**THE THEORETICAL BASES OF PERSPECTIVE THERMAL POWER PROCESSES AND TECHNOLOGIES** GENERAL DESCRIPTION OF THE DISCIPLINE

The work programme of the discipline is compiled according to the Federal State Higher Professional Education Standards

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| --- | --- | --- | --- |
| Code of the field of study and attainment level | Field of study | Details of the order of the Ministry of Education and Science of the Russian Federation on approval and commissioning of the Federal State Higher Educational Standard | |
| Date | Date |
| 13.06.01 | Power Engineering and Electrical Engineering | 30 July 2014 | 30 July 2014 |

## Abstract of the discipline content

This discipline belongs to the disciplines of the postgraduate education programme. The discipline shapes competences in the field of theoretical bases of perspective thermal power processes and technologies.

## Discipline mastering outcome planned

The discipline results in generating the competencies by students as follows:

* the ability to critically analyse and evaluate current scientific achievements, generate new ideas for solving research and practical problems, also in inter-disciplinary areas (UC-1);
* the ability to design and carry out complex research, including that of the inter-disciplinary nature, based on an integral systematic scientific worldview by using the knowledge in the field of history and the philosophy of science (UC-2);
* the theoretical and experimental research methodology in the professional activities (GPC-1);
* the research culture, also by making use of the latest information and communication technologies (GPC-2);
* the ability to develop new research methods and use them in independent research activities in the professional activities (GPC-3);
* the ability to demonstrate basic knowledge in the natural science disciplines and readiness to use the key professional activity laws, apply methods for the mathematical analysis and modelling, theoretical and experimental research (PC-1);
* the ability to conduct kinematic and dynamic analysis and synthesis of up-to-date machine tools, robotics, information, measurement and diagnostic systems, automation and process equipment control systems in heat power engineering (PC-2);
* the ability to develop technical terms of reference (ToR) and feasibility studies for the development of scientific products for the heat and power industry, the provision of production and engineering processes, and the development of quality indicators for products and processes in accordance with the existing national and international regulatory framework (PC-3)
* knowledge of the software of up-to-date production systems, knowledge of programming languages in the design and technology of production preparation, automated product design tools as well as production and engineering processes and systems (PC-4)
* the readiness to use most recent achievements in science and advanced technologies in the heat power engineering research (PC-7)

As a result of mastering the discipline, a post-graduate student should:

Know:

* the basic laws of the science and technology development;
* the scientific creativity methodology; basic principles and provisions of the technical knowledge philosophy; the main scientific schools, research areas, concepts, sources of knowledge and methods of working with them;
* the current energy problems and a potential range of future challenges;
* the contemporary and perspective ways of solving problems in the area of focus;
* the advanced technologies for the electricity and heat production and transmission;
* the principles of operation; the composition and software of automated process control systems;
* the principles of constructing rational process control schemes;

Be able:

* to efficiently deal with information sources, choose promising areas in science and business, find the best ways to accomplish the tasks;
* to apply practically the intellectual property protection methods;
* to be up to speed on the changing social and professional environment;
* to choose the best ways to solve production problems according to the educational profile;
* to compare various competing technologies and choose the optimal one;
* to divide the engineering process into separate operations with a view to further optimising it;
* to compile and solve equations used to describe the models of processes and phenomena in heat engineering and heat-and-power engineering;
* to identify energy challenges that need to be addressed with a PC;
* to solve energy problems by using application programmes on a PC;
* to perform the analytical calculations and graphical analysis of data;
* to analyse the information obtained with computer technologies and make decisions accordingly;
* to use computer technologies to arrange for team work.

Demonstrate skills and experience:

* in working with computer technologies in scientific, business and daily activities;
* in working in up-to-date software products that allow designing, modelling and managing the heat-and-power equipment;
* in using methods for the experimental and calculated data visualisation.

## Scope of the discipline

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| --- | --- | --- |
| **Types of educational activity, forms of control** | **Total, hours** | **Term,**  **number** |
| **5** |
| **In-class learning, hours** | **54** | **54** |
| Lectures, hours | - | - |
| Practical exercises | - | - |
| Laboratory research | 54 | 54 |
| **Self-guided** **of graduate students including all the types of the current attestation** | **50** | **50** |
| **Interim attestation** | 4 | **Test, 4** |
| **Total work input by curriculum, hours** | 108 | |
| **Total work input by curriculum, credits** | 3 | |

# DISCIPLINE CONTENT

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| --- | --- | --- |
| Section and subject code | Section, subject of  the discipline | Content |
| 1 | Section Ι.  Physics and chemistry of heat and power processes | Fundamental laws of modern natural science as a theoretical basis for new high-end technologies. Basic regularities of mechanics and hydromechanics. Examples of use for the creation of modern technologies.  Power engineering of chemical processes. The use of thermal effects of chemical reactions in technology. New chemical identification methods and their implementation prospects. |
| 2 | Section ΙΙ.  Combustion and gasification of organic fuels | Fuel and chemical conversion (FCC). Types of calculations for describing gasification processes. General regularities of chemical kinetics. Types of concentrations. Basic postulates of chemical kinetics. The main types of complex reactions. Reversible reactions. Relationship of activation energy with the thermal effect. Heterogeneous reactions. External diffusion area. The structure of the reacting boundary layer. Non-burning boundary layer. Burning boundary layer. Ignition of carbon. |
| 3 | Section III.  Mathematical modelling and heat-and-power process calculations | Fundamentals of the formulation of spatial models of a continuous medium. Approximations used in the formulation of models of a continuous medium. The boundary conditions of transport equations. Mathematical models of turbulent flows. The computational thermophysics methods. Methods for solving the systems of linear algebraic equations. Iterative methods for solving systems of nonlinear equations. Programme packages for solving the problems of computational fluid dynamics and analysis of simulation results. Integrated software for modelling a continuous environment. |

*\** The discipline may contain division into only sections, without specifying topics, or only topics

# RATIO OF SECTIONS OF the DISCIPLINE AND APPLIED TEACHING TECHNOLOGIES

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Code of section, discipline topic** | **Active teaching methods** | | | | | | **Distance learning technologies and e-learning** | | | | | |
| Project work | Case studying | Simulation exercises/ management games | Problem-based learning | Teamwork | IT | Network training courses | Virtual workshops and simulators | Webinars and videoconferences | Asynchronous web-conferences and seminars | Collaboration and content development | Other (please specify) |
| Section Ι. |  |  |  | + |  | + |  |  |  |  |  |  |
| Section ΙΙ. |  |  |  | + |  | + |  |  |  |  |  |  |
| Section III. |  |  |  | + |  | + |  |  |  |  |  |  |

# 4. CURRICULAR AND INFORMATION SUPPORT

## References

1. Biofuel's Engineering Process Technology/ Ryzhkov A.F., Silin V.E.Bogatova T.F., Popov A.V., Usova G.I. — Croatia: InTech, 2011. 732 p. (http://www.intechopen.com/books/biofuel-s-engineering-process-technology/the-effect-of-thermal-pretreatment-process-on-bio-fuel-conversion)

## 4.4. Databases, information, reference and search systems

1. <http://www.google.ru> etc.
2. <http://lib.urfu.ru/> Zonal Research Library

## 4.5. Electronic educational resources not applicable

**6. APPRAISAL TOOLS FOR THE INTERMEDIATE ATTESTATION**

**List of sample questions for a test**

1. Fundamental laws of modern natural science as a theoretical basis for new high-end technologies.
2. Basic regularities of mechanics and hydromechanics.
3. Examples of use for the creation of up-to-date technologies.
4. Energy of chemical processes.
5. Using the thermal effects of chemical reactions in technology.
6. New methods for the chemical identification and their implementation prospects.
7. Fuel and chemical conversion.
8. Types of calculations for the description of gasification processes.
9. General regularities of chemical kinetics.
10. Types of concentrations.
11. Main postulates of chemical kinetics.
12. Main types of complex reactions.
13. Reversible reactions.
14. Relationship between activation energy and thermal effect.
15. Heterogeneous reactions.
16. External diffusion area.
17. Structure of the reacting boundary layer.
18. Non-burning boundary layer.
19. Burning boundary layer.
20. Carbon ignition.
21. Fundamentals of the formulation of spatial models of a continuous medium.
22. Approximations used in the formulation of continuous medium models.
23. Boundary conditions of the transfer equations.
24. Mathematical models of turbulent flows.
25. Computational thermophysics methods.
26. Methods for solving the systems of linear algebraic equations.
27. Iterative methods for solving the systems of non-linear equations.
28. Software packages for solving the computational fluid dynamics problems.
29. Programmes for analysing simulation results.
30. Integrated software for modelling a continuous environment.