IJSC «Kazakh National Research Technical University» named after K.I. Satpayev»
Institute of Metallurgy and Industrial Engineering
Department of Engineering Physics

Working curriculum
CURRICULUM PROGRAM

Doctor of Phylosophy(PhD)

«Material Science and Engineering»
based on the following specialty that is no longer valid in the specialty Classifier: "6D071000-materials Science and technology of new materials»

1st edition

in accordance with the SMSE of Higher Education 2018

Almaty 2019

The program was drawn up and signet by the parties:

From KazNRTU named K. Satpayev:

1. Head of EP Department _____ R.E. Beisenov
2. Director of Institute of IE _____ B.O. Omarbekov
3. Chairman of Sc. Method. Council of EP Departmant _____ Kh.R. Maylina

From employers

1. Director of the Department of Space Materials Science and Instrumentation, JSC "National Center for Space Research and Technologies" _____ M.B. Ismailov
2. Director of LLP "Alakol Plant" _____ S.A. Sopolnik

Approved at a meeting of the Educational and Methodological Council of the Kazakh National Research Technical University named after K. Satpayev. Protocol №3 from 19.12.2018.

Professional competence:

- possess information about fundamental and applied problems in the field of materials science, creation of new materials, technologies for their production and processing and their innovative potential in the near and far abroad; about concepts and trends in the development of a new generation of materials with a unique set of properties;
- know: current trends in the development of mechanical engineering and the need for special-purpose materials; principles of implementation of scientific programs for solving fundamental and applied problems of modern materials science using information technologies and computer modeling;
- be able to: plan and organize research and production activities; determine the main directions of development of theoretical and applied materials science; apply analytical methods to the formation of a given level of structure and properties of materials from the perspective of the relationship between the technological environment and the control parameters of the process;
- have the following skills: presentation, analysis, generalization and formation of scientific and technical tasks for the implementation of innovative projects for creating promising and improving traditional technologies for obtaining materials; management of production and research activities when justifying criteria for evaluating the technical and economic efficiency of the designed production facilities; - organization of the production process;
- be competent in the following issues: orientation of scientific and technical achievements in the development of advanced materials and high-performance technologies to business processes; monitoring of environmental safety of production of clean and safe materials; human-environment relations, economic and material costs in the field of engineering and technology.

Brief description of the program:

The educational program «materials Science and engineering» is intended for training personnel in scientific, pedagogical and (or) professional activities, with the award of the degree of doctor of philosophy (PhD). The content of the program is aimed at maximum satisfaction of domestic needs in the areas of industrial production, technological engineering, scientific and innovative activities represented by large companies, operating enterprises, research centers and laboratories. In this regard, the goals of the program are:

- providing scientific and engineering training for doctoral students to successfully solve problems in various industries related to the production and use of various materials;
- development of the theoretical basis for obtaining new materials and development of technological processes for the production and processing of finished products from these materials;
- involvement in project activities through participation in solving real problems of the industry in the country and abroad;
- getting ideas about management, organization and management of production in modern conditions.

The scope of professional activity of the doctor of philosophy (PhD) in the field of materials science and engineering is related to the totality of the obtained fundamental scientific and General professional knowledge and covers the following types of work:
- scientific and pedagogical work in universities and colleges;
- fundamental and applied research work in national companies, research centers, universities and laboratories;
- production and technological work at production enterprises in various sectors of the economy;
- organizational and managerial work in state institutions, companies and firms.

The objects of professional activity are:
- employees of national companies (Kazatomprom, KazMunayGas, KTZ), research centers (JSC «national center for space research and technology», NC SRT), business structures, state administration of industry and committees on science and technology, teachers of higher educational institutions)

PASSPORT OF THE EDUCATIONAL PROGRAM

1.Program volume and content

The educational program for the doctor of philosophy (PhD) has a scientific and pedagogical orientation and involves fundamental educational, methodological and research training, as well as in-depth study of disciplines in the relevant areas of science for the system of higher and postgraduate education and the scientific sphere. The content of the educational program "materials Science and engineering" is developed on the basis of studying the experience of foreign universities and research centers.

The main criterion for the completion of the educational process for the preparation of doctors of philosophy (PhD) (doctors in the profile) is the development of a doctoral student at least 180 academic credits, including all types of educational and scientific activities.

The duration of doctoral studies is determined by the amount of academic credits earned. When you complete the set amount of academic credits and achieve the expected learning outcomes for the degree of doctor of philosophy (PhD) or profile, the educational program of the doctoral program is considered fully completed.

Doctoral training is carried out on the basis of master's degree programs.

The content of the educational program

EP «Materials Science and technology of new materials» includes theoretical training in the disciplines of General education, basic and specialized components; additional types of training and final certification.

Taking into account the goals of the program, the list of disciplines of the University component and the component includes disciplines of an interdisciplinary and multidisciplinary nature that provide training at the intersection of a number of fields of knowledge (for example, the discipline «Advanced research in materials science», read in English, aimed at studying advanced trends in materials science based on scientific publications in international journals). At the same time, all specialized disciplines are aimed at deepening knowledge in the field of materials science and engineering, mastering the methodological knowledge necessary for solving scientific and engineering problems, and developing research thinking.

The objectives of the educational program:

In accordance with the professional competencies of a doctor of philosophy (PhD) who has been trained in the educational program "materials Science and engineering", the program's objectives are::

- coverage of the theoretical foundations of the formation of the structure and properties of materials used in engineering, including powder, composite, ceramic, etc.;
- research of technological ways to improve traditional and create new materials;
- scientific analysis of the influence of alloying, thermal, thermomechanical and other types of treatments on the structure and properties of a wide class of technical materials.

2 Requirements for applicants

Persons who have a master's degree and at least 1 (one) year of work experience or have completed residency training are accepted for doctoral studies.

Admission to the number of doctoral students is carried out by the admissions committees of Universities and research organizations based on the results of the entrance exam for groups of educational programs of doctoral studies and a certificate confirming foreign language proficiency in accordance with the common European competencies (standards) of foreign language proficiency.

When enrolling in universities, doctoral students independently choose an educational program from the corresponding group of educational programs.

Enrollment of individuals for targeted training of doctors of philosophy (PhD) under the state educational order is carried out on a competitive basis.

The procedure for admission of citizens to doctoral studies is established in accordance with the» Standard rules for admission to training in educational organizations that implement educational programs of postgraduate education».

The formation of a contingent of doctoral students is carried out by placing a state educational order for the training of scientific and pedagogical personnel, as well as paying for training at the expense of citizens ' own funds and other sources. The state provides citizens of the Republic of Kazakhstan with the right to receive free postgraduate education on a competitive basis in accordance with the state educational order, if they receive this level of education for the first time.

At the" entrance", the doctoral student must have all the prerequisites necessary for the development of the corresponding professional training program of the doctoral program. The list of necessary prerequisites is determined by the higher education institution independently.

In the absence of the necessary prerequisites, the doctoral student is allowed to master them on a paid basis. In this case, doctoral studies begin after the doctoral student has fully mastered the prerequisites.

3 Requirements for completion of training and diploma

Persons who have mastered the educational program of doctoral studies and defended their doctoral dissertation, with a positive decision of the dissertation councils of a UNIVERSITY with a special status or the Committee for control in the field of education and science of the Ministry of education and science of the Republic of Kazakhstan based on the results of the examination, are awarded the degree of doctor of philosophy (PhD)

Individuals who have received a PhD degree, in order to deepen their scientific knowledge, solve scientific and applied problems on a specialized topic, perform a postdoctoral program or conduct research under the guidance of a leading scientist chosen by the University.

3.1 Requirements for key competencies of doctoral graduates:

1) have an idea of:

- the main stages of development and change of paradigms in the evolution of science;
- about the subject, ideological and methodological specifics of natural (social, humanitarian, economic) Sciences;
- about scientific schools of the relevant branch of knowledge, their theoretical and practical developments;
- about scientific concepts of world and Kazakhstan science in the relevant field;
- on the mechanism of implementation of scientific developments in practice;
- on the norms of interaction in the scientific community;
- on the pedagogical and scientific ethics of a research scientist;

2) know and understand:

- current trends, trends and patterns of development of Russian science in the context of globalization and internationalization;
- methodology of scientific knowledge;
- achievements of world and Kazakhstan science in the relevant field;
- (realize and accept) the social responsibility of science and education;
- perfect foreign language for scientific communication and international cooperation;

3) be able to:

- organize, plan and implement the research process;
- analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions;

- analyze and process information from various sources;
- conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis;
- generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge;
- choose and effectively use modern research methodology;
- plan and forecast your future professional development;

4) have the skills:

- critical analysis, evaluation and comparison of various scientific theories and ideas;
- analytical and experimental research activities;
- planning and forecasting of research results;
- public speaking and public speaking at international scientific forums, conferences and seminars;
- scientific writing and scientific communication;
– planning, coordination and implementation of the processes of scientific research;
- a systematic understanding of the field of study and demonstrate the quality and effectiveness of the selected scientific methods;
- participation in scientific events, fundamental scientific domestic and international projects;
- leadership management and team management;
- responsible and creative attitude to scientific and educational activities;
- conducting patent search and experience in transmitting scientific information using modern information and innovative technologies;
- protection of intellectual property rights to scientific discoveries and developments;
- free communication in a foreign language;

5) be competent:

– in the field of scientific and educational activities in the conditions of rapid updating and growth of information flows;
- in conducting theoretical and experimental scientific research;
– in the formulation and solution of theoretical and applied problems in scientific research;
- to conduct a professional and comprehensive analysis of problems in the relevant field;
- interpersonal communication and human resource management;
– in matters of University training of specialists;
- in carrying out expertise of scientific projects and research;
- to ensure continuous professional growth.

3.2 requirements for R & D of a student in the doctor of philosophy (PhD) program):

1) compliance with the main issues of the educational program of the doctoral program, which is defended by the doctoral dissertation;

2) relevant and contains scientific novelty and practical significance;

3) based on modern theoretical, methodological and technological achievements of science and practice;

4) based on modern methods of data processing and interpretation using computer technologies;

5) is carried out using modern methods of scientific research;

6) contains research (methodological, practical) sections on the main protected provisions.

3.3 requirements for the organization of practices:

The practice is conducted for the purpose of developing practical skills in scientific, scientific-pedagogical and professional activities.

The educational program of the doctoral program includes:

1) teaching and research practice - for students of the doctor of philosophy program;

2) industrial practice - for students in the program of specialized doctoral studies.

During the period of teaching practice, doctoral students, if necessary, are involved in conducting classes in bachelor's and master's degrees.

The research practice of a doctoral student is conducted in order to study the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as to consolidate practical skills, apply modern research methods, process and interpret experimental data in a dissertation research.

Practical training of a doctoral student is carried out in order to consolidate the theoretical knowledge obtained in the course of training and improve the professional level.

The content of research and production practices is determined by the topic of the doctoral dissertation.

4. The working curriculum of the educational program

Приложение 2

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
SATBAYEV UNIVERSITY

APPROVED
Rector of Satbayev University
K.K. Beisembetov
"__" _____ 2019 г.

CURRICULUM of educational program for 2019-2020 academic year
Materials science and technology of new materials

Mode of study: Full-time Duration: 3 years Academic degree: Philosophy Doctor (PhD)

Grade level	Code	Name of disciplines	Cycle	Credits ECTS	Credits RK	Classroom volume lec/lab/pr	Prerequisite	Code	Name of disciplines	Cycle	Credits ECTS	Credits RK	Classroom volume lec/lab/pr	Prerequisite
		Term 1							Term 2					
1	PHY300	Computer modelling	BD MC	5	3	1/0/2		AAP325	Pedagogical Practice	BD MC	11	11	0/0/9	
	PHY307	Advanced Structural Technology	BD MC	5	3	1/0/2		AAP301	Research work of the doctoral student, including internships and doctoral thesis	AAP	19	5	0/0/5	
	PHY308	Advanced researches in materials science	SD CC	5	3	1/0/2								
	PHY309	Software for structure formation of materials	SD CC	5	3	1/0/2								
	PHY310	Materials Science and Applied Science	SD CC	5	3	1/0/2								
	PHY311	Factor Analysis of Industrial Experiments	SD CC	5	3	1/0/2								
		Total:		30	18				Total:		30	16		
		Term 3							Term 4					
2	AAP301	Research work of the doctoral student, including internships and doctoral thesis	AAP	18	4	0/0/9		AAP301	Research work of the doctoral student, including internships and doctoral thesis	AAP	30	7	0/0/9	
	AAP314	Research practice	SD CC	12	3	0/0/2								
		Total :		30	7				Total :		30	7		
		Term 5							Term 6					
3	AAP301	Research work of the doctoral student, including internships and doctoral thesis	AAP	30	7	0/0/9		AAP301	Research work of the doctoral student, including internships and doctoral thesis	AAP	18	4	0/0/9	
								BCA302	Writing and defending a doctoral thesis	FA	12	4		
		Total :		30	7				Total :		30	8		
									Total:		180	63		

Decision of the Academic Council of Satbayev University. Protocol No 17 from "21" 06 2019

Decision of the Academic Council of the Institute of Industrial Engineering named after A. Burkitbaev. Protocol No 9 of "10" 06 2019

Vice-Rector for Research and Academic Affairs — D.K. Nauryzbaeva
Director of Institute of Industrial engineering — B.O. Omarbekov
Head of "Engineering physics" department — R.E. Beisenov

5 Descriptors of the level and scope of knowledge, skills and competencies

Requirements to the level of Master's degree are determined on the basis of the Dublin Descriptors of the second level of higher education (Master's degree) and reflect the mastered competencies, expressed in the achieved results of training.

The learning outcomes are formulated both at the level of the entire Master's degree program and at the level of individual modules or academic discipline.

The descriptors reflect learning outcomes that characterize a learner's abilities:

1) Demonstrate evolving knowledge and understanding in materials science and engineering, based on advanced knowledge in materials science, new materials production and processing technologies, when developing and/or applying ideas in the context of research;

2) professionally apply their knowledge, understanding and abilities to solve problems in a new environment, in a broader interdisciplinary context;

3) to collect and interpret information to form judgments taking into account social, ethical and scientific considerations;

4) clearly and unambiguously communicate information, ideas, conclusions, problems and solutions to both professionals and non-professionals;

5) training skills necessary for independent continuation of further training in the field of industrial production, technological engineering, scientific and innovation activities.

6 Competencies for completion of training

6.1 Requirements to the key competencies of graduates of scientific and pedagogical masters, shall:

1) have an idea:

about the role of science and education in public life;

modern trends in the development of scientific knowledge;

actual methodological and philosophical problems of natural (social, humanitarian, economic) sciences;

the professional competence of a higher school teacher;

on contradictions and socio-economic consequences of globalization processes;

2) to know:

2) know: methodology of scientific cognition;

principles and structure of scientific activity organization;

psychology of cognitive activity of students in the process of education;

psychological methods and means to increase efficiency and quality of education;

3) be able to:

3) be able to use the knowledge gained for the original development and application of ideas in the context of scientific research;

critically analyze existing concepts, theories and approaches to process and phenomenon analysis;

integrate knowledge gained from different disciplines to solve research problems in new unfamiliar conditions;

by integrating knowledge to make judgments and decisions based on incomplete or limited information;

apply the knowledge of pedagogy and psychology of the higher school in their pedagogical activities;

apply interactive teaching methods;

carry out informational, analytical and bibliographic work involving modern information technologies;

think creatively and approach creatively to solving new problems and situations;

be fluent in a foreign language at a professional level that allows to conduct scientific research and teach special subjects in higher education institutions;

summarize the results of research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc.;

4) have skills:

4) have skills in: research activities, solving standard scientific problems;

realization of educational and pedagogical activity on credit technology of training;

methods of teaching professional disciplines;

use of modern information technologies in the educational process;

professional communication and intercultural communication;

Oratorical art, correct and logical design of their thoughts in oral and written form; expansion and deepening of knowledge necessary for everyday professional activity and further education in doctoral studies.

5) be competent:

in the field of research methodology;

in the field of scientific and scientific-pedagogical activities in higher education institutions;

in the issues of modern educational technologies;

in the implementation of scientific projects and research in the professional field;

in the ways to ensure constant updating of knowledge, expanding professional skills and abilities.

B - Basic knowledge, skills and abilities

B1 - physical theories and concepts for explanation of structural regularities in materials; complexes of physical and mechanical properties of materials and technological methods of their change by influence on structural parameters; technological route maps of technological processes; principles of rational choice of materials to ensure their optimal application in constructions and products; information sources, databases for solving professional tasks; methods of conducting, analysis and evaluation of experimental results investigated

B2 - analysis of structure and properties of a certain class of materials using modern methods of research and scientific instruments (electro-physical, optical, electron-microscopic, X-ray); modeling the structure and properties of materials based on mathematical processing of scientific research results and the use of software products of material science in solving real problems and problems of science and production; selection and use of materials in technological processes of mechanical engineering, energy,

B3 - the basic technical and economic requirements to the equipment, modern technical means, methods and modes of preparation of initial material, processing for the purpose of reception of demanded properties and quality of production; questions of labour protection and safety precautions, a basis of the law and the nature protection legislation, a basis of patenting and scientific organization of work; independent working out and teamwork at the decision of professional problems with application of theoretical and practical knowledge.

P - Professional competencies:

P1 - to carry out competent, scientifically grounded choice of materials on the basis of extensive theoretical and practical knowledge in the professional field and development of research culture as a result of expansion of ideas about the specialty and formation of the integral view on science of materials;

P2 - to carry out industrial and technological types of professional activity; to solve engineering tasks in the field of obtaining and processing of materials and products from them; to conduct the

necessary research and measurements, using modern scientific equipment; to analyze and interpret the data obtained, to draw conclusions;

P3 - to use the rules of safety and labor protection in conditions of industrial activity.

O - Human, social and ethical competencies

O1 - Ability to be guided by ethical and legal standards;

O2 - Ability to work in an international context;

O3 - Willingness to be aware of the social significance of their future profession, self-development, advanced training;

O4 - Ability to analyze socially significant processes and phenomena, to participate responsibly in social and political life.

C - Special and managerial competences:

C1-competence in production and management, design and development, organizational, technological and scientific-pedagogical fields on the basis of modern training means of information technologies and information resources.

C2-competence to carry out professional functions within one or more types of activities on the basis of the final results of training, taking into account the specifics of these activities, market requirements to organizational, management and professional competencies.

6.2 Requirements for research work of a master's degree student in scientific and pedagogical master's degree:

1) Corresponds to the profile of the Master's degree program on which the master's thesis is performed and defended;

2) is relevant and contains scientific novelty and practical significance;

3) is based on modern theoretical, methodical and technological achievements of science and practice;

4) is performed using modern methods of scientific research;

5) contains research (methodical, practical) sections on the main protected provisions;

6) is based on the best international experience in the relevant field of knowledge.

6.3 Requirements for organization of practices:

The educational program of scientific and pedagogical master's degree includes two types of practices that are conducted in parallel with theoretical training or in a separate period:

1) Pedagogical in the DB cycle - in the university;

2) research in the DB cycle - at the place of the dissertation.

Pedagogical practice is carried out for the purpose of forming practical skills of teaching and learning methods. In this case, the master's degree students are involved in conducting classes at the undergraduate level at the discretion of the university.

The research practice of the master's degree is carried out for the purpose of acquaintance with the newest theoretical, methodological and technological achievements of domestic and foreign science, modern methods of scientific researches, processing and interpretation of experimental data.

7 ECTS Diploma Supplement

The application is developed according to the standards of the European Commission, Council of Europe and UNESCO/CEPES. This document serves only for academic recognition and is not an official confirmation of a document of education. It is not valid without a higher education diploma. The purpose of the European Appendix is to provide sufficient data on the holder of the diploma, the qualification obtained, the level of this qualification, the content of the study program, the results, the functional purpose of the qualification, as well as information on the national education system. The model of the Appendix, on which the transfer of grades will be carried out, uses the European Transfer or Credit Transfer System (ECTS).

The European Diploma Supplement gives the opportunity to continue education in foreign universities, as well as to confirm national higher education for foreign employers. When going abroad for professional recognition you will need additional legalization of the diploma of education. The European supplement to the diploma is filled in English upon individual request and is issued free of charge.

COMPUTER MODELING

CODE-PHY300
CREDIT-1/0/2

GOAL AND OBJECTIVES OF THE DISCIPLINE

The purpose of the STUDY: to teach the construction of mathematical models of various physical phenomena, to study the main methods for solving mathematical problems that arise in this case, to find out the physical meaning of the solutions obtained.

OUTLINE: Construction of a mathematical model (drawing up equations describing the phenomenon under study). Selection of numerical calculation methods (construction of a discrete model approximating the original mathematical problem, construction of a difference scheme, development of a computational algorithm, etc.). Creating a program that implements a computational algorithm. Performing calculations and processing the received information. Analysis of calculation results, comparison (if possible) with a full-scale experiment. The discipline "Computer modeling of engineering problems" connects the analysis of physical processes with the tools of modern information technologies, and therefore plays an integrating role, contributing to the development of skills in using computer systems to solve professional problems.

KNOWLEDGE, SKILLS AT THE END OF THE COURSE: As a result of mastering the discipline doctoral student: 1. must know: about the main classifications of mathematical models, about the principles of modeling, about the main stages, technologies for building a model, about the possibilities of software implementations using tools, about the features of conducting computational experiments. 2. must be able to: independently choose the method of solving and constructing an algorithm for a particular engineering problem, give a complete analysis of the results of the solution and evaluate the limits of applicability of the selected model. 3. must have: knowledge of modeling as a method of cognition; methods of using spreadsheets, specialized mathematical packages (MATCAD, MATLAB), integrated programming environments for building computer models necessary for solving engineering problems; basic methods for analyzing the modeling process and modeling results; basic methods for evaluating the quality of the model used, including when solving problems related to professional activity; with the skills of solving applied problems using visual modeling environments, perform formalization of the description of the system under study, the necessary mathematical transformations of its model, as well as effectively solve practical problems of modeling processes and phenomena, analyze the characteristics of the designed systems.

ADVANCED STRUCTURAL TECHNOLOGY

CODE-PHY307

CREDIT – 1/0/2

THE PURPOSE AND OBJECTIVES OF THE COURSE

Course objective:

- obtaining basic knowledge on modern technologies for strengthening materials and surfaces and applying them in practice in the development of strengthening technologies based on the structural theory of structural strength and the hierarchy of defect-structural levels of solids.

Course objective:

- combining knowledge in the field of structure, physical and chemical interactions, methods of strengthening treatments, methodology for developing and obtaining a given structural and phase state and properties of structural and functional materials for various purposes.

BRIEF DESCRIPTION OF THE COURSE

Classification (hierarchy) of structural levels of solids: composite materials, macro-level – grain structure and its size and morphological characteristics, meso-level-subgrain, cellular and modulated structure, micro – level-atomic – molecular structure. A new conceptual model of the atomic-molecular structure of solids: hierarchy and fractality of real structures; stochasticity and probability of evolution of complex systems; irreversibility, non-uniformity, nonlinearity and unpredictability of processes in open systems; autowave nature of material objects and processes; fractality and self-organization of structures of different levels under external influences. Structural theory (model) of structural strength based on dissipative-synergetic structures and dislocation-disclosure mechanisms of structural strengthening. Methods of structural strengthening of volumes and surfaces of solids: intensive plastic deformation with the formation of ultradisperse structures of different dimensions, molecular beam epitaxy and high-dose ion implantation with the formation of non-equilibrium modulated mesostructures of increased strength and wear resistance, etc. Structurally modified forms of carbon – fullerenes and nanotubes, their General characteristics, methods of production and use in structural hardening processes.

KNOWLEDGE, SKILLS AT THE END OF THE COURSE

KNOWLEDGE

- methods for obtaining, complex research and testing of structurally reinforced materials and ways to assess their compliance with the specified requirements;
- General regularities of structural modification of volume-and surface-hardened materials ;
- traditional and new technological processes and techniques for creating a given structural-phase state when implementing structural strengthening mechanisms.

SKILLS

- solve standard and new tasks of professional activity in the field of advanced technologies for volumetric and surface structural strengthening of materials;
- combine theoretical and practical knowledge of the structural model of structural strength to predict the possibilities of strengthening under different technological influences;
- use modern global information resources in computational and analytical activities in the development of new materials and reinforcing technologies.

SKILLS

- analysis and generalization of scientific and technical information on promising methods and technologies of structural strengthening;
- self-organization and self-education using all available means of the cognitive process;
- selection and evaluation of the possibilities of applying the optimal technology and mode of structural hardening to obtain a given level of structure, operational and technological properties.

ADVANCED RESEARCH IN MATERIALS SCIENCE

CODE-PHY308

CREDIT -1/0/2

PURPOSE AND OBJECTIVES OF THE DISCIPLINE

The purpose of this discipline is:

- introduction and study of the latest achievements in materials science in the most promising areas based on scientific publications in highly rated journals;

The objectives of the discipline are as follows:

- scientific search for the most promising areas of research conducted in laboratories of the country and around the world, using a wide field of information resources;
- analysis of the results of advanced research in the field of new materials and production technologies aimed at solving topical problems of domestic production and science;
- identification of the most promising areas for further development of new materials.

BRIEF DESCRIPTION OF THE COURSE

The course of the discipline" Advanced research in materials science " in PhD training is aimed at introducing scientific and engineering solutions to the problems of modern materials science, namely: creating new alloys with specified properties based on domestic raw materials; developing materials for the nuclear and space industries; obtaining nanostructured materials; improving research methods using new tools. The focus is on those products that are most in demand in domestic production, science and technology. Analysis of the results of promising areas of scientific research is based on knowledge of solid state physics; physical metal science; special-purpose materials science, including the class of non-metallic materials; mechanical, physical, and technological properties of various materials; modern methods of electron microscopy, x-ray, and spectral research; and factors affecting the structure and properties of materials under operating conditions.

KNOWLEDGE, SKILLS AT THE END OF THE COURSE

Doctoral student

Must have an idea about:

- the state of science and production in the country, problems of modern materials science, including issues of technology and effective application of new developments.

Must know:

- a wide range of issues that make up the science of materials and cover the structural laws that determine the behavior and properties of materials under operating conditions;
- the existing connection between General theoretical principles and specific engineering problems of modern materials science.

Must be able to:

- organize a scientific search for optimal solutions to specific material science problems using a wide range of information resources;
- correctly interpret the results of promising areas of research in relation to the problems of production and technologies available in the country.

SOFTWARE FOR STRUCTURE FORMATION OF MATERIALS

CODE-PHY309

ACADEMIC CREDITS – 6 (1/0/2/3)

PURPOSE AND OBJECTIVES OF THE DISCIPLINE

The purpose of studying this discipline is:

Formation of doctoral students ' ideas about the structure formation of materials using software, as well as the use of analytical equipment and devices

Development of engineering skills by doctoral students in building technological processes using software for structuring materials.

The objectives of the discipline are as follows:

- Introduce doctoral students to various modern types of software for studying the structure, properties and composition of materials.

BRIEF DESCRIPTION OF THE COURSE

The discipline "software for structure formation of materials" is a complex for studying modern research methods and using materials. The content of the discipline is based on the knowledge obtained during the study of professional cycle disciplines, and the knowledge, skills and abilities obtained during its study will be used in practical professional activities.

KNOWLEDGE, SKILLS AT THE END OF THE COURSE

Doctoral student

Must have an idea about:

- the current state of the software for structuring materials.

Must know:

processes in the field of theory and practice using modern software with which to analyze materials with a set of specified properties.

Must be able to:

choose types of software for structuring materials, as well as methods and modes depending on their purpose and required characteristics, as well as based on economic considerations.

Acquire practical skills:

to work with the use of software to study the structure, properties and composition of materials, modern methods of monitoring the technological process and product quality.

MATERIALS SCIENCE AND APPLIED SCIENCE

CODE-PHY310

ACADEMIC CREDITS – 6 (1/0/2/3)

PURPOSE AND OBJECTIVES OF THE DISCIPLINE

The purpose of studying this discipline is:

- consideration and search for solutions to applied problems of modern materials science related to real problems of science, production and technology;

The objectives of the discipline are as follows:

- finding solutions to practical problems based on the use of theoretical provisions of physical metal science, thermodynamics, mechanics, and polymer chemistry;
- analysis and scientific justification of the proposed solutions to scientific and technical problems of modern materials science.

BRIEF DESCRIPTION OF THE COURSE

In the course of the discipline "Applied problems in materials science", numerous practical problems and their solutions are selected (if necessary, engineering calculations). The nature of the presented tasks is aimed at mastering the issues of theoretical materials science related to the real problems of modern science, production and technology. The questions of practical use of materials contained in the problems are related to the consideration of equilibria in multiphase systems, reactions and microstructures of materials. The problems of coating and obtaining powder and composite materials, diffusion and exposure to radiation on materials are considered in the problems of logical reasoning. Typical examples of applied problems in materials science are also given, which will help the doctoral student to learn new concepts of materials science. At the same time, the most complex and urgent tasks that are related to solving scientific problems of optimization of individual industries, forming the ability to conduct research on the basis of rational use of natural resources and their processing, development of innovative technologies and equipment, obtaining new materials and products for various branches of engineering are proposed for consideration. Such tasks require the implementation of original ideas and solutions, which contributes to the emergence of new opportunities for professional development of doctoral students.

KNOWLEDGE, SKILLS AT THE END OF THE COURSE

Doctoral student

Must have an idea about:

- theoretical materials science, covering the structure and properties of materials of different classes, as well as physical interpretations of phenomena and processes occurring in materials.

Must know:

- General scientific approaches and principles for solving problems in the field of materials science;
- the existing connection between General theoretical principles and specific engineering problems of modern materials science.

Must be able to:

- find a scientifically based optimal solution to the tasks and formulate clear answers and conclusions

FACTOR ANALYSIS OF INDUSTRIAL EXPERIMENTS

CODE-PHY311

CREDIT-1/0/2

GOAL AND OBJECTIVES OF THE DISCIPLINE

The purpose of this discipline is:

- scientific analysis of factors affecting the error of an experiment reproducing production conditions, using the ideas and principles of scientific experimentation based on the mathematical theory of the experiment;

The objective of the discipline is:

- to consider methodological approaches to scientific analysis of factors affecting the conditions of industrial experiment in order to develop a research strategy for solving problems of modern materials science.

BRIEF DESCRIPTION OF THE COURSE

The discipline "Factor analysis of industrial experiments" covers an experimental workshop of research work of a doctoral student, based on the mathematical theory of experiment, transformed to solve production problems. At the same time, the doctoral student relies on General scientific principles of experiment planning:

- the principle of decision - making in conditions of uncertainty;
- the principle of processing the results of observations;
- the principle of experiment planning.

Compliance with these principles will allow a doctoral researcher to describe/study a phenomenon, phenomenon, or process in a scientifically based system of representations using mathematical statistics. As a result, a doctoral experimenter can change approaches to methods of analysis and evaluation of research results and form the very strategy of a scientific experiment. At the same time, the higher the level of special knowledge about the object of research, the easier it is to plan an industrial experiment based on the methods of mathematical statistics. In addition, sufficient information about the production process is required to select independent variables and transform them from natural variables to certain functions from them. Depending on the level of formalization, all the variety of experimental research tasks can be described and organized with a minimum degree of uncertainty, as well as the best way to evaluate the parameters of the working model of a phenomenon or process.

The course content is divided into separate stages corresponding to the stages of scientific research. Using the information obtained at each stage, the doctoral student is invited to change the research strategy to improve the effectiveness of scientific development.

Factor analysis of industrial experiments allows you to ensure optimal organization of the technological process by using a priori information and sequential step selection.

KNOWLEDGE, SKILLS AT THE END OF THE COURSE

Doctoral student

Must have an idea about:

- ways to implement the ideas of theoretical materials science related to the structure and properties of materials of different classes in real experimental conditions that reproduce industrial ones.

Must know:

- General scientific principles of experiment planning when solving production tasks;
- the existing connection between General theoretical principles and specific engineering problems of modern materials science.

Must be able to:

- formulate experimental research tasks based on the application of special knowledge of their field;
- use mathematical methods of experiment organization in practice.

RESEARCH SCIENTIFIC TRAINING

Code - AAP349

Credits -10

Research practice is a part of the research work of the doctoral program, which also includes research work in the semester and the preparation of a doctoral dissertation.

The purpose of research practice is to prepare students for professional activities in the field of research processes: development of skills for independent research work, consolidation of knowledge obtained in the framework of theoretical training, acquisition of the required research professional competencies, acquisition of experience in the study of an actual scientific problem that is the subject of a doctoral dissertation.

In accordance with these tasks, the specific tasks of research practice are::

- consolidation of knowledge, skills and abilities obtained by doctoral students in the course of studying the disciplines of the doctoral program;
- forming a list of required competencies;
- mastering the modern methodology of scientific research by doctoral students;
- mastering modern methods of collecting, analyzing and processing scientific information;
- formation of a comprehensive understanding of the specifics of research activities in the field of materials science
- formation of the ability to determine the goal, objectives and make a research plan ; - collection of materials on the topic of a doctoral dissertation;
- involvement of doctoral students in the practice of research work carried out at the Department,
- formation of management design skills;
- mastering the skills of presenting the results obtained in the form of reports, publications, reports;
- promotion of research activities of doctoral students.

PEDAGOGICAL PRACTICE

Code - AAP350
Credits – 10

Pedagogical practice is a component of professional training for scientific and pedagogical activities in the University and is a type of practical activity of doctoral students in the implementation of the educational process at the University., including the teaching of special disciplines, the organization of educational activities of students, scientific and methodological work on the subject, obtaining skills and practical teaching.

Pedagogical practice is aimed at forming a comprehensive psychological and pedagogical, methodological and information technology readiness of a doctoral student for scientific and pedagogical activities in higher Education.

Goals and objectives of teaching practice of doctoral students

The purpose of teaching practice is to form a positive motivation for doctoral students to teach and professional competencies that ensure readiness for pedagogical design of educational and methodological complexes of disciplines in accordance with the profile of training and conducting various types of training sessions using innovative educational technologies;

formation of skills to perform design, constructive, organizational, communicative and educational pedagogical functions;

consolidation of psychological and pedagogical knowledge in the field of professional pedagogy and acquisition of skills of creative approach to solving scientific and pedagogical problems.

In accordance with the state standard, pedagogical practice is provided as one of the components of the main educational program for training scientific and pedagogical personnel in doctoral studies.

DOCTORAL STUDENT RESEARCH WORK, INCLUDING INTERNSHIPS AND DOCTORAL DISSERTATIONS

DSRW

Code-AAP346

In accordance with the SES, research work of a doctoral student is a mandatory part of the educational program of doctoral studies and is aimed at the formation of General cultural and professional competencies.

Research work of a doctoral student includes research work in a semester (R & d) as a separate type of activity, for which 25 academic credits are allocated in the curriculum of the doctoral student in each semester.

Research work in the semester is performed by a doctoral student under the supervision of a research supervisor. The direction of research work of a doctoral student is determined in accordance with the doctoral program and the topic of the doctoral dissertation.

The list of forms of research work in the semester for doctoral students is determined by the curriculum of the doctoral program and the individual plan of the doctoral student, agreed with the supervisor. The research plan of the research DEPARTMENT is developed by the doctoral student's supervisor and approved at a meeting of the Department.

The purpose of research work in the semester is to prepare a doctoral student for independent research work, the main result of which is writing and successfully defending a doctoral dissertation, and conducting research as part of a creative team.

Tasks of research work in the semester:

- development of work plans and programs for scientific research and technical development, preparation of individual tasks for performers;
- collection, processing and systematization of scientific and technical information on the topic of planned research, selection of methods and means for solving formulated problems;
- development of experimental research programs, its implementation, including the selection of technical means and processing of results;

preparation of scientific and technical reports in accordance with the requirements of regulatory documents, reviews and publications;

- development of recommendations for practical use of the results obtained;
- development of patent documents for samples of new equipment.

it is aimed at studying research and project activities, solving standard professional tasks in innovative conditions, and the ability to plan and organize production processes.

The research work of a doctoral student in the scientific and pedagogical direction should:

- correspond to the main problems of the educational program on which the master's thesis is being defended, be relevant, contain scientific novelty and practical significance;

– be based on modern theoretical, methodological and technological achievements of science and practice –

- be carried out using modern research methods

WRITING AND DEFENDING A DOCTORAL DISSERTATION

CODE-ECA303

CREDIT – 12

GOALS AND OBJECTIVES

- development and creation of new knowledge in the field of materials science and materials engineering; systematization, consolidation and expansion of theoretical knowledge and practical skills in the specialty and their application in solving specific scientific, technical and production tasks; conducting independent scientific, pedagogical and production activities based on mastering the methodology of scientific research and experimentation.

BRIEF DESCRIPTION

The doctoral dissertation is a scientific work of a doctoral student, which is an independent study on a selected topic relevant to Kazakhstan's industrial production, science and technology. The dissertation develops theoretical positions, the totality of which can be qualified as a new scientific achievement, or solves a scientific problem with the development of scientifically based technical and technological solutions, the introduction of which makes a serious contribution to the development of materials science. The content of the dissertation research is aimed at implementing the program documents of the state's research and production, innovation policy for the development of priority development sectors and should be aimed at solving urgent problems, which actualizes research and development (R&D) aimed at obtaining new knowledge and their practical application in the creation of new materials.

The dissertation should clearly state the scientific apparatus of the research, indicating the goals, objectives, research methods, reasonable and reliable provisions to be submitted for defense. A dissertation can be recommended for defense if there is scientific novelty and practical significance of the research results, as well as if the requirements for its design and implementation are met. The prepared doctoral dissertation ends with a defense procedure, which results in a decision on awarding the academic degree of doctor of philosophy (PhD).

KNOWLEDGE, SKILLS AND ABILITIES AT THE END OF THE DOCTORAL DISSERTATION

As a result of completing the doctoral dissertation, the doctoral student moves to the highest level of scientific qualification and becomes able to: perform theoretical and applied research work within the framework of state programs; conduct independent research and research in the field of materials science and engineering on the basis of formed professional and managerial competencies

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