AL-FARABI KAZAKH NATIONAL UNIVERSITY

EDUCATIONAL PROGRAM

THERMAL POWER ENGINEERING

Specialty 5B071700 – Thermal Power Engineering

ALMATY, 2018

LIST OF AUTHORS-DEVELOPERS
EDUCATIONAL PROGRAM
Thermal Power Engineering

Foreign and domestic universities

Zamorano Toro Montserrat – professor, High Technical School of Civil Engineering, University of Granada, (Granada, Spain);

Badaker Viktor – professor, Economic Commission for Europe Sustainable Energy Division, United Nations (Geneva, Switzerland);

Nadezda Slavinskaya – professor, Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH Bereich Sicherheitsforschung /Safety Research Division Forschungszentrum (Munich, Germany);

Aleksandar Georgiev – professor, European Polytechnic University (Pernik, Bulgaria);

Rumen Kostadinov Popov – PhD, Associated Professor, Department of Electronics, Telecommunications and Information Technologies, at the Faculty of Physics and Technology, Plovdiv University “Paisii Hilendarski” (Plovdiv, Bulgaria)

Moulay Rachid Babaa – doctor, School of Engineering, Nazarbayev University;

Abildinova S.K. – PhD, Associate Professor of the Department "Industrial Thermal Power Engineering", non-profit JSC Almaty University of Power Engineering and Telecommunications;

Issaev A. - Physics teacher, Nazarbayev Intellectual School of Chemistry and Biology in Almaty

O*rganizations-partners:*

Taybassarov Zh.K. - Doctor of Technical Sciences, expert of the National Chamber of Entrepreneurs of the Republic of Kazakhstan "Atameken";

Utegulov N.I. - Deputy Director of PromStroyEnergo LLP;

Zhakypbaev A.K. - Deputy Chief Engineer of the ACHP-2;

Aimuratov D.B. - PhD, deputy head of electrical department CHP-1 of Almaty Electric Networks JSC;

Medenov A.K. - Head of Department, West-Thermal Complex of Almaty Electric Networks JSC;

Ustimenko A.B. - Doctor of Technical Sciences, Director of Plasmatechnics R&D LLP

Al-Farabi Kazakh National University:

Askarova A.S., Messerle V.E., Bolegenova S.A., Mazhrenova N.R., Maximov V.Yu., Bolegenova S.A., Lavrichshev O.A,. Manatbayev R.K., Issatayev M.S., Gabitova Z.Kh., Shortanbayeva Zh.K., Maxutkhanova A.M.

PASSPORT
OF EDUCATIONAL PROGRAM IN ENGLISH

THERMAL POWER ENGINEERING

1. Sphere of application

This educational program on the specialty «Thermal Power Engineering» is developed based on the Typical curriculum of a specialty 5B071700 – Thermal Power Engineering (dated by 16th of August, 2013 №343 with amendments from 05th of July, 2016 №425) in accordance with international documents in higher education, the recommendations of the ECTS Users' Guide (Guidance on the use of ECTS), «Tuning Educational Structures in Europe» and establishes the requirements to the content of education through learning outcomes, the volume of academic load and a professional standard level for bachelors.

The educational program has been developed considering the comparison of the labor intensity of the curriculum in accordance with the requirements of the Bologna Declaration.

2. Regulatory references

1. Nazarbayev N.A. Global Energy-Ecological Strategy for Sustainable Development in the XXI century. - Moscow: Economy, 2011. - 194 p.
2. The law of Republic Kazakhstan «On Education» (№319-III dated 27th of July, 2007, as amended by the Law of the Republic of Kazakhstan dated 24th of October, 2011, № 487-IV, as amended and supplemented on 4th of July, 2018);
3. State compulsory standard of higher education approved by the №1080 Decree of the Government of the Republic of Kazakhstan dated 23rd of August, 2012, as amended on 13th of May, 2016 № 292;
4. Typical curriculum on specialty 5B071700 – Thermal Power Engineering approved by the Minister of Education and Science of the Republic of Kazakhstan dated 16th of August, 2013 № 343, as amended on 5th of July, 2016 №425;
5. The rules of the organization of the educational process on the credit technology of education, approved by the №152 Order of the Minister of Education and Science of the Republic of Kazakhstan dated 20th of April 2011;
6. National framework of qualifications approved by the Protocol of the Republican tripartite commission on social partnership and regulation of social and labor relations dated 16th of March 2016
7. General educational disciplines cycle typical educational program for organizations of higher and (or) postgraduate education, approved by №603 Order of the Minister of Education and Science of the Republic of Kazakhstan dated 31st of October, 2018;
8. Guidance on the use of the European Credit Transfer and Accumulation System (ECTS), developed as part of the Bologna process and officially published by the European Commission in 2009.

3. Basic terms and abbreviations

This document applies the following main terms and definitions in accordance with the law of the Republic of Kazakhstan «On Education», national standard of education of the Republic of Kazakhstan «Higher Education. Undergraduate. Basic Provisions» № 292 dated 13.05.2016 and the national standard of education of the

Republic of Kazakhstan 5.05.001-2005 «Coding system of disciplines of higher and postgraduate education», international documents in education, European Credit Transfer and Accumulation System (European Credit Transfer System):

education – continuous process of education and training, carried out in order to moral, intellectual, cultural, physical development and the formation of professional competence;

baccalaureate – higher education, educational programs of which are aimed at training personnel with the award of a bachelor's degree in the relevant specialty;

bachelor - degree awarded to persons who have mastered higher education programs;

educational program (EP) – single set of basic characteristics of education, including the goals, results and content of education, organization of the educational process, methods and methods for their implementation, criteria for evaluating learning outcomes;

student-centered learning - an approach to learning, characterized by innovative teaching methods, with the aim of facilitating learning through teacher and student communication;

competence - the ability of students to the practical application of acquired in the process of learning knowledge and skills in professional activities;

descriptors - description of the level and amount of knowledge, skills, abilities and competencies acquired by students upon completion of the educational program of the appropriate level of higher and postgraduate education; descriptors are based on learning outcomes, formed competencies, as well as the total number of credits (credit units);

learning outcomes – confirmed by the assessment of the amount of knowledge and skills acquired by students in the development of the educational program, and values and attitudes;

credit education technology – training based on the selection and self-planning of students for the sequence of studying disciplines with the accumulation of academic credits;

academic credit - unified unit of measurement of the volume of scientific and (or) educational work (load) of the student and (or) teacher;

typical curriculum (TC) – training document developed on the basis of the classifier of specialties of higher and postgraduate education of the Republic of Kazakhstan and the State Compulsory Education Standards (SCES), regulating the structure and volume of the educational program for the cycles of disciplines, indicating the list and the minimum amount of credits of the obligatory component disciplines and all types of practices, final certification, approved by the authorized body in of education;

compulsory component (CC) - list of academic disciplines and the corresponding minimum amounts of credits established by the model curriculum and studied by students on a mandatory basis under the curriculum;

elective disciplines - academic disciplines included in the component of choice within the framework of established credits and entered by educational organizations,

reflecting the individual training of the student, taking into account the specifics of socio-economic development and the needs of a particular region, established scientific schools of the higher educational institution;;

curriculum - the document regulating the list, sequence, volume (complexity) of subjects, educational disciplines and (or) modules, professional practice, other types of educational activity of students of the appropriate level of education and forms of control;

module - course system in which each course corresponds to an equal number of credits or a multiple of it;

prerequisites – disciplines containing the knowledge and skills necessary to master the studied discipline;

postrequisites – disciplines for the study of which requires knowledge and skills acquired upon completion of the study of this discipline;

core (working) curriculum (CC) – educational document developed by the organization of education on the basis of the standard curriculum of the specialty and the individual curricula of students;

intermediate assessment of students - a procedure conducted to assess the quality of students learning the content of part or all of one academic subject, one academic discipline and (or) module, as well as professional modules within one qualification after completing their study;

final assessment of students - a procedure carried out to determine the degree of their mastering the volume of subjects, educational disciplines and (or) modules stipulated by the state general obligatory standard of the corresponding level of education;

assessment methods - a full range of written, oral and practical tests/exams, projects, presentations, presentations and portfolios, which are used to assess student progress and confirm the achievement of learning outcomes for the educational component (unit/module);

assessment criteria - description of what a student should be able to do and at what level to demonstrate the achievement of the learning outcome;

academic mobility - the transfer of students or research teachers to study or conduct research for a specific academic period (semester or academic year) to another organization of higher and (or) postgraduate education (domestically or abroad) with mandatory recalculation of mastered curricula, disciplines in in the form of academic credits in their organization of higher and (or) postgraduate education or for continuing their studies in another organization of higher and (or) postgraduate education;

coding system - a set of methods and rules for coding classification groups and objects of classification of a given set;

European Credit Transfer and Accumulation System (ECTS) – student-centered system for the accumulation and transfer of credits based on the principle of transparency in the processes of study, teaching and evaluation.

In addition to them, the following abbreviations are used:

GED – general educational disciplines;

BD – basic disciplines;

PD - profiling disciplines;
CC – compulsory component;
EC – elective component;
EEEA - external evaluation of educational achievements;
SIW – student independent work;
SIWTS – student independent work under teacher supervision.

4. General provisions

4.1 Educational activity at the university is carried out by the credit technology of education based on the student-oriented approach, when the results of training and competence play the main role and become the main result of the educational process for the student.

4.2 Educational program on a specialty «Thermal Power Engineering» is developed in accordance with national standard of education of the Republic of Kazakhstan, National qualifications and is coordinated with the Dublin descriptors and the European framework of qualifications. Educational program is focused on learning outcomes.

4.3 Foreign and domestic specialists and employers were involved during the development of the educational program on the specialty 'Thermal Power Engineering'.

4.4 Priority directions for the development of educational program on a specialty «Thermal Power Engineering» are:

– Programs under the President's Addresses, including the Addresses noted in the «Third Modernization of Kazakhstan: Global Competitiveness»;
– Global Energy-Ecological Strategy for Sustainable Development in the XXI century;
– programs of an interdisciplinary orientation;
– program in English education;
– joint educational programs with foreign universities-partners;
– professional programs under the order of the enterprises-employers;
– programs using distance learning technologies, including additional education programs.

4.5 Educational program is intended to provide the high quality of professional education in heat power engineering in accordance with the highest academic standards in the world educational space.

The program has theoretical and practical components. Duration of study: 4 years. Type of study: full-time. During the period of study, the student masters not less than 160 credits, including the theoretical training – 130 credits, professional practice – 12 credits, physical education – 8 credits and final examination – 3 credits.

The degree awarded for the full mastering of the educational program – Bachelor of Engineering and Technology in the specialty «5B071700 – Thermal Power Engineering».

5. The code and the name of a specialty

The code of the specialty 5B071700 – Thermal power engineering, ~~this~~ educational program is in the section of Technical Sciences in accordance with the Classifier of specialties of higher and postgraduate education of the Republic of Kazakhstan.

Specialists in power engineering have code 2151 in the national classifier of Republic of Kazakhstan (NC of RK 01-2017 Classifier of occupations) and refer to specialists-professionals in science and technology.

6. Qualification level according to the International Standard Classification of Education

The educational program corresponds to the level of ISCED 6, which does not require the preliminary completion of other programs and is classified as first-degree programs. The direction of study is Bachelor's degree. Duration of study – 4 years.

According to the International Standard Classification of Education (ISCED-0-2013), the educational program refers to the following area of education:

07 Engineering, manufacturing and construction industries	071 Engineering and engineering trades	0711 Chemical engineering and processes 0712 Environmental protection technology **0713 Electrical engineering and energy** 0714 Electronics and automation 0715 Mechanics and metal trades 0716 Motor transport vehicles, ships and aircrafts

7. Objectives of the educational program

The educational program is focused on the training of highly qualified specialists of heat and power complex, with the certain knowledge and competencies, in demand on the labor market.

The objectives of the educational program are:

– formation of a national model of continuous education integrated into the world educational field by comparison with foreign educational programs that meet the needs of the individual and society in the specialty 5B071700 – Thermal power engineering;

– creation of conditions for the development of creativity, initiative and innovation;

– obtaining of knowledge on the basic disciplines of thermal power engineering and heat engineering with the subsequent conscious choice of professional elective disciplines;

– acquisition of practical skills required for bachelor student during the period of training and professional practices;

– formation of competitiveness of graduates on a labor market;

– acquisition of a complex of the knowledge, forming the basis of this profession, skills and abilities to navigate in information flows and generate new knowledge for continuing education in Master and PhD programs.

8. The area of professional activity of the specialty

The area of professional activity of the bachelor on specialty 5B071700 – Thermal power engineering is represented by:

- Ministry of Energy of the Republic of Kazakhstan;
- «National Atomic Company «Kazatomprom» Joint Stock Company;
- «National Welfare Fund «Samruk-Kazyna» Joint stock company;
- Group of Companies «Samruk-Energy» JSC;
- «Kazakhstan Electricity Grid Operating Company» (Kazakhstan Electricity Grid Operating Company) «KEGOC» Joint Stock Company;
- «Kazakh Scientific Research Institute of Energy named after academician Sh.Ch. Chokin» JSC;
- Scientific Research Institute of Experimental and Theoretical Physics (IETP);
- Institute of combustion problems;
- «Almaty thermal networks» LLP;
- «Teplocommunenergo» SME;
- Thermal power plants;
- Combined heat and power plants;
- Authorities of nature conservation and environmental management;
- «Plazmatechnika R&D» LLP;
- Academic and research institutions related to the study of the production and distribution of energy.

Types of economic activity according to the TCEA (Total Classification of Economic Activities), where the profession is in demand:

72 Scientific researches and developments
05.10.1 Extraction of coal by opencast methods
05.10.2 Extraction of coal by underground methods
05.10.3 Enrichment of coal
06.20.1 Extraction of natural gas, except of methane
06.20.2 Extraction of methane from coal deposits
20.11.0 Production of industrial gases
25.21.0 Manufacture of radiators and central heating boilers
25.30.0 Manufacture of steam generators, except central heating boilers
28.11.1 Engine production
28.11.2 Production of turbines
28.12.0 Production of hydraulic equipment
28.13.2 Production of compressors
28.21.1 Production of non-electric stoves, burners and devices for furnaces

28.25.2 Production of air conditioners, fans
33.11.2 Repair of radiators and central heating boilers
33.11.3 Repair of steam generators, except central heating boilers
35.11.1 Production of electricity by thermal power plants
35.11.2 Production of electricity hydroelectric power plants
35.11.3 Production of electricity by nuclear (atomic) power plants
35.11.4 Production of electricity by the other electric power plants
35.12.0 Transmission of electricity
35.14.0 The sale of electricity to the consumer
35.21.0 Gaseous fuel production
35.22.0 Distribution of gaseous fuels through pipelines
35.30.1 Production of thermal energy by heating networks
35.30.2 Production of thermal energy by independent boilers
35.30.3 Heat supply
35.30.4 Air conditioning.

9. Areas of professional activity

Graduates of the specialty 5B071700-Thermal Power Engineering can carry out the following types of professional activities under the guidance of a leading (senior) engineer, responsible executor or head of a topic (task):

in engineering design activity:

-In the collection and analysis of data to optimize the processes of generation of heat and electric energy in the fuel and energy complex;

- Conducting a preliminary feasibility study of design solutions for the selection of the most effective methods of burning gaseous, liquid and solid fuels using innovative technologies;

- development of technical solutions for the use of alternative energy sources in the fuel and energy complex;

in production and technology activities:

- monitoring compliance with technological discipline in the provision of industrial facilities with fuel, heat, electricity, technological energy;

- organization of metrological support of technological processes in the consumption of fuel, heat, electricity, process energy, the use of standard methods of quality control of products;

- monitoring compliance with environmental safety in the use of fuel, heat and electricity and process energy in production;

- setting the parameters of the optimal operation mode of the equipment; selection of water and fuel supply schemes for industrial enterprises;

in research activities:

- the study of scientific and technical information, domestic and foreign experience in the field of rational use of fuel and energy and secondary energy resources, increasing the reliability and safety of installations and heating systems;

- carrying out experiments according to a given method at pilot plants and laboratories of heat and power supply systems, and analysis of the results;

- preparation of data for the preparation of reviews, reports and scientific publications in the field of rational use of fuel and energy resources, improving the reliability and safety of installations and power supply systems;

- drawing up a report on the assignment, participation in the implementation of the results of research and development in the field of rational use of fuel and energy resources, improving the reliability and safety of installations and power supply systems;

- research and implementation of low-waste and non-waste technologies;

- the study of methods for controlling heat and mass transfer processes, methods and apparatus for converting various types of energy into thermal electrical energy and the development of appropriate engineering calculation methods;

- the use of innovative information technologies in solving applied problems of power engineering and ecology;

in organizational, management and operational activities:

-planning of equipment commissioning, testing, determining the efficiency and reliability of the installed equipment;

- energy assessment of thermal circuits and installations;

- monitoring and management of energy flows in the enterprise;

- planning energy saving measures and assessing their economic efficiency;

- preparation of a projected assessment of the impact of economic activities of heat and power facilities (in particular, the waste generated by them) on the state of the environment and the development of environmental protection measures with the use of new technologies for processing and recycling waste.

10. Competencies of the specialist

A graduate of specialty "5B071700-Power Thermal Engineering" should have a general cultural (GC) and professional (PC) competencies:

Code of competence	Description of competence
GC-1	knowledge of the main stages of the modern history of the progressive development of the statehood of Kazakhstan in the context of the world and Eurasian historical process;
GC-2	the ability to freely interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to an established state - the Republic of Kazakhstan;
GC-3	competent use of linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena;

GC-4	knowledge of social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;
GC-5	knowledge of the basic laws of the functioning and development of nature and society, the ability to adequately navigate in various socio-economic, political and emergency situations;
GC-6	ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;
GC-7	willingness to cooperate with colleagues, work in a team;
GC-8	the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies;
PC-1	the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;
PC-2	the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;
PC-3	the ability to use IT technologies and application packages to study the processes occurring in modern industrial enterprises;
PC-4	willingness to participate in the organization of the metrological support of technological processes using standard methods for monitoring the operating modes of technological equipment;
PC-5	the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods;
PC-6	readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;
PC-7	the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work;
PC-8	readiness to make technical and economic balances of installations, technological processes, sections of thermal power plants, to organize accounting and rationing of expenses for fuel and energy resources, to carry out an energy assessment of thermal schemes and installations of thermal power plants;

PC-9	the ability to apply knowledge about the organization of burning organic fuels in boiler furnaces, about thermophysical and hydrogasdynamic processes occurring in the gas-air and steam-water paths of a boiler plant, about the operating conditions of heating surfaces when solving applied technical problems
PC-10	willingness to implement low-waste and waste-free technologies for the production of heat and electricity at thermal power plants;
PC-11	the ability to use computer technology for modeling and processing the results of experimental and theoretical studies (OpenFoam, Paraview, OriginLab, Labview, etc.) to organize the technologically efficient burning of fossil fuels and reduce harmful emissions;
PC-12	willingness to ensure the competitiveness and efficiency of heat and power industry facilities using the tools of a competitive economy (laws, scientific approaches, principles, methods, models) for planning innovative energy facilities;
PC-13	the ability to solve problems in determining the energy characteristics and indicators of various installations for the conversion of energy from alternative sources into heat and electricity;
PC-14	willingness to analyze the state and prospects of development of the heat and power complex of the Republic of Kazakhstan using the necessary means and methods;
PC-15	the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources;
PC-16	readiness to regulate relations arising on the results of intellectual creative activity, innovative entrepreneurship.

11. Learning outcomes oriented to Dublin descriptors

Upon completion of this educational program, it is expected that students will be able to:

Cognitive competencies:

A1. have an idea of the basic theories in natural and social and economic sciences, analyze the socially significant problems and processes, be able to use the methods of these sciences in various types of professional activity, have sufficient theoretical training to analyze the social and economic situation of countries and regions; to implement their professional, social, economic role in society;

A2. know the general laws of the development of nature and society, own a culture of thinking; to be guided in ideals and values of a democratic society;

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy

production; use information and communication technologies in their professional activities.

Functional competencies:

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B2. to put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

System competencies:

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste its produce, on the state of the environment and develop environmental protection measures using new technologies and waste management;

Social (communicative) competence:

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

12. The ratio of the expected learning outcomes for teaching and evaluation methods in the formation of competence

12.1 Expected learning outcomes for the educational program

Upon completion of this program, it is expected that students will be able to:

1. Introduce the main provisions of innovations in the energy sector ("Green Technologies", Smart Grid, introduction of renewable energy based on high technologies) for the transition of the national economy to the principles of the "third industrial revolution";
2. determine the elements of the overall structure of the energy industry and alternative energy;
3. analyze the quality characteristics of the energy produced in the heat power sector of the country;
4. apply the knowledge gained in solving applied technical problems and problems of the heat and power industry;
5. use IT and nanotechnology to optimize heat engineering processes for energy generation;
6. apply economic and legal knowledge in professional activities for use in energy and resource saving measures;
7. plan and implement innovative, entrepreneurial, integrated engineering activities in thermal power engineering (study of market demand, search for opportunities to meet them, production planning, organize innovative activities at thermal power plants);
8. develop mathematical thinking for solving production problems in everyday situations (logic and spatial thinking; formulas, models, constructs, graphs, tables) in their professional activities;
9. critically select advanced engineering literature in the specialty, organize the search for patents and data in various databases, including in a foreign language, implementing the principle of lifelong learning;
10. create and maintain relationships, be able to work in a team, have a sense of social responsibility and solidarity.

12.2 Expected results for each module of the educational program

Code and title of competence	Expected results with the indication of the formed knowledge and skills	Module name with the number of credits
GC-1 GC-2 GC-3 GC-4 GC-5 GC-6 GC-7	Upon successful completion of this module students should be able to: 1. demonstrate knowledge of the main stages of the modern history of the progressive development of the statehood of Kazakhstan in the context of the world and Eurasian historical process; 2. freely interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to an established state - the Republic of Kazakhstan; 3. demonstrate knowledge of the basic laws of the functioning and development of nature and society, the ability to adequately navigate in various socio-economic, political and emergency situations, knowledge of socio-ethical values based on social and legal norms and tolerance to various cultural and religious traditions; 4. perceive, analyze and summarize information, set a goal and choose ways to achieve it; 5. formulate and reasonably defend their own ideological position on various issues; 6. freely interpret and creatively use scientific, historical and philosophical knowledge to analyze the factors of development of the Kazakhstan model of society and the economy.	Social and humanitarian module – 6 credits
GC-3 GC-6 GC-8 PC-3	Upon successful completion of this module students should be able to: 1. competently use linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; 2. build oral and written statements in different communicative situations, to understand and analyze the structural and semantic organization of the scientific text;	Instrumental module –15 credits

	3. perform various text operations: describe and summarize information; 4. search for information necessary for the effective performance of professional tasks; 5. use information and communication technologies in scientific and practical activities, self-education and the achievement of other goals.	
GC-5 GC-6 GC-7 GC-8 PC-4 PC-6 PC-12	Upon successful completion of this module students should be able to: 1. know the basics and principles of formation of the cost of production of the energy industry; 2. understand the characteristics of various financial products and services (including instruments of the securities market and collective investments), apply up-to-date information on the situation in the financial markets; 3. work with society, have knowledge in the field of interaction with the customer, personnel management, interaction with consumers; 4. optimize the ratio between savings and consumption; 5. evaluate and make informed decisions about financial products and services and be consciously responsible for such decisions; 6. initiate the development of innovative projects.	Entrepreneurial module – 4 credits
GC-4 GC-5 GC-7 PC-3 PC-5 PC-7	Upon successful completion of this module students should be able to: 1. understand the main ideas and concepts of ecology and sustainable development; 2. know the modern theories and practices of life safety in emergency situations of natural, man-made and social origin; 3. calculate the probability of occurrence of risk and factors causing the occurrence of emergency situations of natural, man-made and social origin; 4. predict emergency situations and their consequences, know the basic methods, means and methods of individual and collective protection in emergency situations; 5. analyze environmental processes in the formulation of specific tasks and priorities in environmental protection; 6. organize rescue operations in emergency situations of various kinds.	Environmental module – 4 credits

GC-3 GC-4 GC-6 GC-7 PC-16	Upon successful completion of this module students should be able to: 1. understand oral (monologue, dialogical) speech within the framework of professional subjects; participate in the discussion of topics related to the specialty; 2. independently prepare and make oral reports on professional topics, including using multimedia technologies; 3. extract necessary information from English-language sources created in various sign systems (text, table, graph, diagram, audiovisual series, etc.) in typical situations of professional and business communication; 4. annotate, review and state in the native language/from the native language the main content of the texts in the specialty, using the dictionary if necessary; 5. write messages, articles, theses, abstracts on professional topics; 6. recognize and use in oral and written statements the basic grammatical units characteristic of professional speech	Professional language – 4 credits
GC-6 GC-7 PC-2	Upon successful completion of this module students should be able to: 1. use the definitions and equations of vector algebra and analytic geometry and apply them when solving problems; 2. apply evidence base from the main areas of complex numbers, integral calculus and differential equations to solve theoretical and applied problems.; 3. use the methods of integral calculus to analyze the relationship between the various parameters of the objects under study; 4. compose mathematical models of typical professional tasks and find ways to solve them, interpret the professional (physical) meaning of the obtained mathematical result; 5. interpret mathematical thinking methods for solving production problems of heat power engineering.	Mathematics – 6 credits
GC-7 GC-8 PC-1	Upon successful completion of this module students should be able to: 1. use the basic physical devices for measuring mechanical quantities;	Physical and chemical fundamentals of heat

PC-2 PC-5	2. formulate and solve the simplest experimental problems of mechanics, process, analyze and evaluate the results obtained; 3. perform thermal calculations of the thermodynamic cycles of heat engines and heat power plants; 4. make calculations of fuel consumption, heat and steam for energy production; 5. describe various electrochemical energy sources and the processes occurring in them, identify the causes and types of corrosion, choose different methods for protecting structures and equipment of various metals from corrosion; 6. develop mathematical and simulation models of the operation of industrial heat and power plants and systems.	engineering – 10 credits
PC-1 PC-2 PC-5	Upon successful completion of this module students should be able to: 1. use the laws of molecular physics in research and study of the structure and properties of heat and power objects; 2. apply the basic principles of molecular kinetic theory and equilibrium thermodynamics in the analysis of natural science and technical situations; 3. interpret the information obtained to make optimal decisions in problems of heat power engineering; 4. solve physical problems and estimate the orders of physical quantities; 5. apply the fundamentals of electrical engineering and radio electronics, to carry out calculations of linear and nonlinear electrical circuits of direct and alternating current; 6. plan an experiment and explain the results of experimental studies with a given measurement error.	Physics 1 – 6 credits
PC-1 PC-2 PC-5 PC-7	Upon successful completion of this module students should be able to: 1. own optical methods of research and the simplest adjustment skills; 2. know the laws of linear and nonlinear optics, use the laws of optics to solve standard and non-standard problems;	Physics 2 – 6 credits

	3. own to configure and adjust the optical apparatus, the ability to apply modern methods and technology to ensure the quality of measurements; 4. explain the fundamental structure of matter, the basic properties of nuclei and products of nuclear reactions, the laws of conservation in nuclear reactions, the main types of nuclear reactions, the phenomenon of radioactivity; 5. classify and interpret the current state of nuclear and nuclear energy; 6. use the methods of processing and analysis of experimental and theoretical information in the field of atomic and nuclear physics.	
GC-8 PC-2 PC-3 PC-5 PC-7	Upon successful completion of this module students should be able to: 1. know how to transform the energy of the sun, wind, biomass, geothermal sources to produce various types of energy used by man; 2. determine the dependence of the amount of energy produced on weather conditions, time of day and time of year; 3. understand the methods of using the kinetic energy of wind; thermochemical and biological methods of biomass processing to produce water vapor, electricity, fuel gas, liquid fuels, etc.; 4. use the methods of choosing the parameters and composition of the main power equipment of generating plants based on renewable energy sources for energy supply to centralized and decentralized consumers, taking into account social, environmental and economic requirements; 5. conduct a comparative analysis of the use of traditional and alternative energy sources; determine the potential for the development of solar, wind, geothermal energy; 6. solve the problem of determining the energy characteristics and indicators of various installations for the conversion of energy from alternative sources into heat and electricity.	Alternative energy sources – 4 credits

GC-8 PC-2 PC-3 PC-6 PC-11	Upon successful completion of this module students should be able to: 1. process numerical data using Microsoft Excel, OriginLab and build two-dimensional graphs describing the results of numerical experiments carried out thermophysical tasks; 2. implement analytical and technological solutions using application packages (OpenFoam, Paraview, OriginLab, Labview); 3. apply the theory of numerical methods to solving thermophysical problems of energy: the flow of an isothermal viscous fluid in a cavity; collapse of the liquid column; flow of bodies of simple and complex shape with viscous incompressible liquid/gas; 4. substantiate the choice of a numerical method for solving systems of differential equations describing a specific thermophysical process (heat and mass transfer, heat transfer, aerodynamics); 5. determine the limits of applicability of the chosen numerical method for solving a specific heat and power problem (flow of an isothermal viscous fluid in a cavity; collapse of a liquid column; flow around bodies of simple and complex shape with viscous incompressible fluid/gas); 6. develop an algorithm for calculating thermophysical tasks, carry out their graphical interpretation and analysis using the graphical editor ParaView.	Computational Methods in Thermal Physics – 4 credits
GC-8 PC-2 PC-4 PC-8 PC-9	Upon successful completion of this module students should be able to: 1. know the types of fuel and methods of its optimal combustion in heat generating plants; 2. assess the effectiveness of the use of a particular type of fuel, as well as the method of its combustion in relation to a specific thermal power plant; 3. realize out calculations of various burner devices for the organization of technologically efficient combustion of organic fuel; 4. possess the skills of a reasonable choice of furnace processes in order to intensify them and reduce harmful emissions;	Fuel preparation and combustion – 9 credits

	5. analyze the mechanisms of chemical interaction of fuel and oxidant along with the physicochemical processes and phenomena accompanying the processes of combustion and explosion; 6. determine the main structural and technological factors affecting the efficiency of fuel combustion processes in modern facilities in order to generate thermal and electrical energy.	
GC-8 PC-1 PC-6 PC-9 PC-13	Upon successful completion of this module students should be able to: 1. analyze the efficiency of use of heat exchangers; 2. work with the necessary measuring equipment (pressure gauges, Pitot tubes, Prandtl tubes, thermostats, thermocouples, etc.) to determine the type and parameters of the flow of a viscous fluid in heat generating installations; 3. solve differential and integral equations of continuity, Euler, Navier-Stokes, convective heat and mass transfer, to apply boundary conditions in their solution; 4. analyze the main results of solving equations and regularities of fluid and gas flows in process plants as applied to problems of heat power engineering; 5. determine the main characteristics of the flow of liquids and gases in heat generating installations; 6. know self-made transformations and find graphical dependencies of flow parameters.	Thermophysical processes – 13 credits
GC-8 PC-1 PC-4 PC-5 PC-6 PC-7	Upon successful completion of this module students should be able to: 1. know the types of thermal power plants (TPP) and the principle of their work; 2. determine the technical and economic indicators of the efficiency of TPP (efficiency, consumption of heat and fuel); 3. calculate the parameters of pumps, compressors and fans and their modes of operation; 4. know the scientific and technical approaches to the creation of environmentally friendly combined-cycle high-power plants with gasifications of solid fuels and with an	Thermal power plants and equipment – 7 credits

	efficiency above 50%, as well as the basis for the development of combined-cycle plants for coal-gas synthesis; 5. apply methods and means of long-term forecasting of changes in the quality of the ecological system under the influence of thermal power plants, to manage personnel in accordance with the requirements of OHSAS 18001, IS0 14001; 6. realize practical actions to improve the state of the ecosystem exposed to the negative environmental impact of thermal power plants on the environment.	
PC-1 PC-8 PC-9	Upon successful completion of this module students should be able to: 1. know the structural features and characteristics, physical principles of work, methods of calculation, industrial application of superchargers and heat engines, power boilers of thermal power plants and steam generators of nuclear power plants; 2. apply knowledge about the organization of burning organic fuels in boiler furnaces, on thermophysical and hydro-gas dynamic processes occurring in the gas-air and steam-water paths of a boiler plant; 3. use skills and abilities in the design of boilers, the implementation of thermal, hydraulic, aerodynamic and strength calculations in power system; 4. ensure the reliability and efficiency of the boiler and auxiliary equipment TPP; 5. realize hydraulic calculations in relation to heat and power plants according to standard procedures using regulatory documentation; 6. analyze the performance characteristics of superchargers and heat engines and evaluate their impact on the efficiency of heat and power systems to improve the efficiency of installations and energy saving.	Heat and power plants – 5 credits
GC-8 PC-1 PC-2 PC-3	Upon successful completion of this trajectory students should be able to: 1. know the technological scheme of the production of electrical and thermal energy for the supply of heat and energy to consumers;	Individual educational trajectory of learning

PC-6 PC-8 PC-9 PC-11 PC-15	2. conduct a selection of types of gas turbine and combined-cycle plants and auxiliary equipment, efficient and economical technologies to ensure high reliability and safety of thermal power plants; 3. know the concepts of water treatment, sources of water pollution and methods of its treatment at TPPs; 4. apply the requirements for the quality of electrical energy, to calculate the need for energy and heat of various heat engineering processes; 5. choose construction materials for heat and power equipment taking into account operational properties and economic indicators and modern achievements in the field of nanomaterials; 6. be able to apply methods of quality control of products and objects in the field of professional activity, to analyze the causes of violations of technological processes and to develop measures for their prevention; 7. apply modern IT-technologies for optimization of technological processes at heat power enterprises; 8. use technologies of automatic regulation and control of processes at TPPs; 9. have the skills to work with modern software systems for the construction of geometry and finite difference schemes PREPROZ, Geom, GAMBIT, Ansys Meshing to conduct computational experiments on 3D modeling of fuel combustion processes in the furnaces of TPPs.	*Engineering power system* – 27 credits
GC-8 PC-1 PC-2 PC-4 PC-7 PC-8 PC-10	Upon successful completion of this trajectory students should be able to: 1. know the structure and content of the management system of the organization of the heat and power industry, the physical and technical basis of energy saving in the systems of transportation and distribution of thermal energy; 2. assess the absolute or specific values of consumption or loss of energy for any purpose for the rational use of fuel and energy resources;	Individual educational trajectory of learning *Energy management in the heat and power industry* – 27 credits

PC-12 PC-14 PC-16	3. calculate standardized indicators of energy efficiency of products for inclusion in state standards, product technical passports, technical and design documentation and for use in product certification and energy expertise; 4. determine indicators of the implementation of energy saving programs for statistical reporting, regulatory legal and procedural documents, for control structures of public administration and supervision; 5. assess the fundamental possibilities of using secondary energy; 6. develop measures to reduce the loss of energy and resources in heat networks; 7. make energy balances, calculate the share of the cost of energy resources in the cost of production; 8. apply state standards for energy saving: state standards for industrial equipment, machines, devices, etc.; 9. ensure the competitiveness and efficiency of heat and power industry facilities using the tools of a competitive economy (laws, scientific approaches, principles, methods, models) for planning innovative energy facilities.	
GC-4 GC-5 GC-7	Upon successful completion of this trajectory students should be able to: 1. understand the need for personal involvement in shaping your own health; 2. choose for yourself an individual physical activity and maintain physical culture; 3. take care of maintaining the normal and improving of his physical condition, its various parameters (health, physique, physical qualities and motor abilities); 4. know the variety of means used for this purpose (exercise, nutrition, etc.); 5. strengthen health, increase working capacity, maintain an active lifestyle; 6. methodically reasonable to use physical culture and sports activities for subsequent life and professional achievements.	Physical education module – 8 credits
GC-3 GC-4 GC-6	Upon successful completion of this trajectory students should be able to: 1. use the obtained theoretical knowledge to understand the processes in practice;	Professional practice module – 12 credits

GC-7 GC-8 PC-1 PC-2 PC-13 PC-14 PC-15	2. understand the principles of operation of devices of the main equipment of thermal power plants and heating networks; 3. analyze problems, processes and tasks of heat power engineering; 4. use in practice advanced knowledge and engineering research methods; 5. solve non-standard engineering problems of power engineering; justify the choice of engineering solutions; 6. conduct research in the chosen field of experimental and (or) theoretical physical research using modern instrumentation base (including sophisticated physical equipment) and information technology, taking into account domestic and foreign experience.	
GC-6 GC- PC-5 PC-13 PC-14 PC-15 PC-16	Upon successful completion of this trajectory students should be able to: 1. substantiate the relevance, content and results of the studied problem; 2. plan and carry out experimental studies, select research methods and apply them in your own research activities; 3. solve applied engineering and technical and economic tasks using application software packages; independently carry out physical and technical studies to optimize the parameters of objects and processes using standard and specially developed tools and software; 4. critically understand, analyze and use the scientific and engineering literature, to be able to comprehensively analyze the problems, processes and tasks of thermal power engineering; 5. substantiate the choice of engineering solutions and present the results of the research conducted in oral, written and multimedia forms in terms understandable to the target audience.	Final examination – 3 credits

Matrix of competencies formation of the modules of the educational program

Module Name	Learning outcomes (competencies) of the program											
	A1	A2	A3	B1	B2	B3	B4	B5	C1	C2	C3	D1
Social and humanitarian module	*	*										*
Instrumental module						*	*					*
Entrepreneurial module					*	*			*			*
Environmental module	*	*						*	*		*	*
Professional language			*					*	*		*	*
Mathematics							*					*
Physical and chemical fundamentals of heat engineering			*				*			*		
Physics 1			*			*	*			*		
Physics 2			*		*		*		*	*		
Computational Methods in Thermal Physics			*	*		*	*					
Fuel preparation and combustion			*		*	*	*		*			
Thermophysical processes			*			*	*			*		
Thermal power plants and equipment	*			*				*	*	*	*	
Heat and power plants						*	*		*	*		
Alternative energy sources	*					*		*	*	*	*	
Organization of technological processes in thermal power engineering			*	*			*		*	*		*
Metrological support and nanotechnology in thermal power engineering			*			*		*	*		*	
IT technologies in thermal power engineering				*		*	*			*		
Production management in thermal power engineering				*					*	*		
Energy and resource saving				*	*			*	*		*	
Green energy production			*		*		*		*			*
Professional practice module		*	*		*	*	*		*	*	*	*

13. CORE (WORKING) CURRICULUM ON THE SPECIALTY 5B071700 - THERMAL POWER ENGINEERING

Duration of study **- 4 years** Form of study **– full-time**

Academic degree: Bachelor of Engineering and Technology by specialty 5B071700 - Thermal Power Engineering

Code	Names of disciplines / types of study	Credits	ECTS	Semesters							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
GENERAL EDUCATIONAL DISCIPLINES (GED)		**29**	**47**								
COMPULSORY COMPONENT (CC)		**21**	**35**								
	Social and humanitarian module	**6**	**10**								
SIK1101	Modern history of Kazakhstan *(State exam)*	3	5	2+1+0							
Phil2105	Philosophy	3	5				2+1+0				
	Instrumental module	**15**	**25**								
FL1102	Foreign language	6	10	0+3+0	0+3+0						
K(R)L1103	Kazakh (Russian) language	6	10	0+3+0	0+3+0						
ICT1104	Information and communication technology	3	5		2+0+1						
	Total for compulsory component	**21**	**35**	**9**	**9**	**0**	**3**	**0**	**0**	**0**	**0**
ELECTIVE COMPONENT (EC)		**8**	**12**								
	Entrepreneurial module	**4**	**6**								
EEOT2106	Economic efficiency of thermal power engineering facilities	2	3			1+1+0					
IP2107	Innovative entrepreneurship	2	3			1+1+0					
	Environmental module	**4**	**6**								
URE2108	Sustainable energy development	2	3			1+1+0					
OBPE2109	Ensuring the safety of energy enterprises	2	3			1+1+0					
	Total for elective component	**8**		**0**	**0**	**8**	**0**	**0**	**0**	**0**	**0**
BASIC DISCIPLINES (BD)		**69**	**111**								
COMPULSORY COMPONENT (CC)		**20**	**31**								
	Professional language	**4**	**6**								

Code	Names of disciplines / types of study	Credits	ECTS	Semesters							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
PK(R)L3201	Professional Kazakh (Russian) language	2	3					0+2+0			
P-OFL3202	Professionally-oriented foreign language	2	3						0+2+0		
	Mathematics	**6**	**10**								
Mat (I) 1203	Mathematics I	3	5	1+2+0							
Mat (II) 1204	Mathematics II	3	5		1+2+0						
	Physical and chemical fundamentals of heat engineering	**10**	**15**								
FIZ 1205	Physics (Mechanics)	4	6	2+1+1							
TOT 2206	Theoretical fundamentals of heat engineering	4	6			2+1+1					
HiM 1207	Chemistry	2	3	1+0+1							
	Total for compulsory component	**20**	**31**	**9**	**3**	**4**	**0**	**2**	**2**	**0**	**0**
ELECTIVE CCOMPONENT (EC)		**49**	**78**								
Basic disciplines of the educational program											
	Physics 1	**6**	**10**								
MF1208	Molecular physics	3	5		1+1+1						
EM2209	Electricity and magnetism	3	5			1+1+1					
	Physics 2	**6**	10								
Opt2210	Optics	3	5				1+1+1				
AYaF3211	Atomic and nuclear physics	3	5					1+1+1			
	Alternative energy sources	**4**	6								
ESV3212	Energy of the sun and wind	2	3					1+1+0			
IGEEB3213	Use of geothermal and biomass energy	2	3					1+1+0			
	Computational Methods in Thermal Physics	**4**	**6**								
IG2214	Engineering graphics	2	3			1+0+1					

Code	Names of disciplines / types of study	Credits	ECTS	Semesters							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
ChMT2215	Numerical methods in thermal power engineering	2	3				1+0+1				
	Fuel preparation and combustion	**9**	**14**								
VTMS1216	Fuel types and its combustion methods	2	3		1+1+0						
TFChMP2217	Physical and chemical methods of fuel preparation	2	3				1+1+0				
FGV3218	Physics of combustion and explosion	3	5					1+1+1			
SVST3219	Special issues of the fuel combustion	2	3						1+1+0		
	Thermophysical processes	**13**	**23**								
TT2220	Technical thermodynamics	2	3			1+1+0					
OTT2221	Fundamentals of the heat conduction theory	3	5				1+1+1				
KT2222	Convective heat transfer	2	3				1+1+0				
TVZh3223	Viscous fluid flow	3	5					1+1+1			
FTT3224	Physics of turbulent flows	3	5						2+1+0		
	Thermal power plants and equipment	**7**	**11**								
TETS2225	Thermal power plants and heat and power networks	2	3				1+1+0				
NVKM3226	Pumps, fans and compressors machines	3	5					2+1+0			
PTTEC3227	Environmental technologies at thermal power plants	2	3					1+1+0			
	Total for the basic disciplines of the educational program	**49**	**80**	**0**	**5**	**7**	**14**	**18**	**5**	**0**	**0**
PROFILING DISCIPLINES (PD)		**33**	**55**								
COMPULSORY COMPONENT (CC)		**5**	**8**								
	Heat and power plants	**5**	**8**								

Code	Names of disciplines / types of study	Credits	ECTS	Semesters							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
KUP 3301	Boiler installations and steam generators	3	5						1+2+0		
NTD 3302	Superchargers and heat engines	2	3						1+1+0		
	Total for compulsory component	**5**	**8**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**
ELECTIVE CCOMPONENT (EC)		**27**	**45**								
	Organization of technological processes in thermal power engineering	**12**	**20**								
GPU3303	Gas turbine and steam-gas installations	3	5					2+1+0			
TVOE3304	Thermomechanical and auxiliary equipment of power stations	3	5						2+1+0		
VTES4305	Water treatment at thermal power stations	3	5							2+1+0	
TSE4306	Thermal power systems and energy use	3	5							2+1+0	
	Metrological support and nanotechnology in thermal power engineering	**6**	**10**								

Code	Names of disciplines / types of study	Credits	ECTS	Semesters							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
MTI4307	Metrology and heat engineering measurements	3	5							2+1+0	
NKMT4308	Nanotechnologies and construction materials in thermal power engineering	3	5							2+1+0	
	IT technologies in thermal power engineering	**9**	**15**								
AT4309	Automation at thermal power plants	3	5							1+1+1	
MPSTTK4310	3D modeling of fuel combustion processes in combustion chambers	3	5							1+1+1	
TOPGSK4311	Optimization technologies of combustion processes in modern thermal power plant boilers	3	5							2+1+0	
	Production management in thermal power engineering	**12**	**20**								
PREPP3303	Production and distribution of energy in industrial enterprises	3	5					2+1+0			
NMOTO3304	Regulatory and methodological support of the thermal power engineering industry	3	5						2+1+0		
UKT4305	Quality management in thermal power engineering	3	5							2+1+0	
OEP4306	Organization of energy management in enterprises	3	5							2+1+0	
	Energy and resource saving	**6**	**10**								
FTE4307	Physical and technical basis of energy saving	3	5							2+1+0	
EAOZhK4308	Energy audit of housing and communal services and the organization of energy saving	3	5							2+1+0	

Code	Names of disciplines / types of study	Credits	ECTS	Semesters							
				I	II	III	IV	V	VI	VII	VIII
				Lec+pract+lab							
	Green energy production	**9**	**15**								
EPAE4309	Environmental problems of alternative energy	3	5							1+1+1	
UPOPTO4310	Utilization and recycling of waste of thermal power engineering companies	3	5							1+1+1	
UEEBP4311	Management of environmental and energy safety of production	3	5							2+1+0	
	Total for elective component	**27**	**45**	**0**	**0**	**0**	**0**	**3**	**3**	**21**	**0**
	Total for theoretical training	**130**	**225**	**18**	**17**	**19**	**17**	**19**	**19**	**21**	**0**
ADDITIONAL TYPES OF TRAINING (ATT)		**20**									
COMPULSORY COMPONENT (CC)											
	Physical education module	**8**	**14**								
PhT	Physical education	8		0+0+2	0+0+2	0+0+2	0+0+2				
	Professional practice module	**12**	**20**								
EP	Educational practice	2	3		2 (1week)						
PT	Industrial practice	8	14				2 (5week)		2 (5week)		4 (10week)
PGI	Pre-diploma practice	2	3								2 (5week)
	Total for additional types of training	**20**	**34**	**2**	**4**	**2**	**4**	**0**	**2**	**0**	**6**
FINAL EXAMINATION		**3**	**4**								**3**
SES	State examination in the specialty	1	**1**								1 (2week)
WPT	Writing and defense of diploma work (project)	2	**3**								2 (4week)
TOTAL		**153**	**262**	**20**	**21**	**21**	**21**	**19**	**21**	**21**	**9**

CURRICULUM MODULES CONTENT

GENERAL EDUCATION DISCIPLINES (GED) – 29 credits

OBLIGATORY COMPONENT (OC) – 21 credits

SOCIAL AND HUMANITARIAN MODULE – 8 credits
GENERAL EDUCATION DISCIPLINES (GED) – 30 credits
OBLIGATORY COMPONENT (OC) – 21 credits

Social and Humanitarian module – 8 credits

General-cultural competencies:

GC-1 knowledge of the main stages of the modern history of the progressive development of the statehood of Kazakhstan in the context of the world and Eurasian historical process;

GC-2 the ability to freely interpret and creatively use scientific, historical and philosophical knowledge to summarize the success factors of the Kazakhstan development model on the way to an established state - the Republic of Kazakhstan;

GC-3 competent use of linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena;

GC-4 knowledge of social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;

GC-5 knowledge of the basic laws of the functioning and development of nature and society, the ability to adequately navigate in various socio-economic, political and emergency situations;

GC-6 ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;

GC-7 willingness to cooperate with colleagues, work in a team.

As a result of studying the module, the student is able:

A1. have an idea of the basic theories in natural and social and economic sciences, analyze the socially significant problems and processes, be able to use the methods of these sciences in various types of professional activity, have sufficient theoretical

training to analyze the social and economic situation of countries and regions; to implement their professional, social, economic role in society;

A2. know the general laws of the development of nature and society, own a culture of thinking; to be guided in ideals and values of a democratic society;

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

Methods for evaluating the results achieved:

1) verbal survey: interview, colloquium, exam;
2) written work: test, final test, essay, abstract, laboratory and settlement and graphic work, the state exam;
3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;
4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

SIK 1101 Modern history of Kazakhstan – 3 credits

Prerequisites: no.

Postrequisites: Phil2105 Philosophy.

As a result of studying the discipline, the student is able to:

- systematize the conceptual foundations of the study of modern history of Kazakhstan;
- compare the ideas of continuity of historical and cultural development, the deep roots of the spiritual heritage of Kazakhstan;
- discover the importance of formation of historical consciousness and ideological principles in accordance with national priorities;
- classify historical sources reflecting the peculiarities of the modern history of Kazakhstan;
- identify the historical patterns of development of society, paying attention to the study of historical originality;
- master the techniques of historical description and analysis of the causes and consequences of the events of the modern history of Kazakhstan;

- forecast possible solutions to contemporary problems based on an analysis of the historical past and reasoned information;
- argue the features and significance of the modern Kazakhstan model of development;
- explain the importance of patriotism education, in the spirit of democratic values of modern society on the example of the vital activity of historical personalities.

Topics for study:

1. Conceptual framework for the study of national history.
2. Prerequisites for the formation of independence in Kazakhstan: national liberation uprisings and formation of the idea of a national state.
3. The process of polarization of political forces.
4. Civil and political confrontation.
5. Implementation of the Soviet model of nation-building.
6. Contradictions and consequences of Soviet reforms in Kazakhstan in the second half of the twentieth century.
7. The policy of "restructuring" of Kazakhstan.
8. Formation of the state structure of the Republic of Kazakhstan.
9. Kazakhstan model of economic development.
10. Social modernization - the basis of the welfare of society.
11. Ethno-demographic processes and the strengthening of interethnic harmony.
12. Socio-political development prospects and spiritual modernization.
13. The policy of forming a new historical consciousness and worldview of the people of the Great Steppe.
14. Kazakhstan is a state recognized by the modern world.
15. N.A. Nazarbayev - a person in history. Formation of a united future nation.

Phi2102 Philosophy – 3 credits

Prerequisites: SIK1101 Modern history of Kazakhstan.

Postrequisites: no.

As a result of studying the discipline, the student is able to:

- describe the main content of ontology and metaPhysics in the context of historical development of philosophy;

- explain the specifics of the philosophical understanding of reality;
- justify the worldview as a product of philosophical understanding and study of the natural and social world;
- classify methods of scientific and philosophical knowledge of the world;
- interpret the content and specific features of the mythological, religious and scientific worldview;
- substantiate the role and significance of key ideological concepts as values of the social and personal being of a person in the modern world;
- analyze the philosophical aspect of media texts, socio-cultural and personal situations to substantiate and make ethical decisions;
- formulate and correctly argue their own moral position in relation to actual problems of modern global society;
- conduct a study that is relevant to identify the philosophical content of problems in the professional field and present the results for discussion.

Topics for study:

1. The emergence and development of philosophy. The subject and method of philosophy.
2. Historical types of philosophy.
3. Basic philosophical understanding of the world.
4. The problem of being. Ontology and metaphysics.
5. Consciousness and language.
6. Cognition and creativity.
7. Scientific and extra-scientific knowledge. Science and technology.
8. Philosophy of man and value world.
9. Man. Life and death. Meaning of life.
10. Ethics. The philosophy of values.
11. Freedom.
12. Aesthetics. Perception and creation of beauty.
13. Society and culture.
14. Philosophy of history.
15. “Mangilik Yel” and “Rukhani Zangyru” - the philosophy of the new Kazakhstan.

INSTRUMENTAL MODULE – 15 credits

General-cultural competencies:

GC-3 competent use of linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena;

GC-6 ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-3 the ability to use IT technologies and application packages to study the processes occurring in modern industrial enterprises.

As a result of studying the module, the student is able to:

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

FL1102 Foreign language – 6 credits

Prerequisites: no.

Postrequisites: P-OFL3202 Professionally-oriented foreign language.

As a result of studying the discipline, the student is able:

- reproduce orthoepic, spelling, stylistic norms of the Russian / Kazakh / foreign languages;
- use the features of professional verbal and written scientific speech;
- apply the technology of interpretation and analysis of the texts of scientific literature in the specialty;
- have an idea of the role and importance of information and information technology in the development of modern society and the economy of knowledge in the English language;
- practice the main methods, methods and means of obtaining, storing, processing information;
- have the skills to work with a computer as a means of managing information;
- build work with information in the global computer networks and corporate computer systems in English;
- competently use linguistic and cultural linguistic knowledge for communication in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena.

Topics for study:

1. The content of the educational program level A1.
2. The content of the educational program level A2.
3. The content of the educational program level B1.
4. The content of the educational program level B2 + LSP.
5. The content of the educational program of level C1.
6. The content of the educational program of the level - CALP –cognitive academic proficiency in the language.

K(R)L1103 Kazakh (Russian) language – 6 credits

Prerequisites: no.

Postrequisites: PK(R)L3201 Professionally-oriented Kazakh (Russian) language.

As a result of studying the discipline, the student is able to:

- make the right choice and use of language and speech means based on the knowledge of a sufficient volume of vocabulary, system of grammatical knowledge, pragmatic means of expressing intentions;

- transfer the factual content of texts, formulate their conceptual information, describe output knowledge (pragmatic focus) of the entire text, as well as its individual structural elements;

- interpret the information from the text, explain the style and genre specificity of the texts of the socio-cultural, socio-political, official business and professional areas of communication within the certification requirements;

- request and report information in accordance with the situation of communication, evaluate the actions and actions of participants, use information as a tool to influence the interlocutor in situations of knowledge and communication in accordance with certification requirements;

- build programs of speech behavior in situations of personal, social and professional communication in accordance with the norms of language, culture, the specifics of the sphere of communication, certification requirements;

- discuss ethical, cultural, socially significant problems in discussions, to express their point of view, to justify it reasonably, to critically evaluate the opinion of interlocutors;

- participate in communication in various situations of different areas of communication in order to realize their own intentions and needs (everyday, educational, social, cultural), declaring about them ethically correctly, meaningfully fully, lexically-grammatically and pragmatically adequate situation;

- compile household, socio-cultural, official business texts in accordance with generally accepted norms, functional orientation, using adequate lexical-grammatical and pragmatic material of a certain certification level, which is adequate for the purpose set.

Topics for study:

1. Content of the educational program of level A1.
2. Content of the educational program of level A2.
3. Content of the educational program of level B1.
4. Content of the educational program of level B2 + LSP.
5. Content of the educational program of level C1.
6. Content of the educational program of level – CALP – cognitive academic proficiency.

ICT1104 Information and communication technology – 3 credits

Prerequisites: Skills acquired within the school program in computer science, mathematics.

Postrequisites: IG2203 Engineering graphics; ChMT2215 Numerical methods in thermal power; TOCP4306 Technologies for optimization of combustion processes in modern boilers of thermal power plants; ISTP4305 Information systems in thermal power; MPST4306 3D simulation of fuel combustion processes in the combustion chambers.

As a result of studying the discipline, the student is able to:

- explain the purpose, content and development trends of information and communication technologies, justify the choice of the most appropriate technology to solve specific problems;
- explain the methods of collecting, storing and processing information, methods of implementing information and communication processes;
- describe the architecture of computer systems and networks, the purpose and functions of the main components;
- use Internet information resources, cloud and mobile services for searching, storing, processing and distributing information;
- use software and hardware of computer systems and networks for collecting, transmitting, processing and storing data;
- analyze and justify the choice of methods and means of information protection;
- using digital technologies to develop data analysis and data management tools for various types of activities;
- carry out project activities in the specialty with the use of modern information and communication technologies.

Topics for study:

1. The role of ICT in key sectors of social development. ICT standards.
2. Introduction to computer systems. Computer systems architecture.
3. Software. Operating Systems.
4. Human-computer interaction.
5. Database systems.
6. Data analysis. Data management.
7. Networks and telecommunications.
8. Cybersecurity.
9. Internet technology.

10. Cloud and mobile technologies.
11. Multimedia technology.
12. Smart technology.
13. E-technology. E-business. E-learning. E-government.
14. Information technology in the professional field. Industrial ICT.
15. Prospects for ICT development

ELECTIVE COMPONENT (EC) – 4 credits

ENTREPRENEURIAL MODULE – 4 credits

General-cultural competencies:

GC-5 knowledge of the basic laws of the functioning and development of nature and society, the ability to adequately navigate in various socio-economic, political and emergency situations;

GC-6 ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;

GC-7 willingness to cooperate with colleagues, work in a team;

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies;

Professional competencies:

PC-4 willingness to participate in the organization of the metrological support of technological processes using standard methods for monitoring the operating modes of technological equipment;

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-12 willingness to ensure the competitiveness and efficiency of heat and power industry facilities using the tools of a competitive economy (laws, scientific approaches, principles, methods, models) for planning innovative energy facilities;

As a result of studying the module, the student is able:

B2. to put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

EEOT2106 Economic efficiency of thermal power engineering facilities – 4 credits

Prerequisites: no.

Postrequisites: PTTEC3227 Environmental technologies at thermal power plants; EAOZhK4308 Energy audit of housing and communal services and the organization of energy saving.

As a result of studying the discipline, the student is able to:

- know the principles of formation of prices and tariffs for thermal energy;
- determine the types of funds of the enterprise and the organization of their use;
- to classify the organizational and economic foundations of various types of power plants;
- determine the economic efficiency of production;
- use methods and types of production planning;
- determine the economic efficiency of production;
- know the power management functions of the enterprise.

Topics for study:
1. Formation and organization of the use of means of production.
2. Labor and personnel in the energy sector. Organization, regulation, remuneration
3. Organization of the energy service of the enterprise
4. Organization of power supply of the enterprise
5. Wholesale and retail electricity and capacity market
6. Organizational and economic foundations of enterprises
7. Production planning. Business planning
8. Forms of maintenance of power equipment. The structure of the energy service
9. Functions of the enterprise energy management
10. Economic production efficiency

IP2107 Innovative entrepreneurship – 2 credits

Prerequisites: no.
Postrequisites: TOPGSK4311Technologies optimize combustion processes in modern boilers of thermal power plants; UKT4305 Quality Management in Thermal Power Engineering.

As a result of studying the discipline, the student is able to:
- analyze the state of the heat and power object;
- formulate the tasks of innovation in thermal power engineering and determine their priorities;
- use the basic principles and tools of innovation management in modern conditions;
- know the methodological foundations of research on innovative problems in power engineering;
- plan research in the field of innovative activity of heat and power production;
- analyze the degree of effectiveness of innovative projects;
- assess the level of influence of economic and social factors on the performance of an innovative project

Topics for study:

1. The essence and concept of innovation and the innovation process
2. The concept, purpose and objectives, functions of the innovation management system in thermal power engineering
3. The procedure for developing an innovative project.
4. The innovation process and its stages
5. Business planning in innovation
6. Risks. Risk factors for innovative entrepreneurship
7. Methods of risk assessment. Responsibility of business entities
8. The main criteria for evaluating innovative projects
9. Methods of forecasting innovation
10. Innovative strategy in power system
11. Strategic planning of innovations in heat and power engineering and diversification
12. The effectiveness of business activities and its evaluation

ENVIRONMENTAL MODULE – 4 credits

General-cultural competencies:

GC-4 knowledge of social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;

GC-5 knowledge of the basic laws of the functioning and development of nature and society, the ability to adequately navigate in various socio-economic, political and emergency situations;

GC-7 willingness to cooperate with colleagues, work in a team.

Professional competencies:

PC-3 the ability to use IT technologies and application packages to study the processes occurring in modern industrial enterprises;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods;

PC-7 the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work.

As a result of studying the module, the student is able:

A1. have an idea of the basic theories in natural and social and economic sciences, analyze the socially significant problems and processes, be able to use the methods of these sciences in various types of professional activity, have sufficient theoretical training to analyze the social and economic situation of countries and regions; to implement their professional, social, economic role in society;

A2. know the general laws of the development of nature and society, own a culture of thinking; to be guided in ideals and values of a democratic society;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management;

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

URE2108 Sustainable energy development – 2 credits

Prerequisites: no.

Postrequisites: ESV3212 Energy of the sun and wind; IGEEB3213 Use of geothermal and biomass energy; PTTEC3227 Environmental technologies at thermal power plants.

As a result of studying the discipline, the student is able to:

- understand the main aspects of ensuring sustainability of development - economic, environmental, social;
- interpret the concept of "energy trilemma", developed by the World Energy Council for the implementation of sustainable energy projects;
- explain the patterns of movement of energy and matter flows in nature and the heat and power industry in particular;
- classify the types of resources (energy, material, information, labor) that determine sustainability in the development of energy;
- use methods of ensuring the security of the relationship between resources - the exploitation of natural resources, the direction of investment, the orientation of scientific and technological development, personality development and institutional changes
- know the main problems of sustainable development energy security; energy, economic and environmental efficiency; innovation;
- apply the basic principles of environmental management and nature conservation;
- master the skills of forecasting changes in the global energy industry

Topics for study:

1. The concept of sustainable development. Sustainable development concept.

2. Conferences in Rio de Janeiro "RIO92" and "RIO + 20".
3. Types of sustainability.
4. Resources defining sustainability in energy development.
5. Criteria and indicators of sustainable development.
6. The main problems of sustainable development.
7. Components of the global socio-environmental crisis of our time.
8. Energy crisis and prospects for overcoming it.
9. Economic and legal mechanisms for the transition to sustainable development.
10. Strategies for the transition to sustainable development.
11. The role of international cooperation in sustainable development.
12. Modern social and environmental problems. The activities of the Republic of Kazakhstan in the field of environmental protection. N.A. Nazarbayev, Global Energy-Ecological Strategy for Sustainable Development in the 21st Century.
13. Environmental protection
14. Environmental problems of Kazakhstan.
15. Green office – modern energy saving mechanism

OBPE2109 Ensuring the safety of energy enterprises – 2 credits

Prerequisites: no.

Postrequisites: PTTEC3227 Environmental technologies at thermal power plants, EPAE4309 Environmental problems of alternative energy; UEEBP4311Management of environmental and energy safety of production

As a result of studying the discipline, the student is able to:

- know the legal, regulatory, and technical bases of safety at the enterprises of the heat and power industry;
- identify hazardous and harmful production factors at the enterprises of heat and power engineering;
- select and use the necessary types of personal and collective protection;
- know the effects of electric current, radiation, mechanical oscillations on the human body and how to reduce them
- apply measures to ensure fire and explosion safety at work
- ensure safety when working with vessels under pressure;

- be able to provide first aid for mechanical damage;
- use protective equipment and protective devices to ensure safe working conditions at thermal power plants;
- assess the anthropogenic impact of production on the environment.

Topics for study:

1. Legislative and legal acts in the field of life safety.
2. Classification of dangerous and harmful factors.
3. Protection of humans and the environment from harmful and dangerous factors of natural and man-made origin.
4. Classification of emergencies of different nature.
5. Sustainability of energy facilities in emergencies
6. Basic principles and methods of protecting the population in emergencies.
7. Organizational and practical security measures for earthquakes.
8. The basics of organizing and conducting rescue operations in natural disasters, fires, accidents and explosions at industrial facilities.
9. Analysis and systematization of threats to energy security by defining characteristics and severity.
10. Limit (threshold) values of indicators, the excess of which leads to the occurrence of negative, destructive phenomena in the heat and energy field.
11. The calculation of the actual values of indicators of energy security and comparing them with threshold values.
12. Determination of values of integral indicators of energy security.
13. Formation of recommendations and measures to anticipate threats and improve energy security indicators.

BASIC DISCIPLINES (BD)– 69 credits

COMPULSORY COMPONENT (CC)– 20 credits
PROFESSIONAL LANGUAGE – 4 credits

General-cultural competencies:

GC-3 competent use of linguistic and cultural linguistic knowledge for solving communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena;

GC-4 knowledge of social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;

GC-5 knowledge of the basic laws of the functioning and development of nature and society, the ability to adequately navigate in various socio-economic, political and emergency situations;

GC-6 ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;

GC-7 willingness to cooperate with colleagues, work in a team.

Professional competencies:

PC-16 readiness to regulate relations arising on the results of intellectual creative activity, innovative entrepreneurship

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste it generate, on the state of the environment and develop environmental protection measures using new technologies and waste management;

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

PK(R)L3201 Professional-oriented Kazakh (Russian) language – 2 credits

Prerequisites: K(R)L1103 Kazakh (Russian) language

Postrequisites: no

As a result of studying the discipline, the student is able to:

- know the features of the professional language of their specialty;
- analyze the term system of their specialty in Russian and Kazakh languages;
- be able to make a glossary of the specialty;
- create written speech works of various genres: plan, outline, written statement of a reproductive and productive nature;
- know the features of the structure and content of scientific work;
- be able to navigate the information on the specialty on various media;
- be able to conduct a targeted search for information, determine the importance and usefulness of information;
- build a monologue statement on a professional theme;
- conduct educational dialogue in the specialty;
- be able to apply the acquired knowledge in professional communication in semi-professional communication situations.

Topics for study:

1. Characteristics of the concept of "special (professional) language". Professional language and its components. Subject and object of study. The topic and the problem of research: methods for the nomination of the subject, the phenomenon in formulating the topic and problems of the study.

2. The terminological system of science. The term and definition. The term and common word. The term and nomenclature. Systematic terminology. Semantization of the term. Set expressions in the text in the specialty. The terminology of science in the Russian and Kazakh languages (comparison). Structure, content and scope of scientific work.

3. Regulatory requirements for the term. Features translation of terminological vocabulary. Introduction as a structural element of scientific work. The problematics of the introductory part of the project/research: justification, presentation.

4. Features of the compilation of a glossary. Use professional dictionaries. The main part as a structural element of scientific work. Problematics of the main part of the project: justification, design, presentation.

5. Morphological structure of texts in the specialty. The use of parts of speech in the scientific text. Selectivity of grammatical meanings (use of case forms). Conclusion as a structural element of scientific work. The issue of conclusion: justification, design, presentation.

6. Features of the syntax of the scientific text: the ratio of simple and complex sentences in the scientific text, the types of complex sentences. Deagents. Personalized character of scientific speech. Language means of registration of scientific work.

7. Culture of professional scientific speech. Culture of speaking and writing. The normative aspect of the culture of speech.

8. Culture of professional scientific speech. Communicative aspect of the culture of speech specialist. Communicative competencies necessary specialist for success in professional activities.

9. Culture of professional scientific speech. The ethical aspect of the culture of speech specialist. Professional ethics. Professional codes of ethics.

10. Verbal professional scientific speech. Basics of oral public speaking. Rules for a successful presentation.

11. Dialogue speech. Communicative features of professional scientific dialogue.

12. Design of an electronic presentation (presentation scheme, design of slides, selection of colors, fonts).

P-OFL3202 Professionally-oriented foreign language – 2 credit

Prerequisites: FL1102 Foreign language.

Postrequisites: no

As a result of studying the discipline, the student is able to:

- communicate with a clear and understandable to others pronunciation;

- understand the main ideas of clear messages made in the literary language on various topics that arise during leisure, study, work, etc.;
- communicate on a variety of general and educational and professional topics;
- express own opinion and defend own position;
- correctly combine words in a sentence in spoken and written language;
- make a presentation of the prepared report;
- understand the basic provisions of clearly pronounced statements within the limits of the literary norm on the studied topics relating to studies, leisure and future profession;
- understand the main points and common sense in most radio and television programs about current events and programs related to personal and professional interests;
- understand the main points and the general meaning of the reports and lectures;
- understand the texts built on the frequency language material of everyday and professional nature;
- understand the descriptions of events, feelings and intentions in texts and letters of a personal nature;
- understand the texts directly posing the questions that are in the sphere of interests of the student;
- fill in various papers: declarations, questionnaires, etc .;
- write personal letters, postcards;
- write a sequence of events in writing, write simple connected texts on familiar topics;
- describe people, places and situations;
- write essays, essays, reports.

Topics for study:

1. Professional language and its components. Subject and object of study. The topic and the problem of research: methods for the nomination of the subject, the phenomenon in formulating the topic and problems of the study.

2. The terminological system of science. The term and definition. The term and common word. The term and nomenclature. Systematic terminology. Semantization of the term. Set expressions in the text in the specialty. The terminology of science in the Russian and Kazakh languages (comparison). Structure, content and scope of scientific work.

3. Regulatory requirements for the term. Features translation of terminological vocabulary. Introduction as a structural element of scientific work. The problematics of the introductory part of the project / research: justification, presentation.

4. Features of the compilation of a glossary. Use professional dictionaries. The main part as a structural element of scientific work. Problematics of the main part of the project: justification, design, presentation.

5. Morphological structure of texts in the specialty. Use of parts of speech in the scientific text. Selectivity of grammatical meanings (use of case forms). Conclusion as a structural element of scientific work. The issue of conclusion: justification, design, presentation.

6. Features of the syntax of the scientific text: the ratio of simple and complex sentences in the scientific text, the types of complex sentences. Deagents. Personalized character of scientific speech. Language means of registration of scientific work.

7. Culture of professional scientific speech. Culture of speaking and writing. The normative aspect of the culture of speech.

8. Culture of professional scientific speech. Communicative aspect of the culture of speech specialist. Communicative competencies necessary specialist for success in professional activities.

9. Culture of professional scientific speech. The ethical aspect of the culture of speech specialist. Professional ethics. Professional codes of ethics.

10. Oral professional scientific speech. Basics of oral public speaking. Rules for a successful presentation.

11. Dialogue speech. Communicative features of professional scientific dialogue.

12. Design of the electronic presentation (presentation scheme, design of slides, choice of colors, fonts).

Mathematics – 6 credits

General-cultural competencies:

GC-6 ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;

GC-7 willingness to cooperate with colleagues, work in a team.

Professional competencies:

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus.

As a result of studying the module, the student is able to:

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Mat (I)1203 Mathematics I – 3 credits

Prerequisites: no.

Postrequisites: Mat (II) 1204 Mathematics II.

As a result of studying the discipline, the student is able to:

- know the basic mathematical concepts included in this program, their interrelation, interdependence and mutual influence not only among themselves, but also with other mathematical disciplines;
- be able to accurately and thoroughly argue the course of reasoning, without cluttering it with unnecessary details;
- acquire practical skills in problem solving in order to mathematically correctly set a specific simplest task of practice, choose a method for solving it and solve it;
- be able to work with the literature on the main sections of higher mathematics.

Topics for study:

1. Analytical geometry on the plane. Rectangular coordinate system on the plane. Coordinate transformations. Equation of the line plane. First order lines.

2. Second order lines. Circle. Ellipse. Hyperbola. Parabola.

3. Determinants. Basic properties of determinants. Systems of linear equations.

4. Rectangular coordinate system of space. Concept of vector. Projection of the vector on the wasp. Decomposition of the vector in the basis. Scalar and vector product of vectors.

5. Equations of the surface and lines in the space of the equation of the plane. Equations of straight line.

6. Concept of a single variable function. Limit function. Theorems on limits of functions. Concepts of continuity of functions. Break point function.

7. Concept of the derivative function. Geometric and Physical meaning of the derivative. Concept of differentiability of functions. Differential function. Rule of differentiation of a complex function.

8. Disclosure of uncertainties. Taylor and Maclaurin Formulas. Finite increments of a function and its consequences.

9. Concept of monotony of the function. Local extremum of function. Necessary and sufficient conditions of extremum.

10. Asymptotes of the function graph. Schedule study function graph.

11. Indefinite integral. Methods of integration by the method of changing variables and in parts.

12. Integrating rational functions.

13. Integration of some irrational functions.

14. Definite integral. Integration of a definite integral of a busy variable and in parts.

15. Some applications of definite integrals. Formulas of the areas of flat figures.

Mat (II)1204 Mathematics II – 3 credits

Prerequisites: Mat (I) 1203 Mathematics I.

Postrequisites: TOT 2207 Theoretical fundamentals of heat engineering; TT2220 Technical thermodynamics; ChMT2215 Numerical methods in thermal power engineering; MPSTTK4310 3D modeling of fuel combustion processes in combustion chambers.

As a result of studying the discipline, the student is able to:

- know the basic mathematical definitions and concepts;
- master the methods of solving various problems;
- reduce the proposed tasks to tasks with known solution algorithms or similar tasks;
- have practical skills in solving applied problems;
- formulate a mathematical model of the problem;

- use a variety of decision techniques;
- be able to evaluate the solution obtained by comparing it with the conditions of the problem.

Topics for study:

1. Functions of several variables. Continuity. Partial derivatives of the first order. Differential function.
2. Concept of the derivative function in this area. Gradient. Maximum and minimum functions of several variables.
3. Curvilinear integral of the 1st kind.
4. Double integral in a rectangle. Formulas for calculating the double integral. Geometric and Physical applications of double integral.
5. Rows. The convergence of the series. Necessary sign of the convergence of the series. Signs of comparison of positive series. Signs of D'Alembert convergence, Cauchy. Integral sign.
6. Power series. Area of convergence. Taylor Row.
7. Differential equations of the first order. Equations with separable variables.
8. Differential equations of the second order. Integrable types of second order differential equations. The case of degrading.
9. General properties of solutions of second-order linear differential equations. Linear homogeneous.
10. Linear inhomogeneous differential equations of the second order with constant coefficients. second order differential equations with constant coefficients.
11. Homogeneous linear systems of differential equations with constant coefficients.
12. Basic definitions and theorems. Random events. Algebra of events. The classic definition of probability. Probability properties.
13. The theorem of multiplication of probabilities. Formula of full probability and Bayes formula.
14. Discrete random variable and its numerical characteristics. The main types of distribution.
15. Continuous random variable and its numerical characteristics. The main types of distribution.

PHYSICAL AND CHEMICAL FUNDAMENTALS OF HEAT ENGINEERING – 10 credits

General-cultural competencies:

GC-7 willingness to cooperate with colleagues, work in a team;

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods;

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Phys1205 Physics (Mechanics) –4 credits

Prerequisites: no.

Postrequisites: MP1208 Molecular Physics; EM2209 Electricity and Magnetism; Opt2210 Optics; AYaF3211 Atomic and Nuclear Physics

As a result of studying the discipline, the student is able:

- know the basic concepts and Physical quantities of the course mechanics;
- explain the basic laws and principles of mechanics, their logical content and mathematical expression;
- interpret the main mechanical phenomena;
- have an idea of the applicability limits of Physical models and hypotheses;
- have an idea of the most important stages in the development of mechanics (and Physics in general), its philosophical and methodological problems;
- effectively apply the laws of mechanics to solve specific problems in the field of Physics and at interdisciplinary boundaries with other fields of knowledge;
- use the basic Physical instruments for measuring mechanical quantities;
- set and solve the simplest experimental problems of mechanics, process, analyze and evaluate the results obtained;
- build mathematical models of the simplest phenomena of mechanics and to use the mathematical apparatus available to him to study these models, including methods of computational mathematics.

Topics for study:

1. The objects of Physical research are the material Universe, Physical laws governing the motion of matter, structure of matter, its properties and development. Features of the Physical research method. Models of Physical phenomena. Hypotheses and Physical theories. System International (SI).

2. Space is time. The main properties of space - time (dimension, curvature, homogeneity, isotropy, mirror symmetry). Coordinate systems (Cartesian, cylindrical, and spherical). Measurement time. Periodic processes. Clock synchronization. The principle of causality.

3. Kinematics of a material point and a solid body. Ways to describe the movement of a material point (*mt*). Movement, speed and acceleration in vector and coordinate form. Normal and tangential components of the vector of full acceleration *mt*.

4. The principle of relativity. The law of inertia. Inertial reference systems. Principle of relativity. Galilean transformations. Invariants of Galilean transformations.

5. Dynamics of a material point. Forces and interactions in nature. Newton's laws of dynamics. Impulse and its preservation in the interaction of bodies.

6. Dynamics of the system of material points. The system of material points (smp). Impulse of a system of material points. Moment of impulse of a material point. Moment of power. The law of conservation of angular momentum isolated smp.

7. Work and energy. Power. Work force on the final path. Potential and non-potential forces. Interaction energy The energy of a relativistic particle and the energy of rest. Kinetic energy. Law of energy conservation.

8. Dynamics of a solid body. Statics. The system of equations of motion of a rigid body. Moment of impulse The calculation of the moment of inertia about the axis. Huygens theorem.

9. Movement in the presence of friction. Dry and fluid friction. Sliding friction and resting friction. Rolling friction Work force friction.

10. Non-inertial reference systems. The laws of mechanics in non-inertial reference systems. Forces of inertia.

11. Movement in the field of aggression. The law of the World Newton. The basic laws of motion of planets and comets. The movement of satellites. The first, second, third cosmic velocity.

12. Collisions. The definition of collision. The laws of conservation in collisions. Image of collision processes using diagrams. Elastic and inelastic collisions. The center of mass system.

13. Elements of continuum mechanics. Deformation of continuous media. Properties of liquids and gases. The laws of hydrostatics. Bernoulli's law. Fluid viscosity. Laminar and turbulent flow. Reynolds number. Poiseuille law.

14. Fluctuations. Harmonic vibrations and their representation in a complex form. The addition of harmonic vibrations. Beats. Own fluctuations. Oscillation energy. Fading vibrations. Logarithmic damping decrement.

15. Waves. Longitudinal and transverse waves. The amplitude, phase, wave propagation velocity. Wave equation. Sound wave energy.

Him 1207 Chemistry – 2 credits

Prerequisites: no

Postrequisites: TOT 2207 Theoretical fundamentals of heat engineering; TFChMP2217 Physical and chemical methods of fuel preparation; SVST3219 Special issues of the fuel combustion.

As a result of studying the discipline, the student is able to:

- describe the stoichiometric laws, the law of equivalents, the gas laws, the quantum-mechanical theory of the structure of the atom, the periodic system of chemical elements, the mechanisms of formation of covalent bonds;
- demonstrate an understanding of the basic laws of chemistry, the basic laws of thermodynamics, chemical kinetics, the theory of solutions. Demonstrate an understanding of salt hydrolysis, redox reactions;
- apply the knowledge gained in the calculations used in predicting the course of chemical reactions;
- make calculations necessary for the synthesis of inorganic substances;
- carry out the calculations necessary for the preparation of solutions of a given concentration;

- develop the knowledge gained to assess the synthesis of inorganic substances, the possibility of their use in obtaining materials;
- forecast ways to obtain products and materials with desired properties using inorganic compounds;
- report information on the current state of development of chemistry of structured metal powders;
- analyze information about new types of materials that can offer new ideas leading to the improvement of the technology of creating new materials.

Topics for study:

1. Basic concepts of chemistry. Atom, molecule, mole, equivalent. The mass of an atom, a molecule, a mole. Atomic-molecular teaching.
2. Stoichiometric laws. The law of equivalents. Gas laws.
3. Quantum-mechanical theory of the structure of the atom: the history of development. Quantum numbers. The shape and orientation of the boundary surfaces of the s-, p-, d- and f- orbitals.
4. The energy levels of the electron in the atom. Pauli principle. Rule of Hund. Electronic structures of atoms of elements. Periodic law and the periodic system of elements of D.I. Mendeleyev.
5. The position of an element in the periodic system as its most important characteristic.
6. Chemical bonding, quantum-mechanical methods of treating covalent bonding. The method of valence bonds (BC).
7. The concept of thermodynamics. The basic laws of thermodynamics. Internal energy and enthalpy of substances. Homogeneous and heterogeneous equilibria. Equilibrium constant. Displacement of chemical equilibrium. The rule of Le Chatelier.
8. Chemical kinetics. Classification of chemical reactions. Homogeneous and heterogeneous processes. The rate of chemical reaction. Speed constant. The order and molecular nature of the reaction.
9. General information about solutions. Solutions of non-electrolytes. The laws of Raul. Cryoscopy and ebulioscopy. Osmotic pressure of solutions. The Van't Hoff law.
10. Electrolyte solutions. Strong and weak electrolytes. Ostwald dilution law.
11. The degree of oxidation. Redox reaction. The most important oxidizing and reducing agents.
12. The method of half-reactions for the compilation of equations OVR. Standard redox potentials. Direction IAD.
13. Electrode potentials. Nernst equation. A series of metal stresses. Electroplating.
14. The concept of electrochemistry. Electrolysis. The laws of Faraday.
15. The concept of construction materials.

TOT 2207 Fundamentals of the heat conduction theory– 4 credits

Prerequisites: Mat (I) 1203 Mathematics I, Mat (II) 1204 Mathematics II.

Postrequisites: TETS2225 Thermal power plants and thermal power networks; NVKM3226 Pumps, fans and compressor machines; NTD 3302 Boiler installations and Steam Generators ; KUP 3301 Boiler installations and Steam Generators

As a result of studying the discipline, the student is able:

- master the basic laws of thermodynamics;
- have a clear understanding of thermodynamic processes, specific gases and vapors;
- have a complete understanding of the operation of internal combustion engines, gas turbine and oil tooling cycles and cooling systems;
- have the skills to prepare practical reports on the theoretical problems of heat engineering;
- know the scientific and technical application of the results of the study of turbulent theory;
- correctly correlate the qualitative and quantitative statement of the main issues of the discipline;
- use the necessary mathematical apparatus for solving problems of heat engineering;
- apply the basic laws of technical thermodynamics to solve specific problems of fluid dynamics and thermal Physics.

Topics for study:

1. The main parameters of the thermodynamic state. Thermodynamic systems. Thermodynamic processes. Reversible and irreversible processes. The equation of state of an ideal gas. Gas mixture.
2. The first law of thermodynamics. Principles of heat and work equivalent. Internal energy. Work expansion. Calculated view of the first law of thermodynamics. Enthalpy. Heat capacity of gases.
3. The second law of thermodynamics. Entropy. General concepts of the second law of thermodynamics. Thermal efficiency of cycles and cooling coefficient. Forward and reverse cycles Carnot.
4. The second law of thermodynamics. Entropy change in reversible and irreversible cycles. Exergy. Carnot Regenerative Cycle.
5. Thermodynamic processes. Isochronous process. Isobaric process. Isothermal process.
6. Thermodynamic processes. Adiabatic process. Polytropic process.
7. Real gases. General concepts. Van der Waals equation. Water vapor Steam formation process Determination of parameters of water and water vapor.
8. Real gases. Ts and hs water vapor diagrams. The main thermodynamic processes of water vapor. Wet air.

9. The expiration of gases and vapors. Basic equations of flow. Nozzle outflow Critical speed. Outflow from the nozzle of variable cross section.

10. The expiration of gases and vapors. Water vapor outflow. The emission of gases and vapors.

11. Thermodynamic processes of compression (compressor). Single piston compression. Multistage compressor.

12. Internal combustion engines (ICE). A brief history of the development of ICE. Heating cycle at constant volume. Heat cycle at constant pressure. Combined feed cycle. Comparison of ICE cycles.

13. The cycle of gas turbines and jet installations. The cycle of gas turbines. Jet engine cycle.

14. Cycle paraturbina installation. Carnot cycle (for water vapor). Rankine cycle. The influence of the main parameters on the Rankine cycle. Regenerative cycle. Basics of district heating.

15. Refrigeration cycle. Air cooling cycle. Steam Refrigeration Cycle.

ELECTIVE COMPONENT (EC) – 49 credits

PHYSICS 1 – 6 credits

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities.

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

MF1208 Molecular Physics – 3 credits

Prerequisites: Fiz 1205 Physics (Mechanics); Him 1207 Chemistry; Mat (I) 1203 Mathematics I

Postrequisites: TT2220 Technical thermodynamics; KT2222 Convective heat transfer; FTT3224 Physics of Turbulent Flows; FGV3218 Physics of combustion and explosion

As a result of studying the discipline, the student is able to:

- know the basic laws of molecular Physics;
- understand the basics of equilibrium thermodynamics;
- explain the patterns of changes in some Physical parameters when others change in different processes;
- apply the mathematical apparatus in solving problems;
- use for measuring devices and methods for measuring the basic thermodynamic parameters;
- reveal the Physical mechanism of the studied phenomena;
- analyze the change in thermodynamic parameters in specific processes;
- apply the basic laws of molecular Physics and thermodynamics in solving problems;
- use the laws of molecular Physics in research and study of the structure and properties of objects of nature at various levels of its organization.

Topics for study:

1. Molecular-kinetic model of material bodies. The masses of atoms and molecules. The relationship of the properties of a substance with its structure and with the nature of the thermal movement of structural elements. Three phases of matter. Perfect gas model.

2. The basic equation of the molecular kinetic theory of gases. The equation of state of an ideal gas. Isoparametric processes. Thermodynamic equilibrium.

3. Basic concepts of mathematical statistics. The concept of a statistical ensemble of thermodynamic systems. Ergodic hypothesis. Fluctuations. Microstate and macrostate. Thermodynamic probability (statistical weight) as the number of microstates by which this macrostate is realized.

4. Maxwell distribution of molecules over velocities. Temperature as a measure of the average kinetic energy of the thermal chaotic motion of gas molecules in a state of equilibrium. Barometric formula. Boltzmann distribution. Maxwell-Boltzmann

distribution.

5. The basic laws of thermodynamics (the beginning of thermodynamics) as a generalization of the observed phenomena, accompanied by energy transformations. State functions. Zero start of thermodynamics. Temperature. The first law of thermodynamics.

6. Heat capacity. Molar and specific heat capacity. The heat capacity of the ideal gas in various processes. Isobaric process. Isochoric process. Isothermal process. Adiabatic process. Polytropic process.

7. Processes are reversible and irreversible. Cyclic processes. Work cycle. Cycle Carnot. Efficiency of the Carnot cycle. Clausius inequality. The second law of thermodynamics.

8. Entropy of ideal gas. The law of entropy increase in closed systems. Entropy change in irreversible processes. Entropy change in isoparametric processes.

9. Forces and potentials of intermolecular interaction. Types of transfer processes: viscosity, thermal conductivity, diffusion, thermal diffusion. Kinetic theory of transport processes in gases.

10. General transport equation. Self-diffusion, viscosity, thermal conductivity, mutual diffusion, thermal diffusion. Physical phenomena in rarefied gas. Heat transfer, effusion, thermal transfer. Features of transport phenomena in liquids and in solids. Frankel formula.

11. Deviation of the real gases properties from the properties of ideal gases. Andrews Experimental Isotherms. Equations of state considering the behavior of real gases.

12. Van der Waals equation. Critical temperature. Critical situation. The law of corresponding states. Joule-Thomson effect.

13. The structure of the fluid. Frankel formula. Features of the phenomena of transfer in liquids. Evaporation and boiling of liquids. Overheated liquid. Bubble cameras.

14. The crystalline and amorphous state of matter. Elements of symmetry of crystals. Grate Bravais. Physical types of crystals. Defects in crystals. Dislocations. Heat capacity of solids. The law of Dulong and Petit.

15. Phase transformations of the first and second kind. Experimental data. Clapeyron – Clausius formula. The gas-liquid-solid state diagram for a normal and anomalous substance. Triple point. Entropy change during first-order phase transitions. Helium state diagram.

EM2209 Electricity and magnetism – 3 credits

Prerequisites: FIZ1205 Physics (Mechanics); Him1207 Chemistry

Postrequisites: TETS2225 Thermal power plants and thermal power networks; NNVKM3226 Pumps, fans and compressor machines; GPU3303 Gas turbine and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants

As a result of studying the discipline, the student is able to:

Topics for study:

- explain the course and causes of phenomena of an electromagnetic nature;
- describe the various Physical processes of electromagnetic origin;
- correct the data and explain the reason for possible changes based on the basic laws of electromagnetism;
- evaluate the obtained theoretical and experimental data to the accuracy of the required order of magnitude;
- summarize and classify the data obtained to identify the electromagnetic nature and the main laws governing the occurrence of an electrical phenomenon or process.

Topics for study:

1. The fundamental principles of the theory of electromagnetic interactions.
2. Scalar potential. Description of electrostatic fields using potential.
3. Electrostatic field in dielectrics.
4. Polarization mechanisms of dielectrics. Forces in the electric field.
5. The main laws governing the flow of electric current through the conductor.
6. Electrical conductivity of solids.
7. Thermoelectric phenomena.
8. Conductivity of semiconductors.
9. Electrical conductivity of gases. Plasma.
10. Magnetic field.
11. The field in magnetic.
12. Magnets.
13. The phenomenon of electromagnetic induction and the consequences arising from it.
14. Chains of quasi-stationary alternating current and methods of their calculation.
15. Maxwell equations with bias current.

PHYSICS 2– 6 credits

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods;

PC-7 the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities

B2. put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

Opt2210 Optics – 3 credits

Prerequisites: FIZ1205 Physics (Mechanics); Mat (I) 1203 Mathematics I

Postrequisites: TETS2225 Thermal power plants and thermal power networks; NVKM3226 Pumps, fans and compressor machines; NTD 3302 Boiler installations and Steam Generators ; KUP 3301 Boiler installations and Steam Generators

As a result of studying the discipline, the student is able to:

- systematize and classify independently the technical literature, using modern educational and information technologies;
- use analytical and numerical analysis of the calculation of optical problems, including the use of modern software;
- calculate and measure the parameters and characteristics of optical systems, filters;
- analyze the Physical processes occurring in various environments, microwave devices, in homogeneous and inhomogeneous environments;
- apply knowledge and skills in special calculations, correctly draw up optical circuits, measure light and energy values using measuring instruments;
- analyze the effectiveness and optimization of optical systems;
- have the skills and understanding of the Physical principles of natural phenomena based on optical phenomena.

Topics for study:

1. Scale of electromagnetic waves. The development of ideas about the nature of light. The first laws of optics. Farm principle. Energy units and the relationship between them. Light values.
2. The phenomena of refraction and refraction in nature. Gladson's law and the equation of refraction. Light fibers. Fockon.
3. Building an image in a thin lens. Building an image in a thick lens. Addition of optical systems. Optical instruments. Camera.
4. Day and twilight vision. The concept of color. Color coordinates. Synthesis of color. Color profiles of devices. Interference of monochromatic light. Interference of plane waves
5. Localization of interference fringes. Experience Fields. Stripes equal tilt. Stripes of equal thickness. Newton's rings. Interference of quasi-monochromatic light. Temporal coherence
6. Two-beam interferometers. Rayleigh’s interferometer. Jamin’s interferometer. Rozhdestvenskiy’s interferometer. Puccianti’s Method. The method of "hooks". Michelson’s interferometer and its modifications.

7. The phenomenon of diffraction. The principle of Huygens-Fresnel, its integral record and interpretation. Principle of Babine. Fresnel's zones. Application of vector diagrams for the analysis of diffraction patterns. Zone records.

8. Amplitude and phase diffraction gratings. Diffraction and spectral analysis. Spectral analysis in optics. Spectroscopy with spatial decomposition of spectra.

9. The Physical basis of the method of holographic image recording. Holograms of Gabor and Denisyuk. The application of optical static holography. Acoustic wave diffraction.

10. The concepts of polarization in optics. Interference of polarized waves. Description of the polarization of radiation in the framework of the electromagnetic theory of light. The role of electric and magnetic fields in the interaction of light waves with matter.

11. Maxwell's equations and waves in metals. Geometric laws of reflection and refraction of light at the metal boundary. Fresnel formulas. Measurement of optical metal constants. Optics of anisotropic media. Propagation of light waves in anisotropic media: experimental facts and elements of the theory.

12. Polarization devices, quarter-wave and half-wave plates. Experiments on polarization effects and double refraction of light. The concept of gyrotropic media. Natural optical activity. Saccharimetry.

13. Light dispersion. Microscopic picture of the propagation of light in a substance. Linear optical oscillator. Classical electron theory of dispersion. The dependence of the refractive index and absorption of frequency. Phase and radial velocities.

14. Heat radiation. Radiative and absorption properties of substances, their ratio. Model is completely black body. Stefan-Boltzmann's law. Wine displacement formula.

15. Illumination and geometry of the sky. Rayleigh scattering in the atmosphere. Sunlight scattering. Crowns, glorias, halos. Spot Poisson in space. Turbulent beam displacement.

AYaF321 Atomic and Nuclear Physics – 3 credits

Prerequisites: FIZ1205 Physics (Mechanics); Him1207 Chemistry; MF1208 Molecular Physics; Opt2210 Optics

Postrequisites: KT2222 Convective heat transfer; TSE4306 Thermal Energy Systems and Energy Use; EPAE4309 Environmental problems of alternative energy.

As a result of studying the discipline, the student is able:

- present the Physical theory of the atom as a generalization of observation, practical experience and experiment, presented on the appropriate mathematical level, as a link between Physical phenomena and quantities;

- enable students to learn the basic laws of atomic Physics and their mathematical expression;
- give a complete picture of atomic phenomena,
- teach methods of observation and experimental study of atomic phenomena;
- teach students to formulate the basic concepts of the discipline, solve Physical problems and evaluate the orders of Physical quantities;
- form a student's ideas about quantum phenomena at the atomic-molecular level, about the experimental foundations of quantum Physics and the Physical phenomena caused by the electron shells of atoms and molecules;
- enable the student to share the results of the research with the scientific community, to enter into dialogue, to defend their point of view;
- develop the ability of the student to use this knowledge in practice (field trip, research, final work, etc.)).

Topics for study:

1. System of units used in atomic Physics. The scale in the microworld. The order of magnitude of distances and energies for atomic-molecular and nuclear processes. Patterns in the spectra of atoms. Rydberg-Ritz's combination principle. Atomic structure models: Thomson's atom model and Rutherford's nuclear atom model. Rutherford's experiments on α-particle scattering.

2. Incompatibility of the planetary model of the atom with the concepts of classical Physics. Bohr postulates. The principle of conformity. Experiments of Frank and Hertz. Bohr's elementary theory of the hydrogen atom.

3. The principle of compliance. Successes and disadvantages of the Bohr's theory. Quantum properties of electromagnetic radiation. Photo effect. Experience Bothe. Photons. Compton effect.

4. Quantum theory of the atom. De Broglie's hypothesis. Wave properties of matter. Experiments of Davidson-Germer. Schrodinger's equation. Mathematical requirements for the wave function.

5. The Physical meaning of the wave function. Properties of microparticles. Heisenberg uncertainty principle. Operators.

6. Schrodinger's equation. The simplest one-dimensional problems of quantum mechanics. Rectangular potential pit and harmonic oscillator.

7. Quantization of Physical quantities. Quantization of energy. Quantization of angular momentum. Postulates of quantum mechanics.

8. The hydrogen atom. Properties of centrally symmetric systems. Energy levels and quantum numbers of an electron in a hydrogen atom. Degeneration. Type of wave functions and probability density distribution. The spectrum of the hydrogen atom and hydrogen-like atoms.

9. Energy levels and spectra of alkali metal atoms. Spin-orbit interaction and fine structure.

10. Mechanical moment of a multielectron atom. Addition of angular moments. Types of links: ls-link and jj-link. The principle of identity. Symmetric and antisymmetric wave functions.

11. Statistics of Fermi-Dirac and Bose-Einstein. Pauli's principle. Electron shells of atoms and their filling. Physical explanation of the periodic law. Rules Hund.

12. The intensity and width of the spectral lines. X-ray spectra and their nature. Continuous and characteristic X-ray spectrum. Mosley's Law

13. Types of motion in the molecule. The order of magnitudes of electronic, vibrational and rotational energy. Electron states of the molecule. Rotational, vibrational and electronic spectra of molecules.

14. Composition and characteristics of the atomic nucleus. Mass and bonding energy of the nucleus. Atomic nucleus models. Nuclear forces Radioactivity. The law of radioactive decay.

15. Nuclear reactions. Nuclear fission. Thermonuclear reactions. Elementary particles. Antiparticles. Conservation laws

ALTERNATIVE ENERGY SOURCES– 4 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-3 the ability to use IT technologies and application packages to study the processes occurring in modern industrial enterprises;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods

PC-7 the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work.

As a result of studying the module, the student is able:

A1. have an idea of the basic theories in natural and social and economic sciences, analyze the socially significant problems and processes, be able to use the methods of these sciences in various types of professional activity, have sufficient theoretical

training to analyze the social and economic situation of countries and regions; to implement their professional, social, economic role in society;

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

ESV3212 Energy of the sun and wind– 2 credits

Prerequisites: TOT 2206 Theoretical fundamentals of heat engineering; Him 1207Chemistry; MF1208 Molecular physics; EM2209 Electricity and magnetism; Opt2210 Optics

Postrequisites: MTI4307 Metrology and heat engineering measurements; TSE4306 Thermal power systems and energy use; EPAE4309 Environmental problems of alternative energy.

As a result of studying the discipline, the student is able to:

- to carry out calculations to determine the dependence of the use of wind energy on the propeller speed;

- use the methods of selecting the parameters and composition of the main power equipment of generating plants based on renewable energy sources (RES) for the power supply of centralized and decentralized consumers, taking into account social, environmental and economic requirements;

- know the principles of operation of generating plants based on renewable energy sources;

- to measure solar radiation using special instruments;

- use methods for calculating solar radiation on horizontal and inclined receiving sites;

- classify solar collectors;

- analyze the results and draw reasonable conclusions;

- Solve the problem of determining the energy characteristics and indicators of a wind power installation.

Topics for study:

1. Traditional and non-traditional sources of energy. Reserves and dynamics of energy consumption, Kazakhstan's policy in the field of non-traditional and renewable energy sources. The main objects of alternative energy in Kazakhstan. The current state of the use of renewable energy in the world.

2. Thermal effects of energy on the environment. Heat release by energy objects into the environment. Modern concepts of thermal conditions, environmental components.

3. Solar energy. Basic concepts and definitions of solar energy. The current state and prospects of the development of the ESS in the world and in Kazakhstan.

4. Instruments and measurement accuracy of solar radiation. Geometry of the receiving area and the sun. Duration of solar radiation, declination of the Sun, hour angle and methods for calculating them. The influence of various variables on the arrival of the SI on a horizontal platform.

5. Methods for calculating the SR on the horizontal and inclined receiving sites.

6. Information and methodological support for the calculation of solar radiation. Solar power plants for household purposes.

7. Solar collectors and schemes of their application. Solar power with a solar pond.

8. Tower SES. Solar hubs. Photoelectricity.

9. Wind energy and its main characteristics. Classification of wind turbines (wind turbines). Theory of sailing wind turbine. The theory of propeller perfect wind turbine

10. Theory of vertical-axial wind turbine: principle of operation; the appointment of the main components; Advantages and disadvantages.

11. Energy characteristics and indicators of wind turbines, as well as methods for calculating them. Features of the choice of parameters of wind turbines operating in centralized and decentralized power supply systems.

12. The dependence of the use of wind energy from the propeller wind speed.

13. The calculation of the angular velocity of rotation of the turbine Darier with straight blades

14. Determination of torque

15. Some promising directions for the development of wind energy industry

IGEEB3213 Use of geothermal and biomass energy – 2 credits

Prerequisites: ICT1104 Information and communication technology.

Postrequisites: ChMT2215 Numerical methods in thermal power engineering; ST4302 Automation at thermal power plants.

As a result of studying the discipline, the student is able:

- know the principle of operation of heat pump installations and the conditions for their use to produce thermal energy;
- use foreign experience in the use of geothermal resources;
- perform calculations and analysis of the main energy characteristics of generating plants;
- perform calculations to determine the energy characteristics of a biogas reactor;
- possess the skills of obtaining biogas by anaerobic digestion;
- solve practical problems related to the design of installations of renewable and alternative energy sources;
- use low potential thermal energy of the earth;
- to classify modern bioreactors;
- explain the principle of thermal energy storage.

Topics for study:

1. The nature of geothermal energy. The main advantages and disadvantages of geothermal energy. Global geothermal energy potential and prospects for its use.

2. Methods and methods of using geothermal heat for electricity generation and in heating systems; environmental performance of geothermal thermal power plant (GeoTPP).

3. Single circuit geothermal power plants. Steam separation problems. GeoTPP double circuit.

4. Use of low potential thermal energy of the earth. Heat pump installations: principle of operation, usage patterns. Use of ocean energy. Energy resources of the ocean.

5. The working substances of heat pumps. Heat Pump Performance.

6. Single-stage and multi-stage heat pump installations (schematic diagram, principle of operation, advantages and disadvantages).

7. The concept and classification of biofuels. Biofuels. The composition and properties of animal and bird excreta.

8. Biogas yield from agricultural waste. The raw material base for the production of biogas. Biomass production for energy purposes.

9. Pyrolysis (dry distillation) of wood. Thermochemical processes.

10. Alcoholic fermentation (fermentation).

11. Methods for obtaining alcohol; the use of ethanol as a fuel.

12. Biogas production by anaerobic digestion.

13. Gas generating installations. Boiler plants for the combustion of biofuels

14. Thermal energy storage. Energy balance of the heat accumulator. Classification of heat accumulators.

15. Thermal storage for solar heating and cooling.

COMPUTATIONAL METHODS IN THERMAL PHYSICS – 4 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies;

Professional competencies:

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-3 the ability to use IT technologies and application packages to study the processes occurring in modern industrial enterprises;

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-11 the ability to use computer technology for modeling and processing the results of experimental and theoretical studies (OpenFoam, Paraview, OriginLab, Labview, etc.) to organize the technologically efficient burning of fossil fuels and reduce harmful emissions.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities.

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

IG2214 Engineering graphics – 2 credits

Prerequisites: ICT1104 Information and communication technology.

Postrequisites: ChMT2215 Numerical methods in thermal power engineering; ST4302 Automation at thermal power plants.

As a result of studying the discipline, the student is able to:

- determine the actual size of objects and geometric parameters between them;
- accurately determine the spatial position of objects (points, lines, planes, polyhedra and surfaces) relative to each other and relative to the planes of the projections;

- correctly build diagrams of points, lines, planes, polyhedra and surfaces;
- possess various ways of graphic and analytical solutions of geometric problems;
- make sound technical decisions using one of the graphic and computer-aided design systems;
- understand the nature and social significance of their future profession, to show a steady interest in it;
- use design documentation in the development of technological processes for the manufacture of parts;
- read the drawings of products, mechanisms and components of the equipment used;
- carry out sketches, technical drawings and simple drawings of parts, their elements, nodes;
- use technological documentation;
- know the basic rules for the development, design and reading of design and technological documentation.

Topics for study:

1. USED in the system of state standardization.
2. Basic information on the design drawings. Geometric constructions.
3. Projection methods. Drawing point.
4. Drawing a straight line.
5. Drawing of the plane.
6. The mutual position of the geometric images.
7. Drawing surfaces.
8. Axonometry
9. USED - the basis of engineering drawing.
10. GOST 2.306 - 68. GOST 2.307 - 68
11. Carving. Threaded connections.
12. Welded connections.
13. Surface roughness.
14. Assembly drawing. Sketch and working drawing details.
15. General view drawing.

ChMT2215 Numerical methods in thermal power engineering – 2 credits

Prerequisites: IG2206 Engineering Graphics, ICT1104 Information and Communication Technology, TT2220Technical Thermodynamics.

Postrequisites: ST4302 Automation at thermal power plants, MPSTTK4310 3D Modeling of Combustion Processes in Furnace Chambers.

As a result of studying the discipline, the student is able to:

- master the main methods, ways and means of obtaining, storing, processing information, have computer skills as a means of managing information;
- develop numerical methods and algorithms, implement these algorithms in a high-level programming language;
- justify the choice of means for solving specific problems of numerical analysis;
- reduce problem statements at a substantive level to formal ones and refer them to the corresponding formal models of numerical analysis or applied computational thermoPhysics tools;
- be oriented in the structure of mathematical models as means of computational thermal Physics, possibilities and prospects of development, taking into account their computer implementation;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- be able to work in a group, conduct discussions with high quality and express one's thoughts;
- participate in research and development on the profile of training: to systematize information on the topic of research, to participate in the experiments, to process the data;
- be able to draw conclusions on the results of the research in the form of technical decisions and recommendations;
- be able to present the results in the form of presentations, reports and reports.

Topics for study:

1. Goals and objectives of the study of numerical methods, a place in the educational process. The main areas of application of numerical methods.
2. Source of errors. Propagation of errors. Graphs of computational processes. Rounding numbers. Significant and correct numbers. The general formula for error. The inverse problem of the theory of errors. Probabilistic estimation of errors.
3. Problems of linear algebra. Direct and iterative methods for solving systems of linear algebraic equations.
4. Methods for solving nonlinear equations and systems of nonlinear equations.
5. Approximation of functions and their derivatives.
6. Numerical differentiation.
7. Numerical integration.
8. Basic quadrature formulas. Trapezium, Simpson’s, Newton’s methods. Estimation of the accuracy of numerical integration. The choice of the optimal step in the numerical differentiation and integration.

9. Solving systems of linear equations using the inverse matrix method. Gauss method with the choice of the main element for solving the simultaneous linear algebraic equation (SLAE). Iterative methods for solving the SLAE. Calculation of determinants and elements of the inverse matrix. Solving systems of nonlinear equations. Newton's methods and iterations for solving SNAE. Accuracy and convergence of the solution.

10. The general task and approximation algorithms. Least square method.

11. Approximate solution of DU. Cauchy's problem.

12. Integration of remote control with the help of rows. Methods of successive approximations and successive differentiation.

13. The method of uncertain coefficients. Numerical tabular methods for solving remote control.

14. Euler method, refinement of the method. Methods of prediction and correction. Runge-Kutta method. Milne and Adams methods. Krylov's method of finding the "initial segment".

15. Approximate analytical and numerical methods for solving differential equations.

FUEL PREPARATION AND COMBUSTION – 9 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-4 willingness to participate in the organization of the metrological support of technological processes using standard methods for monitoring the operating modes of technological equipment;

PC-8 readiness to make technical and economic balances of installations, technological processes, sections of thermal power plants, to organize accounting and rationing of expenses for fuel and energy resources, to carry out an energy assessment of thermal schemes and installations of thermal power plants;

PC-9 the ability to apply knowledge about the organization of burning organic fuels in boiler furnaces, about thermophysical and hydrogasdynamic processes occurring in the gas-air and steam-water paths of a boiler plant, about the operating conditions of heating surfaces when solving applied technical problems;

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities;

B2. to put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

VTMS1216 Types of fuels and methods of its combustion– 2 credits

Prerequisites: Mat (I) 1203 Mathematics I, Fiz1205 Physics (Mechanics), Him1207 Chemistry.

Postrequisites: TOT 2206 Fundamentals of the heat conduction theory, TT2220 Technical thermodynamics, TFChMP2217 Physical and Chemical Methods of Fuel Preparation, SVST3219 Special Issues Combustion, TETS2225 Thermal power plants and thermal power networks.

As a result of studying the discipline, the student is able to:

- understand and apply theoretical knowledge and practical skills to the study of the principles of technical engineering;
- understand and distinguish the features of all types of organic fuel, as well as methods of its combustion in the combustion chambers;

- understand the features of burning low-reaction and high-ash fuels, the influence of the fuel composition (ash content, volatile content, etc.) on the choice of combustion method, type of burner and the efficiency of its combustion;
- analyze the technical documentation on the types of fuel and various technologies for its combustion, as well as make the best decisions in relation to the task;
- classify organic fuel by type, type, characteristics and method of combustion in combustion chambers;
- solve practical problems aimed at consolidating theoretical material;
- systematize the knowledge gained in the context of applied sciences;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- evaluate the positive and negative sides of each type of energy fuel, as well as critically analyze the method of its combustion;
- develop new ideas to improve the quality of burning energy fuel, as well as reduce the anthropogenic impact on the environment;
- be able to work in a group, conduct discussions with high quality and express one's ideas;
- be able to draw conclusions on the results of the research in the form of technical decisions and recommendations;
- be able to present the results in the form of presentations and reports;
- carry out the optimization of burning processes of energy fuel;
- conduct a feasibility study of a particular method of burning fuel.

Topics for study:

1. The current state of the heat and power complex of the Republic of Kazakhstan.
2. Classification of fossil fuels. Analysis of the properties of the fuel.
3. Classification of solid fuels. Coal grades. Grade grades of high-grade hard coal. Oil shale. Wood. Legend.
4. Schemes of the organization of burning solid fuels. General information about the combustion process.
5. Layer burning solid fuel. Types of furnaces. Schemes of the organization of combustion processes.
6. Flare method of burning solid fuel. Types of furnaces. Schemes of the organization of combustion processes.
7. Classification and selection of burners for the combustion of pulverized coal.
8. Classification of liquid fuels. Masut. Characteristics of fuel oil. Cracking. Relative density. Relative viscosity. Flash point Pour point.
9. Classification of gaseous fuels. Dry gases. Natural gases. Artificial gases. Gasification of solid fuels. Water gas. Heavy hydrocarbons.

10. Hydrocarbon fuel. Flare burning of coal-water slurry fuel. Burning of coal-water slurry fuel in a fluidized bed.
11. Co-combustion of coal-water slurry fuel with already used fuels (combined burning).
12. Combustion of gaseous fuels. Types of gas combustion: diffusion method, kinetic, diffusion-kinetic (mixed).
13. Classification and type of burner devices when burning gaseous fuel.
14. Features of burning liquid fuels. The process of burning liquid fuels with a free surface. Burning zone. Combustion products.
15. Classification and type of burner devices when burning liquid fuel.

FChMP2217 Physical and chemical methods of fuel preparation – 2 credits

Prerequisites: MF1208 Molecular Physics, TOT 2206 Theoretical fundamentals of thermal engineering, TT2220 Technical Thermodynamics.

Postrequisites: KT2222 Convective heat transfer, PTTEC3227 Environmental technologies at thermal power plants, GPU3303 Gas turbines and combined-cycle plants, KUP 3301 Boiler installations and Steam Generators.

As a result of studying the discipline, the student is able to:

- understand ways to intensify the combustion of solid, gaseous and liquid fuels;
- form knowledge about the main energy sources for heat generating installations;
- determine the technical characteristics, methods of preparation and methods of burning organic fuel;
- analyze the Physical and chemical processes during the burning of organic fuels;
- develop the ability to analyze the properties of fuels and their behavior in power plants;
- develop skills in the use of methods for calculating burners with optimal conditions for organizing efficient fuel combustion, as well as methods for organizing flue processes to intensify them and reduce harmful emissions;
- calculate the quantitative characteristics and patterns of the flow of these processes and the ability to use the knowledge gained in the development and design of schemes for preparing for the burning of organic fuels;
- systematize and search for information necessary for the effective implementation of the tasks set, as well as professional and personal development;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- participate in experiments, process the data;
- participate in research and development on the training profile;
- be able to work in a group, conduct discussions with high quality and express one's thoughts;

- be able to present the results in the form of presentations, reports and reports using modern means of communication;
- apply the knowledge gained in practice to develop ways to intensify the combustion of fossil fuels;
- evaluate the promising directions of the discipline under study with a view to a deep understanding of the processes of Physico-chemical reaction of the fuel and oxidizer;
- develop new ideas to reduce the anthropogenic impact on the environment during the combustion of various types of fuels;
- be guided in the conditions of frequent change of technologies in professional activity.

Topics for study:

1. The main sources of energy for heat-generating installations.
2. Coal dust and its properties. Grinding fineness and grain characteristic of dust. Polydispersity coefficient of dust.
3. The surface and density of coal dust. Coal processing and pulverization tract.
4. Drying coal dust. Existing methods of drying.
5. Types of dryers and their classification.
6. Dust preparation system with intermediate hopper. Dust system with direct injection of dust into the furnace.
7. Grinding of coal dust and its release from foreign objects. The sieving mechanism. The cost of grinding coal.
8. Carbon mills. Classification of coal mills.
9. Structural scheme of solid fuel processing at power plants.
10. Transport, storage and preparation of fuel oil for incineration. Heated fuel oil.
11. Scheme of fuel oil facilities of the enterprise. Cleaning of fuel oil from mechanical impurities. Purge filters. Introduction of additives.
12. Schemes of supply of fuel oil to the units. Pneumatic and mechanical nozzles.
13. Scheme of gas facilities of the enterprise. Transportation of gas. Classification and types of gas. Major deposits.
14. The main methods applied to the preparation of gas before combustion.
15. The main priorities in the field of environmental protection during the combustion of fossil fuels.

FGV3218 Physics of combustion and explosion – 3 credits

Prerequisites: Fiz1205 Physics (Mechanics), Him1207 Chemistry, MF1208 Molecular Physics, TT2220Technical Thermodynamics, SVST3219Special Issues Combustion, FCHMP2217 Physical and Chemical Methods of Fuel Preparation, VTMS1216 Types of fuels and methods of its combustion.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- understand the patterns of the combustion and explosion processes that accompany the human-induced activities;
- understand the basics of the combustion theory, the basic theoretical and experimental methods used in the study of the combustion processes of various fuels;
- form knowledge about the mechanisms of chemical interaction during combustion, Physicochemical and Physical processes and phenomena that accompany combustion processes;
- classify the energy fuel according to the type, characteristics and methods of combustion;
- solve practical problems aimed at consolidating theoretical material;
- develop new ideas to reduce the anthropogenic impact on the environment during the combustion of various types of fuels;
- be guided in the conditions of frequent change of technologies in professional activity;
- use information and communication technologies in studying the discipline;
- apply the knowledge gained in practice to develop ways to reduce the impact of the processes of combustion and explosion on humans and the environment.

Topics for study:

1. Basics of chemical kinetics. Coefficients of stoichiometry. Reversible reactions. Equilibrium constant.
2. The reaction rate. Reaction order. The dependence of the reaction rate on pressure. Determination of the reaction order.
3. The dependence of the reaction rate on temperature. The connection of the activation energy with the thermal effect of the reaction.
4. Molecular-kinetic substantiation of the Arrhenius law. Chain reactions: unbranched chain reactions; branched chain reactions; total kinetics of complex reactions.
5. Two types of ignition. Theory of thermal explosion according to N.N. Semenov: heat release and heat removal curves; graphic solution.
6. Critical ignition conditions. Induction period of ignition. Borders of spontaneous ignition.
7. Stationary theory of thermal explosion according to Frank-Kamenetsky: exponential decomposition; flat vessel solution; kind of equations for cylindrical and spherical vessels.
8. Non-stationary theory of thermal explosion: statement of the problem; reaction time; induction period.
9. Waves of reaction. The speed of flame propagation.

10. Reaction zone (burning front). Temperature and concentration profiles. Similarity of fields of concentration and temperature.

11. Conditions of similarity. Formula for normal burning rate.

12. Connection of burning rate with gas kinetic properties.

13. Some conclusions from the formula for burning rate.

14. Limits of the spread of the flame.

15. Diffusion-thermal instability of the flame.

SVST3219 Special Issues Combustion– 2 credits

Prerequisites: MF1208 Molecular Physics, TOT 2206 Theoretical fundamentals of thermal engineering, TT2220Technical Thermodynamics.

Postrequisites: KT2222 Convective heat transfer, MPSTTK4310 3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP, FGV3218 Physics of combustion and explosion, KUP 3301 Boiler installations and Steam Generators.

As a result of studying the discipline, the student is able to:

- understand the mechanism of combustion of all types of fuel and the theory of combustion stabilization;
- analyze the methods of burning organic fuel in the combustion chambers of boiler plants and furnace devices of industrial furnaces;
- know about promising designs of furnace and burner devices;
- know about cleaning and removal of flue gases into the atmosphere;
- classify the main thermal characteristics of furnace and burner devices;
- understand the factors affecting the intensification of the process of ignition and combustion of a pulverized coal torch in the combustion chambers of modern steam generators;
- master the method of stabilization and sustainability of burning organic fuel;
- make material and thermal balances of combustion;
- calculate and select the type of burner devices depending on the power of the steam generator and the type of organic fuel;
- systematize and search for information necessary for the effective implementation of the tasks set, as well as professional and personal development;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- participate in the experiments, process the data;

- participate in research and development on the training profile;
- be able to work in group, conduct discussions with high quality and express one's thoughts;
- be able to present the results in the form of presentations, reports using modern means of communication;
- recommend the type and number of burners, as well as their location around the perimeter of the combustion chamber to achieve the best level of fuel combustion, eliminate slagging of the furnace, and reduce the formation of harmful dust and gas emissions into the atmosphere.
- own methods for calculating furnace processes;
- master the methods of analysis of structural and technological factors on the efficiency of combustion processes.

Topics for study:

1. The role of fuel efficiency in the development of new environmentally friendly and economical designs of fuel-burning devices.
2. Characteristics of fossil fuels. Types of fuel, its composition. The heat of combustion and the characteristics given. Technical characteristics and basic properties of solid, liquid and gaseous fuels.
3. Equilibrium composition of combustion products. Determination of the average temperature of the torch.
4. General questions of the theory of combustion. Material and heat balances of burning fossil fuels. Determination of excess air. Enthalpy of air and combustion products.
5. Equilibrium composition of combustion products. Dissociation, its effect on the burning temperature.
6. Heat balance of the boiler unit. Fuel efficiency. Characteristics of heat loss in the boiler. Efficiency of the boiler plant.
7. Artificial stabilization of the flame.
8. Burning a drop of liquid fuel. Spraying. Furnace and burner devices for burning liquid and gaseous fuels. Methods of intensification of combustion. Requirements for the design of combustion chambers that burn fuel oil and gaseous fuel.
9. Basic requirements for the design of gas-oil burners and fuel oil nozzles to improve the reliability and efficiency of combustion of gaseous and liquid fuels. Safety regulations when burning gas and fuel oil.
10. Combustion of a coal particle and its burnout mechanism. Parameters affecting the process of burning coal particles. Burning coal dust in the torch. Factors affecting the intensification of the process of ignition and combustion of a pulverized coal flame in the combustion chambers of modern steam generators.
11. Methods of intensifying the combustion of a pulverized coal torch with a change in the quality of the fuel and their application in the practice of burning coal dust.

12. Conditions of stabilization and stability of combustion of low-reaction coals. Measures to prevent slagging of heating surfaces of the boiler unit.

13. Toxic substances in flue gases and measures to protect the environment from harmful dust and gas emissions.

14. Maximum permissible concentrations (MAC, MPE). NO_x and SO_x in flue gas.

15. Designs of furnace and burner devices, providing a significant reduction in the concentrations of toxic components in flue gases.

THERMOPHYSICAL PROCESSES – 7 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-9 the ability to apply knowledge about the organization of burning organic fuels in boiler furnaces, about thermophysical and hydrogasdynamic processes occurring in the gas-air and steam-water paths of a boiler plant, about the operating conditions of heating surfaces when solving applied technical problems

PC-13 the ability to solve problems in determining the energy characteristics and indicators of various installations for the conversion of energy from alternative sources into heat and electricity.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities.

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

TT2220 Technical thermodynamics – 2 credits

Prerequisites: Fiz1205 Physics (Mechanics); MF1208 Molecular Physics; Mat (I) 1203 Mathematics I; Mat (II) 1204 Mathematics II.

Postrequisites: OTT2212 Bases of Theory of Thermal Conductivity; NTD 3302 Boiler installations and Steam Generators ; KUP 3301 Boiler installations and Steam Generators ; NNVKM3226 Pumps, fans and compressor machines.

As a result of studying the discipline, the student is able to:

- know the laws of obtaining and converting energy;
- know the methods for analyzing the energy efficiency of processes and machines using thermal energy;
- apply methods to control the parameters of heat engineering processes; methods for measuring the thermoPhysical characteristics of working media and materials;
- represent the scope and potential of the main heat engineering equipment;
- identify and use secondary energy resources;
- perform thermal calculations for individual processes;
- perform thermal calculations for the main heat engineering equipment used in various industries and especially in the energy sector;
- select standard instruments and methods for measuring and monitoring thermal parameters of processes;

- be able to do thermodynamic calculations using reference books.
- systematize and search for information necessary for the effective implementation of the tasks set, as well as professional and personal development;
- participate in research and development on the training profile;
- be able to present the results in the form of presentations, reports and reports using modern means of communication.

Topics for study:

1. The subject and method of technical thermodynamics. Thermodynamic system. Thermodynamic state and thermodynamic process. Thermal and caloric parameters of the state. Thermal state parameters.

2. Caloric parameters of the state. The laws of ideal gases. The law of Boyle-Mariot. Gay Lussac's Law. Avogadro's law. Equation of state. Work changing the volume of gas.

3. Heat capacity of gases. Mass, volumetric and molar specific heat capacities. Average and true heat capacity. Heat capacity at constant volume and pressure. Heat capacity tables. The heat of the mixture of working fluids (gas mixture).

4. The first law of thermodynamics. The essence of the first law of thermodynamics. Analytical expression of the first law of thermodynamics for a cycle and an open process. The equation of the first law of thermodynamics for a moving working fluid.

5. The main thermodynamic processes of ideal gases. Isochoric process. Isobaric process. Isothermal process. Adiabatic process. Polytropic process.

6. Water vapor and its properties. Basic concepts and definitions. Steam formation at constant pressure. Determination of parameters of water and water vapor (by tables). HS-diagram of water vapor.

7. The second law of thermodynamics. Circular thermodynamic cycles or processes. The processes are reversible and irreversible. Direct reversible Carnot's cycle. The second law of thermodynamics. The irreversible Carnot's cycle. Entropy and its changes in reversible and irreversible arbitrary processes.

8. Cycles of piston internal combustion engines (ICE). Cycle with isochoric heat supply (Otto cycle). Cycle with isobaric heat supply (Diesel cycle). Cycle with a mixed supply of heat.

9. The expiration of gases and vapors. The equation of the first law of thermodynamics for flow. Basic equations of flow processes. Flow and flow rate of an ideal gas. Outflow from a tapering nozzle. Outflow of ideal gas from a combined nozzle. The outflow of gases and vapors taking into account friction.

10. Throttling of gases and vapors. The adiabatic throttling equation. Choking water vapor.

11. Compressors. Single stage compression in a perfect piston compressor. Features of real compression processes. Multi-stage compression.

12. Cycles of steam turbine installations. Carnot steam cycle. Rankine cycle. Ways to improve the effectiveness of vocational schools.

13. Refrigeration cycles. Reverse thermal cycles. Reverse Carnot cycle. Air cooling cycle. Steam compressor steam cycle. Heat pump. Air conditioners. Thermotransformers.

14. Mixing of gases and vapors. The process of mixing in a constant volume. The process of mixing in the stream. Mixing when filling volume. Entropy change when mixed.

15. Basics of chemical thermodynamics. Chemical reactions. The heat effect of the reaction. Isobaric-isothermal potential. Changes in the thermodynamic properties of substances during chemical transformations

OTT2212 Fundamentals of the Heat conduction Theory– 3 credits

Prerequisites: MF1208 Molecular Physics; TT2220Technical Thermodynamics.

Postrequisites: KT2222 Convective heat transfer; TVZH3223 Viscous-fluid Flow Theory; FTT3224 Physics of Turbulent Flows; FGV3218 Physics of combustion and explosion.

As a result of studying the discipline, the student is able to:

- have an idea of the current state, achievements and practical application of this section of Physics in various fields of engineering and technology.
- correctly correlate the content of specific tasks with the general laws of Physics, effectively apply the laws of heat conduction to solve specific problems in the field of Physics and at interdisciplinary boundaries with other fields of knowledge;
- use the basic Physical instruments for measuring mechanical quantities;
- set and solve the simplest experimental problems of thermal Physics;
- process, analyze and evaluate the results;
- build mathematical models of the simplest phenomena of thermal Physics and use the mathematical apparatus available to him to study these models, including methods of computational mathematics.

Topics for study:

1. The role of thermal Physics in practical human activity. Achievements and development prospects.
2. The heat flux density. The basic Fourier law. Heat flow.
3. Thermal conductivity of a flat wall. Fourier's law for a uniform flat wall. Thermal conductivity of a uniform flat wall.
4. The Fourier law for a multilayer flat wall. Thermal conductivity of a multilayer flat wall.

5. Thermal conductivity of the cylindrical wall. Thermal conductivity of a uniform cylindrical wall. Fourier law for a uniform cylindrical wall.

6. The Fourier law for a multilayer cylindrical wall.

7. Thermal conductivity of the spherical wall. Thermal conductivity of a uniform spherical wall. Fourier law for a uniform spherical wall. Thermal conductivity of bodies of various shapes.

8. Thermal conductivity of a flat wall with an internal heat source. Thermal conductivity of a round rod with an internal heat source.

9. Thermal conductivity with internal heat source. Thermal conductivity of the cylindrical wall if the heat is removed through the outer surface of the pipe.

10. Thermal conductivity of a cylindrical wall if heat is removed through the inner surface of the pipe.

11. Thermal conductivity of a cylindrical wall if the heat is removed simultaneously through the outer and inner surfaces of the pipe.

12. Convective heat transfer. Differential equations of body exchange. Equation of motion. Border conditions.

13. Thermal conductivity when flowing around a flat plate. Heat transfer. Thermal conductivity of the laminar boundary layer. Laminar boundary layer.

14. Heat transfer fluid flowing in the pipe. Heat transfer in laminar mode.

15. Heat transfer in turbulent mode.

КТ2222 Convective heat transfer– 2 credits

Prerequisites: MF1208 Molecular Physics; TT2220 Technical Thermodynamics; OTT2212 Bases of Theory of Thermal Conductivity.

Postrequisites: FTT3224 Physics of Turbulent Flows; FGV3218 Physics of combustion and explosion; GPU3303 Gas turbine and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants .

As a result of studying the discipline, the student is able to:

- explain the basic principles of the theory of convective heat transfer, methods for calculating the basic processes of heat and mass transfer;

- carry out engineering calculations of convective heat transfer problems;

- correlate the content of specific tasks with the general laws of physics, effectively apply the laws of convective heat and mass transfer to solve specific problems in the field of physics and at interdisciplinary boundaries with other fields of knowledge;

- use the basic Physical instruments for measuring mechanical quantities;
- set and solve the simplest experimental problems of thermal Physics;
- process, analyze and evaluate the results;
- build mathematical models of the simplest phenomena of thermal Physics and use the mathematical apparatus available to him to study these models, including methods of computational mathematics.

Topics for study:

1. Basic concepts and definitions of convective heat transfer processes. Physical properties of liquids. Hydrodynamic and thermal boundary layers.

2. The theory of similarity as a theoretical basis for the experimental study of convective heat transfer. Criterion equations. Similarity criteria. Methods of experimental determination of heat transfer coefficients.

3. Averaging of heat transfer coefficients. Obtaining empirical criterial equations. Defining size. Determining temperature.

4. General information about free convection. Rayleigh number. Heat transfer in case of free convection of fluid near a vertical plate or a vertical pipe.

5. Heat transfer with free convection around a horizontal plate. Heat transfer with free convection on the surface of a horizontal cylinder.

6. Heat transfer at small values of the Rayleigh number. Free convection in interlayers and closed cavities. Equivalent thermal conductivity coefficient.

7. Dependence of heat transfer on the fluid flow regime. Laminar boundary layer when wrapped around the plate. Blausius's problem. Polgauzen's problem.

8. Hydrodynamics and heat transfer in a cross-flow around a single round cylinder. The angle of separation of the laminar and turbulent boundary layer.

9. The change in heat transfer coefficient around the circumference of the cylinder. Average heat output of the cylinder being washed laterally. The dependence of the heat transfer coefficient of the cylinder on the angle of attack. Heat transfer in a transverse flow of corridor and checkerboard beams of pipes.

10. Dependence of heat transfer on the row number, the ratio of the longitudinal and transverse steps of the beam. The average heat transfer coefficient for the beam. The dependence of the heat transfer beam pipe from the angle of attack.

11. Hydrodynamics and heat transfer with the flow of fluid in pipes and channels. Sections hydrodynamic and thermal stabilization. Effect of gravity. Viscous and viscous-gravitational modes of heat transfer.

12. Mathematical description of heat transfer when a fluid flows in a circular pipe. The concept of stabilized heat transfer. Lyon's integral.

13. Heat transfer in laminar and turbulent flow in smooth tubes of circular cross-section. Influence of hydrodynamic and thermal stabilization.

14. Features of heat transfer in pipes of non-circular cross section. The influence of surface roughness on heat transfer in pipes. Heat transfer in curved pipes.

15. Heat transfer when the gas flows at high speeds. Adiabatic wall temperature. The change in the Physical properties of the coolant with temperature.

TVZH3223 Viscous fluid Flow– 3 credits

Prerequisites: FIZ1205 Physics (Mechanics), MF1208 Molecular Physics, IG2206 Engineering Graphics, TT2220Technical Thermodynamics.

Postrequisites: FTT3224 Physics of Turbulent Flows, NTD 3302 Boiler installations and Steam Generators , FGV3218 Physics of combustion and explosion, MPSTTK4310 3D modelling of heat transfer in combustion chambers of boilers of TPP.

As a result of studying the discipline, the student is able to:

- understand the ways of describing processes in liquids and gases based on differential equations;
- know the differential equations of continuity, Euler, Navier-Stokes, convective heat and mass transfer and their boundary conditions;
- master the methods of solving differential equations of fluid mechanics and gas;
- analyze the main results of solving these equations and the laws of fluid and gas flows;
- describe hydrodynamic processes and processes of energy and mass transfer using differential equations;
- solve differential equations of fluid and gas mechanics and convective transfer as applied to specific tasks;
- analyze the results and present them in the form of criterion dependencies;
- plan the process of solving scientific and technical problems;
- be able to analyze the results of numerical and full-scale experiments;
- master the skills of working with modern software modeling tools.

Topics for study:

1. Perfect and viscous fluid. Viscosity. Laminar and turbulent flow. Reynolds number. Continuity of the environment. Knudsen number. Compressibility of the medium. Mach's number.

2. The law of conservation of substance. Navier-Stokes' equations. The continuity equation. Equations of motion. Viscous stress tensor.

3. Forward movement. Rotational motion. Translational rotational motion. The law of conservation of momentum for an incompressible fluid with constant properties.

4. The equation of energy. The density of the flow of energy. The law of conservation of energy in differential form. Thermal diffusivity. Divergent form of the energy equation.

5. Layered currents. Poiseuille flow. Dynamic task.

6. Poiseuille's plane flow. Heat problem.

7. Couette's plane flow. Dynamic and thermal problem.

8. The boundary layer. Dynamic boundary layer. Properties of the dynamic boundary layer. The thickness of the boundary layer. Boundary layer equations. Prandtle's method. Mises's Method.

9. Auto-similar transformations of boundary layer equations. Examples of self-similar flow. Dynamic task.

10. Auto-model transformations of boundary layer equations. Heat problem.

11. Longitudinal flow past a plate with a uniform stream of incompressible viscous fluid. Blasius task. Dynamic task.

12. Approximate methods for solving the Blasius problem. Thickness extrusion. The thickness of the loss of momentum. Iteration method.

13. The temperature boundary layer on the plate is the thermal problem of Blasius.

14. Plane free jet (flooded). Free boundary layer.

15. Classification and basic characteristics of inhomogeneous systems. Hydromechanical methods of separation of inhomogeneous systems. Precipitation. Deposition Kinetics. Deposition under the influence of gravitational forces. The calculation of the deposition rate. Gravitational Deposition Equipment. Determination of capacity and size of sedimentation tanks.

FTT3224 Physics of Turbulent Flows – 3 credits

Prerequisites: Fiz1205 Physics (Mechanics), MF1208 Molecular Physics, IG2206 Engineering Graphics, TT2220Technical Thermodynamics.

Postrequisites: NTD 3302 Boiler installations and Steam Generators , FGV3218 Physics of combustion and explosion, TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers; MPSTTK4310 3D modelling of heat transfer in combustion chambers of boilers of TPP.

As a result of studying the discipline, the student is able to:

- compare the main Physical phenomena, their features, control methods and experimental studies;
- use different methods for solving problems of turbulent motion, the basic laws and their mathematical expressions;
- know the scientific and technical application of the results of the study of turbulent theory;
- correctly correlate the qualitative and quantitative statement of the main issues of the discipline;
- use the necessary mathematical apparatus to solve problems of turbulent motion;
- apply the basic laws of turbulent theory to solve specific problems of fluid dynamics and thermal Physics.

Topics for study:

1. The emergence of turbulent motion in nature and practice. Transition of laminar motion to turbulent motion. Experiments that confirm this. The main characteristics of turbulent flow. Medium and pulsating movement.
2. "Theory of impulse". Imaginary stresses in turbulent flow. Turbulent friction stress tensor.
3. Reynolds' equation for turbulent motions. Border conditions.
4. Measurement results of turbulent velocity pulsations. Average square ripple speed. The degree of turbulence. Turbulence in a wind tunnel. Correlation coefficient. Exchange rate Correlation function. Autocorrelation ripple. Frequency analysis of motion. Turbulent flow spectrum.
5. Semiempirical theory of turbulent motion. Prandtle's theory of the "way of mixing", its successes and shortcomings.
6. Universal laws of the distribution of the velocity of Karman and Prandtle.
7. Turbulent flow in the pipe. The relationship between the laws of resistance and speed. The law of distribution of the speed of degree 1/7.
8. Universal laws of velocity distribution over a pipe at very high values of the Reynolds' number.
9. Universal pipe resistance law for very large Reynolds' numbers.
10. Free jets. The free boundary of the jet. The law on the expansion of free submerged jets.
11. Axisymmetric free turbulent jet.
12. Plane-free turbulent jet.
13. "Footprint" for the body.
14. The boundary layer on the surface of the plate when wrapped.
15. Surface semibounded jet.

THERMAL POWER PLANTS AND EQUIPMENT – 7 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-4 willingness to participate in the organization of the metrological support of technological processes using standard methods for monitoring the operating modes of technological equipment;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods;

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-7 the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work.

As a result of studying the module, the student is able to:

A1. have an idea of the basic theories in natural and social and economic sciences, analyze the socially significant problems and processes, be able to use the methods of these sciences in various types of professional activity, have sufficient theoretical training to analyze the social and economic situation of countries and regions; to implement their professional, social, economic role in society;

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities.

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

TETS2225 Thermal power plants and thermal power networks– 2 credits

Prerequisites: MF1208 Molecular Physics; EM2209 Electricity and magnetism; VTMS1216 Fuel types and its combustion methods; FCHMP2217 Physical and chemical methods of fuel preparation.

Postrequisites: PTTEC3227 Environmental technologies at thermal power plants; NNVKM3226 Pumps, fans and compressor machines; PREPP3303 Production and distribution of energy resources in industrial enterprises; TOPG4303 Optimization technologies of combustion processes in modern thermal power plant boilers.

As a result of studying the discipline, the student is able to:

- participate in collection and analysis of source data for the design of systems and elements of the systems of transportation, distribution and consumption of thermal energy using regulatory documentation and modern methods of information search, processing, mathematical analysis and modeling;

- participate in the development of design and working technical documentation, design of completed design work in accordance with standards, technical specifications and other regulatory documents;
- monitor the observance of technological discipline, plan and participate in the conduct of planned tests of equipment of heating systems;
- know the methods for determining the needs of enterprises in the heat;
- possess the rules of technical operation of installations and heating systems;
- perform technical calculations of heat and power plants and their equipment using modern mathematical methods in computers;
- determine the costs of fuel and energy and material resources in installations and systems of heat supply of industrial enterprises and related costs in the energy system of the republic;
- choose the characteristics of heat carriers of heat supply systems of enterprises.

Topics for study:

1. Energy and types of power plants. Types of power plants.
2. Energy performance of a condensation power plant.
3. Energy indicators of combined heat and power plants.
4. Initial parameters and intermediate superheat of steam.
5. Regenerative heating of feed water.
6. Vacation process steam at thermal power plants.
7. Heat supply for heating.
8. Energy characteristics of TPP equipment.
9. Composition of the main building of thermal power plants.
10. Technical water supply.
11. Fuel and ash facilities of thermal power plants.
12. Cleaning and removal of flue gases into the atmosphere.
13. Systems of centralized steam and heat supply of industrial enterprises.
14. Heating equipment of thermal power station, equipment of heat networks.
15. Operation of heat networks.

NNVKM3226 Pumps, fans and compressor machines – 3 credits

Prerequisites: MF1208 Molecular Physics, EM2209 Electricity and Magnetism, TT2220Technical Thermodynamics.

Postrequisites: NTD 3302 Supercharges and heat engines, KUP 3301 Boiler installations and Steam Generators ; GPU3303 Gas turbine and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants.

As a result of studying the discipline, the student is able to:

- determine the principal cycles and diagrams of gas turbine units (GTU);
- use the basics of thermodynamic calculation of gas turbines;
- know the design of GTU;
- explain the design and principles of operation of pumps, compressors and fans of various types;
- apply the methods of calculation and modeling of the main parameters of the pumps, compressors and fans in various systems;
- solve problems of various levels of complexity related to the operation of pumps, fans, compressors;
- analyze the effectiveness of the existing equipment and the proposal of methods for its optimization;
- study and analyze domestic and foreign scientific and technical information in the direction of research of technological processes of pumps, fans, compressors;
- solve the settlement and analytical tasks arising in the course of professional activity;
- use the results of experiments and tabular data to determine the optimal operation modes of pumps, compressors and fans;
- calculate the parameters of pumps, compressors and fans, and their modes of operation based on standard methods.

Topics for study:

1. The main parameters of blowers and heat engines. Pumps. Characteristics of pumps of various types, their advantages and disadvantages.

2. The parameters of pumps. Vane pumps. Schemes and principle of operation. The basic equation of a centrifugal pump. Theoretical pump performance.

3. Dimensionless and universal characteristics. Test pumps. Parallel and serial connection of centrifugal pumps.

4. A simplified method of calculating the impeller pump of low permeability. Cavitation Pumping equipment of thermal power plants and heating networks. Pumping equipment of nuclear power plants. Device and operation of pumping installations.

5. Centrifugal fans. Total pressure ratio Supply, power, fan efficiency. The effect of mechanical impurities in the gas on the

fan.

6. Axial pumps and fans. Pressure, energy loss, efficiency. Calculation of axial pumps and fans.

7. The design of axial pumps and fans.

8. Piston pumps. Power and efficiency. Specifications. Joint work of the piston pump and pipeline. Allowable suction height. The design of piston pumps.

9. Rotary pumps. Main constructive types.

10. Compressor machines. Thermodynamics of the compressor process. Efficiency of compressors.

11. Centrifugal compressors. Step centrifugal compressor. Power of the centrifugal compressor.

12. Approximate calculation of the stage of centrifugal compressors. The design of centrifugal compressors.

13. Axial compressors. Stage axial compressor. Designing the shape of axial compressors. The method of calculating the basic dimensions of the step.

14. Reciprocating compressors. Indicator diagram. Constructive types of compressors. Compressor installation.

15. Rotary compressors. Regulation of the supply of rotary compressors. Rotary compressor designs.

PTTEC3227 Environmental technologies at the thermal power plants – 2 credits

Prerequisites: MF1208 Molecular Physics; VTMS1216.

Postrequisites: PTBES4307 Physical and technical basics of energy saving; EAOZHK4308 Energy audit of housing and communal services and the organization of energy saving; UPOPTO4310 Utilization and recycling of waste of thermal power engineering companies; OEP4306 Organization of energy management in enterprises; UEEBP4311 Management of environmental and energy safety of production; EPAE4309 Environmental problems of alternative energy.

As a result of studying the discipline, the student is able to:

- understand modern approaches to ensuring environmental safety;
- predict the possible consequences of changes in the state of the ecological system, including the natural-technical subsystems and medical and hygienic indicators of the human environment undergoing anthropogenic impact;
- master the new environmental technologies, develop and implement appropriate environmental measures at TPPs;
- apply theoretical knowledge, knowledge of the methodology for studying the state of the environment;
- apply the basic provisions of metrology to ensure the uniformity of measurements by checking and calibrating measuring instruments;
- use relevant documents (environmental standards, etc.) in their professional activities;

- mastering methods and means of long-term forecasting of changes in the quality of an ecological system;
- carry out practical actions to improve the state of the ecosystem;
- use regulatory legal documents in their professional activities;
- willingness to choose measuring instruments in accordance with the required accuracy and operating conditions;
- follow metrological norms and rules; comply with the requirements of national and international professional standards.

Topics for study:

1. The main objectives of environmental activities. Classification of environmental technologies. Environmental activities of the enterprise (EAE).

2. Types of industrial pollution, their classification: material - dusting of the atmosphere, solid particles in water and soil, gaseous, liquid and solid chemical compounds, and elements; energy - heat, noise, vibration, ultrasound, light, electromagnetic field, ionizing radiation.

3. Indicators of the effectiveness of environmental activities of the enterprise. Formation of an effective strategy for environmental activities of the enterprise. The importance of planning in the activities of enterprises.

4. Energy ecology and its tasks. Impact of thermal and nuclear power plants on the environment. The tasks of energy ecology as a science.

5. Environmental monitoring of the state of the territory adjacent to the TPP. The main goals and objectives of environmental monitoring of the environment. Physical and chemical bases of environmental monitoring.

6. Systems of industrial environmental control. Classification of environmental monitoring systems.

7. Modern environmental protection technologies in the power industry. Modernization of the energy industry with the requirements of greening.

8. The best available technologies are a modern tool for improving energy efficiency and reducing the negative impact of energy companies on the environment.

9. Indicators and criteria for assessing the state of the water, air, lithosphere and pedosphere. Assessment of the environmental safety of the territory of the TPP location.

10. Technologies to protect the atmosphere from gas emissions. Air quality control. Air quality standards.

11. Modern wastewater treatment technologies. Control of water pollution.

12. Methods of monitoring pollution of water bodies located on the territory of the TPP location. Rationing of water quality in natural sources and artificial reservoirs.

13. Wastewater treatment technologies for dissolved impurities. Membrane technology in wastewater treatment.

14. Technologies for cleaning soil from pollution. Soil pollution control. Assessment of soil contamination.
15. Protecting the environment from solid waste and Physical impacts from energy companies.

PROFILING DISCIPLINES (PD) – 33 CREDITS
COMPULSORY COMPONENT (CC) – 5 CREDITS
HEAT AND POWER PLANTS – 5 CREDITS

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-8 readiness to make technical and economic balances of installations, technological processes, sections of thermal power plants, to organize accounting and rationing of expenses for fuel and energy resources, to carry out an energy assessment of thermal schemes and installations of thermal power plants;

PC-9 the ability to apply knowledge about the organization of burning organic fuels in boiler furnaces, about thermophysical and hydrogasdynamic processes occurring in the gas-air and steam-water paths of a boiler plant, about the operating conditions of heating surfaces when solving applied technical problems.

As a result of studying the module, the student is able to:

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

KUP 3301 Boiler installations and Steam Generators – 3 credits

Prerequisites: MF1208 Molecular Physics; EM2209 Electricity and Magnetism, TT2220Technical Thermodynamics; TETS2225 Thermal power plants and thermal power networks.

Postrequisites: GPU3303 Gas turbine and steam-gas installations; TVOE3304 Thermomechanical and auxiliary equipment of power plants.

As a result of studying the discipline, the student is able to:

- make basic calculations of the boiler structures and its heating surfaces;
- understand the principle of operation and the Physical bases of the working processes, the design of modern boiler plants and steam generators, methods of technical and economic calculations;
- master the knowledge of steam production technology at TPPs;
- know the principles of choosing the necessary design of the boiler for burning a given type of fuel;
- be able to analyze the scientific and technical documentation and information about boilers;
- be able to make elementary calculations for the boiler as a whole and its heating surfaces;
- analyze the technical condition of the boiler plant and steam generator;
- make sound technical decisions in the design of boiler plants and steam generators;
- develop and implement measures to improve the efficiency and reliability of the boiler plant and steam generator.

Topics for study:

1. Energy and its types. Electric station. Thermal power plants. The main types of heat transfer, heat capacity and enthalpy. Water vapor properties.

2. Boiler fuel and its technical characteristics. Types and composition of fuels. Solid and liquid organic fuel. Natural gas. The heat of combustion of the fuel. General technical characteristics of fuels.

3. Ash content. Moisture content. Sulfur content (sulfur content). Characteristics of solid fuels. The release of volatile substances. Coke structure. Characteristics of fuel oil. Flash and flashpoint. Characteristics of natural gas. Explosive.

4. Toxicity. Grinding capacity of fuel. Fine dust grinding. Energy costs for grinding fuel. Characteristic of coal dust. Surface dust. Dust moisture. Explosive dust.

5. The heat balance of the boiler unit. Heat loss the efficiency of the boiler. Heat loss from external cooling of enclosing structures. Losses from the Physical heat of the slag.

6. Schemes of boilers. Steam boiler. The work of the combustion chamber. Direct-flow boilers.

7. Hot water boilers. Types of steam superheaters.

8. Fuel preparation. Economizers. Tail heating surfaces. Air heaters. Gas path of the boiler. Classification of pipelines boiler.

9. Steam lines boiler room. Feed pipelines of the boiler room. Heating surfaces of steam boilers

10. Thermal perception of heating surfaces. Designs of furnace screens. Vertical furnace screens of boilers with natural circulation. Special designs of boilers.

11. Classification of gas burners. Combustion of gaseous fuels.

12. Burning fuel oil in the boiler furnaces. Schemes of spraying liquid fuel. Fuel oil nozzles.

13. Classification of layered furnaces. Characteristics of solid fuel burning processes in a dense layer.

14. The design of layer furnaces with chain grilles. Firebox with a "fluidized bed". Burners for the flaring of coal dust. Cyclone and vortex furnaces.

15. The layout of the boilers. Burner devices. Dust burners. Fittings and fittings of the boiler unit.

NTD 3302 Superchagers and Heat Engines – 2 credits

Prerequisites: MF1208 Molecular Physics, EM2209 Electricity and Magnetism, TT2220Technical Thermodynamics; NNVKM3226 Pumps, fans and compressor machines, TETS2225 Thermal power plants and thermal power networks.

Postrequisites: TOCPG4303 Optimization technologies of combustion processes in modern thermal power plant boilers; UEEBP4311 Management of environmental and energy safety of production; GPU3303 Gas turbine and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants.

As a result of studying the discipline, the student is able to:

- know the main types and designs of compressors, blowers, turbines, pumps and fans, their characteristics and operating modes;
- carry out the calculation and design of typical types of machines;
- perform thermal and structural calculations of superchargers and heat engines;
- choose the most efficient types of superchargers and heat engines for their use depending on the working conditions;

- master the methods of technical and economic analysis.

Topics for study:

1. Classification of superchargers and heat engines. The principle of operation and design features of the main types of superchargers. Scope of superchargers, their advantages and disadvantages.

2. Thermodynamic principles of the theory of superchargers. Efficiency of superchargers.

3. The principle of the dynamic supercharger. Euler's equation.

4. Pumps. Centrifugal pumps. The effect of temperature and chemical composition of the liquid on the design of centrifugal pumps.

5. Pumps. Ways to regulate the flow. Effect on the performance of pumps of various factors.

6. Fans. Basic design ratios and parameters of fans.

7. Compressors. Purpose and types of compressor machines. Theory of the compressor process.

8. Heat engines. Cycles of piston internal combustion engines.

9. Steam turbines. Fundamentals of the theory of energy conversion in the turbine. Relative blade and relative internal efficiency of the stage.

10. Geometrical dimensions of turbine stages and structural schemes of steam turbines.

11. Directions for improving the efficiency of steam turbines. Thermal efficiency cycle. Thermal schemes of steam turbine installations.

12. Auxiliary equipment of steam turbines.

13. Gas turbine installations. Schemes, cycles and efficiency of gas turbine units.

14.Steam-and-gas installations (SGI). Closed gas turbine units (SGI). Gas turbine units in power system.

15. Internal combustion engines. Technical and economic indicators and heat balance of the internal combustion engine. Exhaust fumes of internal combustion engines and the environment

ELECTIVE COMPONENT (EC) – 27 CREDITS

ORGANIZATION OF TECHNOLOGICAL PROCESSES IN THERMAL POWER ENGINEERING – 9 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods;

PC-9 the ability to apply knowledge about the organization of burning organic fuels in boiler furnaces, about thermophysical and hydrogasdynamic processes occurring in the gas-air and steam-water paths of a boiler plant, about the operating conditions of heating surfaces when solving applied technical problems.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities;

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

GPU3303 Gas turbine and steam-gas installations – 3 credits

Prerequisites: MF1208 Molecular Physics; TOT 2206 Fundamentals of the heat conduction theory, TT2220Technical thermodynamics, KUP 3301 Boiler installations and Steam Generations.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- know about the reliability and efficiency of gas turbine (GT) and combined-cycle plants;
- know the basic design characteristics of gas turbine and combined-cycle plants, their auxiliary equipment at TPPs;
- carry out the selection of types of gas turbines and SGIs at TPPs and their auxiliary equipment;
- apply modern methods of design and operation of gas turbine and combined-cycle plants, which will allow to implement efficient and cost-effective technologies, to ensure high reliability and safety;
- determine the technical, economic and energy saving efficiency of gas turbine and combined-cycle plants used and newly created;
- substantiate specific technical solutions in the design and operation of equipment for gas turbines and SGI;
- determine the indicators of thermal and overall efficiency of these installations;

Topics for study:

1. Schemes and cycles of gas turbines and their analysis Energy gas turbines with an open cycle. Characteristics of thermodynamic cycles of gas turbines.

2. Ways to increase efficiency of GT cycles. GT cycles with regeneration, with intermediate air cooling and intermediate gas heating. Steam-gas cycles.

3. Structural diagrams of energy GT. Energy GT schemes with independent power turbine. Blocked energy schemes of gas turbines.

4. Axial compressors. Types of compressors of power GT. Scheme axial compressor. Multistage compressors and their characteristics

5. Centrifugal compressors. Scheme of a centrifugal compressor. The advantages of centrifugal compressors. Characteristic of a centrifugal compressor.

6. Surge axial and centrifugal complexes. Ways to prevent surge. Physical causes of compressor surge. Surge prevention measures.

7. Gas turbines of power GT and their operation. Constructive schemes of GT. Variable modes

8. Modern methods of raising the temperature of gases in front of the turbine energy GT

9. SGI with fire flooding. The composition of the equipment. Features of the SGI with fire flooding. Their benefits.

10. Design features of waste heat boilers.

11. SGI with a boiler utilizer. Thermal diagrams and indicators of GT with a boiler utilizer. Copper utilizers in the thermal scheme of SGI. Steam turbine units (STU) in the thermal scheme of the SGI.

12. Types of SGI with a boiler utilizer. Constructive schemes of a boiler utilizer.

13. SGI -450 for CHP. Thermal scheme of SGI-450.

14. Thermal scheme of the SGI with the discharge of gases into the boiler furnace. Energy performance

15. The main schemes of modernization of existing plants at TPP and CHP.

TVOE3304 Thermomechanical and auxiliary equipment of power plants – 3 credits

Prerequisites: EM2209 Electricity and magnetism; TT2220Technical Thermodynamics; NTD 3302 Boiler installations and Steam Generators; TETS2225 Thermal power plants and thermal power networks.

Postrequisites: OEP4306 Organization of energy management in enterprises, UEEBP4311 Management of environmental and energy safety of production.

As a result of studying the discipline, the student is able to:

- develop schemes for heat and power facilities;
- use the methods of analysis and modeling the heat and power facilities equipment;
- justify the adoption of a specific technical solution when creating control schemes for devices of heat and power equipment;
- calculate thermal circuits of heat and power facilities;
- calculate the operating modes of heat and power plants for various purposes;

- present the results in the form of presentations, reports and reports using modern means of information transfer;

Topics for study:

1. The value and role of auxiliary equipment in modern thermal power plants. General classification of auxiliary equipment of thermal power plants.
2. Regenerative heaters. Ways to improve the efficiency of equipment in variable modes.
3. Network heaters.
4. Evaporators and steam converters.
5. Auxiliary heat exchange equipment. Calculation of water heating in the deaerator and the degree of oxygen removal.
6. Deaerators.
7. Reduction cooling units.
8. Pumping equipment.
9. Inkjet machines.
10. Batteries and Tanks.
11. Pipelines and fittings
12. Fuel economy TPP on solid fuel. Characteristics and properties of solid fuels.
13. Fuel economy of TPPs on liquid and gaseous fuels.
14. Natural gas fuel and gas facilities of thermal power plants.
15. Auxiliary equipment of the boiler room.

VTES4305 Water treatment at thermal power stations – 3 credits

Prerequisites: EEM2209 Electricity and magnetism; TT2220 Technical Thermodynamics; NTD 3302 Boiler installations and Steam Generators; TETS2225 Thermal power plants and thermal power networks.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- know the concepts of water circulation in the cycles of thermal power plants, sources of water pollution in thermal power plants and methods of its treatment;
- classify the impurities contained in the water used at the TPP and the ways of their elimination;
- determine the physico-chemical parameters of water and technological indicators of water quality;

- calculate the characteristics of colloidal systems; factors determining the quality of water after coagulation; parameters of technological schemes of water coagulation;
- possess the skills of water treatment by ion exchange methods.

Topics for study:

1. The value of water treatment of thermal power plants. Water treatment methods at thermal power plants. Types of thermal power plants. Schematic diagram of the treatment of water in the cycle CHP.

2. Loss of steam and condensate. The choice of water source and performance TLU.

3. Impurities of natural waters. Characteristics of the admixtures of natural waters. Water quality indicators. Determination of types of alkalinity during titration.

4. Preliminary water purification. Coagulation of colloidal impurities. Scheme of coagulation structure. Adsorption of microparticles by flocculants.

5. Filtering water. Schematic diagram of the bulk type clarifying filter.

6. Water treatment by ion exchange. Diagram of the ion exchange process in the ion exchange filter. Ion exchange materials and their characteristics. Typical full exchange capacity of cation exchangers and anion exchangers of various types. Ion exchange technology.

7. Calculation of ion-exchange filters. Calculation of Na-cationite filters.

8. Technological schemes of ionization. The equipment of the ion-exchange part of the TLU. The scheme of operation of an ionic FSD of the type FISDNR. The scheme of operation of ion-exchange FSD with internal regeneration. Schemes of the ion-exchange part of the TLU. Schematic diagram of sequential H-Na-cationization. The schematic diagram of the H-cation with "hungry" regeneration.

9. Schemes of partial chemical desalting. Schematic diagram of the deep chemical desalting. Desalting plant schemes. Operation of ion-exchange installations. Automation schemes TLU. Block diagram of the control of the TLU with block inclusion filters.

10. Technologies of water purification from dissolved gases by distillation methods. Water treatment technology. Desorption of gases from water. The constructive scheme of the deaeration column of jet-bubbling type. Chemical methods for removing gases from water. The method of thermal desalination of water. Thermal desalting in boiling type evaporators.

11. Receiving distillate in evaporators of instant boiling up. Single stage evaporator instant boil. Scheme of a multistage evaporative installation of instant boiling. Vertical evaporator type WIS. The quality of the distillate evaporators. Schemes of evaporative and steam conversion plants. Water mode evaporative installations.

12. Wastewater treatment. Purification and utilization of waste water polluted with oil products. Installation of water purification from petroleum products. Reduction in the quantity and neutralization of wastewater from chemical washes and equipment conservation.

13. Reduction of mineralization and amount of wastewater from water treatment plants. The device and the principle of operation of the electromembrane apparatus. Disposal scheme purge with obtaining pure concentrated alkali and saline.

14. Reverse osmosis and ultrafiltration. Schematic diagram of the direct and reverse osmosis. The structure of the acetyl cellulose membrane.

15. Calculation of technological schemes of reverse osmosis plants. Electrodialysis Schematic diagram of the multi-chamber electrodialyzer. Stabilization treatment of water. Biological fouling prevention. Cooling systems and cooling water stability.

TSE4306 Thermal power systems and energy use – 3 credits

Prerequisites: TT2220 Technical thermodynamics, KUP 3301 Boiler installations and Steam Generators , TETS2225 Thermal power plants and thermal power networks; PTTEC3227 Environmental technologies at thermal power plants.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- determine the technological scheme of the production of electrical and thermal energy;
- find ways to sell heat to steam and hot water from CHP;
- describe the general principles of energy use in heat technology production;
- justify the requirements for the quality of electrical energy and possible ways to meet them;
- determine the energy performance of thermal power plants of various heat cycles;
- calculate the need for energy and heat of various heat-engineering processes;
- substantiate the choice of the main and auxiliary equipment of the stations for the production of energy carriers;
- justify the choice of the scheme of the water treatment system, taking into account the initial data and requirements.

Topics for study:

1. Steam-gas and gas turbine power plants, schemes, layouts, indicators. Use them as baseline and peak thermal power plants. Nuclear power plants (NPP) and nuclear heat and power plants (NHPP).
2. Production and consumption of heat and electricity.
3. Thermal power plants. Gas turbine installation and its efficiency. Maneuverability of GTU.

4. Thermal power plants. Ways to improve efficiency. General information about the auxiliary equipment of thermal power plants.
5. Energy use in industrial production.
6. Energy use in heat technology production.
7. Electrical networks and power supply of industrial enterprises.
8. Electric cars.
9. Electrical apparatus.
10. The processes of heat technology. Devices of heat technology.
11. Evaporative, desalination, evaporation and crystallization plants: principle of operation, basic apparatus designs, thermal circuits
12. Water and fuel technology at thermal power plants: the basics of the territory, methods and means of treatment.
13. Direction, scope and trends in the use of organic fuel in the energy supply systems of industrial enterprises.
14. Systems of production and distribution of energy carriers of industrial enterprises.
15. Technological indicators of the quality of natural waters (transparency, ionic composition, total salt content, hardness and its types, alkalinity and its types, specific electrical conductivity, silica content, oxidability, dissolved gas content).

METROLOGICAL SUPPORT AND NANOTECHNOLOGY IN THERMAL POWER ENGINEERING – 6 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-4 willingness to participate in the organization of the metrological support of technological processes using standard methods for monitoring the operating modes of technological equipment;

PC-15 the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use the information and communication technologies in their professional activities;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

MTI4307 Metrology and heat engineering measurements – 3 credits

Prerequisites: Mat (I) 1203 Mathematics I; Mat (II) 1204 Mathematics II; TOT 2206 Theoretical fundamentals of thermal engineering; TETS2225 Thermal power plants and thermal power networks.

Postrequisites: TSE4306 Thermal Energy Systems and Energy Use; PTBES4307 Physical and technical basics of energy saving; EAOZHK4308 Energy audit of housing and communal services and the organization of energy saving.

As a result of studying the discipline, the student is able to:

- apply the techniques of detecting and eliminating systematic errors in measuring temperature, pressure, flow rate and level of liquids;
- use the method of calculated summation of individual components of the error in assessing the result of direct, linear and nonlinear measurements;
- explain the concepts of accuracy, correctness and precision (reproducibility, repeatability) of measurement methods and results;

- consider the possible consequences of incorrectly calculated errors of measurement results.

Topics for study:

1. Scientific basis of metrological assurance. Metrological services.

2. Classification of means of measurement and control. Measurement and control methods.

3. Metrological expertise and metrological study of technical documentation. The concept of metrological expertise and metrological study of technical documentation.

4. Objectives and content of the metrological study of design documentation in the development of measuring instruments. Approval of the type of measuring instruments and metrological certification of standardized measuring instruments.

5. Verification of measuring instruments. Calibration of measuring tools.

6. Methods of verification (calibration) of measuring instruments. Metrological control and supervision.

7. State metrological control and supervision. Metrological control and supervision in enterprises and organizations.

8. Means of measurement and control. General provisions. Measures Calibers.

9. Means of measuring temperature. Thermoelectric converters. Thermal converters resistance.

10. Thermometric materials. Gauge thermometers. Liquid glass thermometers. TSZh-X alcohol glass thermometer for refrigerators. Pyrometers.

11. Means of measuring pressure and differential pressure. Indicating and recording manometers, vacuum gauges and vacuum gauges. Vacuum gauges for medium, high and ultra high vacuum systems.

12. Means for measuring and controlling consumption. Flowmeters of variable pressure drop. Flowmeters of constant pressure drop. Flow meters and meters for viscous liquids and petroleum products.

13. Flow meters and water meters. Flowmeters and gas meters.

14. Mass flow meters. Heat flow meters that measure the temperature difference between the boundary layer.

15. Instruments for accounting the amount of heat. Level measuring instruments.

NKMT4308 Nanotechnologies and construction materials in thermal power engineering - 3 credits

Prerequisites: MF1208 Molecular Physics; TOT 2206 Fundamentals of the heat conduction theory, TT2220Technical thermodynamics, KUP 3301 Boiler installations and Steam Generators.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- use modern metal processing methods;
- consider the influence of operating conditions of industrial plants on the change in the properties of structural materials and the reasons for the change in these properties;
- know the properties of materials and their structural strength;
- determine the composition of 4 equilibrium phases by the state diagrams of double and ternary alloys;
- conduct tests of metals for hardness, tensile and other important mechanical properties;
- work with equipment used to study the structure and properties of metals and alloys;
- select construction materials for heat and power equipment taking into account operational properties and economic indicators;
- carry out the selection of materials for heat and power equipment.

Topics for study:

1. Materials Science. Features of the atomic-crystalline structure of metals.
2. The structure of real metals. Crystal defects.
3. Crystallization of metals. Metals Research Methods.
4. General theory of alloys. Structure, crystallization and properties of alloys. State diagram.
5. State diagrams of two-component alloys.
6. Loads, stresses and strains. Mechanical properties.
7. Mechanical properties (continued). Technological and operational properties.
8. Structural strength of materials. Features of polycrystalline deformation bodies. Peeling, return and recrystallization.
9. Iron-carbon alloys. Iron-carbon status chart.
10. Steel. Steel classification and marking.
11. Cast iron. The state diagram of iron - graphite. The structure, properties, classification and marking of gray cast iron
12. Types of heat treatment of metals. Fundamentals of the theory of heat treatment of steel.
13. Fundamentals of the theory of heat treatment of steel (continued).
14. Technological features and possibilities of hardening and tempering.
15. Chemical-heat treatment of steel: cementation, nitriding, carbonitriding and diffusion metallization

IT TECHNOLOGIES IN THERMAL POWER ENGINEERING – 9 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies;

Professional competencies:

PC-3 the ability to use IT technologies and application packages to study the processes occurring in modern industrial enterprises;

PC-5 the ability to conduct experimental research and development in the field of power engineering and heat technology, energy use and energy saving at TPPs for individual sections (stages, tasks) of the topic in accordance with approved methods

PC-9 the ability to apply knowledge about the organization of burning organic fuels in boiler furnaces, about thermophysical and hydrogasdynamic processes occurring in the gas-air and steam-water paths of a boiler plant, about the operating conditions of heating surfaces when solving applied technical problems;

PC-11 the ability to use computer technology for modeling and processing the results of experimental and theoretical studies (OpenFoam, Paraview, OriginLab, Labview, etc.) to organize the technologically efficient burning of fossil fuels and reduce harmful emissions;

PC-15 the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources.

As a result of studying the module, the student is able to:

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities;

B3. work with models of technological, physical and chemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

AT4309 Automation at thermal power plants – 3 credits

Prerequisites: IG2206 Engineering Graphics, ICT1104 Information and communication technology; TETS2225 Thermal power plants and heat and power networks

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)

As a result of studying the discipline, the student is able to:

- understand the ways of regulating the main and auxiliary equipment of TPPs in an automatic mode using modern IT technologies;
- find the optimal scheme of regulation of technological processes in the enterprise;
- conduct a critical analysis, synthesis, evaluation and synthesis of new ideas in the context of modern ideas about automated control and management at TPPs;
- use in practice information systems and subsystems for automated process control at TPPs;
- know the principles of operation of regulators of heat and power plants (relays, controllers, communication lines, buses, interfaces, switches, etc.);
- to carry out automatic regulation of direct-flow and drum-type steam boilers, as well as auxiliary equipment systems.

Topics for study:

1. Basic terms and concepts.
2. The laws of regulation in automatic systems.
3. Implementation of automated control at thermal power plants. The structure and function of the process control system.
4. Information subsystems of automated control.
5. Subsystems for remote information input and control.

6. Regulators of heat and power plants.
7. Automatic regulation of drum steam boilers.
8. Automatic regulation of drum steam boilers (continued).
9. Automatic regulation of once-through steam boilers.
10. Automatic control of once-through steam boilers (continued).
11. Automation of auxiliary processes and installations.
12. Automation of energy blocks.
13. Automatic protection systems for thermal equipment.
14. Regulation of emissions of harmful substances with flue gases.

MPSTTK4310 3D Modeling of fuel Combustion processes in combustion chambers– 3 credits

Prerequisites: Mat (I) 1203 Mathematics I, FIZ1205 Physics (Mechanics), MF1208 Molecular Physics, TT2220Technical Thermodynamics, CHMT3213 Convective Heat Transfer, IG2206 Engineering Graphics.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- know the methods of three-dimensional modeling of heat and mass transfer processes during burning of organic fuel in the combustion chambers of industrial boilers;
- be able to draw conclusions on the results of the research in the form of technical decisions and recommendations;
- be able to present the results in the form of presentations, reports and reports;
- justify carrying out the formalization of the studied models of the elements of heat and power systems;
- determine ways to intensify the process of burning solid and liquid fuels;
- use the methodology for the development and application of mathematical models used in simulating the combustion processes of liquid and solid fuels;
- possess skills to work with the main application software for the study of heat and mass transfer processes during the combustion of solid and liquid fuels;
- calculate various currents occurring during the combustion of solid and liquid fuels.

Topics for study:

1. Features of burning liquid and solid fuels.

2. Burning a drop of liquid fuel. Sprayed liquid fuel jet fuel.

3. Heat and mass transfer when burning liquid fuel. Dependences of heat generation and heat absorption during ignition and combustion of a combustible mixture.

4. Mathematical model of the problem of spraying and burning the injection of liquid fuel. The law of conservation of the concentration of a component of a substance.

5. Model of evaporation, burning and collision of liquid fuel droplets. Sauter's average radius.

6. The main properties of the process of burning liquid fuel. Reynolds' number. Weber's number. The Ohnezorge's number. Coefficient of aerodynamic drag drop.

7. Review of the main methods applied to the study of the combustion of energy fuel in combustion chambers.

8. Physical and chemical processes occurring during the combustion of energy fuel in the combustion chambers of coal-fired heat plants.

9. Three-dimensional modeling of convective heat and mass transfer processes in reacting media in areas of real geometry.

10. Simulation of a two-phase flow. The main mechanisms of heat transfer. Heat equation. Fourier's law. Law of energy conservation.

11. Method for solving transport equations. Features of the output of driving coefficients based on the conjugation condition.

12. Calculation of pressure in the simulation of reacting currents in the combustion chambers. Initial and boundary conditions.

13. Analysis of heat and mass transfer processes when burning solid fuel in industrial boilers

14. Simulation of optimal pulverized coal combustion conditions

15. On the problem of reducing the yield of nitrogen oxides NO_x. Characteristics of the furnace chamber of the PC-39 boiler. Results of a numerical experiment.

TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers – 3 credits

Prerequisites: TOT 2206 Theoretical fundamentals of thermal engineering, VTMS1216 Fuel types and its combustion methods, FCHMP2217 Physical and Chemical Methods of Fuel Preparation, SVST3219 Special Issues Combustion, TT2220 Technical thermodynamics.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- demonstrate scientific knowledge in Physicochemical and thermoPhysical properties of substances (energy carriers), methods of their research, ability to choose technology, appropriate schemes and equipment for the conversion of energy carrier;
- master the general principles, structure and functioning of thermal power plants of various types in modern conditions;
- form an idea of the problems of the combined generation of electricity and heat at CHP;
- analyze the relationship of technological, technical and energy aspects of heat technology; to work with heat, heat technology and structural schemes of heat and mass transfer plants, to reveal the basics of energy-saving technologies;
- know about the methods of improving the work processes of TPPs of various types;
- analyze the composition and characteristics of the thermal power system of modern thermal power plants;
- be able to draw conclusions on the results of the research in the form of technical decisions and recommendations;
- be able to present the results in the form of presentations and reports.

Topics for study:

1. The current state of the problem of burning and processing power coal and methods for increasing the efficiency of its use.
2. Theoretical and experimental methods for studying the plasma processes of ignition, thermochemical preparation, combustion and gasification of coal.
3. Basic principles of plasma-fuel systems.
4. Allo-autothermal character of conversion of two-phase fuel flows.
5. Thermodynamic modeling of plasma thermochemical preparation of fuels for combustion.
6. The method of calculating the specific energy consumption for the process of fuel gasification.
7. Energy efficiency of the process of electrothermochemical preparation of energy coals for combustion.
8. Physical model of the process of thermochemical preparation of fuels for combustion.
9. Technology of step burning of pulverized coal in the combustion chambers of industrial boilers of thermal power plants (Over Fire Air Technology).
10. Various systems of staged air supply: separate (SOFA) and dual “sharp” blast systems (CCOFA).
11. Aerodynamic picture of introducing additional air flows into the furnace using “Over fire Air” technology.
12. Technology to reduce emissions of nitrogen oxides using non-catalytic reactions (Selective Non-Catalytic Reduction - SNCR). The general scheme of installation of SNCR systems on the combustion chamber.

13. Physical and chemical model used to apply SNCR technology at TPP boilers. The primary sequence of SNCR reactions involving various reagents.

14. Determination of the most effective temperature window for the SNCR process for reducing nitrogen oxides NO. Comparison of numerical calculations and experimental data.

15. Temperature range for thermal process DeNOx depending on the oxygen concentration in the reaction medium. Reduction of nitric oxide NO by injecting ammonia NH_3. Comparison of numerical calculations and experimental data.

PRODUCTION MANAGEMENT IN THERMAL POWER ENGINEERING – 12 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-12 willingness to ensure the competitiveness and efficiency of heat and power industry facilities using the tools of a competitive economy (laws, scientific approaches, principles, methods, models) for planning innovative energy facilities;

PC-14 willingness to analyze the state and prospects of development of the heat and power complex of the Republic of Kazakhstan using the necessary means and methods;

PC-15 the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources.

As a result of studying the module, the student is able to:

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions;

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

PREPP3303 Production and distribution of energy in industrial enterprises – 3 credits

Prerequisites: EM2209 Electricity and magnetism; TT2220Technical Thermodynamics; NTD 3302 Boiler installations and Steam Generators; TETS3217 Thermal Power Plants and Heat Power Networks.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- calculate energy requirements;
- compile and analyze the schemes and their equipment in the design and off-design modes;
- select and calculate the main and auxiliary equipment of the stations for the production of energy carriers;
- predict the improvement of production systems and the distribution of energy carriers;
- apply computer technology in the design and development of energy production and distribution systems;
- know the basics of design, operation and research of energy production and distribution systems;
- choose rational schemes for the systems of production and distribution of compressed air, cold, separation products of air, fuel, water;
- know the principle of operation and design features of the systems of production and distribution of energy carriers.

Topics for study:

1. Types of energy carriers, requirements for them.

2. General characteristics of the fuel supply of industrial enterprises. Methods of thermodynamic and thermoeconomic evaluation of systems.

3. Air supply systems of industrial enterprises. Methods for determining the daily and daily need for fuel.

4. Systems for the production and distribution of compressed air.

5. Systems of technical water supply of industrial enterprises.

6. Organic fuel production systems.

7. Organic fuel distribution systems.

8. Cold production system.

9. Cold distribution system

10. Production systems of air separation products.

11. Systems for production and distribution of air separation products

12. Systems for providing industrial enterprises with air separation products.

13. Industrial water production systems.

14. Industrial water distribution systems.

15. Economic and energy indicators of industrial water supply systems and ways to further improve them.

RMSTP3304 Regulatory and methodological support in the thermal power engineering industry – 3 credits

Prerequisites: QMTPE3301 Quality Management in Thermal Power Engineering.

Postrequisites: OEP4306 Organization of energy management in enterprises, UEEBP4311 Management of environmental and energy safety of production.

As a result of studying the discipline, the student is able to:

- explain the possibility of a systematic approach to the use of developing processes of regulatory and methodological support of energy saving at the state and local level;

- apply legal, organizational, scientific, industrial, technical and economic measures aimed at the efficient use of energy resources;

- analyze current trends in the attraction of renewable energy sources into economic circulation;

- classify the actively developing regulatory and methodological processes implemented in practice in the Republic of Kazakhstan and abroad.

- systematically streamline the organizational, production, technical and economic measures implemented in practice and aimed at the efficient use of energy resources;

- propose system approaches to the solution of issues related to the involvement of renewable energy sources in the economic turnover.

Topics for study:

1. Fundamental legislative acts, regulatory and methodological documents related to the efficient use of fuel and energy resources.

2. The main objectives, directions of use and principles of regulatory and methodological support of energy saving.

3. Composition and purpose of the complex of regulatory and methodological documents on energy conservation.

4. Subjects of activity on regulatory and methodological support of energy saving.

5. The activities of the authorized bodies of the Republic of Kazakhstan on state standardization for energy conservation in construction.

6. A single conceptual apparatus and a formalized technical language in relation to the rational use of fuel and energy resources.

7. GOST 2661. Standardization, certification and metrology in the field of energy saving.

8. Legal framework for international cooperation.

9. The list of the main regulatory documents that are mandatory for use when conducting energy audits of organizations.

10. Rationing of fuel consumption, heat and electric energy, rationing costs in the distribution and transportation of energy to consumers (energy loss).

11. Regulatory operating technological costs and heat loss in heating networks.

12. The method of calculating the normative annual values of technological heat losses through the insulation and with coolant leakage in the heat network.

13. Classification of energy saving methods: heat technology, kinetic and methods associated with the use of energy-saving technologies. Regulatory and methodological support for assessing the energy efficiency of these methods.

14. Organization of heat metering. Regulatory and technical documentation.

15. Economy of energy saving. Rationing of heat consumption, technological norms of heat consumption. Regulatory and methodological support for energy supervision.

UKT4305 Quality Management in Thermal Power Engineering – 3 credits

Prerequisites: Fiz1205 Physics (Mechanics); TOT 2206 Theoretical fundamentals of thermal engineering; TETS2225 Thermal power plants and thermal power networks.

Postrequisites: TSE4306 Thermal power systems and energy use ; Physical and technical basics of energy saving; EAOZHK4308 Energy audit of housing and communal services and the organization of energy saving.

As a result of studying the discipline, the student is able to:

- classify the types of legal and regulatory documents used in thermal power;
- substantiate the possibility of using regulatory and regulatory documents for creating a quality management system in the thermal power industry;
- apply standards, norms, regulations and other technical documentation when creating quality management systems at enterprises in thermal power engineering;
- interpret the provisions prescribed by international standards, taking into account the peculiarities of the development of the domestic energy industry;
- compile the fuel and energy balances of the enterprise by types of fuel and energy resources.

Topics for study:

1. Quality as an object of management and a factor in improving competitiveness.
2. An integrated approach to quality management in power engineering.
3. The mechanism of quality management in power engineering.
4. The main objectives and principles of quality management systems in enterprises.
5. Tasks and functions of the quality control service.
6. Comparative analysis of the experience of quality management development in the USA and Japan.
7. Features of the use of statistical methods of control in power engineering
8. Requirements in the field of energy saving. Legislative regulation of energy conservation.
9. Typical solutions for energy saving in enterprises.
10. Compilation of energy balances for power plants.
11. Use of fuel and energy resources and energy saving.
12. The place and role of the energy saving system of the enterprise in the quality management system.
13. Types and features of heat and power facilities. Classification of heat and power objects.
14. Indicators for assessing the operational excellence of an energy facility.

15. The concept of the quality of thermal energy, products, raw materials and fuel. Environmental performance of heat and power facilities.

OEP4306 Organization of energy management in enterprises – 3 credits

Prerequisites: PTTEC3227 Environmental technologies at thermal power plants; QMTPE3301 Quality Management in Thermal Power Engineering.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- know the latest discoveries in energy saving, the prospects for their use in thermal power engineering;
- understand the ways and means of ensuring energy and resource conservation and environmental protection in the implementation of heat and energy processes;
- understand the problems of production, transportation and use of thermal energy in modern conditions.
- apply computer technology in modeling and processing the results of experimental and theoretical studies;
- use of mathematical and simulation models of the operation of thermal power and heat technology installations and power equipment;
- analyze the state and prospects of development of heat and power engineering, the energy of heat technology, using the necessary means and methods;
- use in practice new scientific and technical developments, discoveries in power engineering and heat technologies;
- assess the state of energy supply systems and energy consumption at enterprises;
- apply the laws of development of energy systems to solve various Physical problems of an applied nature;
- assess the prospects for the technical development of the thermal power industry.

Topics for study:

1. Legislative regulation of energy saving.
2. Use of fuel and energy resources and energy saving.
3. Thermodynamic indicators of energy efficiency and features of their application in heat engineering and heat technologies.
4. Technical (natural) indicators for assessing energy efficiency.
5. Energy balances of consumers in the fuel and energy industry.

6. Energy balance and energy passport of the building
7. Rationing of energy consumption. Energy industry.
8. Objects of energy management: energy supply processes; transfer processes of fuel and energy resources; energy consumption processes.
9. Search scheme and implementation of energy saving measures.
10. Energy management system as a component of an integrated enterprise management system.
11. Energy saving methods in the production of heat energy.
12. Formation of energy balances and energy accounting.
13. The use of quantitative identification of parameters - the calculation and analytical method, the calculation and static and experimental tests.
14. Energy saving in the systems of transportation and distribution of thermal energy.
15. Rational use of energy in buildings and structures.

ENERGY AND RESOURCE SAVING – 9 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-4 willingness to participate in the organization of the metrological support of technological processes using standard methods for monitoring the operating modes of technological equipment;

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-7 the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work;

PC-8 readiness to make technical and economic balances of installations, technological processes, sections of thermal power plants, to organize accounting and rationing of expenses for fuel and energy resources, to carry out an energy assessment of thermal schemes and installations of thermal power plants;

PC-15 the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources.

As a result of studying the module, the student is able to:

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B2. to put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

PTBES4307 Physical and technical basis of energy saving – 3 credits

Prerequisites: TETS2225 Thermal power plants and thermal power networks; PTTEC3227 Environmental technologies at thermal power plants.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- use production, technical and economic measures aimed at the efficient use of energy resources;
- quantitatively analyze the energy balances of thermal installations and systems;
- evaluate the effectiveness of energy use and energy saving, ways of using secondary energy resources and energy technological combination;
- understand the state and prospects of using unconventional renewable energy sources (NRES);
- calculate passive energy saving measures, solar, wind, bioenergy plants;
- draw conclusions on the results of the research, solve experimental problems of various levels of complexity;
- plan energy saving measures and evaluate their economic efficiency.

Topics for study:

1. The main directions of the energy policy of Kazakhstan.
2. Features and patterns of energy saving. Assessment of energy saving potential.
3. Energy audit. Organization of surveys. Documentary information and questionnaires. Instrumental examination.
4. Accounting and control of energy consumed. The equation of measurement of thermal energy. Secondary energy.
5. Boilers utilizers. The use of heat evaporative cooling. The use of heat of low potential. Energy storage systems. Hydrogen energy.
6. The use of product heat and waste. Use of exhaust steam. Utilization of the heat of polluted effluent.
7. Utilization of heat of aggressive liquids. Heat recovery ventilation emissions. Humid air, wet combustion products. Heat recovery of low-temperature flue gases.
8. Steam and gas installations. Energy saving in boiler and heat networks.

9. Heat losses of pipelines. Energy saving in compressor facilities. Reduced heat loss through the use of double glazing. Infrared heating system for industrial premises.

10. Examples of the introduction of energy-saving technologies. Energy-saving technologies in buildings and structures.

11. Energy saving technologies in buildings and structures. Modern energy efficient technologies.

12. Accounting for energy. Recycling. Obtaining thermal energy based on biofuels. Recycling cages of urban wastewater into fuel. Improving the efficiency of operation of heating networks.

13. The device air curtains at the entrance to the building and at open apertures in the external fences.

14. The device of thermal attics. Thermal protection of the outer wall of the heating device. Air heating.

15. Principles of rational use of energy and resources. Formation of energy-saving behavior.

EAOZHK4308 Energy audit of housing and communal services and the organization of energy saving – 3 credits

Prerequisites: TETS2225 Thermal power plants and thermal power networks; PTTEC3227 Environmental technologies at thermal power plants.

Postrequisites: TSE4306 Thermal power systems and energy use; PT Manufacturing Practice; PGI Undergraduate Practice; WPT Writing and defending a thesis (project).

As a result of studying the discipline, the student is able to:

- understand the specifics of the energy audit of housing and communal services;
- select the necessary methods and means of energy research, energy audit and energy saving;
- use the methods and means of energy and resource conservation and environmental protection in the implementation of heat and energy processes;
- understand the problems of production, transportation and use of thermal energy in modern conditions;
- develop mathematical and simulation models for the operation of thermal power and thermal technology installations and systems, as well as means of controlling energy consumption in the housing and utilities sector.

Topics for study:

1. Methods and criteria for energy efficiency. General concepts in energy saving.
2. Thermodynamic indicators of energy efficiency and features of their application in heat engineering and heat technologies.
3. Energy balances of consumers of the fuel and energy industry.
4. Energy balance and energy passport of the building.

5. Rationing of energy consumption.
6. Energy economy. The issues of organizing energy saving at housing and utilities facilities - energy management.
7. Objects of energy management: energy supply processes; transfer processes of fuel and energy resources; energy consumption processes.
8. Search pattern and implementation of energy saving measures.
9. The energy management system as a component of an integrated enterprise management system.
10. Management of power supply modes and power consumption.
11. Formation of energy balances and energy accounting.
12. Application of the quantitative identification of parameters - the computational-analytical method, computational static and experimental tests.
13. Energy management system as a component of an integrated enterprise management system.
14. Energy saving in the systems of transportation and distribution of thermal energy.
15. Rational use of energy in buildings.

GREEN ENERGY PRODUCTION – 9 credits

General-cultural competencies:

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-6 readiness to develop plans for programs and methods of testing, conducting observations and measurements, drawing up their descriptions and conclusions in the development, modernization and operation of thermal power and heat engineering equipment of thermal power plants;

PC-7 the ability to control environmental safety at work, to develop and implement environmental protection measures and measures for energy and resource saving at work;

PC-10 willingness to implement low-waste and waste-free technologies for the production of heat and electricity at thermal power plants;

PC-13 the ability to solve problems in determining the energy characteristics and indicators of various installations for the conversion of energy from alternative sources into heat and electricity;

PC-14 willingness to analyze the state and prospects of development of the heat and power complex of the Republic of Kazakhstan using the necessary means and methods;

PC-15 the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources.

As a result of studying the module, the student is able to:

A2. know the general laws of the development of nature and society, own a culture of thinking; to be guided in ideals and values of a democratic society;

B1. create technological schemes ensuring the reliability and efficiency of the operation of heat engineering and auxiliary equipment of thermal power plants; apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

B2. to put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

EPAE4309 Environmental problems of alternative energy – 3 credits

Prerequisites: TETS2225 Thermal power plants and thermal power networks; QMTPE3301 Quality Management in Thermal Power Engineering.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- assess the environmental characteristics of alternative energy sources;
- compile and analyze fuel and energy balances of industrial enterprises;
- analyze the environmental impact of energy production from biomass;
- calculate the environmental characteristics of alternative energy sources;
- know the components of tariffs for electricity from renewable sources;
- analyze the negative impact of the wind power plant on the environment;
- understand to explain the problem of the interaction of energy and environment;
- assess the impact of alternative energy sources on the environment;
- use of waste-free technologies and secondary energy resources in power system.

Topics for study:

1. Ecological problems of energy supply of mankind.
2. Environmental problems of traditional energy.
3. Characteristics of modern renewable energy sources: the main aspects of use; advantages and disadvantages in comparison with traditional ones; prospects for use.
4. Tariffs and certificates for electricity from renewable sources.
5. Ecological characteristics of alternative energy sources.
6. Impact of wind energy on the environment.
7. Methods to eliminate the negative impact of wind power plants on the environment.
8. Hydropower and its impact on the environment.
9. Impact of biomass on the environment.
10. Environmental characteristics of the use of bioenergy plants.
11. The impact of solar energy on the environment.
12. Geothermal energy and its environmental impact.
13. Ecological consequences of using ocean energy.
14. Environmental problems of nuclear energy.
15. Waste-free technologies and the use of secondary energy.

UPOPTO4310 Utilization and recycling of waste of thermal power engineering companies – 3 credits

Prerequisites: TETS2225 Thermal power plants and thermal power networks; PTTEC3227 Environmental technologies at thermal power plants.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- be guided in the prospects for development of equipment and technology for protection of man and the natural environment from the dangers of man-made and natural character;
- assess the risk and determine measures to ensure the safety of the technologies and equipment being developed;
- oriented in the basic methods and systems for ensuring technosphere safety, it is reasonable to choose known devices, systems and methods for protecting humans and the natural environment from hazards;
- be guided in the basic regulatory legal acts in the field of ensuring the environmental safety of the enterprises of the heat and power industry;
- use knowledge of the organizational basis for the safety of various industrial processes in emergency situations;
- determine dangerous, extremely dangerous zones and zones of acceptable risk;
- apply theoretical knowledge in practice;
- use innovative technologies in the field of recycling and disposal.

Topics for study:

1. Recycling as one of the ways to greener production. Classification of environmental technologies.
2. Classification of all wastes by the type of their origin: consumption wastes and production wastes.
3. Environmental problems associated with solid waste TPP - ash and slag.
4. Ash and slag waste resulting from the burning of coal in thermal power plants.
5. Processing of liquid fuels (oil and petroleum products). Waste from the production of fuels from petroleum: acid bitumen, residues of petroleum and petroleum products, hydrogen sulfide, mercaptans.
6. Production and processing of gaseous fuels: natural and synthetic.
7. Modern environmental protection technologies in the power industry.
8. The best available technologies are a modern tool for improving energy efficiency and reducing the negative impact of energy companies on the environment.

9. Theoretical foundations of environmental protection. Physical, chemical, and technological bases of methods of environmental pollution by air emissions, wastewater discharges and solid waste.

10. Technologies to protect the atmosphere from gas emissions. Air quality control. Air quality standards.

11. Modern wastewater treatment technologies. Control of water pollution.

12. Protect the environment from solid waste.

13. General characteristics of renewable energy resources (RER) and their classification. RER power plants.

14. Waste recycling: reuse, new materials and goods from recycled materials, extraction of useful fractions from waste and disposal of non-returnable waste and obtaining energy from industrial or household waste incineration or pyrolysis.

15. Disposal of waste as a way to reduce the mass of waste, change its composition, Physical and chemical properties (including incineration and (or) disinfection at specialized facilities) in order to reduce the negative impact of waste on human health and the environment

UEEBP4311 Management of environmental and energy safety of production – 3 credits

Prerequisites: PTTEC3227 Environmental technologies at thermal power plants; QMTPE3301 Quality Management in Thermal Power Engineering.

Postrequisites: PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project).

As a result of studying the discipline, the student is able to:

- assess environmental and technological risks when introducing new technologies;
- create technologies for waste disposal and systems for ensuring environmental safety of production;
- find optimal solutions when creating products with the requirements of quality, reliability, cost and environmental safety of production;
- conduct patent research in order to ensure the patent purity of new design solutions and determine the indicators of the technical level of the project;
- develop methodological and regulatory documents, technical documentation, as well as proposals and measures for the implementation of developed projects and programs;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- participate in the experiments, process the data;
- participate in research and development on the profile of training.

Topics for study:

1. Energy policy of Rebublic of Kazakhstan.
2. Environmental safety in the national safety system.
3. Strategies for ensuringthe environmental safety.
4. Environmental Safety Management.
5. Ecological control as a tool for managing environmental safety of production.
6. Monitoring and auditing the environmental safety of an enterprise.
7. Environmental supervision in terms of production.
8. Energy security as a factor in the socio-economic development of regions.
9. State Energy Policy of the Republic of Kazakhstan.
10. Basic principles of modern energy security.
11. Information and analytical support of the energy security of an economic entity.
12. Legal and methodological framework in the field of energy supply and energy efficiency.
13. The main directions of the state investment policy in the field of energy.
14. Energy security requirements.
15. Special requirements of energy security to the order of work on thermal power plants and heat networks.

PROFESSIONAL PRACTICE MODULE – 12 credits

General-cultural competencies:

GC-4 knowledge of social and ethical values based on social and legal norms and tolerance to various cultural and confessional traditions;

GC-6 ability to communicate in oral and written forms in Kazakh, Russian and foreign languages for solving problems of interpersonal and intercultural interaction;

GC-7 willingness to cooperate with colleagues, work in a team;

GC-8 the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies.

Professional competencies:

PC-1 the ability to apply measurement methods and modern technical means of measuring thermal parameters, methods and technical means of controlling the composition and quality of technological media in thermal power engineering and automating thermal processes;

PC-2 the ability to conduct experimental studies on a given methodology, processing and analysis of the results obtained with the involvement of the appropriate mathematical apparatus;

PC-13 the ability to solve problems in determining the energy characteristics and indicators of various installations for the conversion of energy from alternative sources into heat and electricity;

PC-14 willingness to analyze the state and prospects of development of the heat and power complex of the Republic of Kazakhstan using the necessary means and methods;

PC-15 the ability to apply advanced methods of production management, methods of conducting energy surveys of consumers of energy resources;

PC-16 readiness to regulate relations arising on the results of intellectual creative activity, innovative entrepreneurship.

As a result of studying the module, the student is able to:

A2. know the general laws of the development of nature and society, own a culture of thinking; to be guided in ideals and values of a democratic society;

A3. have an idea of the role of thermal power engineering in engineering, explain and interpret the nature of the main Physical and chemical processes in the combustion chambers of fuel, describe the basic laws of Physics in the process of energy production; use information and communication technologies in their professional activities;

B2. to put into practice the knowledge for election and use of organic fuel in heat-and-power engineering; use modern databases and information retrieval methods; analyze and evaluate the environmental, energy and resource-saving technical policy of the Republic of Kazakhstan;

B3. work with models of technological and physicochemical processes of thermal power plants and interpret their results to optimize energy production by using IT technologies;

B4. analyze the main characteristics of physical phenomena at high temperatures; process and analyze calculations for efficient fuel combustion using computer technologies for modeling and processing the results of experimental and theoretical studies;

B5. assess the state of energy supply systems and energy consumption at enterprises; apply the laws of development of energy systems to solve various Physical problems of an applied nature; assess the prospects for the technical development of the heat and power industry;

C1. explain the methods for assessing the energy efficiency of equipment; technological installations, production;

C2. formulate the terms for selection of measuring instruments in accordance with the required accuracy and operating conditions;

C3. assess the advantages and disadvantages of existing and new technologies in the field of energy production (traditional and alternative energy sources) and to make predictive estimates of the impact of economic activities of heat and power engineering facilities, in particular, the waste they generate, on the state of the environment and develop environmental protection measures using new technologies and waste management;

D1. competently use linguistic and cultural linguistic knowledge to solve the communication problems in a multilingual and multicultural society of the Republic of Kazakhstan and in the international arena; to perception, analysis, synthesis of information, setting goals and choosing ways to achieve it.

Evaluation methods of the results achieved:

1) verbal survey: interview, colloquium, exam;

2) written work: test, final test, essay, abstract, laboratory and calculation and graphic work;

3) control using technical means and information systems: computer testing programs, complex situational tasks; virtual laboratory works, testing by exam, educational tasks on specialized programs;

4) innovative assessment tools: case-method, portfolio, business (role-playing) game, debate, discussion, project method, incident method, method of successive situations, etc.

EP Educational practice – 2 credits

As a result of practice passing the student is able to:

- analyze scientific and technical information;
- observe technological discipline at production sites;
- use theoretical knowledge to understand the physical essence of the processes occurring in the objects of the main and auxiliary equipment of thermal power plants;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- take part in the experiments, process the data;
- conduct the presentation of the report.

Topics of study:

Strengthening and deepening of the knowledge gained from theoretical training; familiarization with the technological cycle of production of heat and electricity at thermal power plants, the composition of the main and auxiliary power equipment; familiarization with the organization of labor; development of safe work methods, ways to save energy and other resources; acquiring environmental skills.

Conducted in the form of introductory lectures, workshops and survey lectures.

PT Professional Training – 8 credits

As a result of practice passing the student is able to:

- know general theoretical information on the organization of the technological process of generating heat and electricity at thermal power plants and in other heat and power plants;
- explain the technology of conversion, transmission and distribution of thermal energy for the needs of the most common consumers;
- understand the principle of operation and design of various heat and power plants, the device, methods for their selection and the main technological parameters of the main and auxiliary equipment of real power facilities;
- organize the metrological support of technological processes;
- search for information on the received task, collect, analyze scientific and technical information;
- observe technological discipline at production sites;
- master the methods of adjustment, adjustment, adjustment and experienced testing of power, heat engineering and heat engineering equipment;
- summarize the results of theoretical knowledge and practical skills in the form of diagrams, graphs and diagrams;
- take part in the experiments, process the data;
- conduct the presentation of the report.

Topics of study:

The study of the production and economic activity of the enterprise; studying the technology of production of electrical and thermal energy, the features of individual technological processes; study of safety rules, labor protection and industrial hygiene in the operation of equipment, obtaining skills and practical experience of independent engineering work; carrying out measurements, drawing up descriptions of the conducted research, preparation of data for the preparation of surveys, reports and scientific publications.

PGI Pre-diploma practice – 2 credits

As a result of practice passing the student is able to:

- know the main regulatory materials on the organization of design, installation and operation of industrial heat and power facilities;
- determine the emission characteristics of industrial enterprises,
- know the principles of the designs of wastewater treatment plants of industrial enterprises, device structures and devices for dry and wet gas cleaning and facilities for physico-chemical gas cleaning and industrial wastewater;
- understand the basics of power generation using the thermodynamic and photoelectric principles of solar energy conversion, the possibility of using solar energy in technological processes, the basic laws of wind energy potential conversion into other types of energy and the construction of wind energy installations, the main methods of converting various sources of biomass into energy products;
- to classify the elementary composition of the fuel, combustible gases, methods of gas combustion and the organization of the combustion of liquid and solid fuels in relation to industrial heat and power engineering facilities;
- analyze the graphs and structure of energy consumption of technical systems, find absolute and relative energy characteristics and analyze energy consumption, determine the energy saving potential of the technical systems and the ways to realize this potential;
- calculate harmful emissions and assess damage from thermal processes, use methods to prevent the formation of harmful emissions and neutralize them in the combustion of fossil fuels;
- perform all calculations related to fuel combustion and organization of combustion, choose one or another fuel for specific industrial installations and use all the features of this or that fuel in order to create energy-saving equipment or the most efficient fire-fighting installations.

Topics of study:

Consolidating theoretical knowledge, applying them to solving specific problems of energy supply, collecting baseline data for a thesis (project), researching ways and possibilities to improve the studied objects, rationalizing their schemes, parameters and modes of equipment operation; analysis of the information collected for the thesis (project), design and preparation of a report on the results of the work performed.

CATALOG OF DISCIPLINES

GENERAL EDUCATION DISCIPLINES (GE)			
COMPULSORY COMPONENT (CC)			
Social and humanitarian module - 6 credits			
SIK1101	**Modern history of Kazakhstan**		
Prerequisites	no	Postrequisites	Phil2105 Philosophy
Credits	3	Semester	1
Aim of discipline	To develop a system of scientific views on the history of modern Kazakhstan society in the context of the world historical process.		
Abstract of discipline	The *Modern History of Kazakhstan* discipline is aimed at developing thinking in future specialists focused on self-development with the priority of universal human values. Large-scale transformations are accompanied by modernization of public consciousness, which involves transformation of learning based on a problem-based approach. Knowledge gained from the study of modern history of Kazakhstan contributes to the understanding of the dynamics of development of historical process and forms value orientations for ethnic, social and cultural identity in the surrounding world. Successful implementation of "Madeni Mura" and "Halyk tarih tolkynynda" government programs has broadened the horizons of historical knowledge and led to fundamental work aimed at changing public consciousness and forming a united Nation of strong and responsible people. The current stage of our country's development is characterized by the Third Modernization of Kazakhstan, the establishment of a new model of economic growth that will ensure global competitive ability of the country. Modernization of the economy is inextricably linked with the modernization of consciousness, when every citizen of Kazakhstan must understand the need for change in order to move to a qualitatively new level of their country's development. Kazakh society should have a spiritual and ideological core for the successful implementation of the goals set, this is facilitated by "Rouhani zhangyru" program which reveals public consciousness modernization mechanisms and is based on the continuity of spiritual and cultural traditions. Knowing the history of one's own people contributes to a broader perception and ability to rethink.		
Phil2105	Philosophy		
Prerequisites	SIK1101 Modern history of Kazakhstan	Postrequisites	no
Credits	3	Semester	4

Aim of discipline	Development of students' holistic systemic understanding of philosophy as a special form of understanding the world, its main branches, problems and methods of their study in the context of future professional activity.		
Abstract of discipline	The *Philosophy* discipline is aimed at developing students' openness of consciousness, understanding their own national code and national identity, spiritual modernization, competitive ability, realism and pragmatism, independent critical thinking, the cult of knowledge and education, and mastering such key ideological concepts as justice, dignity and freedom, as well as the development and reinforcement of such values as tolerance, intercultural dialogue and a culture of peace. Special attention is given to the problems of preserving national identity, the inner core of the national "self" and the national spirit, which are reflected in "Rouhani zhagyru" project, the role of philosophy in modernizing public consciousness and solving global challenges of modernity. Philosophy contributes to the development of philosophical reflection, self-examination and moral self-regulation skills in students; contributes to the development of research and development abilities and development of intellectual and creative potential.		
Instrumental Module – 15 credits			
FL1102	**Foreign language**		
Prerequisites	no	Postrequisites	P-OFL3202 Professionally-oriented Foreign Language
Credits	6	Semester	1, 2
Aim of discipline	Teaching a foreign language as a subject of a general education unit; teaching practical knowledge of everyday language and specialty language for the active use of a foreign language both in everyday and professional communication; development of students' perception of a foreign language as a source of information and a foreign language communication tool.		
Abstract of discipline	The *Foreign Language* discipline is aimed at the further development of language competencies acquired at school as part of the General English discipline program (General English), as well as enhancing of skills and abilities in the use of English as a communication tool with the development of the following competencies: communicative (reading, writing, listening, speaking), language (pronunciation, vocabulary, grammar), general cultural and interpersonal.		
K(R)L1103	**Kazakh (Russian) language**		

Prerequisites	no	Postrequisites	PK(R)L3201 Professional Kazakh (Russian) language
Credits	6	Semester	1, 2
Aim of discipline	Ensure high-quality Russian language proficiency in the context of the Kazakh national culture as an tool for social, intercultural, professional and personal communication through the development of communicative competence in all types of oral activity in accordance with the proficiency levels in a foreign language based on the Council of Europe scale (A1, A2 + LSP; B1, B2 + LSP; C1 + LSP).		
Abstract of discipline	The *Kazakh (Russian) Language* discipline is aimed at shaping social and humanitarian outlook of students in the context of a nationwide idea of spiritual modernization, involving the development of internationalist qualities and tolerance to world cultures and languages as world-class knowledge, advanced modern technologies, the use and transfer of which are capable of ensuring modernization of the country and the personal career growth of future specialists.		
ICT1104	**Information and communication technology**		
Prerequisites	no	Postrequisites	IG2203Engineering graphics; VVT2209 Introduction to computational thermal Physics; ChMVE4305 Numerical methods and computational experiment; TOPG4306 Optimization technologies of combustion processes in modern thermal power plant boilers; IST4305 Information systems in Thermal power engineering; MPST4306 3D simulation of fuel combustion processes in combustion chambers
Credits	3	Semester	2
Aim of discipline	Formation of the ability to critically evaluate and analyze processes, methods of searching, storing and processing information, methods of collecting and transferring information through digital technologies		
Abstract of discipline	The *Information and Communication Technologies* discipline is designed to build the ability to critically understand the role and significance of modern information and communication technologies in the age of digital globalization. In connection with the entry of the economy of Kazakhstan into the age of the Fourth		

	Industrial Revolution, the adoption of a comprehensive “Digital Kazakhstan” Program, development of new technologies, such as Internet of things, cloud technologies, big data, blockchain, etc., the important task is to create a new “digital” thinking in students, their acquisition of knowledge and skills in the use of modern information and communication technologies in various activities.		
ELECTIVE COMPONENT (EC)			
Entrepreneurial Module – 4 credits			
EEOT2106	Economic efficiency of thermal power engineering facilities		
Prerequisites	no	Postrequisites	PTTEC3227 Environmental technologies at thermal power plants; EAOZhK4308 Energy audit of housing and communal services and the organization of energy saving
Credits	2	Semester	3
Aim of discipline	Studying the main aspects of the resource potential; energy pricing principles; methods of calculating the cost of production: the structure of financial, labor and material costs; determination of enterprise efficiency		
Abstract of discipline	The discipline “ Economic efficiency of thermal power engineering facilities” is intended to develop skills for analyzing and evaluating the high-quality operation of process equipment with minimal energy costs for obtaining competitive products; for mastering the method of calculating the comparative economic efficiency of capital investments and innovations of technical progress in order to select the most rational, expedient, promising and economical; to master the skills of planning the heat and power balance of the enterprise; calculation of energy standards as the basis for planning energy supply of production		
IP2107	Innovative entrepreneurship		
Prerequisites	no	Postrequisites	TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers; UKT4305 Quality management in thermal power engineering
Credits	2	Semester	3

Aim of discipline	Acquisition of skills of economic thinking in solving specific engineering problems in scientific, design, technological and production and operational activities in the field of theoretical and industrial heat and power engineering, in the organization of production; Formation of students' ideas about innovation in business, about the main types of innovation, problems and methods of developing innovative projects in the context of future professional activities.		
Abstract of discipline	Providing training in the field of economics and organization of heat and power production, for orientation in technical and economic information, use of economic principles, laws and methods for solving economic problems, principles and methods of organization, production, production processes arising in the course of engineering activity.		
Environmental module – 4 credits			
URE2108	Sustainable energy development		
Prerequisites	no	Postrequisites	PTTEC3227 Environmental technologies at thermal power plants; EPAE4309 Environmental problems of alternative energy
Credits	2	Semester	3
Aim of discipline	Study of the factors of sustainable energy development; methodologies for integrated assessment of energy sustainability; the fundamentals of improving security and reliability of energy supply, reducing the cost of energy resources and production processes; the advantages of carbon-free fuel systems for the development of environmentally friendly and efficient technologies for the processing of fossil fuels (combined-cycle plants, deep processing of coal), placement in the energy balance of renewable energy sources.		
Abstract of discipline	The discipline “Sustainable energy development” is aimed at familiarizing with the main factors of a large-scale transition from the traditional way of generating, distributing and managing energy resources to the new digital power system of the future (Artificial Intelligence Technologies, Machine Learning, Internet of Things, Blockchain, Big Data, and Additive Production).		
OBPE2109	Ensuring the safety of energy enterprises		
Prerequisites	no	Postrequisites	PTTEC3227 Environmental technologies at thermal power plants;

			EPAE4309 Environmental problems of alternative energy
Credits	2	Semester	3
Aim of discipline	The study of the basic principles of energy security management of the enterprise (diversified structure of the energy balance of the enterprise; consideration of the environmental component; efficient use of energy resources; introduction of innovative technologies aimed at the rational use of energy resources; advanced training of personnel in the field of energy management, efficient use of energy resources.		
Abstract of discipline	The discipline "Ensuring the safety of energy enterprises" is aimed at identifying, analyzing and systematizing according to the defining features and the severity of threats to energy security; calculation of the actual values of energy security indicators and their comparison with threshold values; formation of recommendations and measures to prevent threats and improve energy security indicators.		
BASIC DISCIPLINES (BD)			
OBLIGATORY COMPONENT (OC)			
Professional language – 4 credits			
PK(R)L3201	Professional Kazakh (Russian) Language		
Prerequisites	K(R)L1103 Kazakh (Russian) Language	Postrequisites	no
Credits	2	Semester	5
Aim of discipline	Development of skills and techniques of effective speech interaction in various communication situations, development of grammatical skills and knowledge; increasing the level of oral and communicative competence in the professional field.		
Abstract of discipline	The *Professional Kazakh (Russian) Language* discipline is aimed at deepening knowledge of the Kazakh (Russian) language. The acqiored knowledge is aimed at the performance of all types of speech actions (listening, reading, speaking and writing), the development of correct speech and literate writing, the definition of the requirements set for the students: compiling a glossary in the field of study; the ability to navigate information in the field of study; conducting targeted information retrieval, determining the importance and usefulness of information; application of acquired knowledge in professional communication.		
P-OFL3202	Professionally-Oriented Foreign Language		

Prerequisites	FL1102 Foreign Language	Postrequisites	no
Credits	2	Semester	6
Aim of discipline	Development of foreign language professional-oriented communicative competence of students, allowing them to integrate into the international professional environment and use professional Foreign Language as a tool for intercultural and professional communication in order to expand and deepen system knowledge in the field of study and as a means of self-improvement of their professional qualifications.		
Abstract of discipline	*Professionally-Oriented Foreign Language* discipline contributes to the development of functional characteristics of oral and written professional-oriented texts, documentation requirements (within the program), adopted in professional communication and in the country of the studied language, communicative behavior strategies in international professional communication situations.		
Mathematics – 6 credits			
Mat (I)1203	Mathematics I		
Prerequisites	no	Postrequisites	Mathematics II
Credits	6	Semester	1
Aim of discipline	Development of students' system of knowledge, skills, basics of mathematics as a basis for the development of professional competencies.		
Abstract of discipline	The *Mathematics I* discipline involves the study of basic concepts, laws, formulas, theorems and methods of mathematical research to solve various problems, to perform mathematical calculations in professional activities using one or another scheme of mathematical processing of the problems' results .		
Mat (II)1204	Mathematics II		
Prerequisites	Mathematics I	Postrequisites	TBTE2206 Theoretical fundamentals of thermal engineering; ICTT2207 Introduction to computational thermal Physics; T2220Technical thermodynamics; NMCE4302 Numerical methods and computational experiment; MPSTTK4310 3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP

Credits	3	Semester	2
Aim of discipline	Development of students' scientific knowledge about practical application of mathematical ideas and methods for analyzing and modeling complex systems, processes and phenomena; to evaluate optimal solutions and best implementation methods.		
Abstract of discipline	The Mathematics II discipline is aimed at the development of future specialists' ability to use algebra and geometry methods in solving professional problems using the following concepts: matrices and determinants; systems of linear equations; vector algebra; equations of lines and surfaces; linear spaces; elements of analytic geometry in n - dimensional space; logical rigor of maths.		
Fundamentals of the heat conduction theory – 10 credits			
Phys1205	Physics (Mechanics)		
Prerequisites	no	Postrequisites	MF1208 Molecular Physics; EM2209 Electricity and Magnetism; Opt2210 Optics; AP3204 Atomic Physics; NF3205 Nuclear Physics
Credits	4	Semester	1
Aim of discipline	Develop,emt of scientific knowledge about occurrence of patterns in the nature, the study of mechanics as a summarization of observations, practical experience and experiment, teaching basic methods of observation, measurement and experiment for a deeper understanding of Physical processes.		
Abstract of discipline	The *Physics (Mechanics)* discipline is aimed at studying the basic concepts and Physical laws of the mechanics course for the interpretation of the basic mechanical phenomena; to apply the laws of mechanics in solving specific problems in Physics and at interdisciplinary boundaries with other fields of knowledge; to master the skills of using Physical instruments for measuring mechanical quantities; to the explanation of Physical phenomena, Physical models and theories.		
Him1207	Chemistry		
Prerequisites	no	Postrequisites	TBTE2206 Theoretical fundamentals of thermal engineering; FCHMP2217 Physical and Chemical Methods of Fuel Preparation;

			SVST3219 Special Issues Combustion
Credits	2	Semester	1
Aim of discipline	Development of ideas about the basic laws of chemistry, patterns of chemical reactions, the basics of thermodynamics, chemical kinetics, the theory of solutions, oxidation-reduction reactions.		
Abstract of discipline	The *Chemistry* discipline is aimed at developing among future specialists the ability to understand the key concepts of chemistry in the natural sciences system. When studying the discipline, the following aspects will be considered: basic concepts and laws of chemistry; atomic structure and taxonomy of chemical elements; chemical bond; general laws of chemical processes; chemical thermodynamics; electrochemical processes; complex compounds; corrosion and protection of metals; chemistry of non-metallic metals; water chemistry; atomic structure; properties of elements and their compounds; chemical combustion reactions.		
TOT2207	Theoretical fundamentals of thermal engineering		
Prerequisites	Phys1205 Physics (Mechanics); MF1208 Molecular Physics	Postrequisites	TPPTN3217 Thermal power plants and thermal power networks; NNVKM3226 Pumps, fans and compressor machines; NTD 3302 Boiler installations and Steam Generators; KUP 3301 Boiler installations and Steam Generators
Credits	4	Semester	3
Aim of discipline	The study of the laws of thermodynamics and heat transfer; theoretical foundations of the technological process of electric and thermal energy generation; basic principles of operation of structural elements of boiler plants and turbines; process schemes of thermal power plants; issues related to fuel combustion and water treatment; thermodynamic processes in the flow of gases and vapors.		
Abstract of discipline	*Fundamentals of the heat conduction theory* discipline is designed to study theoretical foundations of the internal combustion engines, gas turbine cycles and oil tooling and cooling systems; acquiring skills for solving problems of fluid dynamics, Thermophysics and heat engineering.		
ELECTIVE COMPONENT (EC)			
Physics 1 – 10 credits			
MF1208	Molecular Physics		

Prerequisites	Phys1205 Physics (Mechanics); Him1207 Chemistry; Mat (I) 1203 Mathematics I	Postrequisites	TT2220Technical thermodynamics; KT2222 Convective heat transfer; FTFFTT3224 Physics of Turbulent Flowss; FGV3218 Physics of Combustion and Explosion
Credits	4	Semester	2
Aim of discipline	Development of knowledge about Physical theory based on the generalization of observations, experiment and practical experience, the study of the specific features of the subject of research as a Physical system of a large number of particles, an explanation of the statistical nature of the molecular Physics laws.		
Abstract of discipline	*Molecular Physics* discipline designed to study the statistical and thermodynamic methods of studying systems of many particles and thermoPhysical characteristics of gases, liquids and solids; basic laws of molecular Physics; fundamentals of equilibrium thermodynamics; patterns of change in some Physical parameters when others change in different processes; mathematical apparatus used in molecular Physics; methods for measuring basic thermodynamic parameters.		
EM2209	Electricity and Magnetism		
Prerequisites	Fiz1205 Physics (Mechanics); Him1207 Chemistry	Postrequisites	TETS2225 Thermal power plants and thermal power networks; NNVKM3226 Pumps, fans and compressor machines; GPU3303 Gas turbines and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants
Credits	3	Semester	3
Aim of discipline	Development of undergraduate students of a modern understanding of the nature of electromagnetic phenomena and the spectrum of their possible application, understanding and explanation of processes, which are based on the electromagnetism concept, skills of independent solution of some engineering problems.		

Abstract of discipline	*Electricity and Magnetism* discipline is designed to study the basic Physical phenomena and processes occurring in electric magnetic fields; establishing the connection between various Physical phenomena, deriving basic laws in the form of mathematical equations; explanations of currents and causes of phenomena of an electromagnetic nature; descriptions of various Physical processes of electromagnetic origin.		
Opt2210	Optics		
Prerequisites	Phys1205 Physics (Mechanics); Mat (I) 1203 Mathematics I	Postrequisites	AP3204 Atomic Physics; NF3205 Nuclear Physics; TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers; PREPP3303 Production and distribution of energy resources in industrial enterprises
Credits	3	Semester	4
Aim of discipline	Development of theoretical knowledge and practical skills in the use of optical laws to solve a wide range of tasks in various fields of science and technology, the presentation of the Physics of optical phenomena as a synthesis of observations, practical experience and experiment; familiarization with the main optical phenomena, methods of their observation and experimental research, with the main methods of accurate measurement of Physical quantities, the simplest methods of processing experimental results and basic Physical devices.		
Abstract of discipline	Mastering the *Optics* discipline provides an opportunity to navigate the scientific literature on modern problems of optics, to use its methods and achievements in the field of professional activity; to apply knowledge and skills in special calculations, to correctly draw up optical circuits, to measure light and energy values with the help of measuring instruments.		
Physics 2 – 6 credits			
AYaF3211	Atomic and Nuclear Physics		
Prerequisites	Fiz1205 Physics (Mechanics);	Postrequisites	TSE4306 Thermal Energy Systems and Energy Using;

	Him1207 Chemistry; MF1208 Molecular Physics; Opt2210 Optics		
Credits	3	Semester	5
Aim of discipline	Development of understanding of quantum phenomena at the atomic-molecular level, experimental foundations of quantum Physics and Physical phenomena caused by the electron shells of atoms and molecules.		
Abstract of discipline	*Atomic Physics* discipline explores the atomic structure as a quantum system, which consists of a nucleus and electrons, energy levels of an atom with their characteristics, quantum transitions in an atom, processes of excitation of an atom and atomic collisions, electromagnetic properties of atoms and how they behave in external fields; designed to acquire the skills of using mathematical apparatus of quantum Physics to explain the properties of atoms, molecules and crystals.		
NF3205	Nuclear Physics		
Prerequisites	Fiz1205 Physics (Mechanics); Him1207 Chemistry; MF1208 Molecular Physics; Opt2210 Optics; AP3204 Atomic Physics	Postrequisites	TSE4306 Thermal Energy Systems and Energy Using; EPAE4309 Environmental problems of alternative energy
Credits	3	Semester	6
Aim of discipline	Introduction to the main provisions of science of the atomic nuclei structure, properties of nuclear forces, the laws of change and transformation of nuclei during decay and nuclear reactions, interactions of nuclear radiation with a matter and features of neutron Physics, high energy Physics and elementary particles.		
Abstract of discipline	*Nuclear Physics* discipline is designed to form an understanding of the objective laws of the flow of Physical processes in the microworld; about modern problems in nuclear Physics and particle Physics; studying the general laws of radioactivity in the natural environment; radiation sources; methods and means of measuring and quantifying them.		
Computational Methods in Thermal Physics – 4 credits			
IG2206	Engineering graphics		
Prerequisites	ICT1104 Information and Communication Technologies	Postrequisites	ICTP2207 Introduction to computational thermal Physics; NMCE4302 Numerical

			methods and computational experiment; ISTPE4302 Information systems in Thermal power engineering
Credits	2	Semester	3
Aim of discipline	Teaching students methods of displaying spatial objects in the plane, methods of graphical and analytical solutions of various geometric problems, methods of graphical modeling of geometric objects using graphics programs included in the Corel Draw package.		
Abstract of discipline	The *Engineering graphics* discipline is designed to master the skills to determine the actual size of objects and geometric parameters between them; various ways of graphic and analytical solution of geometric problems; to make informed technical decisions using graphical packages of application programs and computer-aided design systems.		
ICTP2207	Introduction to computational thermal Physics		
Prerequisites	IG2206 Engineering graphics, ICT1104 Information and Communication Technologies , TT2220Technical thermodynamics	Postrequisites	NMCE4302 Numerical methods and computational experiment, ST4302 Automation at thermal power plants, MPSTTK4310 3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP
Credits	2	Semester	4
Aim of discipline	Teaching the skill to solve the Navier-Stokes and Euler equations for thermoPhysical problems using computational algorithms and programming languages; the main approaches and methods that form the basis of computational thermoPhysics for scientists and engineers.		
Abstract of discipline	The *Introduction to computational thermal Physics* discipline is designed to study numerical methods and algorithms; application of basic concepts and methods of computational thermal Physics for practical solution of typical problems of computational thermal Physics, requiring a small amount of computation using computer programming tools and numerical implementation on a computer.		
Fuel Combustion Technique – 6 credits			
TFMC1208	Types of fuels and methods of its combustion		

Prerequisites	Mat (I) 1203 Mathematics I, Fiz1205 Physics (Mechanics), Him1207 Chemistry	Postrequisites	TBTE 2206 Theoretical fundamentals of thermal engineering, TT2220Technical thermodynamics, FCHMP2217 Physical and Chemical Methods of Fuel Preparation, SVST3219 Special Issues Combustion, TPTPNS3217 Thermal power plants and thermal power networks
Credits	2	Semester	2
Aim of discipline	Formation of the energy fuel understanding and main methods of its combustion, as well as the problems of using its heat on an industrial scale, introduction to modern methods of burning gaseous, liquid and solid fuels with the highest efficiency, methods of selection and calculation of burners depending on the type and characteristics of the burned fuel.		
Abstract of discipline	The Types of fuels and methods of its combustion discipline is designed to study the properties of fuels and their behavior in power plants; designs and characteristics of equipment necessary for the preparation of fuel, its combustion and modes of operation; developing skills in determining methods and means of optimal management of the process of preparing fuel for combustion, aimed at implementing highly efficient operation of boiler units and industrial furnaces.		
FCHMP2217	Physical and Chemical Methods of Fuel Preparation		
Prerequisites	MF1208 Molecular Physics, TBTE 2206 Theoretical fundamentals of thermal engineering, TT2220Technical thermodynamics	Postrequisites	KT2222 Convective heat transfer, PTTEC3227 Environmental technologies at thermal power plants, GPU3303 Gas turbines and combined-cycle plants, KUP 3301 Boiler installations and Steam Generators
Credits	2	Semester	4
Aim of discipline	Development of knowledge of the Physical and chemical bases of combustion of organic fuels, examination of fuel properties and characteristics, as well as methods of fuel preparation for combustion.		
Abstract of discipline	The Physical and Chemical Methods of Fuel Preparation discipline aims to build knowledge about the main sources of energy for heat-generating plants; the ability to determine technical characteristics, methods of		

	preparation and methods of burning fossil fuels; learning methods of analysis of Physical and chemical processes during organic fuels combustion; the study of ways to intensify the combustion of solid, gaseous and liquid fuels.		
SIC2210	Special Issues Combustion		
Prerequisites	MF1208 Molecular Physics, TBTE 2206 Theoretical fundamentals of thermal engineering, TT2220Technical thermodynamics	Postrequisites	KT2222 Convective heat transfer, MHTC4303 3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP, FGV3218 Physics of Combustion and Explosion, KUP 3301 Boiler installations and Steam Generators
Credits	2	Semester	4
Aim of discipline	Developing knowledge in the field of fuel combustion methods in combustion chambers of power boilers of industrial enterprises, introduction to present-day methods of burning gaseous, liquid and solid fuels with the highest efficiency; method of selection and calculation of burner devices depending on the type and characteristics of combusted fuel.		
Abstract of discipline	is intended to study the effect of fuel composition (ash content, volatile matter content, etc.) on the combustion mechanism of fuel and on the efficiency of its combustion; mastering skills of assessing properties of fuels and their behavior in power plants; calculation of factors affecting the intensification of the process of ignition and combustion of fuel in the combustion chambers of state-of-the-art steam generators.		
ThermoPhysical processes			
TT2211	Technical thermodynamics		
Prerequisites	Fiz1205 Physics (Mechanics); MF1208 Molecular Physics; Mat (I) 1203 Mathematics I; Mat (II) 1204 Mathematics II	Postrequisites	OTT2212 Bases of Theory of Thermal Conductivity; NTD 3302 Boiler installations and Steam Generators ; BSSG 3301Boiler installations and Steam Generators ;

			NNVKM3226 Pumps, fans and compressor machines
Credits	2	Semester	3
Aim of discipline	Development of knowledge and practical skills in obtaining, converting, transferring and using thermal energy, as well as the correct selection and operation of heat engineering equipment with maximum savings of heat and power resources, and materials, and intensification of technological processes.		
Abstract of discipline	The Technical thermodynamics discipline is designed to study mathematical models of thermal processes; mastering the skills of analyzing thermoPhysical properties of the materials used; calculation of parameters of working processes and cycles; thermal calculations of individual devices, machine aggregates and devices; development of technical requirements for the development of various technological systems; analysis of thermodynamic cycles of machines		
OTT2212	Bases of Theory of Thermal Conductivity		
Prerequisites	MF1208 Molecular Physics; TT2220Technical thermodynamics	Postrequisites	KT2222 Convective heat transfer; TVZH3223 Viscous-fluid Flow Theory PTFFTT3224 Physics of Turbulent Flowss; FGV3218 Physics of Combustion and Explosion
Credits	3	Semester	4
Aim of discipline	Development of knowledge in the field of theoretical foundations of heat exchange processes and their use in the process of further study of special disciplines for understanding thermal conductivity theory, theoretical foundations of radiant heat transfer and heat loss; in the study of complex heat transfer processes in power system; analysis and evaluation of properties of thermal insulation materials and products used in the thermal power industry.		
Abstract of discipline	The *Bases of Theory of Thermal Conductivity* discipline aims to develop future specialists' ability to understand key concepts of thermal conductivity theory; introduction to the basic principles of thermal conductivity theory; thermal conductivity in stationary mode; thermal conductivity in non-stationary mode;		

	main provisions of convective heat transfer; basics of the similarity and simulation method; basics of the heat exchange and heat transfer theory.		
KT2222	Convective heat transfer		
Prerequisites	MF1208 Molecular Physics; TT2220Technical thermodynamics; OTT2212 Bases of Theory of Thermal Conductivity	Postrequisites	PTFFTT3224 Physics of Turbulent Flows; FGV3218 Physics of Combustion and Explosion; GPU3303 Gas turbines and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants
Credits	2	Semester	5
Aim of discipline	Development of knowledge about fundamental laws, patterns and methods of analysis and calculation of convective heat transfer processes; studying the phenomena of convective heat transfer in technological processes in power system; mastering practical skills of determining characteristics of heat exchange processes in heat and power devices and apparatus, analysis of the processes of convective heat and mass transfer in the combustion chambers of power boilers.		
Abstract of discipline	The discipline is aimed at developing the ability of future specialists to understand key concepts of convective heat transfer theory; knowledge of the Physical basis of heat transfer by thermal conductivity; thermoPhysical properties of the substance; thermal conductivity and thermal diffusivity; methods for solving parabolic heat equation; heat transfer theories: heat conduction, convection, radiation, intensification of heat exchange, heat transfer; and the basics of mass transfer; heat and mass transfer devices.		
ThermoPhysics interactions			
TVZH3223	Viscous-fluid Flow Theory		
Prerequisites	Fiz1205 Physics (Mechanics), MF1208 Molecular Physics, IG2206 Engineering graphics,	Postrequisites	PTFFTT3224 Physics of Turbulent Flowss, NTD 3302 Boiler installations and Steam

	TT2220Technical thermodynamics		Generators , FGV3218 Physics of Combustion and Explosion, MPSTTK4310 3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP
Credits	3	Semester	5
Aim of discipline	Studying fundamentals of continuum mechanics, methods for calculating currents in the boundary layer, formed by longitudinal flow past a plate and in jets of different geometry, methods for calculating self-similar flows, calculations of currents in the boundary layer; developing an understanding of an idea of the role and importance of the mechanics of a viscous fluid in the development of aircraft manufacturing, rocket technology and cosmonautics, in describing heat and mass transfer processes in the power economy and ecology.		
Abstract of discipline	The discipline is aimed at developing the ability of future specialists to describe heat and mass transfer processes in viscous liquids; viscous fluid properties; methods for solving ideal liquid and gas equation; Navier-Stokes equations; flow characteristics of a viscous incompressible fluid; fundamentals of the theory of similarity.		
PTF3215	Physics of Turbulent Flows		
Prerequisites	FIZ1205 Physics (Mechanics), MF1208 Molecular Physics, IG2206 Engineering Graphics, TT2220Technical thermodynamics	Postrequisites	NTD 3302 Boiler installations and Steam Generators , FGV3218 Physics of Combustion and Explosion, TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers; MPSTTK4310 3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP
Credits	3	Semester	6

Aim of discipline	Formation of knowledge about modern ideas of turbulence, methods of its study, mathematical models; the study of the equations of fluid dynamics and their main consequences; hydrodynamic instability properties; mastering the skills of calculating turbulent flows; analysis of methods for constructing a mathematical description of turbulence, problems of motion of particles in a turbulent flow; evaluation of modern models and numerical methods for modeling turbulent flows.		
Abstract of discipline	The discipline is aimed the developing ability to understand hydrodynamic instability; the study of the equations of fluid dynamics and their main consequences; issues of hydrodynamic instability and the occurrence of turbulence; mathematical methods for describing turbulence and determining averages and correlation functions; Reynolds equations and semi-empirical theories of turbulence; problems of motion of particles in a turbulent flow; modern models and numerical methods for modeling turbulent flows.		
FGV3218	Physics of Combustion and Explosion		
Prerequisites	Fiz1205 Physics (Mechanics), Him1207 Chemistry, MF1208 Molecular Physics, TT2220Technical thermodynamics, SVST3219Special Issues Combustion, FCHMP2217 Physical and Chemical Methods of Fuel Preparation, TFMC1208 Types of fuels and methods of its combustion	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	The study of the theoretical foundations of combustion and explosion processes with an analysis of the types of their effects on the environment, with the qualitative and quantitative characteristics of these effects; explosion safety assessment at various heat and power facilities.		
Abstract of discipline	The *Physics of Combustion and Explosion* discipline is aimed at the development of fundamental knowledge about theory of combustion and explosion, about the mechanisms of chemical interaction during combustion, about the combustion of hydrocarbon fuels; critical ignition conditions; profile and velocity of		

	the combustion wave, heat fluxes; "critical conditions" methods; burning and detonation; Physicochemical and Physical processes and phenomena accompanying combustion processes.		
Thermal power plants and equipment			
TPPTNS3217	Thermal power plants and thermal power networks		
Prerequisites	MF1208 Molecular Physics; **EM2209** Electricity and Magnetism; TFMC1208 Types of fuels and methods of its combustion; PCNFP2209 Physical and Chemical Methods of Fuel Preparation; SVST3219Special Issues Combustion	Postrequisites	ETCZ3218 Environmental technologies at thermal power plants; NNVKM3226 Pumps, fans and compressor machines; PREPP3303 Production and distribution of energy resources in industrial enterprises; TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers
Credits	2	Semester	4
Aim of discipline	Development of knowledge about the basics of operating thermal power plants and heat networks; the state and prospects of development of the energy industry in the world and in the Republic of Kazakhstan; developing skills of analyzing the reliability of equipment of various heat and power complexes and systems; assessment of reliability of thermal power plants and heating networks and safety equipment.		
Abstract of discipline	The *Thermal power plants and thermal power networks* discipline is designed to study the structure, theoretical and technical foundations and principles of operation of the systems of transportation, distribution and consumption of thermal energy, the requirements for reliable and economical operation of these systems with high thermodynamic and economic efficiency indicators; mastering methods of assessing operational reliability of heat and power equipment; ensuring reliability of operating thermal power plants; safety of energy facilities.		
ETC3218	Environmental technologies at thermal power plants		

Prerequisites	MF1208 Molecular Physics; TFMC1208 Types of fuels and methods of its combustion	Postrequisites	PTBES4307 Physical and technical basics of energy saving; EAHC4308 Energy audit of housing and communal services and the organization of energy saving; UPOPTO4310 Utilization and recycling of waste of thermal power engineering companies; MEESP4307 Management of environmental and energy safety of production; EPAE4309 Environmental problems of alternative energy
Credits	2	Semester	5
Aim of discipline	Delepment of professional competence in the management of the system for ensuring environmental safety of thermal power plants (TPP) through the development and implementation of environmental technologies		
Abstract of discipline	The *Environmental technologies at thermal power plants* discipline aims to explore present-day approaches to ensuring environmental safety; forecasting the possible consequences of changes in the state of ecological system, including natural and technical subsystems and medical and hygienic indicators of human environment, which are subject to anthropogenic impact; introduction to new environmental technologies, methods for developing and implementing environmental protection measures at CHPPs		
NNVKM3226	Pumps, fans and compressor machines		
Prerequisites	MF1208 Molecular Physics, **EM2209** Electricity and Magnetism, TT2220Technical thermodynamics	Postrequisites	NTD 3302 Boiler installations and Steam Generators , KUP 3301 Boiler installations and Steam Generators ; GPU3303 Gas turbines and combined-cycle plants;

			TVOE3304 Thermomechanical and auxiliary equipment of power plants
Credits	3	Semester	5
Aim of discipline	Development of knowledge for solving practical problems related to the operation of pumps, fans, compressors in heat and gas supply systems		
Abstract of discipline	The discipline is aimed at studying the principal cycles and diagrams of pumps, fans, compressors; basics of thermodynamic calculation of pumps, fans, compressors; operating modes and performance characteristics of pumps, fans, compressors; designs of pumps, fans, and compressors		
PROFILE DISCIPLINES (PD)			
OBLIGATORY COMPONENT (OC)			
THERMAL ENGINES – 5 CREDITS			
BSSG3301	Boiler installations and Steam Generators		
Prerequisites	MF1208 Molecular Physics; **EM2209** Electricity and Magnetism, TT2220Technical thermodynamics; TPPTN3217 Thermal power plants and thermal power networks	Postrequisites	GPU3303 Gas turbines and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants
Credits	3	Semester	6
Aim of discipline	The study of the types and designs of power boilers of TPPs and steam generators of NPPs, Physical principles of operation, processes in gas and working environments, calculation and design, characteristics, fundamentals of operation and industrial application of boiler plants and steam boilers; thermoPhysical and hydrogasdynamic processes occurring in the gas-air and steam and water paths of the boiler plant.		
Abstract of discipline	The *Boiler installations and Steam Generators* discipline is aimed at developing students' knowledge about the types and designs of power boilers of thermal power plants and steam generators of nuclear power plants, about organizing the combustion of organic fuels in the furnaces of boilers, about thermoPhysical and hydro-gas dynamic processes; about technological scheme of the steam boiler; the role of a steam boiler		

	and the role of a steam generator in the schemes of thermal and nuclear power plants; about heat balance of the boiler unit; prospects for the development of steam generators and boiler units		
BTE3302	Boiler installations and Steam Generators		
Prerequisites	MF1208 Molecular Physics, **EM2209** Electricity and Magnetism, TT2220Technical thermodynamics; NNVKM3226 Pumps, fans and compressor machines, TPPTPN3217 Thermal power plants and thermal power networks	Postrequisites	TOPGSK4311 Optimization technologies of combustion processes in modern thermal power plant boilers; UEEBP4311 Management of environmental and energy safety of production; GPU3303 Gas turbines and combined-cycle plants; TVOE3304 Thermomechanical and auxiliary equipment of power plants
Credits	2	Semester	6
Aim of discipline	Development of knowledge about the designs and characteristics, Physical principles of operation, calculation methods, industrial use of pressurizers and heat engines; Physical aspects of pressurizers and heat engines; about peculiar characteristics of use of presurizers of the use of drivers and heat engines.		
Abstract of discipline	The *Boiler installations and Steam Generators* discipline is aimed at studying the basic thermodynamic and gas-dynamic principles of operation of pumps, compressors, fans, steam and gas turbines and installations, internal and external combustion engines, the acquisition of skills for analyzing the performance characteristics of pressurizers and heat engines and evaluating their impact on the efficiency of heat and power systems, of which they operate as a part, and to improve efficiency of units and energy saving; acquisition of skills to make and substantiate specific technical decisions when choosing one or another type of a pressurizer or heat engine for the heat and power system; introduction to the new directions of improvement of this class of energy machines.		
ELECTIVE COMPONENT (EC)			
Optimization of combustion processes at CHP – 9 credits			
MMPE3301	Metrology and Measurement in Power Engineering		

Prerequisites	Mat (I) 1203 Mathematics I; Mat (II) 1204 Mathematics II; TBTE 2206 Theoretical fundamentals of thermal engineering; TPPTPNS3217 Thermal power plants and thermal power networks	Postrequisites	NMCE4302 Numerical methods and computational experiment; TESEU4306 Thermal Energy Systems and Energy Using; PTBES4307 Physical and technical basics of energy saving; EAOZHK4308 Energy audit of housing and communal services and the organization of energy saving
Credits	3	Semester	5
Aim of discipline	Development of knowledge of the basics of metrology, regulatory and legal framework of metrological support, fundamentals of ensuring the uniformity of measurements; basic concepts of errors, technical measurements in power system; fundamentals of the theory of measurement and methods for measuring thermal values.		
Abstract of discipline	The discipline is aimed at developing students' ability to understand and apply the basics of conducting technical measurements of thermal parameters in thermal power engineering using methods of statistical processing of measurement results; to study the means of measuring thermal quantities and their errors, taking into account the specific conditions in which measurements are made; metrological support of heat and power facilities; introducing students to various methods and means used in the practice of power engineering for control, regulation and analysis of heat engineering processes.		
NMCE4302	Numerical methods and computational experiment		
Prerequisites	Mat (I) 1203 Mathematics I, Fiz1205 Physics (Mechanics), MF1208 Molecular Physics, TT2220Technical thermodynamics, KT2222 Convective heat transfer, ICTP2207 Introduction to computational thermal Physics, IG2206 Engineering graphics	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)

Credits	3	Semester	7
Aim of discipline	Review of the main methods of numerical calculation of Physical processes, development of the representation of the role and significance of numerical methods in energy and ecology; introduction of students to the basic principles and methods of computer modeling of problems of thermal Physics, with finite-difference schemes used for the numerical solution of differential equations.		
Abstract of discipline	The discipline is aimed at developing future specialists' ability for independent critical thinking and use of methods for the numerical calculation of Physical processes; introduction to the basics of mathematical modeling; methods for solving scalar equations, linear equations systems, and methods for solving nonlinear equations systems; numerical integration; methods for solving ordinary differential equations (ODE) with initial conditions; methods for solving boundary value problems for ordinary differential equations; partial differential equations.		
TOPGSK4311	Optimization technologies of combustion processes in modern thermal power plant boilers		
Prerequisites	TBTE 2206 Theoretical fundamentals of thermal engineering, TFMC1208 Types of fuels and methods of its combustion, FCHMP2217 Physical and Chemical Methods of Fuel Preparation, SVST3219Special Issues Combustion, TT2220Technical thermodynamics	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Development of a future specialist who is able to solve the problems of designing, researching and operating heat and power plants and systems; analyze the efficiency of energy conversion schemes, evaluate the prospects of new ways of energy production, introduce innovative solutions into practice.		
Abstract of discipline	The *Optimization technologies of combustion processes in modern thermal power plant boilers* discipline is aimed at systematic studies of energy complexes for analyzing trends and patterns of energy development; study of the method of predictive analysis of energy technologies based on mathematical modeling; mastering the skills of posing and solving problems of energy use in heat engineering production at the present stage of industrial development; formation of knowledge about modernization of production systems.		

Thermal Power Systems – 9 credits			
GPU3303	Gas turbines and combined-cycle plants		
Prerequisites	MF1208 Molecular Physics; TBTE 2206 Theoretical fundamentals of thermal engineering, TT2220Technical thermodynamics, BSSG 3301Boiler installations and Steam Generators	Postrequisites	TSE4306 Thermal Energy Systems and Energy Using; PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	6
Aim of discipline	Study of the technology of electricity and heat production in modern energy gas turbine and steam-gas units of thermal power plants; advantages of combined-cycle technology, cycles and circuits of combined-cycle plants of power plants, functions and diagrams of technological systems of gas turbines and combined-cycle plants, environmental advantages of gas turbines and combined-cycle plants of TPPs.		
Abstract of discipline	The *Gas turbines and combined-cycle plants* discipline aims to study the principles of operation of gas turbine plants as a drive for electric generators of thermal power plants; schemes and cycles of power gas-turbine installations (GTU), their structure and principle of operation, parameters of the working medium, characteristics of thermal circuits of power GTUs, profitability indicators, ways of improving the efficiency of GTU, analyzes the peculiarities of the variable modes of power GTUs. The "Gas turbine and steam-gas TPPs" course describes.		
CMTPE3305	Constructional materials in thermal power engineering		
Prerequisites	MF1208 Molecular Physics; TBTE 2206 Theoretical fundamentals of thermal engineering, TT2220Technical thermodynamics, BSSG 3301Boiler installations and Steam Generators	Postrequisites	TESEU4306 Thermal Energy Systems and Energy Using; PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	6

Aim of discipline	Development of knowledge, skills and abilities in the field of Physical fundamentals of materials science, modern methods of obtaining structural materials, methods of diagnosing and improving their properties; development of technologies for the creation and quality control of products in the heat and energy sector.		
Abstract of discipline	The *Constructional materials in thermal power engineering* discipline is aimed at studying scientifically based principles of material selection for the manufacture of elements of power equipment depending on its operating conditions and materials processing methods to obtain specified level of service properties; the internal structure of structural materials and determination of material properties, chemical composition, technological and operational effects.		
TESEU4306	Thermal Energy Systems and Energy Using		
Prerequisites	TT2220Technical thermodynamics, BSSG 3301Boiler installations and Steam Generators TPPTPNS3217 Thermal power plants and thermal power networks; PTTEC3227 Environmental technologies at thermal power plants	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Development of students' knowledge of general principles, structure and functioning of heat and power systems of industrial enterprises, systems of heat and electricity supply of industrial enterprises, setting and solving problems of energy use in heat technology production.		
Abstract of discipline	The discipline is aimed at introducing students to "*Power Engineering*" specialty with the composition and characteristics of thermal power system of an industrial enterprise, intended to provide heat and power thermal technology production; study of the system of production and distribution of energy carriers of industrial enterprises; general principles, structure and functioning of thermal power plants of various types.		
Energy saving and waste-free production – 9 credits			
PTBES4307	Physical and technical basics of energy saving		
Prerequisites	TPPTPN3217 Thermal power plants and thermal power networks;	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship;

	PTTEC3227 Environmental technologies at thermal power plants		WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Developing an understanding about the main methods of energy analysis of technological processes and devices; on managing control and accounting for the use of energy resources; on Physicotechnical fundamentals of energy saving in power system; on the development of energy-saving measures in enterprises		
Abstract of discipline	This discipline is aimed at developing future specialists with the ability for independent critical thinking and understanding of key concepts of energy saving problems; Physical and technical basics of energy saving; fuel and energy resources; types, methods of obtaining, converting and using energy; modern techniques and means of managing energy efficiency and energy saving; accounting and regulation of energy consumption; basics of energy audit and management		
EAOZHK4308	Energy audit of housing and communal services and the organization of energy saving		
Prerequisites	TPPTPN3217 Thermal power plants and thermal power networks; PTTEC3227 Environmental technologies at thermal power plants	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Development of students' knowledge in the field of energy conservation and understanding of the basics of energy survey (energy audit) of enterprises to improve energy efficiency of organizations.		
Abstract of discipline	This discipline is aimed at studying innovative problems of energy saving in the area of housing and utilities infrastructure (Housing and Utility Infrastructure) arising during production activities, installation and operation of heat and power engineering and heat technology equipment; examination of the necessary energy research methods and tools, energy audit and energy conservation; ways and means of ensuring energy and resource conservation and environmental protection in the implementation of heat and power processes; methods of monitoring energy consumption in the housing and utility sector.		
DRWTPP4309	Disposal and recycling of waste thermal power industry enterprises		
Prerequisites	TPPTPN3217 Thermal power plants and thermal power networks;	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship;

	PTTEC3227 Environmental technologies at thermal power plants		WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Development of professional competences in the field of solving problems of disposal and recycling of waste produced by heat and power industry enterprises through the development and implementation of environmental measures.		
Abstract of discipline	The discipline is aimed at studying basic statutory acts in the field of ensuring environmental safety of heat and power industry enterprises; organizational foundations for the safety of various industrial processes in emergencies; innovative technologies in the field of waste recycling and disposal; risk assessment and identification of measures to ensure the safety of technologies and equipment under development.		
Modern management in power system – 9 credits			
QMTPE3301	Quality Management in Thermal Power Engineering		
Prerequisites	Fiz1205 Physics (Mechanics); TBTE 2206 Theoretical fundamentals of thermal engineering; TPPTPN3217 Thermal power plants and thermal power networks	Postrequisites	TESEU4306 Thermal Energy Systems and Energy Using; PTBES4307 Physical and technical basics of energy saving; EAOZHK4308 Energy audit of housing and communal services and the organization of energy saving
Credits	3	Semester	5
Aim of discipline	Development of knowledge about product quality management system of heat and power enterprises, the quality management principles in thermal power engineering, introduction to regulatory framework and organization of a quality management system based on ISO 9000 standards, the "Total Quality Management" concept.		
Abstract of discipline	This discipline is aimed at obtaining knowledge on the basic principles of theory and practice of quality management, present-day requirements for quality management systems and its practical application; development of skills and abilities in the field of analysis of quality assurance problems in thermal power		

	engineering, metrological assurance of thermal Physical quantities, regulatory and statutory documents for the creation of a quality management system in the thermal power industry.		
ISPE4302	Information systems in Thermal power engineering		
Prerequisites	Mat (I) 1203 Mathematics I, Fiz1205 Physics (Mechanics), MF1208 Molecular Physics, TT2220Technical thermodynamics, KT2222 Convective heat transfer, ICTP2207 Introduction to computational thermal Physics, IG2206 Engineering graphics	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Acquisition of skills for simulation and analysis of technical devices in heat and power engineering to practically apply the acquired knowledge and when writing a thesis; the study of mathematical models, methods and means of mathematical modeling in power engineering, based on basic mathematical disciplines with respect to the problems of applied technologies, including in power engineering and ecology.		
Abstract of discipline	The *Information systems in Thermal power engineering* discipline aims to study and use of state-of-the-art software for thermal processes simulation; fundamentals of software for automated systems, methods for creating and analyzing models used in information systems in thermal power engineering; software packages for calculating the parameters of various equipment.		
MPSTTK4310	3D Modeling of Heat Transfer in Combustion Chambers of Boilers of TPP		
Prerequisites	Mat (I) 1203 Mathematics I, Fiz1205 Physics (Mechanics), MF1208 Molecular Physics, TT2220Technical thermodynamics, KT2222 Convective heat transfer, ICTP2207 Introduction to computational thermal Physics, IG2206 Engineering graphics	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)

Credits	3	Semester	7
Aim of discipline	Development of knowledge of Physicochemical principles of the theory of combustion of organic fuels, consideration of the properties and characteristics of fuel, as well as methods for modeling pulverized coal burners, mechanical nozzles for liquid fuel, modeling coal-burning furnaces and their layout.		
Abstract of discipline	The *3D Modeling of fuel Combustion processes in combustion chambers*discipline is aimed at developing knowledge of the theory of combustion of fossil fuels, designs and characteristics of fuel-burning equipment, modes of operation of furnaces; mastering the skills of choosing the means to optimally manage heat exchange processes in the furnace space for highly efficient operation of boiler plants and industrial furnaces; organization of furnace processes in order to intensify them and reduce harmful emissions into the environment.		
Power supply and heat engineering equipment – 9 credits			
RMSTP3304	Regulatory and methodological support in the thermal power industry		
Prerequisites	TPPTNS2208 Thermal power plants and thermal power networks	Postrequisites	MEESP4307 Management of environmental and energy safety of production, PDDAES4308 Perspective directions of development of alternative energy sources
Credits	3	Semester	5
Aim of discipline	Development of knowledge, skills and abilities in the field of quality assurance problems analysis in thermal power engineering and practical skills in the application of regulatory and methodological support for energy saving in the thermal power sector.		
Abstract of discipline	The *Regulatory and methodological support in the thermal power engineering industry* discipline aims to acquire knowledge in the field of regulatory and methodological support of energy conservation; study of domestic and international experience in the application of standards, norms and requirements in the field of energy conservation, a systematic approach to the use of developing processes of regulatory and methodological support of energy conservation at the national and local levels.		

TVOE3304	Thermomechanical and auxiliary equipment of power plants		
Prerequisites	EM2209 Electricity and Magnetism; TT2220Technical thermodynamics; NTD 3302 Boiler installations and Steam Generators ; TPPTPN3217 Thermal power plants and thermal power networks	Postrequisites	MEESP4307 Management of environmental and energy safety of production, PDDAES4308 Perspective directions of development of alternative energy sources
Credits	3	Semester	6
Aim of discipline	Development of a strong theoretical base of students on the design and operation of heat and power equipment to solve theoretical and practical problems in their professional activities related to the design, testing, commissioning and operation of heat and power equipment that ensure safety, reliability and high economical efficiency of power plants.		
Abstract of discipline	The *Thermomechanical and auxiliary equipment of power plants* discipline is aimed at acquiring knowledge related to the heat exchange equipment of nuclear and thermal power plants using modern technologies for highly efficient conversion of thermal energy into other types; operation of modern highly efficient heat and power equipment in compliance with environmental protection and production safety requirements; basic heat transfer and hydrodynamics equations in professional activities in the calculation of power equipment; on the designs of thermal and auxiliary equipment at power plants; design calculation methods.		
PREPP3303	Production and distribution of energy resources in industrial enterprises		
Prerequisites	EM2209 Electricity and Magnetism; TT2220Technical thermodynamics; NTD 3302 Boiler installations and Steam Generators ; TPPTPN3217 Thermal power plants and thermal power networks	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Developmeny of knowledge of general principles on the production (generation), distribution and consumption of electric and thermal energy; ideas about the methods of calculating the steady-state modes of electrical networks; general principles, structure and operation of power plants, divided based on the		

	form of the primary energy source converted into electrical or thermal energy, into thermal (TPP), nuclear (NPP) and hydraulic (HPP).		
Abstract of discipline	The *Production and distribution of energy in industrial enterprises* discipline aims to study the classification of electrical networks; the structure and general principles of operation of electric power systems; purpose and main schemes of power supply systems; main types and characteristics of electrical networks, industrial consumers and receivers of electrical energy; requirements for the quality of electrical energy and possible ways to meet such requirements.		
The greening energy production – 9 credits			
MEESP4307	Management of environmental and energy safety of production		
Prerequisites	PTTEC3227 Environmental technologies at thermal power plants; QMTPE3301 Quality Management in Thermal Power Engineering	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Development of knowledge on organization of the process stages, which implies cyclicality, step-by-step implementation, coordination of planning and creation at an enterprise of adequate management structures and incentive and control mechanisms over the efficient consumption of fuel and energy resources.		
Abstract of discipline	The *Management of environmental and energy safety of production* discipline is aimed at studying basic provisions of the energy management system, allowing to predict and control processes of generation, transportation and use of the required amount of energy resources to ensure the economic activity of the enterprise; provide a system analysis of the entire energy distribution chain: from generator to consumer; ways and means to ensure energy and resource conservation and environmental protection in the implementation of heat and power processes.		
UEEBP4311	Management of environmental and energy safety of production		
Prerequisites	PTTEC3227 Environmental technologies at thermal power plants;	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship;

	QMTPE3301 Quality Management in Thermal Power Engineering		WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	*Developing environmental and energy survey skills to determine energy efficiency and energy saving potential, implement an energy management system, develop a program of measures to improve energy efficiency, implement the program, monitor the environment and confirm the effect of energy conservation.*		
Abstract of discipline	The *Management of environmental and energy safety of production* discipline aims to explore ways to improve energy and environmental efficiency and safety of the facility; mastering methods of assessing the efficiency of use of fuel and energy resources in the enterprise, reducing the cost of energy supply, preserving natural non-renewable resources, preventing negative anthropogenic environmental impacts and environmental risks; impact assessment and prediction of the environmental impact of the enterprise in connection with the use of fuel and energy resources; identifying opportunities for improving energy efficiency and environmental safety of an enterprise.		
PDDAES4309	Perspective directions of development of alternative energy sources		
Prerequisites	TPPTPN3217 Thermal power plants and thermal power networks; QMTPE3301 Quality Management in Thermal Power Engineering	Postrequisites	PT Practice Training; PGI Pre-Graduation Internship; WPT Writing and Presentation of Diploma Work (Project)
Credits	3	Semester	7
Aim of discipline	Introduction to the main directions and prospects for the development of alternative energy; determination of the economic and environmental benefits of using wind, solar, geothermal, space, hydrogen, hydrogen sulfide energy, biofuels.		
Abstract of discipline	The *Perspective directions of development of alternative energy sources* discipline it is aimed at developing future specialists' skills of making an informed specific technical decision when choosing noradational energy sources; selection of technical means and technologies taking into account the environmental consequences of their use; study of the state and prospects of development of alternative energy sources;		

	methods of converting solar energy into electrical energy; thermal energy storage and use; use of wind energy and its use; geothermal heat sources.

EVALUTION CONCLUSIONS