*Federal state autonomous educational institution of higher education*
*Peoples' Friendship University of Russia*

*Faculty of physical, mathematical and natural sciences*

# DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»

| **Discipline** | **Academic English** |
|---|---|
| Total | 4 credits(144 hours) |
| Contents | |
| **Units** | **Topics** |
| Academic activities (organization and participation) | 1. Development of skills and abilities sufficient for linguistic support of academic events: writing an information letter of the conference, preparation and discussion of the conference program, etc.<br>2. Improvement and skills sufficient to travel abroad to participate in conferences, debates, debates, presentations, etc. |
| The teaching of the English language | 1. Familiarity with the structural and content features of the educational and program documentation of the training course in English.<br>2. Preparation for teaching in English: lectures and seminars. |
| Academic correspondence and documentation | 1. Training in writing different types of academic letters and documents: grant applications, offer of cooperation, letter of recommendation.<br>2. Improving the skills needed to describe graphical data |

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## DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»

| **Discipline** | **Academic Russian** |
|---|---|
| Total | 4 credits(144 hours) |
| Contents | |
| **Units** | **Topics** |
| Elementary level. Introductory phonetic and grammatical course. | Russian alphabet. Greeting. "Who is it?" Personal pronoun. Acquaintance. Product name. "What is it?" Is that milk? Yes, it's milk. I (not) eat ..., I (not) love.... Numerals 1 – 1000. Design How much is it? Adverbs of place (here, there, right, near, etc.). Question sentences with the word where? |
| Elementary level. Gender of nouns. Possessive pronoun. Formation of plural nouns. | Gender of nouns. Possessive pronoun. Names of men and women. "What is ...?" What do you mean ...? What is the word for ...? Names of objects of surrounding reality (street, pen, etc.). Formation of plural nouns. |
| Elementary level. The expression of time in a simple sentence. | The expression of time in a simple sentence. (on Monday, in the morning, tomorrow, then, at 6 o'clock, etc.). "What time is it?" Adverbs of time, names of days of the week. |
| Elementary level. The concept of the Russian verb. | The verb to be in the future and past tense. "What Time?" and in 10 minutes. The functioning of the verb to be in constructions What will you be? I won't have coffee. Verb to want in the present and past tense. |
| Basic level. The education model of the past tense verb with a constant emphasis on the basis of the model (to want). Model of past tense formation from verbs with variable stress (be model). | The accusative case of an object, the endings of nouns in the accusative case. Construction need + infinitive, can be + infinitive, that need (can be) + infinitive. |

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| Basic level. Complex future tense of verbs. Etiquette of the simplest telephone conversation. | The verbs to work, to relax, to learn, to speak, to teach, to understand, to speak, to know. Constructions with the word must (must + infinitive). Adverbs of time answering the question when? (often, etc.), negative pronominal adverbs (never, nowhere). |
| Basic level. But I have (was, will) and I have not (was not, will not). The concept of an impersonal sentence. | But I have (was, will) and I have not (was not, will not). The concept of an impersonal sentence. |
| Basic level. The verb to love in the present and past tenses. I like the design. | Comparison of typical contexts of use of verbs to love and like. The first acquaintance with the verbal forms. The rule of compatibility of verbs to love and like with infinitives. |
| Basic level. Prepositional case of place. | Endings of singular nouns in the prepositional case. The use of prepositions on and B. the Use of the determinative pronoun all. Design what is where. |
| Базовый уровень. Глаголы движения идти, ехать, пойти, поехать, прийти, приехать, ходить, ездить. Глагол вернуться. Особенности спряжения глаголов с частицей –ся. Конструкция Как называется…? | Accusative case to indicate the direction of movement. Genitive to indicate direction (with the question from where?). |
| Basic level. Genitive with prepositions from and from (from whom? from whom?). The dative case with the preposition to (to whom?) | Comparison of constructions answering the questions where? from where? to whom? from whom? |
| Basic level. Etiquette of the phone conversation. | "What can I tell him?" Can you tell him?" The formation and use of forms of the imperative mood with the word let (let him call me back). |

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## DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»
(«Real, complex and functional analysis»)

| **Discipline** | **Additional chapters of functional analysis** |
|---|---|
| Total | 4 credits(144 hours) |
| Contents | |
| **Units** | **Topics** |
| The definition and General properties of the space $L_p$, $0 < p \le \infty$. Properties of the norm and quasinorm. | Basic concepts of measure and integral theory Lebesgue's. Chebyshev inequality and its consequences. Theorems Levy, Lebesgue and Fatou on the ultimate the transition to the Lebesgue integral. |
| Helder inequality. | Helder's inequality, its justification. Accuracy of Helder inequality. The absence of linear continuous functionals in the $L_p$, $0 < p < 1$. Application space of the Helder inequality. |
| Minkowski inequality. | Minkowski inequality at $p \ge 1$, a property of the norm. Minkowski inequality at $0 < p < 1$, a property of the quasinorm. The accuracy of the constants in the Minkowski inequality. Generalized Minkowski inequality for sums at $p \ge 1$. |
| Hardy's inequality. | Conclusion of the Hardy inequality. The nonbetterability of the conditions of justice of Hardy's inequality. |
| The subspace of entire functions of exponential type in the space of Lebesgue. | Integral representation of an integer function of exponential type. Basic integral inequalities for integer functions of exponential type. |
| Best approximation of functions from Lebesgue spaces with the help of entire functions of exponential type. | The concept of the best approximation, its General properties. Realization of the best approximation in the space of quadratically integrable functions. |
| The properties of the modules of continuity as characteristics of nonlinear fractional smoothness. | Properties of finite differences and continuity modules as nonlinear fractional smoothness characteristics of functions. Monotonicity properties and evaluation of the modules of the system-news. Marchot's theorem on the connection of continuity modules of different orders. |
| The General properties of the spaces of fraction- | Definitions of Nikolsky-Besov spaces, their |

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| al smoothness. Classical Nikolsky-Besov spaces. Spaces of generalized smoothness. | General properties. Equivalent norms in Nikolsky-Besov spaces in terms of continuity modules, in integral and in discrete form. The completeness of Nikolsky - Besov spaces. Generalizations of the spaces of Nikolsky-Besov spaces of generalized smoothness. |
| Embedding Nikolsky-Besov spaces without changing the metric. | The main Lemma on the estimation of discrete sums. Embedding theorem on the smoothness index and on the second index. The expanding scale of Nikolsky - Besov spaces. Estimation of the modulus of continuity of a function with a local singularity and criteria of its belonging to Sobolev, Nikolsky-Besov spaces and generalized smoothness spaces. |
| An exact description of the trace space of functions from Sobolev spaces to subspaces of smaller dimension. | Theorem on traces of functions from Sobolev spaces. Continuation theorems. The coincidence of the space of traces with the space of Besov on the border of the region. Statement of boundary value problems in Sobolev classes. |
| The inclusion of derivatives in the norm of spaces of Nikolsky-Besov and their generalizations. | Equivalent norms in generalized spaces of Nikolsky - Besov with the use of generalized derivatives and moduli of continuity. |

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**DISCIPLINE ANNOTATION**

**Education Programs in all fields of postgraduate study**

| **Discipline** | **History and Philosophy of Science** |
|---|---|
| **Total** | **4 credits (144 hours)** |
| **Contents** | |
| Units | Topics |
| The subject and basic concepts of modern philosophy of science | Philosophy of science as the study of general laws of scientific knowledge in its historical development and changing socio-cultural context. The evolution of approaches to the analysis of science. Logical and epistemological approach to the study of science. Positivist tradition in the philosophy of science. Expansion of the field of philosophical issues in the postpositivistic philosophy of science. |
| Science in the culture of modern civilization | Traditionalist and technogenic types of civilizational development and their basic values. The role of science in modern education and the formation of personality. Functions of science in society. |
| The genesis of science and the main stages of its historical evolution | The culture of the ancient polis and the formation of the first forms of theoretical science. Antique logic and mathematics. Western and Eastern medieval science. The formation of experimental science in the new European culture. Background of the experimental method and its connection with a mathematical description of nature. Formation of science as a professional activity. The genesis of disciplinary organized science. Formation of technical sciences. The formation of social and human sciences. |
| The structure of scientific knowledge | The variety of types of scientific knowledge. Empirical and theoretical levels, the criteria for their distinction. Features of the empirical and theoretical language of science. The structure of empirical knowledge. Experiment and observation. Empirical dependencies and empirical facts. The structure of theoretical knowledge. Primary theoretical models and laws. Developed theory. Theoretical models. Foundations of science. Ideals and norms of research. Scientific picture of the world. Philosophical foundations of science. |
| Dynamics of science | The interaction of the foundations of science and experience, the formation of a new discipline. Formation of primary theoretical models and laws. The role of analogies in the theoretical search. Procedures to substantiate theoretical knowledge. The relationship of the logic of discovery and logic of justification.. Formation of a developed scientific theory. Problem |

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| | situations in science. The development of science under the influence of new theories. |
| Scientific traditions and scientific revolutions. Types of scientific rationality | The interaction of traditions and the emergence of new knowledge. Scientific revolution as the restructuring of the foundations of science. Problems of typology of scientific revolutions. Intra-disciplinary mechanisms of scientific revolutions. Global revolutions and types of scientific rationality. Historical change of types of scientific rationality: classical, non-classical, post-non-classical science. |
| Features of the modern stage of development of science. Prospects for scientific and technological progress | Modern processes of differentiation and integration of sciences. Global evolutionism as a synthesis of evolutionary and systemic approaches. New ethical problems of science at the end of XX century. The problem of humanitarian control in science and high technology. Environmental and socio-humanitarian expertise of scientific and technical projects. Scientism and anti-scientism. Science and parascience. The role of science in overcoming contemporary global crises. |
| Science as a social institution | Scientific communities and their historical types. Science schools. Scientific training. Historical development of the methods of transmitting scientific knowledge. Science and economics. Science and power. The problem of state regulation of science. |
| Modern philosophical problems of the branch of science | In the areas of training postgraduate students |

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# DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»

| **Discipline** | **Foreign language** |
|---|---|
| Total | 5 credits(180 hours) |
| | Contents |
| **Units** | **Topics** |
| Methods of writing a written statement on scientific topics (scientific articles) | Genre features of the scientific article. Structure of the model article.<br>Writing annotations to the article.<br>Writing the introductory part of the article: the theme and subject of the study, goals and objectives, formulation of the hypothesis. choice of method.)<br>Writing the theoretical part of the article: background, literature review.<br>Description of the main results of the study-the practical part of the article.<br>Formulation of conclusions.<br>Discussion of results and conclusion.<br>Making a list of sources. |
| Scientific vocabulary and translation of scientific texts | The main stages of work on the translation.<br>Type of translation. Text analysis: genre, compositional structure of the text, type of speech, lexical and grammatical features of the text.<br>Translation strategy: taking into account the purpose of translation, text type and requirements.<br>Adequacy and / or equivalence of translation. Editing and design of the translation text.<br>Grammatical difficulties of translation.<br>Lexical difficulties of translation.<br>Stylistic difficulties of translation.<br>Paralinguistic difficulties of translation.<br>Practice of translation and interpretation of texts in the specialty on the following topics: analytical geometry; algebra and differential equations; topology; mathematical analysis; functional analysis; set theory; probability theory; mathematical statistics and methods of statistical analysis. |
| Abstracting and annotating scientific texts | Types of reading.<br>Viewing reading: headings, subheadings, headings, annotations.<br>Division of the text into chapters, paragraphs, parts, fragments.<br>Search reading: definition of genre and communica- |

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| | tive function, the main idea of the text, etc.<br>Studying reading: identifying the introduction, main body and conclusion of the text, the isolation of the primary and secondary information in each section, logical links of text.<br>Abstract reading: techniques of text compression.<br>Main abstract genres: abstract, summary, abstract, review, review.<br>The composite structure of the abstract genres.<br>Practical recommendations for the preparation of abstracts, summaries, abstracts and reviews. |
| Oral communication on scientific topics (preparation of oral reports on scientific work) | Types of reports: plenary, sectional, poster, report on the defense of dissertation research.<br>The composition of the report and the structure of scientific discourse.<br>Informative part of the report. Formulation of the conclusions of the report.<br>Discussion and debate as genres of oral scientific communication. Ways to formulate a question and types of answer to the question.<br>Ways to convey the emotional evaluation of the message: expression of agreement or disagreement, approval/disapproval, surprise, discontent, etc.<br>Extralinguistic elements of the report and visualization tools used: stand, slides, presentation, multimedia accompaniment.<br>Methods of compression presentation of information in multimedia accompaniment of the report. |

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## DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»

| **Discipline** | **Mathematical methods in Economics** |
|---|---|
| Total | 4 credits(144 hours) |
| Contents | |
| **Units** | **Topics** |
| Leontiev's model of intersectoral balance. | Leontiev's model of intersectoral balance. Statement of the problem of production productivity. |
| Productive matrices. | Productive matrices. Theorem on series expansion of the resolvent of a productive matrix |
| Frobenius-Perron theorem. | Frobenius – Perron Theorem. Properties of the Frobenius-Perron number and their economic interpretation. Indecomposable matrices and their properties. Theorem on stable matrices. |
| Theorems of nonnegative matrices. | Idempotent analogs of theorems on nonnegative matrices. The task of planning large research projects. The problem of finding arbitrage chains in the currency markets. Theorem Afriat-Veriana |
| Duality. | Linear programming problems with mixed constraints. Duality. |
| Economic interpretation of duality. | Economic interpretation of duality: labor theory of value and its critique |
| The decomposition of the resource allocation problem. | Decomposition of the resource allocation problem using Lagrange multipliers and its economic interpretation. Evaluation of the effectiveness of new technologies. |
| Economic interpretation of the maximum principle. | Economic interpretation of the maximum principle in models of optimal economic growth |
| The concept of highway. | The concept of highway. |
| The Cox-Ross-Rubinstein Model. | The Cox-Ross-Rubinstein Model. |
| Game in normal form. | Game in normal form. |
| Nash's Theorem | Nash's Theorem |

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# DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»

| **Discipline** | **Methodology of scientific research** |
|---|---|
| Total | 5 credits(180 hours) |
| Contents | |
| **Units** | **Topics** |
| Introductory section (introductory remarks) | What is the history and history of mathematics in particular? Their immensity. General principles of research of mathematical discoveries of the past. Historical evidence. A historian of the past and a historian of the present. Possibility of the history of modern mathematics. The necessity of the history of mathematics. The difference between the history of mathematics and just history. The history of mathematics as a science from various points of view on the concept of science. Methodology of mathematics in the past and present. |
| Overview of the historical development of mathematics | Pre-Greek mathematics. Mathematics Of Ancient Hellas. Mathematics as a science in the ancient world. European mathematics in the Middle ages. Arabic mathematics. Mathematics of the Renaissance and Modern times the Development of mathematics in the XVIII century. Mathematics of the XIX century. Mathematics at the turn of the century. Mathematics of the early XX century. |
| History of the discovery of non-Euclidean geometry | Euclid's "beginnings", the 5th postulate, attempts to prove it. The works of Saccheri, Lambert, and Lagrange. Lobachevsky's works, their similarity and fundamental difference from the works of his predecessors: attempts of reasoning from the opposite, the statement about the existence of "imaginary" geometry, the solution with its help of some problems of analysis. A brief sketch of Lobachevsky's geometry (repeating the path of Lobachevsky himself). The works of Janos of Bolyai and Gauss. Further history of non-Euclidean geometries. Works of F. Klein and others. Modern approaches to the construction of Lobachevsky geometry. |

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| The history of solving algebraic equations of the 5th degree | Solving quadratic equations, equations of the third and fourth degree. Attempts to construct a General formula for solving the 5th degree equation. Abel and Galois, the history of their discoveries. Permutation, on top of the Riemannian-news and groups. Complete solution of the problem. The significance of the discoveries of Abel and Galois for the further development of mathematics. |
| History of the foundations of mathematics | A brief sketch of the history of discovery and the foundations of mathematical analysis. An essay on the history of constructing a real number. Different views on the concept of a real number. Dedekind, Peano and others.<br>Cantor and his set theory. Paradoxes, Russell's paradox. G. Frege. Leibniz, Hilbert and the Foundation program of mathematics. Discoveries of logic of the XX-th century (theorems of Goedel et al.) Axiomatic systems of set theory. Continuum hypothesis. Problems of foundations of mathematics. Attempts to resolve these issues. Constructivism and traditional set-theoretic mathematics. |

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*Faculty of physical, mathematical and natural sciences*

# DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»
(«Real, complex and functional analysis»)

| **Discipline** | **Nonlinear partial differential equations** |
|---|---|
| Total | 4 credits(144 hours) |
| Contents | |
| **Units** | **Topics** |
| Basic concept | Some applied problems in which nonlinear partial differential equations arise . Statement of the main problems for nonlinear partial differential equations. Classification of methods for studying nonlinear partial differential equations: algebraic, analytical, topological, variational, numerical methods. |
| Method of monotony | Nonlinear elliptic equations with monotone operators. Nonlinear parabolic equations with monotone operators. Nonlinear hyperbolic equations with monotone operators. |
| The method of compactness | Quasilinear elliptic equations of the second order. The Condition Of Bernstein–Nagumo. Quasilinear elliptic equations of higher order. Growth condition of subordinate nonlinear operators. Quasilinear parabolic equations. Growth condition of subordinate nonlinear operators. Nonlinear wave equations. |
| Destruction of solutions | The problem of lack of solutions for some classes of partial differential equations and inequalities. Methods of its solution: the method of trial functions, the method of comparison, the energy method. |

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*Faculty of physical, mathematical and natural sciences*

## DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»

| **Discipline** | **General theory of functional differential equations** |
|---|---|
| Total | 4 credits(144 hours) |
| Contents | |
| **Units** | **Topics** |
| Differential equations with a deviating argument. | Classification of differential equations with a deviating argument. Statement of the initial problem. The method of steps and its applicability. |
| Linear equations, differential-difference equations. | Linear equations, general properties. Characteristic quasipolynom of differential-difference equations with constant coefficients. Decomposition of the solution of a linear differential-difference equation into a series of basic solutions. |
| Equations with a deviating argument. | Stability of equations with deviating argument. N. N. Krasovsky's generalization of the second Lyapunov method. Stability on the first approximation. |
| Equations with deviating argument, quasilinear equations. | Existence of periodic solutions of the equation with a deviating argument. Periodic solutions of quasilinear equations. |
| Generalized equation of the pantograph. | Generalized equation of the pantograph. The solution of the initial problem. Behavior of solutions at infinity. |
| Variational and boundary value problems with deviating argument. | Variational and boundary value problems with deviating argument. Solvability and regularity of generalized solutions. |
| Boundary value problems for differential-difference equations. | Boundary value problems for differential-difference equations in the one-dimensional case. Reduction of the boundary value problem for the differential-difference equation on the segment to the differential equation with non-local boundary conditions. |
| Boundary value problems for strongly elliptic differential-difference equations. | Boundary value problems for strongly elliptic differential-difference equations in bounded |

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| | domains. |
| Boundary value problems for differential equations with extensions and compressions of arguments. | Boundary value problems for differential equations with extensions and compressions of the arguments of an unknown function in the one-dimensional case. Solving boundary value problems for differential equations with extensions and compressions of the arguments of an unknown function on a segment. |
| Boundary value problems for differential equations with extensions and compressions of arguments. | Boundary value problems for strongly elliptic differential equations with extensions and contractions of the arguments of an unknown function in stellar domains. Boundary value problems for strongly elliptic functional differential equations in stellar domains. |

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***Philological Faculty***

**DISCIPLINE ANNOTATION**

**Education Programs in all fields of postgraduate study**

| **Discipline** | ***Pedagogy of Higher Education*** |
|---|---|
| **Total** | **2 credits (72 hours)** |
| **Contents** | |
| **Units** | **Topics** |
| **Unit I.**<br>**Pedagogy of higher education as a field of study and academic subject area.** | 1. Pedagogy as a science, key concepts. Pedagogy of higher education in the system of pedagogical science.<br>2. Systems of higher education: comparative analyses.<br>3. Contemporary trends in higher education. Internationalization of higher education. |
| **Unit 2.**<br>**Didactics of higher education.** | 1. General aspects of didactic system.<br>2. Content of higher education (laws and regulations; main principles of selecting content). Curriculum and course syllabus.<br>3. Forms and methods of teaching. Lecture in modern higher education. Seminars, practical training, laboratory class. Project – working.<br>4. Students' individual work.<br>5. Interactive methods of teaching (discussions, case-study, training, professional simulation etc.).<br>6. ICT in modern higher education.<br>7. Monitoring and evaluation of academic performance. Point rating system. |
| **Unit 3.**<br>**Educational environment of modern university.** | 1. Faculty members' rights and responsibilities. Professional ethics.<br>2. Faculty interaction with students: case study.<br>3. Educational potential of extra-curricular activities. |

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# DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»
(«Real, complex and functional analysis»)

| **Discipline** | | **Variational analysis of differential equations** |
|---|---|---|
| Total | | 4 credits(144 hours) |
| Contents | | |
| **Units** | | **Topics** |
| 1. | Mathematical methods of analytical dynamics | Hamilton's Principle. Euler-Lagrange Equations. Hamilton equation. Some of the methods of Hamiltonian mechanics. |
| 2. | Direct and indirect variational formulations of differential equations | Gato derivative and differential. Potential operators. Helmholtz potentiality conditions. Variational multipliers. Methods of construction |
| 3. | Variational symmetries and first integrals of the corresponding Euler-Lagrange equations | The conditions of invariance of the action at Hamilton. Theorem Of E. Noether. Construction of the first integrals of equations. |
| 4. | Symmetries of equations and their first integrals | The invariance of the equations. Formulas for constructing the first integrals. Relationship of symmetries of functionals and equations. |

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# DISCIPLINE ANNOTATION

Educational program
01.06.01 « Mathematics and mechanics»
(«Real, complex and functional analysis»)

| **Discipline** | | **Variational problem** |
|---|---|---|
| Total | | 2 credits(72 hours) |
| Contents | | |
| **Units** | | **Topics** |
| 1 | A direct variation problem | Gato derivative and differential. Extreme points of the functional. Bilinear and quadratic functionals. Euler-Lagrange Equations. Symmetric, positive, and positive definite operators. The Ritz Method. |
| 2 | Potential operators and variational symmetries | Potential operators. The criterion of potentiality and the formula for constructing the functional. Conditions of potentiality of systems of ordinary differential equations with derivatives of the first order. Algebraic and geometric values of potentiality conditions. Classical Hamiltonian systems and their potentiality. Conditions of potentiality of systems of differential and integro-differential equations with partial derivatives. Variational symmetries. |
| 3 | Inverse problems of the variation calculations | Kirchhoff equations and their universal value Statement of the classical problem for the General equation and systems with derivatives of the second order. Construction of variational principles for dissipative problems. Examples. |
| 4 | Inverse problems of the variation calculations for partial differential equation | Non-existence of semi-bounded solutions of problems for some classical equations. Non-Eulerian functional classes. Constructive problem solving for a boundary value problem with a parabolic operator. Satisfaction of the criterion of generalized potentiality due to the choice of bilinear form and variational factors. E. Tanti's scheme of problem solving for equations with nonlinear non-potential operator. problems for an evolutionary operator equation with a first-order derivative in time. Hamiltonian operators. An example of the Korteweg-de Vries equation. |

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