsmooth data in the form of an operator equation and explore them by functional methods. |
| Content of the course | Hilbert space. Spectral theorems. Conjugate operator, completely continuous operator, and their various properties. An alternative to Fredholm. Spectrum of the operator. Symmetric operators |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | **1.** Trenogin V.A. Functional analysis: in 2 volumes: textbook. - Moscow: Academy, 2013. - 230 p. - ISBN 978-5-7695-9137-2. - ISBN 978-5-7695-9138-9. (in Russian)<br>**2.** Vlasova E.A. Elements of functional analysis: textbook / St. Petersburg; Moscow ; Krasnodar: Lan, 2015. - 397 p. ISBN 978-5-8114-1958-6 (in Russian)<br>**3.** Filimonenkova N.V. Collection of problems in functional analysis: a study guide. - St. Petersburg. Lan, 2015. - 228 p. - ISBN 978-5-8114-1822-0 (in Russian)<br>**4.** A.N. Kolmogorov, S.V. Fomin. Elements of the theory of functions and functional analysis: textbook / 7th ed. - Moscow: Fizmatlit, 2006. - 572 p. - ISBN 5-9221-0266-4 (in Russian)<br>**5.** Bakushinsky A.B. Elements of functional analysis: a study guide. - 2nd ed., corrected. - Moscow: Academy, 2013. - 187 p. - ISBN 978-5-7695-9744-2 (in Russian) |

**Module 9**

| | | | |
|---|---|---|---|
| Course code and name | MATH 53011 Discrete space and the basic inequalities in them | | |
| Semester(s) when the course is taught | 1 | | |
| Persons responsible for the module | Y.D. Nursultanov,<br>A.A. Jumabayeva | | |
| Language of instruction | Russian | | |
| Connection with the curriculum (cycle, component) | Basic (Optional component) | | |
| Credit points (total by discipline) | 8 ECTS | | |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference, “hot chair” method. | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 240 | | |
| | Lectures | Practical training | Self-study hours |
| | 45 | 30 | 165 |
| Required and recommended prerequisites for joining the course | Functional analysis | | |

| | |
|---|---|
| Module objectives/intended learning outcomes | - know the methods of the theory of interpolation spaces for their application to Lebesgue, Lorentz's concrete discrete spaces.<br>- to own the skills of work with various inequalities.<br>- be able to apply them at research of specific objectives. |
| Content of the course | Discrete Lebesgue, Lorentz spaces, Inequalities of holder, Minkowski, young-O'neill, their generalizations. Theorems Of Hardy-Littlewood, Stein, Boas. Interpolation of basic discrete spaces. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. Alessandra Lunardi, Interpolation theory, Scuola Normale Superiore, 2009.<br>2. Hans Triebel. Theory of Function Spaces, Springer Science & Business Media, 2010.<br>3. R.E. Edwards. Fourier Series: A Modern Introduction Volume1,2, Springer New York, 2011.<br>4. Zorich V.A. Mathematical analysis. - Moscow: Center for Continuing Mathematical Education, 2012 (in Russian).<br>5. Trenogin V.A. Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002 (in Russian).<br>6.Nikolsky S.M. Selected works. The 3 volumes. V.2. - M .: Science, 2007 (in Russian).<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=8585 |

**Module 10**

| | | | |
|---|---|---|---|
| Course code and name | MATH 53012 Topological vector spaces | | |
| Semester(s) when the course is taught | 1 | | |
| Persons responsible for the module | Kusainova L.K | | |
| Language of instruction | Russian | | |
| Connection with the curriculum (cycle, component) | Basic (Optional component) | | |
| Credit points (total by discipline) | 8 ECTS | | |
| Teaching methods | Lectures, practical classes | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 240<br>Lectures<br>45 | Practical training<br>30 | Self-study hours<br>165 |
| Required and recommended prerequisites for joining the course | Topological vector spaces | | |
| Module objectives/intended learning outcomes | To give the basics of the theory of topological vector spaces. Definitions and properties of basic topological concepts and objects/Fluency within the stated theory. The ability to apply functional analysis methods in research | | |
| Content of the course | Topological spaces. The fundamental system of neighborhoods. Continuous displays. Compact sets. Topological vector spaces (TVP). The neighborhood system in TVP. The concept of separability in TVP. Locally convex topological vector spaces. The space of continuous linear functionals on locally convex TVPs. Examples. | | |
| Examination forms | Oral examination (theoretical and practical tasks) | | |

| | |
|---|---|
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media |
| Reading list | 1. Burbaki N. Topological vector spaces. M.: Publishing house of foreign Languages. lit-ry, 1959<br>2. Ioshida K. Functional analysis. M.: Publishing house "Mir", 1967. — 616 p.<br>3. Kolmogorov, A.N.; Fomin, S.V. Elements of the theory of functions and functional analysis. Publisher: M.: Fizmatlit; 7th edition, 2004. |

**Module 11**

| | |
|---|---|
| Module code and name | MATH 53013 Metric spaces and theory of operators |
| Semester(s) in which the module is taught | Semester 1 |
| Persons responsible for the module | R. Oinarov<br>L.K. Kusainova<br>A.M. Abylaeva |
| Language | Kazakh,Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Type of teaching, contact hours | Lectures, Seminars, SIW |
| Workload | Lectures 45 Seminars 30 SIW 135 |
| Credit points | 7 |
| Requirements according to the examination regulations | Formation of theoretical and practical knowledge in theory of metric spaces and theory of operators, development of skills development and execution of scientific experiments.<br>Perform all kinds of work (participation in lectures, active work at seminars, perform SIW, to hand in all kinds of control etc.) provided by the module, the positive rating for the exam. |
| Recommended prerequisites | Mathematical Analysis II |
| Module objectives/intended learning outcomes | To master theoretical knowledge on the theory of metric spaces, be able to analyse, prove, do conclusions and apply the knowledge gained in research work. To be able to prove theorems and solve problems. To acquire knowledge about linear operators, their properties, to be able to find the norms of operators in various function spaces. |
| Content | Definitions and basic properties of various function spaces, metric, norm, scalar product, types of convergences in various function spaces, open, closed sets, closure of sets, contraction mapping principle, compactness in metric spaces, linear bounded operators, functionals, inverse operators, closed, adjoint, compact operators. |
| Study and examination requirements and forms of examination | combined exam |
| Media employed | Syllabus, educational guide, computer, projector, interactive whiteboard |
| Reading list | 1. Kolmogorov A. N., Fomin S. V. Elements of the theory of functions and functional analysis. 7th ed. FIZMATLIT, 2004. ISBN 5-9221-0266-4. 572 pp. (in Russian)<br>2. Trenogin V.A. Functional analysis. Textbook. 3rd ed. FIZMATLIT, 2002. 488 pp. ISBN 5-9221-0272-9 (in Russian)<br>3. V. A. Sadovnichy, Operator Theory. 5th ed. Bustard, 2004. 384 pp. ISBN 5-7107-8699-3. (in Russian)<br>4. V. M. Fedorov, Course of Functional Analysis. Lan, 2005. 352 pp. ISBN 5-8114-0589-8. (in Russian)<br>4. V. M. Fedorov, Course of Functional Analysis. Lan, 2005. 352 pp. ISBN 5-8114-0589-8. (in Russian) |

| | |
|---|---|
| | 5. Bogachev V. I., Smolyanov O. G. Real and functional analysis: University course. RHD, 2009. 724 pp. ISBN 978-5-93972-742-6. (in Russian)<br>6. L. V. Kantorovich and G. P. Akilov, Functional Analysis. 3rd ed. The science. GRFML, 1984. 750 pages. (in Russian) |

**Module 12**

| | |
|---|---|
| Course code and name | MATH 53014 Classes of multipliers in the trigonometric system |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | N.T. Tleukhanova,<br>A.A. Jumabayeva<br>G.K. Mussabayeva |
| Language | Kazakh,Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 7 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference, “hot chair” method. |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures: 45 — Practical training: 30 — Self-study hours: 135 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | To master mathematical apparatus of the theory of ranks, concept of classes of multipliers, to be capable to build classes of multipliers on trigonometric system |
| Content of the course | Trigonometric series, Fourier coefficients, the classes of multipliers, trigonometric system, the classes of multipliers for trigonometric system. The properties of the class of multipliers. The relationship of the class of multipliers with the space of Lorentz and Besov. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. H. Triebel Function Spaces. Basel; Boston: Birkhäuser Verlag, 2010 (in Russian).<br>2.The multipliers of multiple trigonometric Fourier series/ A.Ydyrys, L.Sarybekova, N.Tleukhanova/Open Eng.2016.-P367-371<br>3.A. Jumabayeva, E. Smailov, N. Tleukhanova On spectral properties of the modifiedconvolution operator // Journal of Inequalities and Applications 2012, 2012:146<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=9176 |

**Module 13**

| | |
|---|---|
| Course code and name | MATH 53015 Spaces of potentials and their applications |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | Bokayev N.A. |
| Language | Kazakh/Russian |

| | |
|---|---|
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 7 ECTS |
| Teaching methods | Classical teaching method: lecturing and solving problems in the classroom. |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures 45 / Practical training 30 / Self-study hours 135 |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis |
| Module objectives/intended learning outcomes | Mastering by students the necessary mathematical apparatus of potentials, which helps to analyze, model and solve applied problems using modern technologies. / Mastering by students the apparatus of the theory of potentials and the ability to apply the acquired knowledge to solve problems of mathematical modeling. |
| Content of the course | The course covers the following sections:<br>Operators in function spaces, Riesz and Bessel potentials and interconnection.<br>The Hardy-Littlewood-Sobolev theorem on fractional integration. Potential spaces and their properties. Nikolsky-Besov spaces. Connection of the space of potentials with other functional spaces. Liouville function classes. Morrey type spaces. Boundedness of the Riesz potential in spaces of Morrey type. Communication with Hardy operators. Connection with fractional-maximal operators. Applications of the potential space. |
| Examination forms | Verbal |
| Study and examination requirements | Mandatory attendance by students of all classes according to the schedule; Preliminary preparation for classes; Timely completion and submission of SROs; Preparation for all types of classes should be independent, creative; Active work and manifestation of creativity during classes; Participation in all types of control; Commitment to the University's Academic Integrity Policy. |
| Technical and electronic learning tools | Interactive whiteboard, interactive whiteboard projector, computer. |
| Reading list | 1. Stein I.M. Singular properties of functions and differential properties of functions. M.: MIR. 1973. - 342p.<br>2.Stein I., Weiss G. Introduction to harmonic analysis in Euclidean spaces. M.: Mir 1984.- 280p.<br>3. Kashin B., Sahakyan A. Orthogonal series M. Nauka, 2015 – 320p.<br>4.Triebel H. Functional spaces. M.: Mir 1986. - 447p.<br>5. Nikolsky S.M. Approximation of functions of several variables and embedding theorems M.: Nauka 2009. - 318p. |

**Module 14**

| | |
|---|---|
| Course code and name | MATH 53016 Finite Abelian groups |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 7 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |

| | |
|---|---|
| Workload (incl. contact hours, self-study hours) | Total workload: 210 hours.<br>Lectures: 45 hours, practical: 30 hours, independent work of students: 135 hours. |
| Required and recommended prerequisites for joining the course | No |
| Module objectives/intended learning outcomes | To acquaint with the basic concepts and results of the theory of Abelian groups and the development of methods for solving problems on this theory.<br>As a result of the course, students will know the basic definitions and statements of the theory of Abelian groups, be able to prove the main results and solve problems in the discipline. |
| Content of the course | Finite abelian groups. Periodic abelian groups. Primary groups. Elementary divisors of the primary group. The number of non-isomorphic primary groups of order pn. Free abelian groups. Finitely generated abelian groups. Divisible Abelian groups. Torsion coefficients of a finite Abelian group. Abelian groups without torsion. Factorial divisible groups. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |
| Reading list | 1. Gorodentsev A.P. Algebra, textbook for mathematics students, Part 1, 2013. - 485 p.<br>2. Kurosh A.G. - Theory of groups - Publishing house "Fizmatlit" - 2011 - 808s. - ISBN: 978-5-9221-1349-6<br>3. Lyapin E.S., Aizenshtat A.Ya., Lesokhin M.M. - Exercises on group theory - Publishing house "Lan" - 2010 - 272s. - ISBN: 978-5-8114-1015-6. |

**Module 15**

| | |
|---|---|
| Module code and name | MATH 53017 Computational (Numerical) diameter by exact information |
| Semester(s) in which the discipline is taught | 1 |
| Persons responsible for the module(s) | N. Temirgaliyev, N. Nauryzbaev, G. Taugynbaeva, A. Zh. Zhubanysheva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit scores (by discipline) | 7 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, self-employment hours) contact hours | Total workload: 210<br>Lectures: 45 — Practical training: 30 — Self-study hours: 135 |
| Required and recommended prerequisites for attaching to the module | Mathematical analysis, Theory of functions of a real variable (Real analysis), Functional analysis, Mathematical physics |
| The purpose of the discipline / expected learning outcomes | Acquaintance with the formulation of the problem of the Computational (Numerical) diameter by exact information and its concretization in the context of International Mathematics |

| | |
|---|---|
| The content of the discipline | The idea of the Computational (Numerical) diameter, the definition of the Computational (Numerical) diameter by exact information (C(N)D-1), function classes, C(N)D-1 in the context of the informative power of a given set of functionals, an illustrative example of the physical of the content of C(N)D-1, well-known widths as a specification of the Computational (Numerical) diameter when recovered by exact information, an example of a diameter that does not fit into the scheme of the Computational (Numerical) diameter, illustrative results on the topic of the Computational (Numerical) diameter (by exact information) |
| Exam Forms | Oral exam |
| Tuition and Exam Requirements | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |
| Technical and electronic learning aids | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e[Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series. ], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. (postojanno dopolnjaemyj po novym rezul'tatam i sootvetstvenno po novym i utochnjaemym postanovkam zadach – iz-za laviny rezul'tatov poslednih let vse vremja otodvigaemyj) [Electronic edition. IThMandSC. (constantly supplemented by new results and accordingly on new and more refined statements of problems - because of the avalanche of the results of recent years)], Astana, 2018.<br>3. Temlyakov V. Multivariate Approximation. Cambridge University Press, 2018.<br>4. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p.<br>5. Temirgaliyev N., Zhubanysheva A.Zh. Approximation Theory, Computational Mathematics and Numerical Analysis in new conception of Computational (Numerical) Diameter // Bulletin of L.N. Gumilyov Eurasian National University. Mathematics. Computer science. Mechanics series, - 2018. Vol. 124. №3. P. 8-88.<br>6. Azhgaliev Sh., Temirgaliev N. Informativeness of Linear Functionals //Mathematical Notes. 2003. Vol. 73, No 6, P. 759-768.<br>7. Bailov E.A., Temirgaliev N. Discretization of the solutions to Poisson's equation //Computational mathematics and mathematical physics, 2006. Vol. 46, No. 9. P. 1515-1525.<br>8. Ibatulin I., Temirgaliev N. On the informative power of all possible linear functionals for the discretithation of the solutions of the Klein-Gordon equation in the metric of $L_{2,\infty}$ //Differential equation, 2008, Vol.44, No.4, P. 510-526.<br>9. Abikenova Sh. K., Utesov A., Temirgaliev N. On the Discretization of Solutions of the Wave Equation with Initial Conditions from Generalized Sobolev Classes // Mathematical Notes, 2012, Vol. 91, No. 3, P. 121-125. |

**Module 16**

| | |
|---|---|
| Course code and name | MATH 52116 The linear differential operators |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | 1. K.N. Ospanov |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 7 ECTS |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures 45 / Practical training 30 / Self-study hours 135 |
| Required and recommended prerequisites for joining the course | Functional analysis |
| Module objectives/intended learning outcomes | - know the properties of operators in Hilbert spaces, properties of compact sets and operators, properties of the spectrum of a linear operator.<br>- to own the methods for solving functional analysis problems, the technique of proving theorems of functional analysis.<br>- to be able to find the norms of elements and operators, calculate scalar products, find conjugate operators, determine the spectrum of an operator, use Fredholm theorems, represent boundary value problems with nonsmooth data in the form of an operator equation and explore them by functional methods |
| Content of the course | Theories of closed linear operators in Hilbert space. Operator spectrum. Symmetric operators. Unlimited operators. Spectrum and resolvent of unbounded operators. Differential operators. Operator tracks |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | 1. Serovaisky S.Ya. Introduction to the spectral theory of operators / Almaty: Alem, 2003. - 365 pp. - ISBN 9965-553-071-3 (in Russian)<br>2. A.N. Kolmogorov, S.V. Fomin. Elements of the theory of functions and functional analysis: textbook / 7th ed. - Moscow: Fizmatlit, 2006. - 572 p. - ISBN 5-9221-0266-4 (in Russian)<br>3. A. Ibatov, Z. Abdikhalykova Functional analysis: okulyk / Astana: L.N. Gumilyov atyndagy EҰU, 2010. - 376 p. - ISBN 9965-31-379-2 (in Kazakh)<br>4. Trenogin V.A. Functional analysis: in 2 volumes: textbook. - Moscow: Academy, 2013. - 230 p. - ISBN 978-5-7695-9137-2 (in Russian)<br>5. Filimonenkova N.V. Collection of tasks on functional analysis: educational. - Krasnodar: Lan, 2015. - 228 p. - ISBN 978-5-8114-1822-0 (in Russian) |

**Module 17**

| | |
|---|---|
| Course code and name | MATH 53019 Inequalities in functional spaces |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | Y.D. Nursultanov,<br>A.A. Jumabayeva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | 7 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures 45 / Practical training 30 / Self-study hours 145 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis III |
| Module objectives/intended learning outcomes | An algorithm for building various filtering operators for signal processing will be proposed. Based on these operators, a method for identifying a given frequency range of the original signal will be described. |
| Content of the course | Undergraduates are taught the Lebesgue, Lorenza spatial definition and basic properties, introductory theorems. In addition, Hölder, Minkowski, Young-O'Neil, inequalities are studied. Given basic inequalities in different functional spaces. During this course the undergraduates acquire the skills of understanding and applying different inequalities. |
| Examination forms | oral exam. |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. Alessandra Lunardi, Interpolation theory, Scuola Normale Superiore, 2009.<br>2. Dorothee Haroske, Thomas Runst, Hans-Jürgen Schmeisser. Function Spaces, Differential Operators and Nonlinear Analysis: The Hans Triebel Anniversary Volume, Birkhäuser Basel, 2012.<br>3. R.E. Edwards. Fourier Series: A Modern Introduction Volume 1, Springer New York, 2011.<br>4. R. E. Edwards. Fourier Series: A Modern Introduction Volume 2, Springer New York, 2011.<br>5. Zorich V.A. Mathematical analysis. - Moscow: Center for Continuing Mathematical Education, 2012 (in Russian).<br>6. Trenogin V.A. Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002 (in Russian). |

**Module 18**

| | |
|---|---|
| Course code and name | MATH 53020 Elements of the theory of generalized functions |
| Semester(s) when the course is taught | 1 |
| Persons responsible for the module | L.K. Kusainova, Koshkarova B.S |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |

| | |
|---|---|
| Credit points (total by discipline) | 7 ECTS |
| Teaching methods | Lectures, practical classes |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures 45 Practical training 30 Self-study hours 145 |
| Required and recommended prerequisites for joining the course | Elements of the theory of generalized functions |
| Module objectives/intended learning outcomes | - To give the basic of the theory of generalized functions and its application in the analysis and solution of problems of mathematical physics and mechanics / Fluency in the basic provisions of the theory of generalized functions.<br>- The ability to apply in applied tasks. |
| Content of the course | The space of smooth finite functions as the main space and generalized functions. Operations on generalized functions (shift, compression, variable replacement, differentiation, direct product, convolution).<br>The Schwarz space of (rapidly decreasing functions) of basic functions. The space of generalized functions of moderate growth Operations on generalized functions (shift, compression, variable substitution, differentiation, direct product, convolution). Convolution and Fourier transform operations. Generalized solutions of the basic equations of mathematical physics. |
| Examination forms | Oral examination (theoretical and practical tasks) |
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media |
| Reading list | 1. V.S. Vladimirov. Equations of mathematical physics. Nauka Publishing House, 2000-e.<br>2. M.Reed, B.Simon. Functional analysis. 1. Ed.Mir, 1973 e.<br>3. M.Reed, B.Simon. Harmonic analysis. Ed.Mir, 1973--El.<br>4. S.G. Mikhlin. Linear partial differential equations. M. -El.<br>5. S.L. Sobolev. Some applications of functional analysis in mathematical physics. Publishing house of LSU.200- E.<br>6. L.K.Kusainova, A.S. Kasym. Elements of the theory of generalized functions. Study guide.Almaty.2018. |

**Модуль 19**

| | |
|---|---|
| Course code and name | ENGL 52002 Foreign language (professional) |
| Semester(s) when the course is taught | ½ |
| Persons responsible for the module | Sagimbaeva . |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component) |
| Credit points (total by discipline) | Group work. Problematic discussion. Search method. Construction. Essay. Situational modeling. Text analysis. Creative writing. |
| Teaching methods | Total workload: 120 hours. Practical: 37 hours, independent work of students: 83 hours |
| Workload (incl. contact hours, self-study hours) | 5 ECTS |
| Required and recommended prerequisites for joining the course | Foreign language B2 |

| | |
|---|---|
| Module objectives/intended learning outcomes | The purpose of the discipline: The acquisition and improvement of competencies in accordance with international standards of foreign language education, allowing the use of a foreign language (the level of super-basic standard (C1) as a means of communication for successful professional and scientific activities of the future master, able to compete in the labor market. Expected learning outcomes: - to know the functional and stylistic characteristics of the scientific presentation of the material in the studied foreign language; - be able to use general scientific terminology and terminological sublanguage of the relevant specialty in a foreign language; - freely read, translate original Reading list on the chosen specialty with subsequent analysis and evaluation of the extracted information; - to make a presentation of scientific research (at seminars, conferences, symposiums, forums); - to perceive by ear and understand public speeches with direct and indirect communication (lectures, reports, TV and internet |
| Content of the course | Introduction to the course. Developing a focus. How to write master's dissertation (introductory course). Sourcing information for your project. Developing your project. Using evidence to support your ideas. Avoiding plagiarism. Paraphrasing and summarizing. Academic Style – some guidelines (Part I). Academic styles (Part II). Writing introductions. Incorporating data and illustrations. Writing conclusions. Presentation skills. Preparing for conference presentation. Preparing for a conference presentation. |
| Examination forms | Oral examination |
| Study and examination requirements | Undergraduates are required to attend practical classes in a foreign language and take an active part in performing tasks on CPM, the results of which are accepted by the teacher online or in the classroom of the university, depending on the type and form of the task. |
| Technical and electronic learning tools | Databases:*https://library.enu.kz/MegaPro/Web*<br>*https://englishforacademicstudy.com*<br>*https://garneteducation.com*<br>*http://presentationexpressions.com*<br>*http://wiki.ubc.ca/Presentation_Skills*<br>*https://global.oup.com/?cc=kz*,<br>*https://www.macmillanyounglearners.com/macmillanenglish/*<br>*https://www.britishcouncil.kz/kk*<br>*https://edpuzzle.com/* |
| Reading list | 1. Sagimbayeva J.E., Moldakhmetova G.Z., Kurmanayeva D.K. Tazhitova G.Z., Kassymbekova N.S. English course book for Master programme students of "Governmental audit and Financial control" specialty (from extended reading to academic writing) - Astana: L.N. Gumiloyv Eurasian National University, 2018. – 357p.<br>2. Sagimbayeva J.E., Kurmanayeva D.K., Tazhitova G.Z., Kassymbekova N.S. Электронное пособие - English course book "Environment and Natural Resources Protection" for Master students of "Management and Engineering in the field of Environmental Protection educational programs" – Nur-Sultan, 2022<br>3. English for Academic Study. Joan McCormack and John Slaght - Extended Writing and Research Skills, University of Reading, 2012 – 152 p. |

| | |
|---|---|
| | 4. Tamzen Armer - Cambridge English for Scientists – Cambridge University Press, 2013 – 128 p.<br>4. Martin Hewings – Cambridge Academic English – Upper Intermediate- Cambridge University Press, 2012 – 176 p.<br>5. Dorothy E. Zemach, Lisa A. Rumisek - Academic Writing: from paragraph to essay. – London: Macmillan Education, 2016 - 130 p.<br>6. Academic Writing. A Handbook for International students. Stephen Bailey. Routledge. 2011 |

**Модуль 20**

| | |
|---|---|
| Course code and name | PHIL 52001 History and Philosophy of Science |
| Semester(s) when the course is taught | ½ |
| Persons responsible for the module | |
| Language | Russian |
| Connection with the curriculum (cycle, component) | Basic (Optional component). |
| Credit points (total by discipline) | Traditional. Active and interactive teaching methods |
| Teaching methods | Total workload: 120 hours. Practical: 37 hours, independent work of students: 83 hours |
| Workload (incl. contact hours, self-study hours) | 4 ECTS |
| Required and recommended prerequisites for joining the course | World History, Political Science, Sociology. |
| Module objectives/intended learning outcomes | The main purpose of the course is to develop undergraduates' interest in fundamental knowledge, to stimulate the need for philosophical assessments of the formation and development of sciences, critical analysis of modern scientific achievements, to develop a methodological culture of research work Expected learning outcomes: Analyze the main ideological and methodological problems, including interdisciplinary ones, studied in science at the present stage of its development and use the results professionally; understanding the dynamics of science development, its impact on the development of society, the formation of a holistic image of science, mastering the theory of method, mastering the logic and methodology of science; mastering in-depth skills analysis of texts on philosophical problems of various sciences; critical understanding of various concepts of the growth of scientific knowledge; mastering the methodological culture of research work and the ability to use the acquired skills in their own professional activities. |
| Content of the course | The relationship between the philosophy of science and the history of science. Philosophical ideas as a heuristic of scientific search. The problem of demarcation in the philosophy of science. The genesis of science. Discussions about the emergence of science. The problem of scientific rationality. Classical science. The scientific picture of the world. The ethos of classical science. Non-classical science and post-non-classical science. The scientific picture of the world. The ethos of science. Philosophy of Science: basic meanings. Problems of the boundaries of scientific knowledge in the philosophy of I. Kant. Positivist tradition Analytical philosophy and its influence on the philosophy of science. The transition from the logic of science to the history of science. The structure of scientific knowledge. |

| | |
|---|---|
| | The main types of sciences. Types of cognitive procedures. Philosophy of natural Sciences. The range of problems of the philosophy of natural science. Philosophy of Engineering and Technical Sciences. The role of technology in science. Information and computer technologies in non-classical technical sciences. Environmental aspects of the social assessment of technology. The specifics of socio-humanitarian knowledge. The problem of the formation of social theory. The theme of "death |
| Examination forms | Oral examination |
| Study and examination requirements | To successfully pass the final control, a master's student needs to know the terminology, theories and concepts of the discipline. Know the personalities and their works. The Code of Conduct and Ethics must comply with the requirements of the university. In this regard, scores from 0 to 100 points are given. |
| Technical and electronic learning tools | Computer, projector. https://mooc.enu.kz/, https://moodle.enu.kz/ |
| Reading list | 1.1. Kanke V.A. Basic philosophical directions and concepts of science. Moscow, 2013 2. Kohanovsky V.A. History and philosophy of science.- M., - 2010 3. Klyagin N. Modern scientific map of the world [Electronic resource]: textbook / N. Klyagin.- 1, 02 MB.- Moscow: Logos, 2017.- 186 s 4. Kuhn T. The structure of scientific revolutions. -M. AST.- 2015 ISBN 978-5-17-089239-6 http://www.psylib.ukrweb.net/books/kunts01/index.htm 5. Philosophy of science: General problems of cognition. Methodology of natural sciences and humanities: a textbook - M.: Progress-Tradition : MPSI : Flint, 2005. - 992 p. 6. Nurmanbetova, D.N. History and philosophy of science [Text] / D.N. Nurmanbetova.- Astana: ENU, 2012 |

**Module 21**

| | |
|---|---|
| Course code and name | MATH 52021 Boundary value problems for ordinary differential equations |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | 1. K.N. Ospanov<br>2. B.S. Koshkarova<br>3. R.D. Akhmetkaliyeva |
| Language | Russian |
| Connection with the curriculum (cycle, component) | Profile ( University component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures 30 / Practical training 15 / Self-study hours 105 |
| Required and recommended prerequisites for joining the course | Differential equations |

| | |
|---|---|
| Module objectives/intended learning outcomes | - Understand the essence of setting boundary value problems for model classes of differential equations, master the technique of reducing boundary value problems for differential equations to an equivalent integral equation in classes of discontinuous functions. To know is the essence of setting boundary value problems for model classes of differential equations, the properties of eigenvalues and eigenfunctions of the Sturm-Liouville problem, To be able to reduce boundary value problems for differential equations to an equivalent integral equation in classes of discontinuous functions and apply the Fredholm theory. Have the skills to prove the existence of solutions to differential equations with variable discontinuous coefficients. |
| Content of the course | Differential equations with variable coefficients. Statement of boundary value problems. Eigenvalues and eigenfunctions of the one-dimensional Sturm-Liouville problem, their properties. Integral Equations in Spaces of Summable Functions. Reduction of boundary value problems to the study of integral equations. Alternatives to Fredholm. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | 1. Tikhonov A. N., Vasil'eva A. B., and Sveshnikov A. G., Differential Equations. - Moscow: Fizmatlit, 2002. - 253 p. - ISBN 5-9221-0134-X (in Russian)<br>2. Sergeev I.N. Differential equations. - Moscow: Academy, 2013. - 286 p. ISBN 978-5-7695-9606-3 (in Russian)<br>3. Denisov A.M., Razgulin A.V., Ordinary differential equations: textbook / Moscow: MAKS Press, 2009. - 231 p. ISBN 978-5-317-02770-4 (in Russian)<br>4. Vasilyeva A.B., Medvedev G.N., Tikhonov N.A., Urazgildina T.A. Differential and integral equations, calculus of variations in examples and problems / Moscow: Fizmatlit, 2005. - 432 p. ISBN 5-9221-0628-7 (in Russian) |

**Module 22**

| | |
|---|---|
| Module code and name | MATH52022 Nonlinear analysis in finite-dimensional space. |
| Semester(s) in which the module is taught | Semester 2 |
| Person responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language | Kazakh,Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Type of teaching, contact hours | Seminars, SIW |
| Workload | Lectures 30 Seminars 15 SIW 105 |
| Credit points | 5 ECTS |
| Requirements according to the examination regulations | Perform all kinds of work (participation in lectures, active work at seminars, perform SIW, to hand in all kinds of control etc.) provided by the module, the positive rating for the exam. |

| | |
|---|---|
| Recommended prerequisites | Mathematical Analysis I |
| Module objectives/intended learning outcomes | To master the theoretical knowledge of nonlinear analysis in a finite-dimensional space, be able to analyse, prove, draw conclusions and apply the knowledge gained in research work. Be able to prove theorems and solve problems. Master the theory of differential and integral calculus of functions of many variables, numerical and functional series, trigonometric Fourier series, Fourier transforms, measures of sets in a finite-dimensional space. Be able to find extrema of functions of many variables and solve problems for differential and integral calculus of functions of many variables. |
| Content | Functions of many variables, implicit functions, differential and integral calculus of functions of many variables, numerical and functional series, trigonometric Fourier series, Fourier transforms, measure of sets in a finite-dimensional space, multiple and curvilinear integrals. |
| Study and examination requirements and forms of examination | combined exam |
| Media employed | Syllabus, educational guide, computer, projector, interactive whiteboard |
| Reading list | 1. O. V. Besov, Lectures on Mathematical Analysis, Moscow Institute of Physics and Technology, Moscow, 2004. (in Russian)<br>2. Nikolsky M. Course of mathematical analysis, 2001. (in Russian)<br>3. Kudryavtsev L.D. Course of mathematical analysis, volume 2, 2003. (in Russian)<br>4. Ulyanov P.L., Bakhvalov A.N. and other Real analysis in problems. FIZMATLIT, 2005. 416 pp. ISBN 978-5-9221-0595-8. (in Russian)<br>5. Glazman I.M., Lyubich Yu.I. Finite-dimensional linear analysis. Moscow: Nauka, 1969. (in Russian) |

**Module 23**

| | | | |
|---|---|---|---|
| Course code and name | I MATH53023 Th 5302 Interpolation theory | | |
| Semester(s) when the course is taught | 2 | | |
| Persons responsible for the module | N.T. Tleukhanova,<br>A.N. Kopezhanova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | Functional analysis | | |
| Module objectives/intended learning outcomes | To own conceptual apparatus of the theory of interpolation methods for interpolation spaces, to be able to apply them to specific spaces Lebesgue Lorentz weighted spaces, to be able to work with abstract interpolation theorems. | | |
| Content of the course | The discipline “ Interpolation theory ” is aimed at studying the method of interpolation: Theorems of Riesz - Torin, Marcinkiewicz, Calderon, Pairs of spaces, intermediate, interpolation spaces, definition of K-methods and its properties, definition of J - methods and its properties. As a result of training, undergraduates receive skills to interpolation of the main functional spaces. | | |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). | | |

| | |
|---|---|
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1.Trenogin VA Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002.<br>2. H. Triebel Function Spaces. Basel; Boston: Birkhäuser Verlag, 2010 (in Russian).<br>3.G. K. Mussabayeva, N. T. Tleukhanova/Bochkarev inequality for the Fourier transform of functions in the Lorentz spaces L2,r(R)/ EurasianMath. J., 2015, V6, N1, p. 76–84. http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=9176 |

**Module 24**

| | |
|---|---|
| Course code and name | MATH53024 Singular Integrals in Function Spaces |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | Bokayev N.A. |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | Classical teaching method: lecturing and solving problems in the classroom. |
| Workload (incl. contact hours, self-study hours) | Total workload: 150 hours.<br>Lectures: 15 hours, practical: 30 hours, independent work of students: 105 hours. |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis |
| Module objectives/intended learning outcomes | Mastering by students the necessary mathematical apparatus of singular integrals, which helps to analyze, model and solve applied problems using modern technologies. / Mastering the apparatus of singular integrals by students and the ability to apply the acquired knowledge to solve problems of mathematical modeling. |
| Content of the course | The course covers the following sections: Functional spaces. Operators and functionals in function spaces. Nonincreasing permutation. maximum function. Hilbert transform. Limited in Lp. Calderón-Sigmund operators. Singular integral operators commuting with dilations. Riesz transformations. Conditions for boundedness of the Riesz potential in Lp.<br>Inequalities for potentials. The Hardy-Littlewood-Sobolev theorem on fractional integration.<br>Poisson integrals and unit approximation.<br>Bessel potentials and its properties |
| Examination forms | Verbal |
| Study and examination requirements | Mandatory attendance by students of all classes according to the schedule; Preliminary preparation for classes; Timely completion and submission of SROs; Preparation for all types of classes should be independent, creative; Active work and manifestation of creativity during classes; Participation in all types of control; Commitment to the University's Academic Integrity Policy. |

| | |
|---|---|
| Technical and electronic learning tools | Interactive whiteboard, interactive whiteboard projector, computer. |
| Reading list | 1. Stein I.M. Singular properties of functions and differential properties of functions. M.: MIR, 1973.- 342p.<br>2.Stein I., Weiss G. Introduction to harmonic analysis in Euclidean spaces. M.: Mir 1984.- 280p.<br>3. Kashin B., Sahakyan A. Orthogonal series. M.: Nauka, 2015 -320p.<br>4.Triebel H. Functional spaces. M.: Mir 1986. -447p.<br>5. Nikolsky S.M. Approximation of functions of several variables and embedding theorems. M.: Nauka 2009. -318p. |

**Module 25**

| | |
|---|---|
| Course code and name | MATH53025 Spaces and rings |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |
| Workload (incl. contact hours, self-study hours) | Total workload: 150 hours.<br>Lectures: 30 hours, practical: 15 hours, independent work of students: 105 hours. |
| Required and recommended prerequisites for joining the course | The theory of groups |
| Module objectives/intended learning outcomes | To acquaint with the basic concepts and results of the theory of rings and spaces and the development of methods for solving problems using these theories.<br>As a result of the course, students will know the basic definitions and statements of the theory of rings, the theory of linear spaces, be able to prove the main results and solve problems in this discipline. |
| Content of the course | Finite-dimensional spaces. Basis and dimension of space. Linear transformation. Image and kernel of linear transformation. Invariant subspaces. Nilpotent and semisimple transformations. Jordan form of a matrix. Euclidean and unitary spaces. Otrogonal transformations. Symmetric transformations. polar expansion. Ring. Subring. Ring ideal. Ring homomorphism. Kernel and image of a homomorphism. Factor ring. Theorems on ring homomorphisms. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |
| Reading list | 1. Kurosh A.G. Higher Algebra Course: Textbook. 23rd ed. - St. Petersburg: Lan, 2022. - 432 p. ISBN: 978-5-8114-4304-8<br>2. Vinberg E.B. Algebra course. M: MTsNMO, 2019. -592 p. 978-5-4439-2804-3<br>3. Benyash-Krivets V.V., Melnikov O.V. Lectures on algebra: groups, rings, fields. - Minsk: BGU, 2008. - 116 p. |

**Module 26**

| | |
|---|---|
| Code and name of the module | MATH 53026 Algebraic number theory in restoration problems |
| Semester(s) in which the discipline is taught | 2 |
| Persons responsible for the module(s) | N. Temirgaliev, N. Nauryzbaev, G. Taugynbaeva, A. Zh. Zhubanysheva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit scores (by discipline) | 5 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, hours of independent work) contact hours | Total workload: 150 hours.<br>Lectures: 15 hours, practical: 30 hours, independent work of students: 105 hours. |
| Necessary and recommended prerequisites for joining the module | Mathematical analysis, Algebra and number theory, Complex analysis |
| The purpose of the discipline/ expected learning outcomes | Acquaintance with the necessary concepts of algebraic number theory and their application in problems of numerical integration and recovery of functions |
| Content of the discipline | The idea of applying algebraic number theory in the geometry of numbers and in problems of analysis, necessary information from algebraic number theory, setting the problem of numerical integration and recovery of functions, uniformly distributed Korobov's grids, a brief overview of number-theoretic methods in numerical integration, about quadrature formulas related to divisors fields of Gaussian numbers, equivalent conditions for the uniform distribution of Korobov grids, an algorithm for construction a grids close to critical, an algorithm for construction uniformly distributed Korobov's grids in the case of dimension less than 18, an algorithm for construction uniformly distributed Korobov's grids for arbitrary dimensions, |
| Exam Forms | Oral exam |
| Requirements for training and exams | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |
| Technical and electronic learning tools | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |
| | |
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e[Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series. ], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. Astana, 2018. |

| | |
|---|---|
| | 3. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p.<br>4. Temirgaliev N. Application of divisor theory to approximate recovery and integration of multivariable periodical functions // Doklady Akademii Nauk SSSR, 1990, Vol.310, No5, P. 1050-1054<br>5. Zhubanysheva A. Zh., Temirgaliev N., Temirgalieva Zh. N. Application of divisor theory to the construction of tables of optimal coefficients for quadrature formulas //Computational mathematics and mathematical physics, 2009, Vol. 49, No1, P. 12-22.<br>6. Bailov E.A., Sikhov M.B., Temirgaliev N. General Algorithm for the Numerical Integration of Functions of Several Variables // Computational mathematics and mathematical physics, 2014, Vol. 54, No. 7. P. 1061–1078. |

**Module 27**

| | |
|---|---|
| Course code and name | MATH 53027 The singular differential equations |
| Semester(s) when the course is taught | *2* |
| Persons responsible for the module | 1. K.N. Ospanov<br>2. R.D. Akhmetkaliyeva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | *5 ECTS* |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures 30 / Practical training 15 / Self-study hours 105 |
| Required and recommended prerequisites for joining the course | Ordinary differential equations |
| Module objectives/intended learning outcomes | - know the methods of the theory of differential equations, elements of the theory of generalized functions, understand the essence of generalized derivatives, generalized solutions of a differential equation<br>- to own the methods of studying singular differential equations for their application in research work and the application of theorems of functional analysis to find generalized solutions.<br>- be able to prove a priori estimates for solutions of the simplest differential equations and the solvability of equations with an operator with a closed range of values, |
| Content of the course | Equation with a closed operator and a dense domain in a Banach space. Adjoint equation in a Banach space. A priori estimates. Equations with a finite defect. Noetherian equations, index |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |

| | |
|---|---|
| Reading list | **1.** K.N. Ospanov, Singular differential equations, Almaty, 69 p., 2017 (in Kazakh)<br>**2.** Otelbaev, M. To the formulas for the distribution of eigenvalues of singular differential operators // Collection of selected scientific papers published in 1972-2011 - Astana: L.N. Gumilyov, 2012.- P.24-30.<br>**3.** S.A. Abdymanapov, G.A.Esenbayeva, M.T.Kosmanova Equations of Mathematical Physics. - Almaty.-Rauan, 2001. -161. (in Russian)<br>**4.** Muratbekov M.M. Separability and spectral properties of singular differential operators of mixed type: // Almaty: Evero, 2019. - 141 p. - ISBN 978-601-7528-92-8. (in Russian)<br>**5.** M. Aldai, K.R. Myrzataeva, Introduction to simple differential equations: textbook / - Almaty: Evero, 2020. - 207 p. - ISBN 978-601-310-780-5. (in Kazakh) |

**Module 28**

| | | | |
|---|---|---|---|
| Course code and name | MATH 53028 Generalized Morrey spaces and their application | | |
| Semester(s) when the course is taught | 2 | | |
| Persons responsible for the module | Y.D. Nursultanov,<br>A. K. Kopezhanova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis | | |
| Module objectives/intended learning outcomes | To master definition of space of Morrey, properties of spaces of Morrey, to be capable to the proof of interpolation theorems of space of Morrey, to be capable to apply them at the solution of specific objectives. | | |
| Content of the course | Undergraduates are taught the Lebesgue, Lorenza spatial definition and basic properties, introductory theorems. In addition, Hölder, Minkowski, Young-O'Neil, inequalities are studied. Given basic inequalities in different functional spaces. During this course the undergraduates acquire the skills of understanding and applying different inequalities. | | |
| Examination forms | final oral exam. | | |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. | | |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles | | |

| | |
|---|---|
| Reading list | 1. Alessandra Lunardi, Interpolation theory, Scuola Normale Superiore, 2009.<br>2. Dorothee Haroske, Thomas Runst, Hans-Jürgen Schmeisser. Function Spaces, Differential Operators and Nonlinear Analysis: The Hans Triebel Anniversary Volume, Birkhäuser Basel, 2012.<br>3. R.E. Edwards. Fourier Series: A Modern Introduction Volume 1, Springer New York, 2011.<br>4. R. E. Edwards. Fourier Series: A Modern Introduction Volume 2, Springer New York, 2011.<br>5. Zorich V.A. Mathematical analysis. - Moscow: Center for Continuing Mathematical Education, 2012 (in Russian).<br>6. Trenogin V.A. Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002 (in Russian). |

**Module 29**

| | | | |
|---|---|---|---|
| Course code and name | MATH53029 The theory of measure | | |
| Semester(s) when the course is taught | 2 | | |
| Persons responsible for the module | L.K. Kusainova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | Lectures, practical classes | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | The theory of measure | | |
| Module objectives/intended learning outcomes | Read a course of lectures covering the basic principles of constructing a regular measure on the example of the Lebesgue measure/ Complete mastering of the course read. The possibility of independent development of the general theory of measure as an extension of the function of a set given on an arbitrary semicircle. | | |
| Content of the course | Systems of sets. A half-ring. Ring. σ is a ring.Functions of sets. Additive function of sets (measure) on the ring of elementary sets. Construction of an external measure $\mu^*$. Construction of a σ-ring of $\mu$ measurable sets. Properties. Extension of $\mu^*$ to the Lebesgue measure. Properties of the Lebesgue measure. | | |
| Examination forms | Oral examination (theoretical and practical tasks) | | |
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work | | |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media | | |
| Reading list | 1. A.N., Kolmogorov, S.V., Fomin. Elements of the theory of functions and functional analysis. Publisher: M.: Fizmatlit; 7th edition, 2004.( in Russian)<br>2. G.M. Fichtenholz, “Course of differential and integral calculus (Volume 2). (in Russian)<br>3. P. Halmosh. The theory of measure.<br>4. G.E. Shilov, B.L. Gurevich. Integral, Measure and Derivative: General Theory Ed. 2, reprint 1967. | | |

**Module 30**

| | |
|---|---|
| Module code and name | MATH 53030 Weighted inequalities of Hardy type |
| Semester(s) in which the module is taught | Semester 2 |

| | |
|---|---|
| Person responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language | Kazakh/Russian/English |
| Relation to curriculum | Elective |
| Teaching methods | explanatory-illustrative, information-reporting |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures 30 Seminars 15 SIW 105 |
| Credit points | 5 ECTS |
| Required and recommended prerequisites for joining the module | Functional analysis |
| Module objectives/intended learning outcomes | The main objective of the course is to acquaint with theoretical material and teach undergraduates to apply modern research methods to the problems of determining conditions for boundedness of Hardy-type operators in weighted spaces. To know methods of proving the fulfilment of weighted inequalities of Hardy type;<br>To be able to prove the classical inequalities of analysis, necessary and sufficient conditions for the weight of the Hardy inequalities with different parameters and different weights for their use in research. To develop skills and abilities in solving problems of assessing the norms of Hardy operators and acquire research skills. |
| Content | The discipline "Weighted Hardy-type inequalities" is a continuation of the theory of linear operators and is aimed at studying integral and discrete weighted Hardy-type inequalities, establishing their necessary and sufficient conditions, and estimating the norms of integral and discrete Hardy-type operators. In the process of learning, undergraduates must master the basic methods for establishing necessary and sufficient conditions for Hardy's integral and discrete inequalities and acquire research skills. |
| Exams and assessment formats | Two oral Midterm control in the form of a colloquium in $7^{th}$ and $15^{th}$ weeks. Colloquium ticket has 2 questions (25 minutes for each question). One final oral exam (50 minutes). |
| Study and examination requirements and forms of examination | Current control is estimated weekly, is estimated at 100 points, which includes the recording of lecture notes, work at the blackboard, homework and independent work. 60% of the admission rating. The final grade in the module consists of 40% of the progress in the exams. The admission rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Reading list | 1. G. Hardy, JE Littlewood G. Polya inequality. M .: Gos. ed. foreign. Litas. 1978 (in Russian).<br>2. V.A. Sadovnichy Operator theory. -M .: Ed. Moscow State University, 1986 (in Russian).<br>3. Opic B., Kufner A. Hardy-type inequalities // Pitman Research Notes in Mathematics Series, Longman Scientific & Technical, Harlow, 1990.<br>4. Kufner A., Persson L.-E. Weighted inequalities of Hardy type// London-Singapore, “World Scientific”, 2003.<br>5. Stepanov V.D Weighted norm inequalities of Hardy type for a class of integral operators// J.London Math.Soc, 50(1994), 105-120. |

**Module 31**

| | |
|---|---|
| Course code and name | MATH 53031 Fourier series in the regular system |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | N.T. Tleukhanova,<br>G.K.Mussabayeva |

| | |
|---|---|
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures 30 Practical training 30 Self-study hours 105 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | To master definitions of orthogonal ranks, trigonometric ranks, regular ranks, their properties, Fourier's ranks on regular systems, to be capable to apply methods of regular ranks in the theory of animators, theories of multipliers, in the theory of functional spaces. |
| Content of the course | Orthogonal series. Trigonometric Fourier series, properties, sufficient convergence conditions. Regular system. Examples. Multipliers, multipliers for regular systems. |
| Examination forms | Oral exam |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. B. S. Kashin, A. A. Saakyan, Orthogonal Series, American Mathematical Soc., 2005.<br>2.Nursultanov E. D., “On the coefficients of multiple Fourier series from Lp-spaces”, Izv. Ross. Akad. Nauk Ser. Mat., 64:1 (2000), 95–122<br>3.Nursultanov E. D., Tleukhanova N. T., “Lower and upper bounds for the norm of multipliers of multiple trigonometric Fourier series in Lebesgue spaces”, Funktsional. Anal. i Prilozhen., 34:2 (2000), 86–88<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=9176 |

**Module 32**

| | |
|---|---|
| Course code and name | MATH 53032 Binary Analysis |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | Bokayev N.A. |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | Classical teaching method: lecturing and solving problems in the classroom. |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures 30 Seminars 15 SIW 105 |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis |

| | |
|---|---|
| Module objectives/intended learning outcomes | Mastering by students the necessary mathematical apparatus that helps to analyze, model and solve applied problems using binary analysis. / Mastering the apparatus of binary analysis by students and the ability to apply the acquired knowledge to solve problems of mathematical modeling. |
| Content of the course | The course covers the following sections of binary analysis:<br>Walsh and Haar systems.<br>Properties of the Fourier-Walsh, Fourier-Haar coefficients.<br>Fourier-Walsh transform and their properties.<br>Properties of partial sums of Fourier-Walsh, Fourier-Haar series.<br>Conditions for the convergence of the Fourier-Walsh, Fourier-Haar series.<br>Walsh and Haar series with monotonic coefficients.<br>Direct and inverse theorems for the approximation of a function by Walsh polynomials and Haar polynomials<br>Hadamard-ordered Walsh-Hadamard transform and their applications to signal processing. |
| Examination forms | Verbal |
| Study and examination requirements | Mandatory attendance by students of all classes according to the schedule; Preliminary preparation for classes; Timely completion and submission of SROs; Preparation for all types of classes should be independent, creative; Active work and manifestation of creativity during classes; Participation in all types of control; Commitment to the University's Academic Integrity Policy. |
| Technical and electronic learning tools | Interactive whiteboard, interactive whiteboard projector, computer. |
| Reading list | 1. Golubov B.I., Efimov A.V., Skvortsov V.A. Walsh series and transformations. Theory and applications. M.: Nauka, 201. – 420p.<br>2.Shipp, Wade, Simon. walsh series. 1990. – 560p.<br>3. Kashin, Sahakyan. orthogonal rows.<br>4. Golubov B.I. Elements of Binary Analysis. 2010, - 210p.<br>5. Ahmed N., Rao K.R. Orthogonal transformations in the processing of digital signals. - M.: Svyaz, 1980. |

**Module 33**

| | |
|---|---|
| Course code and name | MATH 53033 Lie algebras and their automorphisms |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |
| Workload (incl. contact hours, self-study hours) | Total workload: 150 hours.<br>Lectures: 30 hours, practical: 15 hours, independent work of students: 105 hours. |
| Required and recommended prerequisites for joining the course | Group theory, Finite Abelian groups |
| Module objectives/intended learning outcomes | To acquaint with the basic concepts and results of the theory of Lie Algebras and their automorphisms.<br>As a result of the course, students will know the basic definitions and statements of the theory of Lie algebras and their automorphisms, be able to prove the main results and solve problems in the discipline. |

| | |
|---|---|
| Content of the course | Free algebras. Varieties. Algebras free in variety. Free associative algebra. Free Lie Algebra. Basis of a free Lie algebra. The universal enveloping algebra of a free Lie algebra. The Poincaré-Birkhoff-Witt theorem. Subalgebras of a finitely generated free Lie algebra. Automorphisms of a free Lie algebra of finite rank. Tame automorphisms. Kohn's theorem. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |
| Reading list | 1. Hall J.I. Introduction to Lie Algebras. –2015. 131 p.<br>2. Vinberg E.B. Algebra course. M: MTsNMO, 2019. -592 p. 978-5-4439-2804-3<br>3. Humphreys J. Introduction to the theory of Lie algebras and their representations / translated from English. B.R. Frenkin. - M.: MTSNMO, 2003. -216 p. |

**Module 34**

| | |
|---|---|
| Module code and name | MATHP53034 Problems of numerical integration in the context of a computer (computing) diameter |
| Semester(s) in which the discipline is taught | 2 |
| Persons responsible for the module(s) | N.Temirgaliyev, N. Nauryzbayev, G.Taugynbayeva, A.Zh.Zhubanysheva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit scores (by discipline) | 5 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, self-employment hours) contact hours | Total workload: 150<br>Lectures Seminars SIW<br>30 15 105 |
| Required and recommended prerequisites for attaching to the module | Mathematical Analysis, Algebra, Complex Analysis, Functional Analysis |
| The purpose of the discipline / expected learning outcomes | Introduction to the methods of numerical integration of functions from multidimensional classes in the context of Computational (Numerical) diameter |
| The content of the discipline | Formulation of the numerical integration problem, number-theoretic methods in numerical integration problems, divisor theory in numerical integration problems, tensor product method of functionals in numerical integration problems, Smolyak quadrature formulas, numerical integration of infinitely differentiable functions |
| Exam Forms | Oral examination |
| Tuition and Exam Requirements | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |
| Technical and electronic learning aids | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |

| | |
|---|---|
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e [Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series.], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. (postojanno dopolnjaemyj po novym rezul'tatam i sootvetstvenno po novym i utochnjaemym postanovkam zadach – iz-za laviny rezul'tatov poslednih let vse vremja otodvigaemyj) [Electronic edition. IThMandSC. (constantly supplemented by new results and accordingly on new and more refined statements of problems - because of the avalanche of the results of recent years)], Astana, 2018.<br>3. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p.<br>4. Korobov N. M., Theoretic-Numerical Methods in Approximate Analysis, 2nd. revised and extended edition (MTsNMO, Moscow, 2004) [in Russian].<br>5. Bailov E.A., Sikhov M.B., Temirgaliev N. General Algorithm for the Numerical Integration of Functions of Several Variables // Computational mathematics and mathematical physics, 2014, Vol. 54, No. 7. P. 1061–1078.<br>6. Nurmoldin, E.E.Restoration of functions, integrals, and solutions to the heat conductivity equation from the Ul'yanov $U_2$-classes. (Russian) //Sib. Zh. Vychisl. Mat. 2005, Vol. 8, No. 4, P. 337-351.<br>7. Temirgaliev N. Classes $U_s(\beta,\theta,\alpha;\psi)$ and quadrature formulas //Dockland mathematics. 2003, Vol. 68, No 3, P. 414-415. |

**Module 35**

| | | | |
|---|---|---|---|
| Course code and name | MATH 53035 Expansion and contraction of linear operators | | |
| Semester(s) when the course is taught | *2* | | |
| Persons responsible for the module | 1. K.N. Ospanov | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures<br>30 | Practical training<br>15 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | Ordinary differential equations | | |

| | |
|---|---|
| Module objectives/intended learning outcomes | - know the basic methods of functional analysis, theory of linear operators and theories of differential equations;<br>- to own the basic methods of the theory of representation of correct restrictions and regular extensions of linear operators in a Hilbert space and applications of the obtained abstract theorems to differential equations, construct correct restrictions and extensions of linear operators in a Hilbert space;<br>- be able to investigate non-self-adjoint operators, classify by spectral features and prove the completeness or basicity of the system of root vectors of a linear operator. |
| Content of the course | Minimum and maximum operator concepts. Extension theory for symmetric operators. Regular extension for elliptic equations. Abstract theorems on correct restrictions of the maximal operator. Abstract theorems on correct extensions of the minimal operator. Abstract theorems on regular extensions. Applications of abstract theorems to concrete differential operators. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | **1.** Sadovnichiy V.A. The theory of operators: textbook. - Ed. 4th, rev. and additional - Moscow: Bustard, 2001. - 381, - ISBN 5-7107-4297-X. (in Russian)<br>**2.** V.A. Trenogin, B.M. Pisarevsky, T.S. Sobolev. Functional analysis: in 2 volumes: textbook. - Moscow: Academy, 2012. - 239 p. - ISBN 978-5-7695-9136-5 (in Russian)<br>**3.** Otelbaev, M. On the formulas for the distribution of eigenvalues of singular differential operators // Collection of selected scientific papers published in 1972-2011 - Astana: L.N. Gumilyov, 2012.- S.24-30.<br>**4.** Biliev N. Functional analysis (kyskasha course): okulyk / Almaty: Kazakh university, 2014. – 164 p. - ISBN 978-601-04-0336-9 (in Kazakh) |

**Module 36**

| | | | |
|---|---|---|---|
| Course code and name | MATH53036 Net spaces and their application | | |
| Semester(s) when the course is taught | 2 | | |
| Persons responsible for the module | Y.D. Nursultanov,<br>A. K. Kopezhanova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150 | | |
| | Lectures | Practical training | Self-study hours |
| | 30 | 30 | 105 |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis. | | |

| | |
|---|---|
| Module objectives/intended learning outcomes | To master definitions of the main functional spaces, anisotropic spaces, interpolation spaces, their properties, interpolation methods, multiple parameter interpolation methods; to be capable to apply methods of interpolation spaces to Lebegue's concrete spaces, Net spaces, Lorentz spaces, to weight spaces.<br>Cubature formulas for functions from network spaces will be studied, methods for forecasting economic problems will be developed on the basis of these cubature formulas. |
| Content of the course | Introduces the Net Space and its Properties in the proposed subject. Also, the interpolation properties of Net spaces, the definition and properties of the generalized Net Spaces are given. In the learning process, undergraduates should be trained in studying and using Net spaces. |
| Examination forms | Oral exam |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. Alessandra Lunardi, Interpolation theory, Scuola Normale Superiore, 2009.<br>2. Triebel Interpolation theory, function spaces, differential operators. - Huthig Pub Limited 1995.<br>3 Nursultanov ED, "Interpolation theorems for anisotropic spaces and their applications",Kazakh/Russian Academy of Sciences reports, 394: 1 (2004), 22-25 (in Russian).<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=8585 |

**Module 37**

| | | | |
|---|---|---|---|
| Course code and name | MATH53037 Weighted space of functions whole smoothness | | |
| Semester(s) when the course is taught | 2 | | |
| Persons responsible for the module | L.K. Kusainova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | Lectures, practical classes | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | Functional analysis | | |
| Module objectives/intended learning outcomes | A special course dedicated to the basic provisions of the theory of spaces of Bessel potentials and the construction of new functional spaces. Extension of knowledge in the theory of functional spaces. | | |
| Content of the course | Function of length $0 < h(x) \leq 1$. Immersion and oscillation conditions. The Bezikovich double covering of the area Ω and the unit partition.Spaces of potentials $H_p^s$. Determination of the weight space of potentials $H_p^s(\Omega;\rho,v_s)$. The correctness of the definition. Sobolev weight spaces $W_p^m(\Omega;v_m)$. Embedding theorems of spaces $H_p^s(\Omega;\rho,v_s)$. | | |
| Examination forms | Oral examination (theoretical and practical tasks) | | |
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work | | |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media | | |

| | |
|---|---|
| Reading list | 1. X.Tribel. Interpolation theory, functional spaces, differential operators, Mir Publishing House, 1980.<br>2. L.K., Kusainova, Ya.T., Sultanaev, G. Murat. Approximative estimates for a single differential operator in a weighted Hilbert space Differential equations. 2019. 55 (12).<br>3. Kusainova L.K. On the interpolation of Sobolev weight spaces. // Izv.Ministry of Science – Academy of Sciences of the Republic of Kazakhstan. Ser.phys.-mat. 1997. No. 5. |

**Module 38**

| | |
|---|---|
| Module code and name | MATH62038 Linear analysis in finite-dimensional space |
| Semester(s) in which the module is taught | Semester 3 |
| Persons responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language | Kazakh,Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Workload | Lectures Seminars SIW<br>30 15 105 |
| Credit points | 5 ECTS |
| Requirements according to the examination regulations | Perform all kinds of work (participation in lectures, active work at seminars, perform SIW, to hand in all kinds of control etc.) provided by the module, the positive rating for the exam. |
| Recommended prerequisites | Mathematical Analysis II |
| Module objectives/intended learning outcomes | To master the theory of linear spaces, to be able to locate the conditions of compatibility of a system of linear equations, solve linear systems, an orthonormal basis in the nite-dimensional space, eigenvalues and eigenvectors of linear operators in finite-dimensional space. |
| Content | The discipline "Linear analysis in a finite-dimensional space" is aimed at studying the properties of finite-dimensional spaces and the properties of linear operators in finite-dimensional spaces, linear spaces, bases and dimensions of linear spaces, a finite-dimensional orthogonal basis in Euclidean space, spaces of linear operators, eigenvalues and eigenvectors of a linear operator, characteristic polynomial of a linear operator, self-adjoint linear operators in Euclidean space, norms of a linear operator, and spectrum of a self-adjoint operator. |
| Study and examination requirements and forms of examination | combined exam |
| Media employed | Syllabus, educational guide, computer, projector, interactive whiteboard |
| Reading list | 1. V. A. Ilyin and E. G. Poznyak, Linear Algebra, 2007.<br>2. Glazman I.M., Lyubich Yu.I. Finite-dimensional linear analysis. Moscow: Nauka, 1969.<br>3. Gelfand I.M. Lectures on linear algebra, Ed.3, Nauka, 1966.<br>4. Khalmosh P. Dimensional vector space, Fizmatgiz, 1963. |

**Module 39**

| | |
|---|---|
| Module code and name | MATH63039 Boundedness of integral and matrix operators |
| Courses, if applicable | 2 |
| Semester(s) in which the module is taught | Semester 3 |
| Persons responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language | Kazakh/Russian |

| | |
|---|---|
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Workload | Lectures 30 Seminars 30 SIW 120 |
| Credit points | 6 ECTS |
| Requirements according to the examination regulations | Perform all kinds of work (participation in lectures, active work at seminars, perform SIW, to hand in all kinds of control etc.) provided by the module, the positive rating for the exam. |
| Recommended prerequisites | Functional Analysis |
| Module objectives/intended learning outcomes | To form a system of knowledge about linear integral and matrix operators and their properties. The main objective of the course is to introduce theoretical material and teach undergraduates to apply modern research methods to the problems of determining the boundedness conditions for integral and matrix operators in weighted Lebesgue spaces for various parameters and weights. |
| Content | Discipline "Boundedness of integral and matrix operators" is aimed at studying the properties of boundedness and compactness of some classes of integral and matrix operators in functional spaces. In the process of learning, undergraduates should learn the basic methods for establishing the properties of integral and matrix operators in various functional spaces, as well as methods for assessing their norms and acquire research skills. |
| Study and examination requirements and forms of examination | oral exam |
| Media employed | Syllabus, educational guide, computer, projector, interactive whiteboard |
| Reading list | 1. Kufner A., Persson L.-E. Weighted inequalities of Hardy type// London-Singapore, “World Scientific”. 2003.<br>2. V. A. Sadovnichy, Operator Theory. 5th ed. Bustard, 2004. 384 pp. ISBN 5-7107-8699-3.<br>3. Krasnoselsky M.A. Integral operators in spaces of summable functions - M.: Nauka. 2005. -S. 499.<br>4. R. Oinarov, “Boundedness and compactness of integral operators of Volterra type,” Sib. math. j., 48:5 (2007), 1100–1115.<br>5. Temirkhanova A. M., Beszhanova A. T., Boundedness and compactness of a certain class of matrix operators with variable limits of summation, Eurasian Math. J. 11:4 (2020), 66–75.<br>6. Oinarov R., Persson L.-E., Temirkhanova A. M., Weighted inequalities for a class of matrix operators: the case // Mathematical Inequalities and Applications. - Croatia, 2009. - V. 12. - No. 4. - P. 891-903. |

**Module 40**

| | |
|---|---|
| Course code and name | MATH63040 Summability of multiple Fourier series |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | N.T. Tleukhanova,<br>A.N. Kopezhanova |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures 30 Practical training 30 Self-study hours 120 |

| | |
|---|---|
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | To master methods of trigonometrical ranks of Fourier, Fourier's transformation for application in the theory of animators, the theory of multipliers, in the theory of functional spaces. To master the theory of orthogonal ranks, multiple trigonometrical ranks, Fourier's multiple ranks on trigonometrical system, to be capable to apply methods of multiple trigonometrical ranks of Fourier, in the theory of animators, the theory of multipliers, in the theory of functional spaces. |
| Content of the course | Orthogonal series. Multiple trigonometric Fourier series, properties, sufficient convergence conditions. Multipliers, multipliers for multiple trigonometric systems. Fourier transformation. Properties. |
| Examination forms | Oral exam |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. B. S. Kashin, A. A. Saakyan, Orthogonal Series, American Mathematical Soc., 2005.<br>2.Nursultanov E. D., “On the coefficients of multiple Fourier series from Lp-spaces”, Izv. Ross. Akad. Nauk Ser. Mat., 64:1 (2000), 95–122<br>3.Nursultanov E. D., Tleukhanova N. T., “Lower and upper bounds for the norm of multipliers of multiple trigonometric Fourier series in Lebesgue spaces” 34:2 (2000), 86–88<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=9176 |

**Module 41**

| | | | |
|---|---|---|---|
| Course code and name | MATH 63041 The theory of Function approximation theory | | |
| Semester(s) when the course is taught | 3 | | |
| Persons responsible for the module | Bokayev N.A. | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 6 ECTS | | |
| Teaching methods | Classical teaching method: lecturing and solving problems in the classroom. | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>120 |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis | | |
| Module objectives/intended learning outcomes | Students mastering the apparatus of the theory of approximation of functions, the ability to analyze and apply the knowledge gained to solve problems of mathematical modeling. | | |

| | |
|---|---|
| Content of the course | The course covers the following sections: Polynomials of the best approximation. Moduli of continuity and their properties. Approximation of periodic functions by trigonometric polynomials. Approximations of functions by algebraic polynomials. Weipstrass' first and second theorems. Direct and inverse theorems of approximation theory. Relation between the modulus of continuity and best approximations. Bernstein's inequality. Polynomials deviating least from zero. Chebyshev polynomials. |
| Examination forms | Verbal |
| Study and examination requirements | Mandatory attendance by students of all classes according to the schedule; Preliminary preparation for classes; Timely completion and submission of SROs; Preparation for all types of classes should be independent, creative; Active work and manifestation of creativity during classes; Participation in all types of control; Commitment to the University's Academic Integrity Policy. |
| Technical and electronic learning tools | Interactive whiteboard, interactive whiteboard projector, computer. |
| Reading list | 1. Timan A.F. The theory of approximation of functions of a real variable. Fizmatgiz. M. 1969, 610 p.<br>2. Korneichuk A. Approximation of functions by polynomials. M.Nauka 2015, 352p.<br>3. Nikolsky S.M. Approximation of functions of several variables and embedding theorems. 2017, 475 p.<br>4. Bari N.K. Trigonometric series. M.: Fizmatgiz, 1961 - 960s.<br>5. Kashin B.S., Sahakyan A.A. Orthogonal serias. M.: Nauka, 2015 -315s |

**Module 42**

| | |
|---|---|
| Course code and name | MATH 63041<br>Galois theory |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |
| Workload (incl. contact hours, self-study hours) | Total workload: 180 hours.<br>Lectures: 30 hours, practical: 30 hours, independent work of students: 120 hours. |
| Required and recommended prerequisites for joining the course | Group theory, Finite Abelian groups |
| Module objectives/intended learning outcomes | The goal is to acquaint students with Galois theory, teach them to apply theoretical knowledge to solving problems in research and teaching activities.<br>As a result of the course, students will know the basic concepts associated with Galois theory, be able to perform calculations related to finite groups, finite fields, and their Galois groups, and master the skills of applying Galois theory. |

| | |
|---|---|
| Content of the course | The concept of a field, types of fields. Field extensions, types of field extensions. Automorphisms of finite fields. Solvable automorphism groups. Galois group. Solvable equations. Decomposition field of a polynomial. Galois group of the equation. A theorem on the connection between the solvability of an equation in radicals and the solvability of the Galois group of this equation. Construction of an equation of the 5th degree, unsolvable in radicals. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |
| Reading list | 1. Artin E. Galois theory / - M .: MTsNMO (Moscow Center for Continuous Mathematical Education), 2016. - 68 p.<br>2. Postnikov M.M. Galois theory / - M: Factorial Press, 2003. - 304 p.<br>3. Ermolaev Yu.B. Introduction to Galois Theory: Textbook. - Kazan: Publishing house of KSU, 2001. - 37 p. |

**Module 43**

| | |
|---|---|
| Module code and name | MATH 63043 Limiting error of unexact information under optimal recovery (the case of recovery of functions) |
| Semester(s) in which the discipline is taught | 3 |
| Persons responsible for the module(s) | N. Temirgaliyev, N. Nauryzbaev, G. Taugynbaeva, A. Zh. Zhubanysheva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit scores (by discipline) | 6 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, self-employment hours) contact hours | Total workload: 180<br>Lectures 30 / Practical training 30 / Self-study hours 120 |
| Required and recommended prerequisites for attaching to the module | Mathematical analysis, Theory of functions of a real variable (Real analysis), Functional analysis |
| The purpose of the discipline / expected learning outcomes | Acquaintance with the formulation of the problem of the Computational (Numerical) diameter by exact and unexact information in the case of recovery of functions and the results on them in the context of International Mathematics |
| The content of the discipline | Statement of the problem of the Computational (Numerical) diameter by exact and unexact information, informative power of all possible linear functional in the problem of recovery of functions from classes, limiting error of unexact information when optimally recovery functions from trigonometric Fourier coefficients, limiting error of unexact information when optimally recovery functions by their values at points. |
| Exam Forms | Oral exam |
| Tuition and Exam Requirements | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |

| | |
|---|---|
| Technical and electronic learning aids | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e [Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series.], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. (postojanno dopolnjaemyj po novym rezul'tatam i sootvetstvenno po novym i utochnjaemym postanovkam zadach – iz-za laviny rezul'tatov poslednih let vse vremja otodvigaemyj) [Electronic edition. IThMandSC. (constantly supplemented by new results and accordingly on new and more refined statements of problems - because of the avalanche of the results of recent years)], Astana, 2018.<br>3. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p.<br>4. Temirgaliyev N., Zhubanysheva A.Zh. Approximation Theory, Computational Mathematics and Numerical Analysis in new conception of Computational (Numerical) Diameter// Bulletin of L.N. Gumilyov Eurasian National University. Mathematics. Computer science. Mechanics series, 2018. Vol. 124. №3, P. 8-88.<br>5. Temirgaliev N., Sherniyazov K. E., Berikhanova M. E. Exact Orders of Computational Cross-Sections in Problems of Reconstructing Functions and Sampling Solutions of the Klein-Gordon Equation from Fourier Coefficients // Proceedings of the Steklov Institute of Mathematics (Supplementary issues), 2013, 282, suppl. 1, 165-191.<br>6. Temirgaliev N., Abikenova Sh. K., Zhubanysheva A. Zh., Taugynbaeva G. E.. Discretization of Solutions to a Wave Equation, Numerical Differentiation, and Function Recovery with the Help of Computer (Computing) Diameter //Kazakh/Russian Mathematics (Iz. VUZ), 2013, Vol. 57, No. 8, pp. 75-80. |

**Module 44**

| | |
|---|---|
| Course code and name | MATH 63044 Maximum Regularity Approach to Equations of Quantum Mechanics |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | 1. K.N. Ospanov<br>2. R.D. Akhmetkaliyeva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures: 30 / Practical training: 30 / Self-study hours: 120 |

| | |
|---|---|
| Required and recommended prerequisites for joining the course | Ordinary differential equations |
| Module objectives/intended learning outcomes | - know the possess the basics of the classification of bounded linear operators by the structure of the spectrum, the properties of Hilbert-Schmidt operators, nuclear operators,<br>- to own the research methods the maximum regularity of differential equations for their application in research work and analyze the eigenvalues of elliptic differential operators.<br>- be able to apply the simplest embedding theorems to determine the type of the resolvent of the Sturm-Liouville operator, apply the properties of the resolvent in questions of evaluating the quality of approximate schemes for solving differential equations, |
| Content of the course | Bounded normal operators in a Hilbert space. Hilbert-Schmidt operators. Carleman's theorem. Classes Cp of completely continuous operators. Unbounded operators in Hilbert space. Spectral theorem for unbounded self-adjoint operators. Completeness theorems for the system of root vectors of unbounded operators. |
| Examination forms | One final oral exam. |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | **1.** Otelbaev, M. Estimates of the eigenvalues of singular differential operators // Collection of selected scientific papers published in 1972-2011 - 2012. - P.53-61.<br>**2.** Ospanov K.N. Singular differential equations: textbook / Almaty: CyberSmith, 2017. - 69 p. - ISBN 978-601-310-955-8 (in Kazakh)<br>**3.** Muratbekov M.M. Separability and spectral properties of singular differential operators of mixed type: // Almaty: Evero, 2019. - 141 p. - ISBN 978-601-7528-92-8 (in Russian)<br>**4.** Demidovich B.P. Mathematical Foundations of Quantum Mechanics: textbook / Ed. 2nd, rev. - St. Petersburg: Lan, 2005. - 196 p.: - ISBN 5-8114-0624-X (in Russian) |

**Module 45**

| | | | |
|---|---|---|---|
| Course code and name | MATH 63045 Fourier multipliers in Lorentz spaces | | |
| Semester(s) when the course is taught | 3 | | |
| Persons responsible for the module | Y.D. Nursultanov<br>A.A. Jumabayeva | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 6 ECTS | | |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>120 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. | | |

| | |
|---|---|
| Module objectives/intended learning outcomes | To master methods of regular ranks, their properties, to be capable to apply methods of regular ranks in the theory of animators, theories of multipliers, in the theory of functional spaces, to have skills of work with Fourier's specific animators |
| Content of the course | Lebesgue Spaces, Lorentz. Trigonometric Fourier series, properties, sufficient convergence conditions. Regular system. Multipliers. The Theorem Of Marcinkiewicz, Germander, Lizorkina. |
| Examination forms | Oral exam |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. A. Jumabayeva, E. Smailov, N. Tleukhanova On spectral properties of the modified convolution operator // Journal of Inequalities and Applications 2012, 2012:146<br>2.Nursultanov E. D., "On the coefficients of multiple Fourier series from Lp-spaces", Izv. Ross. Akad. Nauk Ser. Mat., 64:1 (2000), 95–122<br>3. Trenogin V.A. Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002 (in Russian).<br>4.Nursultanov E. D., Tleukhanova N. T., "Lower and upper bounds for the norm of multipliers of multiple trigonometric Fourier series in Lebesgue spaces", Funktsional. i Prilozhen., 34:2 (2000), 86–88<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=9176 |

**Module 46**

| | | | |
|---|---|---|---|
| Course code and name | MATH 63046 Interpolation of weighted Sobolev spaces | | |
| Semester(s) when the course is taught | 3 | | |
| Persons responsible for the module | L.K. Kusainova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 6 ECTS | | |
| Teaching methods | Lectures, practical classes | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>120 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. | | |
| Module objectives/intended learning outcomes | Summary of the main provisions of the course "Theory of interpolation of Sobolev weight spaces". / Knowledge of the basic provisions of the theory of interpolation of Banach spaces. The practice of ownership on the example of Sobolev weight spaces with regular weights. | | |
| Content of the course | Interpolation pairs. Interpolation functors. Retraction. Correction. The main theorem for interpolation functors. The method of real interpolation. K-functionals. Spaces $(A_0, A_1)_{\theta,p}$ (interpolation of spaces $(l_p(A_j)$. Sobolev weight spaces with regular weights. Reduction of the interpolation problem for Sobolev spaces to the interpolation theorem for spaces of type $l_{p(}A_{j)}$. Interpolation theorems of Sobolev weight spaces. | | |
| Examination forms | Oral examination (theoretical and practical tasks) | | |

| | |
|---|---|
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media |
| Reading list | 1. X.Tribel. Interpolation theory, functional spaces, differential operators, Mir Publishing House, 1980-El.<br>2. J. Berg, J.Lefstrom. Interpolation spaces. Introduction, Ed.Mir, 1980<br>3. L.K.Kusainova. On the interpolation of Sobolev weight spaces. Izvestiya MNAN Kaz.SSR.1997. No. 5 |

**Module 47**

| | |
|---|---|
| Module code and name | MATH 63047 Additive and multiplicative weighted inequalities |
| Semester(s) in which the module is taught | Semester 3 |
| Person responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language | Kazakh/Russian |
| Relation to curriculum | Elective |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures 30 Seminars 30 SIW 120 |
| Credit points | 6 ECTS |
| Required and recommended prerequisites for joining the module | Mathematical analysis, Functional analysis, Weighted inequalities of Hardy type |
| Module objectives/intended learning outcomes | The main objective of the module is to acquaint with theoretical material and teach undergraduates to apply modern research methods to the problems of determining conditions for fulfilment of additive and multiplicative inequalities in weighted spaces.<br>- to know methods of proving the fulfilment of discrete and integral additive inequalities in weighted sequence and function spaces, respectively;<br>- to know methods of proving the fulfilment of discrete and integral multiplicative inequalities in weighted sequence and function spaces, respectively;<br>-to be able to prove the additive and multiplicative inequalities in weighted spaces, necessary and sufficient conditions for the weights of the additive and multiplicative inequalities with different parameters. |
| Content | The discipline "Additive and multiplicative weighted inequalities" is aimed at studying additive and multiplicative estimates for the weighted norm of a function through the weighted norm of a differentiation operator or an integral operator. Discrete additive, multiplicative inequalities in weighted sequence spaces. Integral additive, multiplicative inequalities in weighted function spaces. Three-weighted discrete inequality. Three-weighted integral inequality. Dual inequalities for the additive estimate of the matrix operator. The multiplicative generalization of Hardy's inequality. |
| Exams and assessment formats | Two oral Midterm control in the form of a colloquium in $7^{th}$ and $15^{th}$ weeks. Colloquium ticket has 2 questions (25 minutes for each question). One final oral exam (50 minutes). |

| | |
|---|---|
| Study and examination requirements and forms of examination | Current control is estimated weekly, is estimated at 100 points, which includes the recording of lecture notes, work at the blackboard, homework and independent work. 60% of the admission rating. The final grade in the module consists of 40% of the progress in the exams. The admission rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Reading list | 1. Oinarov R., Shalgynbaeva S.K. Weighted additive estimate of a class of matrix operators // Известия НАН РК, серия физ.-мат. –2004. № 1. –P.39–49.<br>2. Temirkhanova A.M., Taspaganbetova Z.A. Criteria on Boundedness of matrix operators in weighted spaces of sequences and their applications // Annals of functional analysis. –2011. –Vol. 2, № 1. –P. 114–127.<br>3. Oinarov R., Kalybay A. Three-parameter weighted Hardy type inequalities // Banach joirnal of mathematical analysis. –2008. –Vol. 2. –P. 85-93. |
| | 4. Oinarov R. On one tree-weighted generalization of Hardy inequality Mathematicheskie zametki, 1993. (2). 54. -P.56-62. (in Russian)//<br>5. Oinarov R., Sagintaeva S.S. On one Hardy type tree-weighted inequality // Science and education of South Kazakhstan, Series: economics, math., 1997. (6). -P.183-194. (in Russian)<br>6. Oinarov R. Reversion of Hölder type inequalities for sums of weighted norms and additive weighted estimates of integral operators // Journal of mathematical inequalities and applications. –2003. –Vol. 6. №.3. –P. 421-436.<br>7. Oinarov R. A dual inequality for an additive estimate of a matrix operator // Trudy Int. conf. "The current state and prospects for the development of mathematics in the framework of the program" Kazakhstan in the third millennium, 2001. –C. 111-115. |

**Module 48**

| | |
|---|---|
| Course code and name | MATH63048 Multipliers of trigonometric Fourier series in optimal monitoring problems |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | N.T. Tleukhanova<br>G.K. Mussabayeva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures 30 Seminars 30 SIW 120 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | On the basis of new achievements in the theory of multipliers of Fourier series and the Fourier transform, an operator is constructed for recovering multiplicative transformations of functions of several variables from the values of the function at fixed points. This knowledge allows us to develop new approaches to solving the problems of optimal monitoring. |

| | |
|---|---|
| Content of the course | The theory of Multipliers is an intensively developing section of functional analysis<br>The course focuses on the overall report, history of multipliers, and recent results. In addition, they study the properties of the class of multipliers in the trigonometric system and the properties of the class of factors in the trigonometric system. |
| Examination forms | One final oral exam. |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. A. Jumabayeva, E. Smailov, N. Tleukhanova On spectral properties of the modified convolution operator // Journal of Inequalities and Applications 2012, 2012:146<br>2.Nursultanov E. D., "On the coefficients of multiple Fourier series from Lp-spaces", Izv. Ross. Akad. Nauk Ser. Mat., 64:1 (2000), 95–122<br>3. Trenogin V.A. Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002 (in Russian).<br>4.Nursultanov E. D., Tleukhanova N. T., "Lower and upper bounds for the norm of multipliers of multiple trigonometric Fourier series in Lebesgue spaces", Funktsional i Prilozhen., 34:2 (2000), 86–88 |

**Module 49**

| | |
|---|---|
| Course code and name | MATH 63049 C* - Algebras |
| Semester(s) when the course is taught | 2 |
| Persons responsible for the module | 1. T. Nurlybekuly |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures 30 Seminars 30 SIW 120 |
| Required and recommended prerequisites for joining the course | Complex Functions, Real Functions, Functional Analysis. |
| Module objectives/intended learning outcomes | To own Gelfand fundamental theorem, the continuous function calculus and its application. To develop theoretical basis and useful research tools for noncommutative martingale theory and noncommutative harmonic analysis. |
| Content of the course | Basic properties of C* algebra. Spectral set and resolvent set. Positive elements, approximate identity, homomorphisms and ideals of C * algebra. Basic properties of positive linear functionals and representation of C* algebras. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |

| | |
|---|---|
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | 1. Xu Q., Bekjan T. N., Chen Z., Introduction to C* algebra and noncommutative Lp- space theory, 2010.<br>2. Sakai S., C*-algebras and W*-algebras, SpringerVerlag, Berlin, 1971.<br>3. Takesaki M., Theory of Operator Algebras I, Springer Verlag, New York, 1979. |

**Module 50**

| | |
|---|---|
| Course code and name | MATH 63050 Group-based cryptography |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |
| Workload (incl. contact hours, self-study hours) | Total workload: 180 hours.<br>Lectures: 30 hours, practical: 30 hours, independent work of students: 120 hours. |
| Required and recommended prerequisites for joining the course | Spaces and rings |
| Module objectives/intended learning outcomes | To acquaint with the basic concepts, results and methods of the theory of locally nilpotent derivations, to teach students to apply theoretical knowledge in solving problems, to form their skills in research and teaching activities.<br>As a result of the course, students will know the basic concepts, results, methods and ideas of the theory of locally nilpotent derivations, be able to prove basic statements and apply the theoretical knowledge gained in solving problems, have the skills to apply the methods and ideas of the discipline in research activities in the field of algebra and affine-algebraic geometry, as well as apply the studied material in teaching activities in educational organizations when reading relevant courses. |
| Content of the course | Derivation. Locally nilpotent derivations of free algebras. Algorithms for locally nilpotent derivations of free algebras. Free Metabelian Lie Algebra. Locally nilpotent derivation and exterior automorphisms of a free metabelian Lie algebra. Locally nilpotent derivations of the algebra of polynomials. Derivation and the Jacobi condition. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |

| | |
|---|---|
| Reading list | 1. Arno van den Essen, Polynomial automorphisms and the Jacobson conjecture / Basel, Boston, Berlin: Birkhauser, 2000.<br>2. E. B. Vinberg, Algebra Course / Moscow, 2015.<br>3. Berson J., Polinomial coordinates of their behavior in higher dimensions / Manuscript 2004.<br>4. Bardakov V.G. Lectures on Algebra Yu.I. Mezlyakova: Proc. allowance / Novosib. state un-t. Novosibirsk, 2012.<br>5. O. V. Melnikov, V. N. Remeslinikov, and V. A. Roman'kov, General Algebra. T. 1. Under the general. ed. L.A. Skornyakova / M.: Nauka, 1990. |

**Module 51**

| | |
|---|---|
| Module code and name | MATH63051 Optimal approximation of a thermal process with infinitely smooth initial conditions |
| Semester(s) in which the discipline is taught | 3 |
| Persons responsible for the module(s) | N. Temirgaliyev, N. Nauryzbaev, G. Taugynbaeva, A. Zh. Zhubanysheva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit scores (by discipline) | 6 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, self-employment hours) contact hours | Total workload: 180<br>Lectures 30 Seminars 30 SIW 120 |
| Required and recommended prerequisites for attaching to the module | Mathematical analysis, Theory of functions of a real variable (Real analysis), Functional analysis |
| The purpose of the discipline / expected learning outcomes | Acquaintance with the formulation of the problem of the Computational (Numerical) diameter by exact and unexact information in the case of recovery of functions and the results on them in the context of International Mathematics |
| The content of the discipline | Statement of the problem of the Computational (Numerical) diameter by exact and unexact information, informative power of all possible linear functional in the problem of recovery of functions from classes, limiting error of unexact information when optimally recovery functions from trigonometric Fourier coefficients, limiting error of unexact information when optimally recovery functions by their values at points. |
| Exam Forms | Oral exam |
| Tuition and Exam Requirements | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |
| Technical and electronic learning aids | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |

| | |
|---|---|
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e [Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series.], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. (postojanno dopolnjaemyj po novym rezul'tatam i sootvetstvenno po novym i utochnjaemym postanovkam zadach – iz-za laviny rezul'tatov poslednih let vse vremja otodvigaemyj) [Electronic edition. IThMandSC. (constantly supplemented by new results and accordingly on new and more refined statements of problems - because of the avalanche of the results of recent years)], Astana, 2018.<br>3. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p. |
| | 4. Temirgaliyev N., Zhubanysheva A.Zh. Approximation Theory, Computational Mathematics and Numerical Analysis in new conception of Computational (Numerical) Diameter// Bulletin of L.N. Gumilyov Eurasian National University. Mathematics. Computer science. Mechanics series, 2018. Vol. 124. №3, P. 8-88.<br>5. Temirgaliev N., Sherniyazov K. E., Berikhanova M. E. Exact Orders of Computational Cross-Sections in Problems of Reconstructing Functions and Sampling Solutions of the Klein-Gordon Equation from Fourier Coefficients // Proceedings of the Steklov Institute of Mathematics (Supplementary issues), 2013, 282, suppl. 1, 165-191.<br>6. Temirgaliev N., Abikenova Sh. K., Zhubanysheva A. Zh., Taugynbaeva G. E.. Discretization of Solutions to a Wave Equation, Numerical Differentiation, and Function Recovery with the Help of Computer (Computing) Diameter //Kazakh/Russian Mathematics (Iz. VUZ), 2013, Vol. 57, No. 8, pp. 75-80. |

**Module 52**

| | | | |
|---|---|---|---|
| Course code and name | MATH63052 The linear equations in the Banach space | | |
| Semester(s) when the course is taught | *3* | | |
| Persons responsible for the module | K.N. Ospanov | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 6 ECTS | | |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>120 |
| Required and recommended prerequisites for joining the course | Functional analysis | | |

| | |
|---|---|
| Module objectives/intended learning outcomes | - know the methods of the theory of closed linear operators in a Hilbert space, functional equations of the second kind, elements of the theory of generalized functions,<br>- to own the methods of studying linear equations in a Banach space for their application in research work and the application of theorems of functional analysis to search for generalized solutions.<br>- be able to introduce a generalized solution of the posed boundary value problem in the class of discontinuous functions, |
| Content of the course | Adjoint equation in a Banach space. Fredholm equations. Redefined Equations. Indefinite Equations. Integral equations. Differential Equations. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | 1. Otelbaev, M. On the formulas for the distribution of eigenvalues of singular differential operators // Collection of selected scientific papers published in 1972-2011 - Astana: L.N. L.N. Gumilyov, 2012.- S.24-30.<br>2. S.A. Abdymanapov, G.A.Esenbayeva, M.T.Kosmanova Equations of Mathematical Physics. - Almaty.-Rauan, 2001. -161 p. (in Russian)<br>3. Vlasova E.A. Elements of functional analysis: textbook / St. Petersburg. Lan, 2015. - 397 p. ISBN 978-5-8114-1958-6 (in Russian)<br>4. Shubin. Lectures on the equations of mathematical physics. 2nd ed. 2003 (in Russian)<br>5. Filimonenkova N.V. Collection of tasks on functional analysis: educational. - St. Petersburg. Lan, 2015. - 228 p. - ISBN 978-5-8114-1822-0 (in Russian) |

**Module 53**

| | |
|---|---|
| Course code and name | MATH63053 Summability of Fourier coefficients functions from weight spaces |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | Y.D. Nursultanov,<br>A. A. Zhumabayeva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures: 30 — Practical training: 30 — Self-study hours: 120 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | To own definitions, characteristics, fundamentals of functionals-spaces, weighted spaces.<br>To own definitions, properties, methods of Fourier series, Fourier transform |

| | |
|---|---|
| Content of the course | Multiple rows. Methods of summability. Multiple Trigonometric Fourier series, properties, sufficient convergence conditions. Multipliers, multipliers for trigonometric systems. Fourier transformation. Properties. The weight Lebesgue spaces. The weight space of type Baseva, Sobolev, Nikol'skii. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. Alessandra Lunardi, Interpolation theory, Scuola Normale Superiore, 2009.<br>2. Triebel Interpolation theory, function spaces, differential operators. - Huthig Pub Limited 1995.<br>3 Nursultanov ED, "Interpolation theorems for anisotropic spaces and their applications",Kazakh/Russian Academy of Sciences reports, 394: 1 (2004), 22-25 (in Russian).<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=8585 |

**Module 54**

| | |
|---|---|
| Course code and name | MATH63054 The general theory of interpolation Sobolev spaces |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | L.K.Kusainova |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 6 ECTS |
| Teaching methods | Lectures, practical classes |
| Workload (incl. contact hours, self-study hours) | Total workload: 180<br>Lectures 30 Seminars 30 SIW 120 |
| Required and recommended prerequisites for joining the course | The general theory of interpolation Sobolev spaces |
| Module objectives/intended learning outcomes | Mastering the mathematical apparatus of elements of the theory of interpolation of Sobolev spaces and its application in functional analysis problems.<br>/Fluency in the following theoretical material.<br>- The main provisions of the theory of real interpolation of Banach spaces.<br>- The theory of real interpolation of Sobolev spaces. |
| Content of the course | Interpolation pairs. Interpolation functors.<br>Retraction. Correction. The main theorem for interpolation functors. The method of real interpolation. K-functionals. Spaces $(A_0, A_1)_{\theta,p}$ (interpolation of spaces $(l_p(A_j)$. Sobolev weight spaces with regular weights. Reduction of the interpolation problem for Sobolev spaces to the interpolation theorem for spaces of type $l_{p(}A_{j)}$. Interpolation theorems of Sobolev weight spaces. |
| Examination forms | Oral examination (theoretical and practical tasks) |
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media |

| | |
|---|---|
| Reading list | 1. X.Tribel. Interpolation Theory, functional spaces, Differential operators, Mir Publishing House, 1980- https://www.twirpx.com/file/477252/<br>2. M.Reed, B.Simon. Functional analysis. 1. Ed.Mir, 1977- https://www.twirpx.com/file/235076/3. M.Reed, B.Simon.<br>3. Harmonic analysis. 2.Ed.Mir, 1978 http://old.pskgu.ru/ebooks/ridm2.html<br>4. S. G. Mikhlin. Linear partial differential equations. M. Higher School, 1977 http://padabum.com/d.php?id=2954<br>5. J. Berg, J. Lefstrom. Interpolation spaces. Introduction, Ed.Mir, 1980https://search.rsl.ru/ru/record/0100 |

**Module 55**

| | |
|---|---|
| Module code and name | MATH63055 Weighted estimates of matrix operators |
| Semester(s) in which the module is taught | Semester 3 |
| Person responsible for the module | R. Oinarov<br>A.M. Temirkhanova<br>A.M. Abylaeva |
| Language | Kazakh/Russian/English |
| Relation to curriculum | elective |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures 30 Seminars 15 SIW 105 |
| Credit points | 5 ECTS |
| Required and recommended prerequisites for joining the module | Functional analysis, Weighted inequalities of Hardy type |
| Module objectives/intended learning outcomes | The main objective of this course is to introduce the concept of matrix operators defined in sequence spaces and learn to study their properties. and teach students to use modern research methods in solving problems of determining the conditions of matrix operators in weighted spaces.<br>- to know methods of proving the fulfilment of weighted inequalities for matrix operators;<br>-to be able to prove the classical inequalities of analysis, necessary and sufficient conditions of boundedness of matrix operators in Lebesgue sequence spaces when $0 < p, q < \infty$.<br>- to develop skills and abilities in solving problems of assessing the norms of matrix operators and acquire research skills. |
| Content | Two-weighted discrete inequalities for one class of matrix operators when $1 < p, q < \infty$ and $a_{ij} \approx a_{ik} + a_{kj}, \quad i \geq k \geq j \geq 1$. Two-weighted discrete inequalities for one class of matrix operators when $1 < p, q < \infty$ and $a_{ij} \approx \frac{a_{ik}}{c_k} c_j + \frac{a_{kj}}{b_j} b_i, \quad i \geq k \geq j \geq 1$. Criterion of boundedness and compactness for a class of matrix operators in Lebesgue sequence spaces when $1 < p, q < \infty$ and $a_{ij} \approx b_{ik}\omega_i + a_{kj}, \quad i \geq k \geq j \geq 1$. Criterion of boundedness and compactness for a class of matrix operators in Lebesgue sequence spaces when $1 < p, q < \infty$ and $a_{i,j} \approx a_{i,k} + b_{k,j}\omega_k, \ i \geq k \geq j \geq 1$. Criterion of boundedness of the operator of multiple summation in Lebesgue sequence spaces when $1 < p, q < \infty$. |
| Exams and assessment formats | Two oral Midterm control in the form of a colloquium in 7th and 15th weeks. Colloquium ticket has 2 questions (25 minutes for each question). One final oral exam (50 minutes). |

| | |
|---|---|
| Study and examination requirements and forms of examination | Current control is estimated weekly, is estimated at 100 points, which includes the recording of lecture notes, work at the blackboard, homework and independent work. 60% of the admission rating. The final grade in the module consists of 40% of the progress in the exams. The admission rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Reading list | 1. Kufner A., Persson L.-E. Weighted inequalities of Hardy type. World Scientific, New Jersey, 2003.<br>2. Oinarov R., Persson L.-E., Temirkhanova A. Weighted inequalities for a class of matrix operators: the case $p \le q$ // Mathematical Inequalities and Applications. – Croatia, 2009. – V. 12. - № 4. – P. 891-903.<br>3. Oinarov R., Okpoti C.A., Persson L.E. Weighted inequalities of Hardy type for matrix operators: the case $q < p$ // Mathematical inequalities and applications. –2007. –Vol. 10. –P. 843–861.<br>4. Oinarov R., Shalgynbaeva S.K. Weighted additive estimate of a class of matrix operators // Известия НАН РК, серия физ.-мат. –2004. № 1. – P.39–49.<br>5. Temirkhanova A.M., Taspaganbetova Z.A. Boundedness and compactness criteria of a certain class of matrix operators // Математический журнал. –2011. № 11. –P. 125–139.<br>6. Temirkhanova A.M., Taspaganbetova Z.A. Criteria on Boundedness of matrix operators in weighted spaces of sequences and their applications // Annals of functional analysis. –2011. –Vol. 2, № 1. –P. 114–127.<br>7. Kalybay A.A., Oinarov R., Temirkhanova A.M. Boundedness of n - multiple discrete Hardy operators with weights for 1<q<p<∞ // Journal of function spaces and applications. – 2013. – P. 1-9.<br>8. Oinarov R., Temirkhanova A.M. Boundedness and compactness of a class of matrix operators in weighted sequence spaces // Journal of mathematical inequalities. – 2008. – Vol. 2, № 4. – P. 555-570. |

**Module 56**

| | |
|---|---|
| Course code and name | MATH63056 Transformations of type Hardy and Bellman |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | N.T. Tleukhanova<br>A.N.Kopezhanova |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures 30 / Practical training 30 / Self-study hours 105 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | To master mathematical apparatus of the theory of Hardy and Bellman transformations, methods, to be capable to apply them in appendices. |
| Content of the course | Hardy and Bellman type transformation theory, methods and applications of this theory. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |

| | |
|---|---|
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. A. Jumabayeva, E. Smailov, N. Tleukhanova On spectral properties of the modified convolution operator // Journal of Inequalities and Applications 2012, 2012:146<br>2.Nursultanov E. D., "On the coefficients of multiple Fourier series from Lp-spaces", Izv. Ross. Akad. Nauk Ser. Mat., 64:1 (2000), 95–122<br>3. Trenogin V.A. Functional Analysis, 3rd edition, M .: FIZMATLIT, 2002 (in Russian).<br>4.Nursultanov E. D., Tleukhanova N. T., "Lower and upper bounds for the norm of multipliers of multiple trigonometric Fourier series in Lebesgue spaces", Funktsional i Prilozhen., 34:2 (2000), 86–88 |

**Module 57**

| | |
|---|---|
| Course code and name | MATH63057 Wavelet analysis |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | Bokayev N.A. |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | Classical teaching method: lecturing and solving problems in the classroom. |
| Workload (incl. contact hours, self-study hours) | Total workload: 150 hours.<br>Lectures: 15 hours, practical: 30 hours, independent work of students: 105 hours. |
| Required and recommended prerequisites for joining the course | Functional Analysis, Harmonic Analysis |
| Module objectives/intended learning outcomes | Mastering by students the necessary mathematical apparatus that helps to analyze, model and solve applied problems using wavelet analysis. / Mastering the apparatus of wavelet analysis by students and the ability to apply the acquired knowledge to solve problems of mathematical modeling. |
| Content of the course | The course covers the following sections of wavelet analysis:<br>- Continuous wavelet transform and windowed Fourier transform; scaling functions, Haar wavelets, wavelet functions; restoration of the function through the wavelet transform; multiscale analysis, Meyer wavelets, spline wavelets and Daubechies wavelets.<br>Applications of wavelet transform in signal processing, in computational tomography problems. |
| Examination forms | Verbal |
| Study and examination requirements | Mandatory attendance by students of all classes according to the schedule; Preliminary preparation for classes; Timely completion and submission of SROs; Preparation for all types of classes should be independent, creative; Active work and manifestation of creativity during classes; Participation in all types of control; Commitment to the University's Academic Integrity Policy. |
| Technical and electronic learning tools | Interactive whiteboard, interactive whiteboard projector, computer. |

| | |
|---|---|
| Reading list | 1. Dobeshi I. Ten lectures on wavelets. Moscow-Izhevsk: Research Center "Regular and Chaotic Dynamics", 2007.-264p.<br>2. Malla S. Wavelet in signal processing. M.: Mir, 2007.-671s.<br>3. Zakharova T.V., Shestakov O.V. Wavelet analysis and its applications. Moscow, Infra_M, 2018.-210p.<br>4. Blatter K. Wavelet analysis. Fundamentals of the theory. M.: Technosphere, 2007.-280 |

**Module 58**

| | |
|---|---|
| Course code and name | MATH 63058 Polynomial automorphisms |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | 1. Naurazbekova A.S., acting associate professor, PhD;<br>2. Abutalipova Sh.U., senior Persons responsible for the module, Candidate of Physical and Mathematical Sciences |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | explanatory-illustrative, reproductive, problematic |
| Workload (incl. contact hours, self-study hours) | Total workload: 150 hours.<br>Lectures: 30 hours, practical: 15 hours, independent work of students: 105 hours. |
| Required and recommended prerequisites for joining the course | Spaces and rings |
| Module objectives/intended learning outcomes | To acquaint students with the most important results concerning the theory of automorphism groups of polynomial rings and the Jacobian conjecture.<br>As a result of the course, students will know the basic facts of the theory of automorphisms of polynomial rings, be able to prove the main results and solve problems in the discipline. |
| Content of the course | Polynomial automorphism of an affine space. Tame automorphisms of an affine space in two variables. Combined work. Linearization of a finite subgroup. Birational extension of a polynomial automorphism. Derivations and automorphisms of the ring of polynomials. Locally nilpotent differentiation. Differentiation and the Jacobian conjecture. Tame automorphisms of the ring of polynomials in two and three variables. Abyankar-Moh theorem. stabilization method. Application of the Jacobian conjecture. |
| Examination forms | Oral exam |
| Study and examination requirements | Students should: prepare in advance for lectures and practical exercises based on the materials of previous classes, teaching aids and relevant Reading list; timely fulfill and hand over the tasks of the IWS; participate in all types of control (current control, IWS control, boundary control, final control). |
| Technical and electronic learning tools | projector, laptop, screen, discipline syllabus, EMCD, textbooks and materials on topics. |
| Reading list | 1. Arno van den Essen, Polynomial automorphisms and the Jacobson conjecture / Basel, Boston, Berlin: Birkhauser, 2000.<br>2. E. B. Vinberg, Algebra Course / Moscow, 2015.<br>3. Berson J., Polinomial coordinates of their behavior in higher dimensions / Manuscript 2004. |

**Module 59**

| | |
|---|---|
| Code and name of the module | MATH 53059 Limiting errors unexact information for the discretization of PDE solutions |
| Semester(s) in which the discipline is taught | 3 |
| Persons responsible for the module(s) | N.Temirgaliyev, E. Nurmoldin, N. Nauryzbayev, G.Taugynbayeva, A.Zh.Zhubanysheva |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit scores (by discipline) | 5 ECTS |
| Teaching methods | explanatory and illustrative, reproductive, detailed evidence, work with scientific Reading list, offline and online consultations |
| Workload (incl. contact hours, hours of independent work) contact hours | Total workload: 150 hours.<br>Lectures: 15 hours, practical: 30 hours, independent work of students: 105 hours. |
| Necessary and recommended prerequisites for joining the module | Mathematical analysis, Theory of functions of a real variable (Real analysis), Functional analysis, Equations of mathematical physics |
| The purpose of the discipline/ expected learning outcomes | Introduction with the formulation of the Computational (Numerical) diameter problem by exact information and unexact information in the case of discretization of solutions of partial differential equations and results on them in the context of International Mathematics |
| Content of the discipline | Introduction of Computational (Numerical) diameter problem by exact information and unexact information in the case of discretization of solutions to partial differential equations, discretization of solutions to the heat equation, discretization of solutions to the wave equation, discretization of solutions to the Poisson equation, discretization of solutions to the Klein-Gordon equation, discretization of solutions to the Laplace equation |
| Exam Forms | Oral examination |
| Requirements for training and exams | Attendance at all classroom sessions, fulfillment of independent work of a student, assignments of all types of controls (current, intermediate and final) |
| Technical and electronic learning tools | Projector, presentations, Microsoft Teams platforms, ZOOM, electronic textbooks |
| Reading list | 1. Temirgaliyev N. Komp'juternyj (vychislitel'nyj) poperechnik. Algebraicheskaja teorija chisel i garmonicheskij analiz v zadachah vosstanovlenija (metod Kvazi-Monte Karlo). Teorija vlozhenij i priblizhenij. Rjady Fur'e [Computational (Numerical) diameter. Algebraic number theory and harmonic analysis in recovery problems (Quasi-Monte Carlo method). The theory of embeddings and approximations. Fourier series.], Vest. ENU im. L. N. Gumileva. Spec. vypusk, posvjashhennyj nauchnym dostizhenijam matematikov ENU im. L. N. Gumilyova [Bulletin of L. N. Gumilyov Eurasian National University. Special issue devoted to the scientific achievements of mathematicians L. N. Gumilev ENU], 1-194 (2010).<br>2. Temirgaliyev N. Nepreryvnaja i diskretnaja matematika v organicheskom edinstve v kontekste napravlenij issledovanij [Continuous and discrete mathematics in organic unity in the context of research directions], Jelektronnoe izdanie. ITMiNV. (postojanno dopolnjaemyj po novym rezul'tatam i sootvetstvenno po novym i utochnjaemym postanovkam zadach – iz-za laviny rezul'tatov poslednih let vse vremja otodvigaemyj) [Electronic edition. IThMandSC], Astana, 2018. |

| | |
|---|---|
| | 3. Temirgaliyev N. Matematika: Izbrannoe. Nauka // pod red. B. S. Kashina [Mathematics: Selected. Science//under the editorship of B. S. Kashin]. Astana: L.N.Gumilyov ENU publishing house, 2009, 613 p.<br>4. Temirgaliev N., Sherniyazov K. E., Berikhanova M. E. Exact Orders of Computational Cross-Sections in Problems of Reconstructing Functions and Sampling Solutions of the Klein-Gordon Equation from Fourier Coefficients // Proceedings of the Steklov Institute of Mathematics (Supplementary issues), 2013, 282, suppl. 1, 165-191.<br>5. Temirgaliev N., Abikenova Sh. K., Zhubanysheva A. Zh., Taugynbaeva G. E.. Discretization of Solutions to a Wave Equation, Numerical Differentiation, and Function Recovery with the Help of Computer (Computing) Diameter //Kazakh/Russian Mathematics (Iz. VUZ), 2013, Vol. 57, No. 8, pp. 75-80.<br>6. N. Temirgaliev, Sh. K. Abikenova, Sh.U. Azhgaliev, G. E. Taugynbaeva and A.Zh.Zhubanysheva Theory of Radon Transform in the Concept of Computational (Numerical) Diameter and Methods of the Quasi-Monte Carlo Theory// Bulletin of L.N. Gumilyov Eurasian National University. Mathematics. Computer science. Mechanics series, 2019. Vol. 129. №4, P. 8-53. |

**Module 60**

| | | | |
|---|---|---|---|
| Course code and name | MATH63060 The generalized solutions of the equations of mathematical physics | | |
| Semester(s) when the course is taught | 3 | | |
| Persons responsible for the module | 1. K.N. Ospanov<br>2. R.D. Akhmetkaliyeva | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | *5 ECTS* | | |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 210<br>Lectures<br>30 | Practical training<br>15 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | Equations of mathematical physics | | |
| Module objectives/intended learning outcomes | - understand and be able to explain the structure of spaces of functions with generalized derivatives, prove coercive estimates for the solution of linear differential equations and the solvability of quasilinear equations.<br>- know the methods of research and solution of quasilinear differential equations with increasing coefficients.<br>- to own the method and solution of nonlinear differential equations containing unlimited coefficients.<br>- be able to determine the form of a quasilinear differential equation and derive the differentiability properties of its generalized solutions and understand and be able to explain the structure of spaces of functions with generalized derivatives, prove coercive estimates for solutions of linear differential equations and the solvability of quasilinear equations. | | |
| Content of the course | Sobolev spaces with a singular weight function, conditions for embedding into the Lebesgue space. Statement of a singular problem for differential equations. Localization principle. Existence and uniqueness of a generalized solution to the singular problem. Coercive estimates of the solution, behavior of the approximate numbers of the resolvent. Schauder's principle. Methods for proving the solvability of a quasilinear singular equation | | |

| | |
|---|---|
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work. The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, cards, internet access to receive articles. |
| Reading list | **1.** Shubin. Lectures on the equations of mathematical physics. 2nd ed. 2003 (in Russian)<br>**2.** Derevich I.V. Workshop on the equations of mathematical physics: textbook / Ed. 2nd, St. Petersburg, Lan, 2018. - 427 p. : ISBN 978-5-8114-2601-0 (in Russian)<br>**3.** T.E. Omarov, B.K. Shayakhmetov. Equations in independent works: textbook / - Almaty: CyberSmith, 2017. - 170 p. - ISBN 978-601-310-393-8 (in Kazakh)<br>**4.** Ospanov K.N. Single differential equations: textbook / Almaty: CyberSmith, 2017. - 69 p. - ISBN 978-601-310-955-8 (in Kazakh)<br>**5.** S.A. Abdymanapov, G.A.Esenbayeva, M.T.Kosmanova Equations of Mathematical Physics. - Almaty.-Rauan, 2001. -161 (in Russian) |

**Module 61**

| | |
|---|---|
| Course code and name | MATH63061 Multivariable interpolation method and its application |
| Semester(s) when the course is taught | 3 |
| Persons responsible for the module | Y.D. Nursultanov,<br>A. K. Kopezhanova |
| Language | Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Profile (Optional component) |
| Credit points (total by discipline) | 5 ECTS |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference. |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures: 30 — Practical training: 30 — Self-study hours: 105 |
| Required and recommended prerequisites for joining the course | Mathematical Analysis II. |
| Module objectives/intended learning outcomes | To master definitions of the main functional spaces, anisotropic spaces, interpolation spaces, their properties, interpolation methods, multiple parameter interpolation methods; to be capable to apply methods of interpolation spaces to Lebegue's concrete spaces, Net spaces, Lorentz spaces, to weight spaces. |
| Content of the course | Within the discipline, the multiparameter interpolation method and its application are studied. Undergraduates will become familiar with K, J - methods, the method of multiparameter interpolation, the definition of anisotropic function spaces, multidimensional Besov spaces, anisotropic Lorentz spaces, and will also learn the method and properties of interpolations of multidimensional and anisotropic function spaces. |
| Examination forms | Two oral Midterm control (40 minutes each) in the form of a colloquium and control work. One final oral exam (60 minutes). |

| | |
|---|---|
| Study and examination requirements | Current control is set weekly, is estimated at 100 points, includes the recording of lecture notes, work at the blackboard, homework and independent work.The final grade in the module consists of 40% of the progress in the exams, 60% of the admission rating. Tolerance rating is the arithmetic mean of midterm controls, including 50% of the current rating and 50% of intermediate controls. To be admitted to the exam, you must have an admission rating of 50 points or higher. |
| Technical and electronic learning tools | Multi-projector, presentations, maps, internet access for articles |
| Reading list | 1. Alessandra Lunardi, Interpolation theory, Scuola Normale Superiore, 2009.<br>2. Triebel Interpolation theory, function spaces, differential operators. - Huthig Pub Limited 1995.<br>3 Nursultanov ED, "Interpolation theorems for anisotropic spaces and their applications",Kazakh/Russian Academy of Sciences reports, 394: 1 (2004), 22-25 (in Russian).<br>http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=8585 |

**Module 62**

| | | | |
|---|---|---|---|
| Course code and name | MATH 63062 Multipliers on weighted spaces of smooth functions | | |
| Semester(s) when the course is taught | 3 | | |
| Persons responsible for the module | L.K.Kusainova | | |
| Language | Kazakh/Russian | | |
| Connection with the curriculum (cycle, component) | Profile (Optional component) | | |
| Credit points (total by discipline) | 5 ECTS | | |
| Teaching methods | Lectures, practical classes | | |
| Workload (incl. contact hours, self-study hours) | Total workload: 150<br>Lectures<br>30 | Practical training<br>30 | Self-study hours<br>105 |
| Required and recommended prerequisites for joining the course | The general theory of interpolation Sobolev spaces | | |
| Module objectives/intended learning outcomes | Functional analysis | | |
| Content of the course | Sobolev weight spaces, basic properties.<br>Theorems on Guzman-Bezikovich type coverings.<br>Maximum functions.<br>The Bezikovich type double cover theorem.<br>Embedding inequalities.<br>Theorems describing multipliers on a pair of non-weighted Sobolev spaces.<br>Multipliers on a pair of Sobolev weight spaces. | | |
| Examination forms | Oral examination (theoretical and practical tasks) | | |
| Study and examination requirements | Timely completion of tasks on the subject under study, independent work | | |
| Technical and electronic learning tools | Textbooks, manuals, monographs on electronic media | | |

| | |
|---|---|
| Reading list | 1. K.T. Mynbayev, M.O. Otelbayev. Weighted functional spaces and the spectrum of differential operators. M., Nauka. 1988-El.<br>2. L.K. Kusainova. Embedding and interpolation theorems of Sobolev weight spaces (doct. dis.). 1998.-El.<br>3.In. G. Mazya. Spaces of S. Sobolev. LSU Publishing House, 1985- E.<br>4. V. G. Mazya, T. O. Shaposhnikova. Multipliers in spaces of differentiable functions. LSU Publishing House, 1080-e. 5. U. Rudin. Fundamentals of mathematical analysis. Mir, M., 1976-e.<br>6. V.A.Trenogin et al. tasks and exercises on functional analysis. Nauka, 1984-El.<br>7. A. Myrzagalieva. On pointwise multipliers in some function Scuola di dottorato di ri ricerca in Scienze Matematiche Indirizzo. Matematica CICLO:XXIX.2015-El. |

**Module 63**

| | |
|---|---|
| Course code and name | SRWG 52120 Scientific-research work of graduate students |
| Semester(s) when the course is taught | 1/2/3/4 |
| Persons responsible for the module | Musabayeva G.K. |
| Language | Kazakh,Kazakh/Russian |
| Connection with the curriculum (cycle, component) | Required Component |
| Credit points (total by discipline) | ECTS 24 |
| Teaching methods | Search, research |
| Workload (incl. contact hours, self-study hours) | Total workload: 720 hours.<br>1st semester: 210 hours, 2nd semester: 210 hours, 3rd semester: 120 hours, 4th semester: 180 hours. |
| Required and recommended prerequisites for joining the course | non |
| Module objectives/intended learning outcomes | Obtaining professional skills and professional experience in the field of scientific research by undergraduates.<br>Learning outcomes:<br>- own methods of search, processing and analysis of scientific Reading list on the subject of research;<br>- be able to formulate a problem statement;<br>- own research methods on the subject of a master's thesis;<br>- be able to formalize the results of research in the form of a report, article, thesis;<br>- demonstrate knowledge of the research results obtained |
| Content of the course | The study of new scientific results in accordance with the subject of the master's thesis; preparation of scientific reviews on the subject of ongoing research; solution of tasks according to an individual plan; registration of research results in the form of reports, articles, participation in scientific conferences and scientific seminars of the department, approbation of research results |
| Examination forms | Report |
| Study and examination requirements | Timely implementation of the individual plan of the undergraduate |
| Technical and electronic learning tools | Search databases of scientific Reading list |
| Reading list | On the subject of scientific research |

**Module 64**

| | |
|---|---|
| Module designation | TEIN 52063Teaching internship |
| Semester(s) in which the module is taught | 3 |
| Person responsible for the module | A.A. Jumabayeva<br>G.K. Musabayeva |
| Language | Kazakh,Kazakh/Russian |

| | |
|---|---|
| Relation to curriculum | compulsory |
| Teaching methods | Case study, brainstorming, works in group, communicative method, cinquain method, interactive method, differentiated approach, project method, lecture-conference, “hot chair” method. |
| Workload (incl. contact hours, self-study hours) | Total workload: 120 hours |
| Credit points | 4 |
| Required and recommended prerequisites for joining the module | Higher School Pedagogy<br>Management psychology |
| Module objectives/intended learning outcomes | To know the modern pedagogical technologies and possesses communication skills.<br>The ability to put the latest achievements in the field of pedagogical activity into practice, to expand and deepen their knowledge in the field of scientific research |
| Content | Acquaintance with the peculiarities of the organization of educational work in higher educational institutions. Monitoring the demonstration by the teacher-mentor of methods and techniques for organizing various types of educational, educational and extracurricular work with students, analysis and evaluation. Independent activity of students in the organization and conduct of educational activities. Planning and conducting a form of extracurricular work. Development of class notes for one of the sections of the discipline, conducting classes under the supervision of a teacher. |
| Exams and assessment formats | Report |
| Study and examination requirements | Visiting the classes, the classroom activity, timely execution and submission of tasks; visiting interim control, submission of tasks of final examination |
| Reading list | Individual selection of educational and methodical Reading list depending on the discipline taught |

**Module 65**

| | |
|---|---|
| Module designation | SRWG 62065 Research practice |
| Semester(s) in which the module is taught | 4 |
| Person responsible for the module | A.A. Jumabayeva<br>G.K. Musabayeva |
| Language | Kazakh,Kazakh/Russian |
| Relation to curriculum | compulsory |
| Teaching methods | explanatory-illustrative, information-reporting, partial-search, reproductive |
| Workload (incl. contact hours, self-study hours) | Total workload: 360 |
| Credit points | 12 |
| Required and recommended prerequisites for joining the module | |
| Module objectives/intended learning outcomes | To be capable to be correct to formulate the purposes and problems of scientific research, the concept of scientific search; to be capable to make the plan of research work for separate sections of the master thesis, to plan works necessary for performance resources, to estimate results of own work; to be capable to take useful scientific and technical information from electronic libraries, abstract magazines, the Internet; to be capable to present own new scientific results in the form of strictly reasonable statements. |

| | |
|---|---|
| Content | - The study of fundamental and periodical Reading list, regulatory and methodological materials on issues developed in the final qualifying master's work;<br>- Confirmation of the relevance and practical significance of the research topic chosen by the master student;<br>- Evaluation of the practical significance of the test questions;<br>- The collection, systematization and generalization of practical material for use in the final qualifying (Master's) work;<br>- Preparation of a scientific report on the final conference abstracts on student conference or an article for publication |
| Exams and assessment formats | Report |
| Study and examination requirements | Visiting the classes, the classroom activity, timely execution and submission of tasks; visiting interim control, submission of tasks of final examination |
| Reading list | Review of current scientific journal Reading list on the selected topic of master students. |

Considered and approved at the meeting of the department of Fundamental Mathematics.
date 15.03.2022 Record № 8

Alday M _____ __15.03.2022ж.
(Name) (signature) (date)