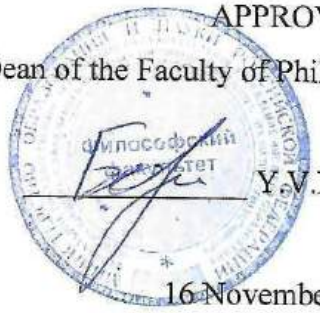
MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION

National Research Tomsk State University

Faculty of Philosophy

APPROVED by

The Dean of the Faculty of Philosophy



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16 November, 2015

Programme for the discipline

History and Philosophy of Science

Part 1 "History of Philosophy and Science (general problems)",

(for all majors and specialities)

Part 2 "Philosophy of Natural Sciences"

Specialities: Mathematics and Mechanics, Physics and Astronomy, Computer Science and Engineering, Earth Sciences, Chemical Sciences

Graduate's qualification (degree)

Researcher, Lecturer-researcher

Mode of study

Full-time (Extramural)

Status: Cluster 1 "Disciplines (Modules)"

Basic part

The programme was approved by

Educational Methodical Commission,

Faculty of Philosophy,

Tomsk State University

16 November, 2015, record No. 18

Tomsk – 2015

The programme is compiled on the basis of Federal State Educational Standard of the principal educational program of higher education for training teaching staff in graduate schools *(PhD/research studies)* covering the following specialities: Mathematics and Mechanics, Physics and Astronomy, Computer Science and Engineering, Earth Sciences, Chemical Sciences.

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PROGRAMME OUTLINE

The programme is compiled on the basis of Federal State Educational Standard of the principal educational program of higher education for training teaching staff in graduate schools *(PhD/research studies)*. The course "History of Philosophy and Science" is designed in view of requirements for the programme of PhD studies entrance examination in "History of Philosophy and Science" approved by Presidium of State Commission for Academic Degrees and Titles of Ministry of Education of the Russian Federation. The complete course comprises two parts. Part 1"History of Philosophy and Science (general problems)" – for all specialities. Part 2 The subjects discussed within "Philosophy of Concrete Sciences" are determined by graduate students' speciality. In this programme Part 2 is called "Philosophy of Natural Sciences".

The programme is recommended for preparation to take PhD studies entrance examination in "History of Philosophy and Science".

Part 1 and Part 2.1 – for specialities: Physics and Astronomy, Mathematics and Mechanics.

Part 1 and Part 2.2 – for specialities: Earth Sciences, Chemical Sciences.

1. LEARNING OBJECTIVES

The aim of the discipline "History of Philosophy and Science" is to provide a comprehensive view on "History of Philosophy and Science" by means of philosophical reflection over science and scientific cognition.

Overview of tasks:

1) to form research skills of graduate students through the study of fundamental problems of epistemology of science, preparation of graduate students to take entrance examination in "History of Philosophy and Science";

2) to raise competence in scientific work methodology;

3) to form an understanding of the nature of scientific knowledge, the position of science in modern culture, the mechanisms of functioning of science as a social institution, history of science as conceptual history.

2. PLACE OF THE DISCIPLINE IN BASIC EDUCATIONAL PROGRAM OF GRADUATE STUDENTS

The discipline "History of Philosophy and Science" belongs to the disciplines of the basic part of the curriculum. It introduces history of science, the main stages of development of science in Western culture, paradigm change of scientific rationality and forms the knowledge of the nature of science, the criteria of scientific character, the scientific research methods, the structure of scientific knowledge, the problems of truth and objectivity, the correlation of fundamental and applied knowledge in modern research, the role of values in scientific knowledge. As a result of the course acquisition graduate students are aware of

basic schools in the philosophy of science, different interpretations of scientific discourse, trends in cognitive practices, contributing to the development of independent critical thinking, necessary in the practice of scientific research.

To successfully acquire the discipline graduate students need to possess the following knowledge and skills:

- the knowledge of "Fundamentals of philosophy";
- the knowledge of cognitive theory;
- the ability to use original texts on history and philosophy of science;

3. COURSE ACQUISITION REQUIREMENTS

3.1 Competences

- the ability of critical analysis and evaluation of modern scientific achievements, production of new ideas while solving research and practical tasks including those in interdisciplinary fields (UK-1);
- the ability to project and carry out complex research including interdisciplinary ones, on the basis of holistic system scientific outlook using knowledge in the field of history and philosophy of science (UK-2).
- the readiness to participate in the work of Russian and International research teams in the sphere of solving scientific and educational tasks (UK-3);
- the readiness to use modern methods and scientific communication techniques both in the Russian and foreign languages (UK-4);
- the ability to plan and solve tasks of their own professional and personal development (UK-5).
- the ability to conduct individual research work and to obtain scientific results which meet the established requirements for the content of PhD dissertations.

3.2 Discipline acquisition requirements:

Cognitive and creative competences can be distinguished among the key competences forming in graduate students. These competences contribute to critical assessment of cognizable information and independent search of it.

The graduate student should

know:

the subject, the problem area of history and philosophy of science, the nature of modern social problems connected with functional features of this sphere of society;

– be able to answer the questions about the nature of science and common patterns of scientific knowledge in its historical development and in changing sociocultural context;

– know the main schools of philosophy of science and the key representatives of domestic and foreign philosophy of science;

– understand basic methodological and philosophical problems arising in science at the present stage of its development;

form the skills of methodological analysis in the field of theoretical and applied research.

The graduate student should

be able:

- to use basic theoretical knowledge in order to solve professional problems;
- to apply basic professional skills in practice;

possess:

information on the discipline on the level sufficient enough to be able to conduct a discussion and to defend their own point of view.

4. STRUCTURE AND CONTENTS OF THE DISCIPLINE

4.1. Total workload is 3 credits, 108 hours.

Part 1. (for all majors and specialities)

Part 2.1 – for specialities: Physics and Astronomy, Mathematics and Mechanics.

Part 2.2 – for specialities: Earth Sciences and Chemical Sciences.

No.	Section of the discipline	Semester	Week of semester	Kinds of academic work including students' individual work and workload (hours)					Forms of current control of academic performance *(weekly during semester)*
				Lectures	Lab. works	Internship	Individual work	Total	
Section 1. History and Philosophy of Science (general problems)									
1	Subject and concepts of Philosophy of Science	1		2		2	6	10	Test
2	The emergence of science and the main stages of its historical evolution	1					4	4	Test
3	Philosophy of scientific knowledge	1					4	4	Test
4	Schools of Philosophy of Science	1		2		4	6	12	Test
5	The structure of scientific knowledge	1					4	4	Test
6	The dynamics of science as a change of conceptual framework	1		2		2	4	8	Test
7	Actual problems of modern philosophy of science	1				2	4	6	Essay
8	Science in the culture of modern civilization	1					4	4	Test
	Subtotal for Part 1			6		10	36	52	Credit
Section 2.1. Philosophical problems of natural science (Mathematics, Physics, Cosmology)									
1	Modern natural-scientific picture of the world	2					4	4	Test

2	Subject, method and functions of philosophy of mathematics	2		2		2	6	10	Test
3	Philosophy and problem of substantiation of Mathematics	2		2		4	4	10	Essay
4	Philosophical, methodological and historical problems of science mathematisation	2		2		2	4	8	Test
5	Physics in the system of scientific knowledge	2					4	4	тест
6	Philosophical foundations of Physics (ontological, epistemological, methodological)	2		2		2	4	8	Test
7	Philosophical problems of Quantum Physics, and Relativistic Physics and Cosmology	2					4	4	Test
8	Physics and knowledge of complex systems	2					4	4	Test
9	Philosophical problems of Astronomy and Cosmology	2					4	4	Essay
	Subtotal for Part 2			8		10	38	56	
	TOTAL			14		20	74	108	Exam

Section 2.2. Philosophical problems of Chemistry and Earth Sciences									
1	Philosophy of Natural Sciences	2					4	4	Test
2	Chemistry as an object of philosophical analysis	2		2		2	4	8	Test
3	History of Chemistry as a problem of philosophy of science	2		2		2	4	8	Essay
4	Stages of physicalization of Chemistry	2		2		2	4	8	Test
5	Philosophical problems of Geology	2					4	4	Test
6	The problem of space and time in Geology	2		2		2	4	8	Test
7	Geology and Ecology	2					4	4	Test
8	Modelling in Geology	2					2	2	Test
9	Philosophical problems of Geography	2					4	4	Test
10	The problem of space and time in Geography	2				2	4	6	Essay
	Subtotal for Part 2			8		10	38	56	
	TOTAL			14		20	74	108	Exam

Students' individual work on the topics of the discipline lies in performance of practical tasks. In addition, individual work is subdivided into individual work

with sources, individual extracurricular work with a presentation of the results of practical tasks.

4.2 Content

Part 1. History and Philosophy of Science (general problems)

No.	Section title	Content of section
1	Subject and basic concepts of Philosophy of Science	**1.1. Philosophy of Science.** Science as a system of knowledge, science as a field of knowledge (theoretical activity), science as a social institution and a special sphere of culture. Science as a theory of objectivity (Martin Heidegger). Science as an intellectual sense of nature (Gottfried Spengler). Science as an activity aimed at production of new knowledge (Vjacheslav Stepin). Structure of scientific revolutions. Science as the totality of true propositions (Ludwig Josef Johann Wittgenstein). Science as the totality of true propositions. Science and Religion. Can one believe in God and accept evolution. Science and Art. Art and scientific investigation in early-European art. The science of color in 19th century painting. Art and Science of the 20th century. Opposition: science and antiscience. Types of scientific knowledge (physical, biological, mathematical, humanitarian). The criteria of scientific character – the totality of a set of attributes which specify scientific knowledge; a number of requirements which science must satisfy: objectivity, experience, experiment, repeatability, reliability, intersubjectivity. **1.2. Subject of Philosophy of Science.** The subject of philosophy of science is common patterns and trends of scientific cognition as a special activity for production of the scientific knowledge. Review of the functions of science in social life. Interdisciplinarity as a theme of philosophy of science (Vladimir Porus). Intersections of methods. The structure of interdisciplinary knowledge. The main aim of philosophy of science. The range of problems of philosophy of science. The problem of scientific knowledge growth as the central problem of philosophy of science. **1.3. Conceptual model of philosophy of science.** Systemic integrity of the following aspects of knowledge: logic and methodology of science, history of science, sociology of science (cognitive sociology), cognitive psychology, philosophy of technique. Models of philosophy of science are the history of evolution of the conceptual framework. An individual is a subject of scientific activity.
2	The emergence of science and the main stages of its historical evolution	**2.1. Genesis of science.** The scientific programs of antiquity (Democritus, Plato, Aristotle). Scientific knowledge in the Middle Ages, the doctrine of scholasticism. The origin and development of classical science. **2.2. Formation of classical science in the New Era.** The becoming of science of the New Era as the formation of object, subject and method. Copernicus' heliocentric cosmology. Philosophical significance of Copernican Revolution. The becoming of science as a social institution (Francis Bacon, René Descartes). The becoming of experimental science, preconditions for the emergence of experimental method, the connection with mathematical description. The formation of scientific method (Galileo Galilei, René Descartes, Isaac Newton, Johannes Kepler). Stages of development of science: classical, non-classical, post-nonclassical paradigms (Vjacheslav Stepin). The difference between classical and nonclassical methods.

3	The philosophy of scientific knowledge	**3.1. Evolution of visions of human cognitive activity.** General visions of the nature of knowledge. The classification of forms of knowledge: ordinary, mythological, religious, artistic, philosophical, scientific. Activity, analytical and semantic approaches to knowledge. The specificity of scientific cognition. Basic procedures of cognitive activity: representation, interpretation, convention. The main conclusions of modern philosophy of knowledge. **3.2. Epistemological practices.** The contemplative model of knowledge as a cognitive practice of antiquity. Hermeneutic model of knowledge as a cognitive practice in the Middle Ages. Kant's revolution in epistemology. Representative model of knowledge. The activity theory of knowledge. Projectively constructive model of knowledge. The interactive model of knowledge. Evolutionary epistemology. **3.3. Science and Philosophy in the New Era.** Empiricism and rationalism of solving the problem of sources of knowledge. The dilemma "sensible - rational" - the problem field of epistemology of the New Era. Empiricism (Francis Bacon, John Locke, George Berkeley, David Hume). Rationalism (René Descartes, Gottfried Wilhelm Leibniz). Gnoseological transcendentalism as a way to solve gnoseological problems (Immanuel Kant)
4	School of Philosophy of Science	**4.1. Positivism.** Stages of development of positivism: classic positivism (Herbert Spencer, Marie Auguste François Xavier Comte, John Stuart Mill); physical positivism (Ernst Mach); logical positivism (Friedrich Albert Moritz Schlick, Rudolf Carnap, Friedrich Ludwig Gottlob Frege, Bertrand Arthur William Russell). Positivism as the first school of philosophy of science. Postpositivism and its vision of science. Critical rationalism of Karl Raimund Popper. The theory of falsifiability, criticism as the main scientific setting. Hypothesism and fallibilism. Truth and objectivity as the values of scientific knowledge. The concept of the three worlds and the notion of "Epistemology without a knowing subject". Phenomenology. The phenomenological theory of cognition (Edmund Husserl). Language in the philosophy of knowledge. Linguistic vision of the world. Language as a means of building and development of science. **4.2. T. Kuhn and the concept of scientific revolutions.** The notion of paradigm. The history of science is a change of normal and revolutionary periods in the development of science. The main directions of criticism of T. Kuhn's concept. Heuristicity of Kuhn's conception for the sociology of science. Imre Lakatos about methodology of research programs. The concept of mature falsificationism. Discussion about the possibility of a decisive experiment, heuristicity of Imre Lakatos' methodological concept and its discussion. Stephen Edelston Toulmin and the search for new scientific rationality. The problem of understanding as the problem of natural science cognition. The connection between the problem of understanding and the problem of rationality. Values and Science (Larry Laudan). Michael Polanyi's concept of personal knowledge. Paul Karl Feyerabend's criticism of the basic settings of the classical scientificity – objectivism, universalism, rationalism. Paul Karl Feyerabend's criticism of the theory of scientific method. **4.3. Sociology of Science. Science as a social institution.** Two areas of research in the philosophy of science: the social structure of science and its ethos, the use of a sociological approach to the study of scientific knowledge. Social epistemology. Michael Mulkay's Sociology of science and view change on science. Formation of foundations of sociological science analysis as a special social institution (Robert King Merton). The notion of scientific ethos. Post-Merton period of sociology of scientific knowledge (Barry Barnes, David Bloor, Karin Knorr-Cetina , Bruno Latour).
5	The structure of scientific	**5.1. Empirical and theoretical levels of scientific cognition. Methods and forms of empirical level.**

	knowledge	Observation and experiment as the methods of empirical level of cognition. Specificity of scientific observation. The experiment as the main method of scientific research. Experiment and observation: similarities and differences. The role and functions of the theoretical knowledge in implementation and interpretation of experiment. The notion of empirical object and empirical scheme. Fact as the basic form of empirical level of scientific knowledge. Facts of reality and facts of science. Formation of the scientific fact. Theoretical content of the fact. **5.2. Methods and forms of theoretical level of scientific cognition.** Problem, hypothesis, theory and law as the basic forms of the theoretical level of cognition. The structure of a scientific theory: the system of theoretical objects, mathematical apparatus, the connection between theoretical objects. The system of rules of interpretation. The notion of scientific law: the laws of nature and the laws of science. The principle of symmetry as a methodological principle, "the law of laws". **5.3. Basic cognitive functions of science.** The notion of sense and meaning of linguistic expressions. The semantic structure of language and its relation to reality. Understanding as the interpretation and as a method of understanding the sense. The principles of interpretation in science. Prediction, foresight and prognosis in science.
6	The dynamics of science as a change of conceptual framework	**6.1. Growth and development of scientific knowledge.** The basic ideas of the classical ideal of scientificity: fundamentalism, reductionism, universalism. The socio-cultural conditioning of scientific cognition. Internalism and externalism in epistemology. The concepts of objective growth of knowledge (K. Popper, I. Lakatos, S. Toulmin). R. Merton: social theory and social structure, sociological ambivalence. Thomas Samuel Kuhn: structure of scientific revolutions. **6.2. The philosophy of science of the dynamics of scientific rationality. Non-classical paradigm of scientific rationality.** The criteria for distinguishing between classical, non-classical and postnonclassical scientific rationality. Werner Karl Heisenberg's uncertainty principle. Niels Henrik David Bohr's principle of subsidiarity and its general scientific nature. **6.3. The concept of post-nonclassical science, its characteristics.** Postnonclassical stage in the development of science. Computerization of science, growth of interdisciplinary research, humanization of scientific research. Self-developing systems as the object of postnonclassical science. The idea of global evolutionism and the idea of systematicity as the fundamental ideas of the foundations of postnonclassical science. Evolutionary-synergetic paradigm as the core of postnonclassical science. Evolutionary epistemology as a cognitive practice which is adequate in cognition of the objects of postnonclassical science. Specificity of postnonclassical rationality. The transformation of the concept "knowledge" in postnonclassical science.
7	Urgent problems of modern philosophy of science	**7.1 The problem of objectivity of scientific knowledge.** Truth in scientific cognition. The concepts of truth: classical (correspondent), coherent and pragmatic. Tarski's theory of truth. Realism and truth. Deflationism. Truth and language. Truth and theory of meaning. **7.2. The problem of scientific rationality.** The forms of philosophical rationality. Theories of scientific rationality. The dynamics of scientific rationality. The criteria for distinguishing between classical, non-classical and postnonclassical scientific rationality. **7.3. Scientific realism and relativization in scientific cognition.** Scientific realism. Arguments for and against scientific realism. Antirealism. The concept of scientific realism as the most important setting of scientific outlook. Relativism and relativization as an objective characteristic in the development of scientific cognition. Types of relativism: personalistic, cognitive and cultural. Scientific realism (hypothetical realism) and "naturalistic turn" in contemporary epistemology.
8	Science in the culture of modern civilization	The place of science in modern civilization. The functions of science in social life (science as an ideology, as the productive and social force). Science and economy. Science and authority.

4.3. Content

Part 2. Philosophy of Natural Sciences.

Part 2.1 Philosophy of Mathematics, Physics and Cosmology.

No.	Section title	Content of section
1	Philosophy of Natural Sciences	1.1. Natural philosophy or the philosophy of nature. What is the philosophy of nature? The notion "world view". World view as the link between scientific and philosophical reflection. 1.2. Forms of organization of knowledge in philosophy of natural sciences: natural philosophy, philosophical realism, scientific outlook, style of thinking. Interdisciplinary research in modern science.
2	Mathematics: specificity, place in the structure of science	2.1. Subject area of Philosophy of Mathematics. Definition of philosophy. The spread of meanings. The functions of philosophy in their relation to Mathematics. The philosophy in mathematics. Findings and evaluation. 2.2. Specificity of the mathematical knowledge. The mathematical object as an abstraction of abstraction. Mathematics as the science of the relations. The problem of freedom of mathematical creativity. 2.3. The mathematical reality. Sign and meaning. The problem of mathematical object's existence. The concept of Carnap's linguistic frameworks and two languages of Mathematics. Mathematics and the objective world. Pythagorean syndrome. 2.4. Mathematics in the sciences. The principle of the dichotomy of knowledge. Mathematics as a language of science. Mathematical methodology. Mathematics as a source of notions and concepts in natural science.
3	The philosophical foundations of Mathematics	3.1. The problem of the foundations of mathematics and its solution by logicism. The notion of the foundations of Mathematics. Logicism program. A reason for failure. Philosophical evaluation. 3.2. The program of intuitionism and its constructive branch. Intuitionists' criticism of the foundations of logicism and the problem of infinity. Intuitionists' alternative. Limitation of intuitionism. Constructive branch. 3.3. Formalistic justification of mathematics. Policy statement. The concept of absolute proof and formalized axiomatic method. Gödel's results. 3.4. Current state of the problem of justification. The inquiry results. New approaches. Justification in the light of evolution of mathematics.
4	Mathematical truth: status, structure, criteria guidelines	4.1. Specificity of truth in Mathematics. Truth in formalized languages. The criterion of deducibility and the notion of correctness. Mathematics and the methods of scholasticism. 4.2. Deductive systems. A mathematical proof. Principles of construction of deductive theories. The criteria for "external" justification. 4.3. Criteria guidelines of mathematical search. Secondary indicators of truth. Criteria of "internal perfection". The probabilistic nature of the secondary criteria.
5	Place of physics in the sciences	5.1. Natural history, culture, development of technology and social life of society. Physics as the foundation of science. Ontological, epistemological and methodological foundations of fundamentality of physics. Specificity of methods of physical cognition. The problem of fundamentality of physics and opposition reductionism vs. antireductionism. Interpretation of reductionism. Physics and synthesis of natural science and the humanitarian knowledge. The role of synergetics in this synthesis.
6	Ontological problems of Physics	6.1. The notion of the ontology of physical knowledge. The ontological status of the physical world view. The evolution of the physical world view and changes in the ontology of physical knowledge. Stages of development of physical knowledge (mechanical, electromagnetic and modern quantum relativistic world view). Particles and fields as the fundamental abstractions

		of modern physical world view and the problem of their ontological status. The ontological status of virtual particles. The problem of classification of fundamental particles. Types of interactions in physics and the nature of interactions. The Standard Model of fundamental particles and interactions, and its conceptual difficulties. Physical vacuum and the search for a new ontology.
7	Quantum Mechanics and objectivity of scientific knowledge	7.1. Features of quanta-mechanical description of reality as the gnoseological foundation of the denial of ideals of objectivity and truth of scientific knowledge. Objectivity as the objectivity of quantum-mechanical description of reality. Objectivity as the adequacy of the quantum theory. Quantum mechanics as a universal theory applied to all the phenomena of reality. 7.2. The problem of space and time in classical mechanics. The Copernican system of the world and becoming of Galilei-Newtonian concepts of space. The notion of inertial system and Galilei 's principle of inertia. The notions of the covariance of the laws of mechanics and absolute space. Philosophical and religious background of the concept of absolute space and the problem of its ontological status. Theoretical, experimental and methodological background of the transition from mechanical to electromagnetic world view. The special and general relativity theory of Einstein as modern concepts of space and time. The substantial and relational concepts of space and time. Observer's role in relativistic physics. The problem of the relation of space-time continuum and gravitational field. The space manifesting time and vacuum. The concept of the geometrization of physics at the present stage. Interpretation of interactions in the framework of the theory of calibration fields. The topological properties of space-time and the fundamental physical interactions. 7.3. The concept of determinism and its role in the physical cognition. Determinism and causality. Discussions about the nature of causal relations (David Hume, Auguste Comte, Bernard Russell, Rudolf Carnap, Karl Popper). The idea of existence of two levels of causal relations: visual and theoretical causality. Causality and expediency. The notion of target synergetics. The notion of "light cone" and relativistic causality. The problem of determinism in classical physics. The concept of unequivocal determinism. Statistical patterns and probability distributions in classical physics. The probabilistic nature of the laws of the microworld. Probability in classical and quantum physics. The concept of probabilistic causality. The concept of Karl Popper, Niels Bohr and Werner Heisenberg. Change in perceptions of the nature of physical laws due to the concept of "Big Bang" in cosmology and the formation of synergetics. Causality in open nonequilibrium systems.
8	Physics and the notion of complex systems	Systemic ideas in physics. Perception of physical objects as systems. Simple mechanical systems, systems with feedback and systems with self-improvement. The contradiction between classical thermodynamics and evolutionary biology and the concept of self-organization. Ilya Prigogine's thermodynamics of open nonequilibrium systems. The status of the concept of time in mechanical systems and the systems with self-development. The irreversibility of the laws of nature and the "the arrow of time". Synergetics as a source of evolutionary ideas in physics. Deterministic chaos and evolutionary problems.
9	Philosophical problems of astronomy and cosmology	The uniqueness of the Universe. The concept of the Big Bang. The Universe in space and time. The question of the Universe origin. The Universe as a basis for existence. The genesis of the Universe in the vacuum world view: physical and philosophical aspects. The concept of multiple universes. Self-organization in the Universe. The theory of elementary particles and the principle of expediency. The anthropic principle: strong, weak, finalistic. Life and mind in the universe as constituents of its evolution. Individual and the Universe, in the context of universal evolutionism.

Part 2.2 Philosophical problems of Chemistry and Earth Sciences

No.	Section title	Section content
1	Philosophy of Natural Sciences	1.1Natural philosophy or the philosophy of nature. What is the philosophy of nature? The notion "world view". World view as the link between scientific and philosophical reflection. 1.2Forms of organization of knowledge in philosophy of natural sciences: natural philosophy, philosophical realism, scientific outlook, style of thinking. Interdisciplinary research in modern science.
2	Chemistry as an object of philosophical analysis	The subject of Chemistry: its specificity and historical retrospective. The substance as a subject of Chemistry. Conceptual systems of Chemistry and their evolution. The place of Chemistry among the other natural sciences.
3	History of Chemistry as a problem of philosophy of science	3.1. Practical human activity and the emergence of chemistry. Chemistry of the 19th century: formation of the initial system of concepts. The terms "chemical atom", "chemical bond" and "chemical compound" as central idealizations of Chemistry. John Dalton: father of chemical atomism. Investigation of gas mixtures. Antoine Lavoisier's oxygen theory. Acid, its theoretical properties. Metal as chemical idealization and a simple substance. The notion of "chemical element", its characteristics. Robert Boyle as the founder of scientific analytical chemistry. The notion of "chemical analysis". Dmitri Mendeleev: discovery of the periodic table. Philosophical and methodological significance of Mendeleev's discovery. Alexander Butlerov: formation of organic chemistry. The notion of "structure", dependence of the properties of matter on the structure. Philosophical and methodological significance of Butlerov's discovery. 3.2. Quantum Chemistry as a stage of non-classical chemistry: review of the original categorical apparatus. The notion of physical-chemical atom. Physical models as the foundation of determination of chemical bonds. The link between Periodic Table and quantum-mechanical theory of atoms. Fritz Paneth: two layers of a chemical element. The emergence of the physical and chemical analytical Chemistry. The notion of chemical bond as the central concept. Chemical kinetics: individuality of chemical reactions. Charles Coulson: specificity of theoretical knowledge in Chemistry. The notion of natural kind. 3.3. Postnonclassical chemistry: transition from structural theories to self-organization. Stages of the theory of self-organization.
4	Stages of physicalization of Chemistry	4.1. The first stage is the penetration of physical ideas into Chemistry. The transition from the notion of force to the concept of chemical affinity. The second stage is the penetration of physical laws into the chemistry. The emergence of chemical thermodynamics. Helmholtz, van't Hoff, Gibbs: method of thermodynamic potentials. Chemical thermodynamics and electrochemistry. Physical chemistry. The third stage is the physical description and explanation of chemical bond and chemical interaction. Heitler and London. Quantum chemistry. 4.2 The practical significance of modern chemistry. The direct connection of Chemistry with technology and industry. Chemistry as a "science of manufacturing" (Nikolai Semenov). "Big Chemistry".
5	Philosophical Problems of Geology	The philosophy of the nature of the geological knowledge. The specificity of philosophical problems of Geology. The place of Geology in modern classification of sciences. The geological world view and its reflection in the geological reality.
6	The problem of space and time in Geology	The notion of geological "space and time." Vladimir Vernadsky and his "geochemical principle of allocation of terrestrial shells". The boundaries of Biosphere and Noosphere, according to Vernadsky.
7	Geology and Ecology	The notion of "environmental geology" in the modern scientific world view. The border nature of Geology as an Earth Science. The link between

		Geology, Natural Sciences and Humanities. Consistency as the quality of modern geological research.
8	Modelling in Geology	Modeling as a method of scientific research in Geology. Possibilities of synergetic approaches in modern Geology.
9	Philosophical problems of Geography	The notions "geographic reality," "geographic motion mode of matter," "geographic shell of the Earth," "geographic environment", "landscape", "landscape area" and "natural system". The ontological status of geographical objects and criteria of the reality of their existence.
10	The problem of space and time in Geography	Ordinary understanding of space and time and its importance in today's Geography. Alfred Hettner's chronological concept and Konstantin Markov's metachronous concept. Vernadsky's ideas of space and time as the properties of empirically studied processes. Synergetic Paradigm and its importance for Geography.

5. EDUCATIONAL TECHNOLOGIES

The following educational technologies can be applied while studying the discipline:

- the use of interactive equipment (projector, interactive board) at lectures;
- seminars with discussions of the issues given in the themes of discipline; colloquia which include organized presentations and discussions on the selected issues and sources.
- individual work which is necessary for acquisition and consolidation of the knowledge on history and philosophy of science.

6. ASSESSMENT TOOLS FOR CURRENT CONTROL OF PROGRESS AND INTERIM ASSESSMENT

While teaching the discipline "History and Philosophy of Science" current and summative progress assessment is applied. The current assessment is organized by means of students' work on preparation for seminars and colloquia which involves individual work with the recommended sources, analysis and processing of information.

Individual work of students is aimed at:

- intensification of their educational and cognitive activities;
- development and accumulation of skills and abilities to work with philosophical texts.

Part 1. Themes of practical classes

1. Philosophy of science as philosophical knowledge or is it a "no man's land" between philosophy and science? The subject of philosophy of science. The nature of science, images of science.
2. Schools in philosophy of science: Positivism, School of Historians of Science, School of Sociology of Science.

3. The dynamics of science in culture. Ancient science (episteme); science of the Middle Ages (doctrinal knowledge); modern science (classical science); from the end of the 19th century to the beginning of the 20th century – the formation of non-classical scientific paradigm; the second half of the 20th century – the formation of postnonclassical scientific paradigms.
4. The problem of truth and objectivity of scientific knowledge. The problem of scientific rationality. Scientific realism and relativization in scientific knowledge.
5. Science in technogenic culture. Computerization of science, combination of science with economics and industry, dissemination of multidisciplinary research and integrated research programs. Technoscience.

Themes of practical classes. Part 2.1

1. The subject of philosophy of Mathematics.
2. Philosophical foundations of Physics.
3. Philosophical problems of quantum physics and the theory of relativity.

Themes of practical classes. Part 2.2

1. Chemistry in the system of scientific knowledge.
2. Philosophical foundations of Geology.
3. Philosophical foundations of Geography.

Sample exam questions for Part 1.
History of Philosophy and Science (general problems)

1. The subject of philosophy of science. Conceptual model of philosophy of science.
2. Science in the culture of modern civilization.
3. The boundaries of science. Science and Philosophy. Science and Religion. Science and Art.
4. Science and non-scientific forms of knowledge. Science and antiscience, quasi-science, pseudo-science.
5. Socio-cultural preconditions for the emergence of the experimental method.
6. Types of scientific knowledge (physical, biological, mathematical, humanitarian).
7. Empiricism and rationalism on the sources of knowledge.
8. Positivism as a theory of cognition: the stages of development of positivism.
9. The subject of methodology of science.
10. Empirical and theoretical levels of scientific knowledge and criteria for their distinguishing.
11. Observation and experiment – the procedures of formation of scientific fact.
12. The theoretical level of scientific knowledge: hypothesis, theory and the laws of science.
13. Formalization, idealization, modeling and mathematization – methods of theoretical level of science.

14. The notion of scientific world view and scientific paradigm.
15. Philosophical foundations of science. Ideals and norms of scientific research.
16. The cumulative model of science. Criteria of scientific character.
17. Karl Popper's critical realism.
18. School of Historians of Science on the nature of science (I. Lakatos, P. Feyerabend).
19. School of Historians of Science (S. Toulmin, J. Polanyi).
20. T. Kuhn on the development of science and scientific revolutions.
21. Types of scientific rationality, its historical forms.
22. Non-classical science. The principle of subsidiarity.
23. Explanation and understanding in scientific cognition.
24. Postnonclassical science: its basic principles, ideas and theories.
25. Evolutionary-synergetic paradigm as the core of postnonclassical science.
26. Truth in scientific cognition. The problem of objectivity of scientific knowledge.
27. Science as a social institution. Science and power.
28. Science in the context of technological civilization.
29. Science and values. Ethos of science.
30. Genesis of science. Greeks' episteme. The scientific programs of antiquity (Democritus, Plato, Aristotle).
31. The becoming of modern science. Subject and object of classical science.
32. History of science a change of conceptual framework (classical, nonclassical and postnonclassical scientific rationality).
33. The becoming of science as a social institution (F. Bacon, R. Descartes).
34. The formation of scientific method (G. Galilei, J. Kepler).
35. Formation of the object of modern science (N. Copernicus, I. Newton).

Sample exam questions for Part 2.1

1. The specificity of the subject area of philosophy of mathematics.
2. Basic philosophical problems of mathematical cognition.
3. The link between mathematics and other sciences.
4. The problem of ontological status of mathematical object.
5. Realism, conceptualism and nominalism in Mathematics.
6. The problem of substantiation of Mathematics. The program of logicism.
7. The problem of substantiation of Mathematics. The program of intuitionism.
8. The problem of substantiation of Mathematics. The program of formalism.
9. The concepts of actual and potential infinity in Mathematics.
10. The crises in the history of Mathematics.
11. The crisis of Euclidean geometry and philosophical system of I. Kant.
12. Truth in mathematical cognition: the correspondence and coherence theories.
13. Philosophy of Mathematics today: problems, approaches and solutions.
14. Logic and intuition in mathematical cognition.
15. The specificity of natural science in relation to philosophy.

1. Physics and the nonlinearity. Features of synergetic paradigm.
2. The physical world views (mechanistic, electromagnetic and quantum-relativistic).
3. The specificity of astronomical cognition.
4. The problem of reality in Philosophy and Physics.
5. The problem of objectivity in modern Physics.
6. The problem of determinism in Physics.
7. Evolution of the visions on space and time in physics.
8. The structure and function of a physical theory. The problem of observability in Physics.
9. Quantum-relativistic world view and Philosophy.
10. The problem of completeness of the reality description in quantum physics. Einstein-Bohr debate.
11. The subject of Philosophy of Physics.
12. The anthropic principle and its worldview and methodological significance.
13. Classical and non-classical physics. The crisis in physics at the turn of XIX - XX centuries.

Sample exam questions for Part 2.2.

1. Conceptual levels of Chemistry and its main problem.
2. Status of philosophical and methodological research in the field of Chemistry.
3. Antique Chemistry. Features of schematization of handicraft practice.
4. The idea of transmutation of elements, genotype of alchemy and its evaluations.
5. Main stages of development of alchemy and the features of its prescribed knowledge.
6. R. Boyle's chemical program and its evaluations.
7. G. Stahl's phlogiston program; its reverse side and importance for development of scientific chemistry.
8. Lavoisier's Oxygen theory and the first scientific classifications.
9. Formation of the first scientific picture of the chemical reality. Proust-Berthollet debate within the boundaries of the picture of chemical reality.
10. Search for fundamentals of Chemistry and the role of D. Mendeleev.
11. Differentiation of chemical knowledge. Physicalization of Chemistry.
12. Formation of quantum-chemical program.
13. Current state and prospects of Chemistry development. Nanochemistry.

15. The specificity of Natural Sciences in relation to Philosophy. The place of Geography in the classification of sciences: genetic, structural and disciplinary, and interdisciplinary approaches.

1. The problem of space and time in Geography.
2. Synergetic Paradigm and its importance for Geography.
3. Geographic environment – general characteristics: the genesis of visions, historical character, and its role in the socio-economic dynamics.
4. Vernadsky's geochemical doctrine of biosphere and noosphere.

5. The structural organization of biosphere, its borders, the possibility of transition to noosphere – a modern view on the problem.
6. Different interpretations of noosphere – philosophical aspect.
7. Geography as human ecology: natural and ecological, and socio-ecological aspects of the problem.
8. The place of Geology in the genetic classification of sciences.
9. The problem of space and time in Geology.
10. The principles of historicism and development in Earth Sciences.
11. The interaction of sciences while studying the Earth – the problems of interdisciplinary synthesis.
12. Natural science as a unified science of nature. The place and role of natural sciences in social life.

7. EDUCATIONAL AND METHODICAL, MATERIAL, TECHNICAL, AND INFORMATION SUPPORT

Literature used for Part 1

a) Main List:

1. Feyerabend P. Philosophy of Science: A Subject with a Great Past. URL: http://mcps.umn.edu/assets/pdf/5.8_Feyerabend.pdf, Retrieved September 25, 2015.
2. Feyerabend, Paul K.: Knowledge, Science and Relativism, Retrieved September 20, 2015http://www.contraversus.net/uploads/6/7/3/6/6736569/feyerabend_p._1999._philosophical_papers_vol.3._knowledge_science_and_relativism.pdf, Retrieved September 15, 2015
3. Philosophy of Science History. Source URL: https://explorable.com/history-of-the-philosophy-of-science, Retrieved September 15, 2015
4. The Internet Encyclopedia of Philosophy (IEP) (ISSN 2161-0002) URL: http://www.iep.utm.edu/home/about/
5. Stanford Encyclopedia of Philosophy URL: http://stanford.edu/index.html. Retrieved September 15, 2015
6. Philosophy of science Retrieved September 15, 2015, URL: http://web.stanford.edu/class/symsys130/Philosophy%20of%20science.pdf
7. Nonclassical Science? URL: http://www.thur.de/philo/project/ncscience.htm Retrieved October 25, 2015
8. Ladyman, James. Understanding philosophy of science. London and New York. This edition published in the Taylor & Francis e-Library, 2002.
9. Spirkin, Alexander. 1983. "Philosophy as a World-view and a Methodology". *Dialectical Materialism*. Moscow: Progress Publishers/ http://www.marxists.org/reference/archive/spirkin/works/dialectical-materialism/index.html

10. Kuhn, Thomas S. The Structure of Scientific Revolutions. URL: http://projektintegracija.pravo.hr/_download/repository/Kuhn_Structure_of_Scientific_Revolutions.pdf
11. Philosophy and methodology of science. The textbook for Post-graduate students and Masters. Ed. by A.I. Zelenkov, 2011.
12. Philosophy as Methodology https://www.marxists.org/reference/archive/spirkin/works/dialectical-materialism/ch01-s03.html

b) Additional List:

1. Butterfield J., J. Earman (eds.) Philosophy of Physics. Elsevier. 2007. – 24 p.
2. Faye J. The Nature of Scientific Thinking: On Interpretation, Explanation and Understanding. Palgrave Macmillan, 2014. - 348 p.
3. Faye J. Rethinking Science: A Philosophical Introduction to the Unity of Science. Ashgate, 2002 r. - 219 p.
4. Hempel, C.G. Philosophy of Natural Science. Pearson, 1966.
5. Chalmers, A.F. What Is This Thing Called Science?, 4th edition. Hackett, 2013.
6. Cornelius Benjamin A. Is the Philosophy of Science Scientific? // Philosophy of Science Vol. 27, No. 4 (Oct., 1960), pp. 351-358ıo
7. Gillies D, D.L Hull. Philosophy of Science // Philosophical Books, 2003, Vol.44(1), pp.92-96
8. Godfrey-Smith, P. Theory and Reality: An Introduction to the Philosophy of Science. University of Chicago Press, 2003.
9. Herron John P.. Science and the social good : nature, culture, and community, 1865-1965. Oxford: Oxford University Press, 2010. – 280 p.
10. World Congress of Philosophy. Philosophy of science. Boston. Bowling Green. Philosophy Documentation Center, Bowling Green State University 2001. 245 p.
11. Philosophy of social science / Alexander Rosenberg. - 3rd ed. http://www.bou.ac.ir/Portal/File/ShowFile.aspx?ID=28d09d78-8724-432d-888f-b70dcefb1d80

Literature used for Part 2.1

Recommended sources on Philosophy of Natural Sciences (Mathematics, Physics, Cosmology)

a) Main List:

1. Physics and Philosophy. The Revolution in Modern Science. URL: http://www.naturalthinker.net/trl/texts/Heisenberg,Werner/Heisenberg,%20Werner%20-%20Physics%20and%20philosophy.pdf
1. Batterman, Robert W. Physics–Philosophy: Handbook of philosophy of physics, 2013

2. Philosophy of Physics (Handbook of the Philosophy of Science) 2 volume Edition by Jeremy Butterfield (Editor), John Earman (Editor), Dov M. Gabbay (Series Editor), Paul Thagard (Series Editor), John Woods (Series Editor).URL: http://pitt.edu/~jearman/ButterfieldEarman_2007PhilosophyOfPhysics_PartA.pdf
3. George F R Ellis. Issues in the Philosophy of Cosmology. University of Cape Town, Rondebosch, Cape Town 8001, South Africa.
4. Vernadsky V.I. Scientific Thought as a Planetary Phenomenon./ Translated from Russian by B.A.Starostin. - Moscow, Nongovernmental Ecological V.I.Vernadsky Foundation, 1997.- 265 pp.
5. Ellis, George On the philosophy of cosmology URL:http://www.mth.uct.ac.za/~ellis/philcosm_18_04_2012.pdf
6. Zinkernagel, Henrik Philosophical aspects of modern cosmology // Published as the introduction to Studies in History and Philosophy of Modern Physics 46 (Special Issue on Philosophy of Cosmology), 2014, pp. 1-4.

b) Additional List:

1. Bundy, A. Discovery and reasoning in mathematics / Scotland : Department of Artificial Intelligence: University of Edinburgh.1985. – 266 p.
2. Cheng T.– P. Relativity, Gravitation and Cosmology: A Basic Introduction (Oxford Master Series in Physics) / Ta– Pei Cheng. – Oxford: Oxford University Press, USA; 2 edition, 2010. – 400 p.
3. Hacking, I. Why is there Philosophy of Mathematics AT ALL? // South African Journal of Philosophy. - *2011.* - №30ю – pp.1-15.
4. Marion, M. Wittgenstein, finitism, and the foundations of mathematics / Oxford : Clarendon , 1998. – 260 p.
5. Sternberg, R. J ; Ben-Zeev, Talia. The nature of mathematical thinking / Mahwah, NJ: L. Erlbaum Associates, 1996. – 335 p.
6. Hart, W. D. The philosophy of mathematics / Oxford: Oxford University Press, 1996. – 316 p.
7. Irvine, A. D. Philosophy of mathematics. / London: Elsevier, 2009. – 717 p. Jeremy Butterfield & John Earman (eds.) Philosophy of Physics. Elsevier. 2007. – 24 p.
8. Lewis, D. Papers on Metaphysics and Epistemology. Cambridge: Cambridge University Press, 1999. – 245 p.
9. Lawrence Sklar. Philosophy of Physics. Westview Press, 1992 - 246 p.
10. Lawrence Sklar. Philosophy and Spacetime Physics. University of California Press, 1985. - 335 p.
11. Lawrence Sklar. Physical Theory: Method and Interpretation. Oxford University Press, 2014. - 304 p.
12. Lawrence Sklar. Physical Theory: Method and Interpretation. Oxford University Press, 2014. - 304 p.
13. Meinard Kuhlmann, Wolfgang Pietsch. What Is and Why Do We Need

Philosophy of Physics? // Journal for General Philosophy of Science, Vol. 43 (2), 2012. P. 209-214.
14. Michael Tooley. Time, Tense, and Causation. Clarendon Press, 2000 - 403 p.
15. Strawson, P. F. Analysis and metaphysics an introduction to philosophy. Oxford: Oxford University Press 1992. - 144 p.
16. Book Review of Ernest, P., Social constructivism as a philosophy of mathematics.Albany, New York: State University of New York Press, 1998. – 315 pp. (including 36 pages of bibliography and index). ISBN 0-7914-3588-1 (pbk.)

Literature used for Philosophical problems of Chemistry and Earth Sciences

a) Main List:

1. Brakel, Jaap van Philosophy of Science and Philosophy of Chemistry. HYLE--International Journal for Philosophy of Chemistry, Vol. 20, No. 1 (2014), pp. 11-57. URL: http://www.hyle.org/journal/issues/20-1/vanbrakel.htm
2. Philosophy of Chemistry/ URL:http://plato.stanford.edu/entries/chemistry/#toc
Philosophy of geology URL: http://www.aughty.org/pdf/philosphy_geology.pdf
3. Thrift, Nigel Space: The Fundamental Stuff of Human Geography
4. Couclelis, H Space, time, geography, URL: http://www.geos.ed.ac.uk/~gisteac/gis_book_abridged/files/ch02.pdf
5. Stuart Aitken and Gill Valentine Approaches to Human Geography Philosophies, Theories, People and Practices
6. Achille C. Varzi Philosophical Issues in Geography—An Introduction
New York, USA. URL: http://www.columbia.edu/~av72/papers/Topoi_2001.pdf

b) Additional List:

1. Carroll S. From Eternity to Here: The Quest for the Ultimate Theory of Time / Sean Carroll : Dutton Adult; First Edition edition 2010. – 448 p.
2. Drexler J. Discovering Postmodern Cosmology: Discoveries in Dark Matter, Cosmic Web, Big Bang, Inflation, Cosmic Rays, Dark Energy, Accelerating Cosmos / Jerome Drexler, 2008. – 292 p.
3. Grandpierre A. The Dynamics of Time and Timelessness: Philosophy, Physics and Prospects for our Life / Attila Grandpierre [Электронный ресурс]. – Режим доступа: http: // www. konkoly.hu/ staff /grandpierre / NATO_ARW.html.
4. Moles, A. Nietzsche's philosophy of nature and cosmology. New York : Peter Lang, 1990. – 434 p.
5. Leslie, J. Modern cosmology and philosophy / Amherst, N.Y. : Prometheus Books, 1998. – 363 p.
6. Leslie, J. Physical cosmology and philosophy / London : Collier Macmillan, 1990 – 277 p.
7. Gal-Or, B. Cosmology, physics, and philosophy / New York : Springer-Verlag, 1983. – 282 p.

8. Curd, M., Psillos, S. The Routledge companion to philosophy of science /London ; New York : Routledge, 2008. – 619 p.
9. Heller, M., Woodin, W. H. Infinity : new research frontiers / Cambridge : Cambridge University Press, 2011. – 311 p.
10. Bridgman P. The Logic of Modern Physics Percy Bridgman [Электронный ресурс]. – New York : Beaufort Books, 1927. – Режим доступа: http:// www.marxists.org / reference / subject / philosophy/ works/ us / bridgman.htm.
11. Hoyle F. A Different Approach to Cosmology: From a Static Universe through the Big Bang towards Reality / F. Hoyle, G. Burbidge, and J. V. Narlikar. – Cambridge : Cambridge University Press, 2005. – 372 p.
12. Hubble E. The observational approach to cosmology / Edwin Powell Hubble. – Oxford : The Clarendon Press 1937.
1. Lawrence Sklar. Physical Theory: Method and Interpretation. Oxford University Press, 2014. - 304 p.
17. Strawson, P. F. Analysis and metaphysics an introduction to philosophy. Oxford: Oxford University Press 1992. - 144 p.
18. Popper, K. The Logic of Scientific Discovery, 2nd edition. Originally published in 1935, first English edition in 1959. Routledge, 2002.
19. Bunge, M. Philosophy of Science, 2 vols. Transaction Books - Rutgers University Press, 1998.
20. Chalmers, A.F. What Is This Thing Called Science?, 4th edition. Hackett, 2013.
21. Godfrey-Smith, P. Theory and Reality: An Introduction to the Philosophy of Science. University of Chicago Press, 2003.
22. Pacholczyk, A.G.. The catastrophic universe : an essay in the philosophy of cosmology / Tucson : Pachart Pub. House, 1984. – 126 p.

Sample exam questions for Part 2.2.

1. Conceptual levels of Chemistry and its main problem.
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3. Antique Chemistry. Features of schematization of handicraft practice.
4. The idea of transmutation of elements, genotype of alchemy and its evaluations.
5. Main stages of development of alchemy and the features of its prescribed knowledge
6. The crisis of alchemy. Iatrochemistry and the revival of atomism.
7. R. Boyle's chemical program and its evaluations.
8. Lavoisier's Oxygen theory and the first scientific classifications.
9. Formation of the first scientific picture of the chemical reality. Proust-Berthollet debate within the boundaries of the picture of chemical reality.
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18. Geographic environment – general characteristics: the genesis of visions, historical character, and its role in the socio-economic dynamics.
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21. Different interpretations of noosphere – philosophical aspect.
22. Geography as human ecology: natural and ecological, and socio-ecological aspects of the problem.
23. The place of Geology in the genetic classification of sciences.
24. The problem of space and time in Geology.
25. Geoecology: history, concepts and current state.
26. Abiotic factors and ecological functions of lithosphere.
27. The principles of historicism and development in Earth Sciences.
28. The interaction of sciences while studying the Earth – the problems of interdisciplinary synthesis.
29. Natural science as a unified science of nature. The place and role of natural sciences in social life.

Practical lessons are provided with the use of multimedia and interactive equipment.

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Doctor of Philosophy, Professor _____ V.V.Cheshev