MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION

Federal State Autonomous Education “Ural Federal University named after the first President of Russia B.N. Yeltsin”

Institute of Construction and Architecture

Signed and Approved

Vice-rector for Research

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V.V. Kruzhaev

«\_\_\_» \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2018 г.

COURSE PROGRAM

**TECHNOLOGICAL PROCESSES MODELING AND CALCULATIONS IN WATER-CARRIAGE SYSTEMS**

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| **Information about the course program** | **Accounting data** |
| **Education program**  The main education doctoral graduate program | **Specialty code**  08.06.01/09.11 |
| **Major**  Engineering and Construction Technologies **Training program**  Water supply, sewerage, engineering of water resources protection systems | **Training program code**  08.06.01 |
| **Level of training**  The level of training of highly qualified personnel |
| **Federal State Educational Standard** | **The Ministry of Education and Science of the Russian Federation approval FSES HE order details:**  July 30, 2014 No. 873  (revised April 30, 2015) |

**Ekaterinburg**

**2018**

**1. GENERAL CHARACTERISTIC OF THE course**

**Technological Processes Modeling And Calculations In Water-Carriage Systems**

* 1. **Abstract of the course content**

The course " Technological Processes Modeling And Calculations In Water-Carriage Systems" is an elective one. During the course graduate students are engaged in modeling and calculating the technological processes of water –carriage systems in populated areas, industrial enterprises and territorial-industrial complexes (TIC), including structures and devices for obtaining water from natural sources, its preparation for various needs, transportation to places consumption, subsequent processing when used in technological cycles, as well as drainage and purification of waste water in order to prevent pollution of surface and underground waters.

**1.3. Planned learning outcomes**

After mastering this discipline, the graduate student must acquire the following competencies:

**UC-6:** readiness to use modern methods and technologies of scientific communication in the state and foreign languages;

**GPC-1**: Possession of the methodology of theoretical and experimental research in the field of construction;

**GPC-2**: mastering the culture of scientific research in the field of construction, including using the latest information and communication technologies;

**PC-2:** the ability to develop physical and mathematical models of objects and processes in the design of engineering structures, structures and processes;

**PC-3**: the ability to analyze and synthesize engineering structures, technologies and structures, develop new ones and develop existing methods for their calculation and optimization.

After mastering this discipline, the graduate student must to:

**Know:**

* the purpose of using water in enterprises of various industries;
* the status of the issue with wastewater treatment, their reuse and discharge into water bodies;
* schemes of water supply and drainage systems for industrial enterprises of various industries;
* features of the organization of "open" and "closed" turnover cycles of water supply in industrial enterprises;
* traditional and special technologies for water treatment for industrial water supply and wastewater treatment; hardware design of the specified technological processes;
* methodology for the development of technological models of water management systems for industrial enterprises and individual elements of such systems (circulating cycles, water treatment facilities and wastewater treatment, etc.);
* the main investment and operating costs for water management facilities of industrial enterprises;
* basic indicators of the efficiency of water management systems of industrial enterprises.

**Be able to:**

* analyze time series of data on water consumption and sanitation of industrial enterprises;
* develop technological schemes for water supply and water disposal of industrial enterprises;
* define and predict the technological parameters of circulating water supply cycles, water treatment facilities and wastewater treatment;
* compile water and material circulating cycles of water supply, water treatment facilities and wastewater treatment;
* compile calculation schemes and a mathematical description of technological models of water management systems of industrial enterprises in the stationary and transfer modes of work;
* solve technological models of water management systems of industrial enterprises with the help of computer algebra systems;
* check if the developed technological models of water management systems of industrial enterprises are in well condition;
* optimize the water management systems of industrial enterprises for various criteria of optimality.

1. **COURSE CONTENTS**

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| **Code** | **Section, topic** | **Contents** |
| **Р1** | Section 1 "The role of mathematical modeling in engineering" | Modeling and technological progress. The main stages of mathematical modeling. Ma-thematic models in the water industry |
| ***Р2*** | Section 2 "Mathematical model" | The concept of a mathematical model. Structure of the mathematical model. Properties of mathematical model. Structural and functional models. Theoretical and empirical models. Features of functional models. Hierarchy of mathematical models and forms of their representation |
| ***Р3*** | Section 3 "Mathematical models of the simplest type elements" | The simplest elements of mechanical systems. Some elements of thermal systems. Models of elements of hydraulic systems |
| ***P4*** | Section 4 "Mathematical models of systems of standard elements" | Examples of mathematical models of hydraulic systems |
| ***P5*** | Section 5 "Non-linear mathematical models of micro-level" | Causes of nonlinearity. Static and stationary models. Some nonstationary models. Simplest dynamic models |
| ***P6*** | Section 6 "Mathematical models of the micro-level" | One-dimensional models of hydraulic systems. |
| ***P7*** | Section 7 "Algorithmization of mathematical models" | Methods of converting mathematical models to an algorithmic form. Computational operations of linear algebra |

**4. Sample homework topics**

As a result of doing homework, you need to prepare a presentation. There are sample presentation topics:

1) Creation of scientific foundations and mathematical modeling of water supply and sanitation systems for settlements, industrial enterprises, energy and agriculture facilities, with the development and implementation of methods for optimizing systems for economic, technological and ecological criteria of optimality. The quality of natural and waste water, the methods for determining individual components of pollution, the regularities of the processes of their interaction in water bodies and in water management systems, forecasting changes in water quality in natural and man-made reservoirs.

2) Methods for purification of natural and waste water, technological schemes and structures of used structures, installations, apparatus and mechanisms.

3) Methods for treating sludge and sediments of sewage and natural waters, constructions of used structures, installations, apparatus and mechanisms.

4) Methods of disinfection and conditioning of natural and waste waters, providing sanitary-hygienic, toxicological and epidemiological requirements, technological schemes and constructions of used structures, installations and apparatuses.

5) Application of biocenoses, biochemical stimulators and secretion of active microorganism strains for biological treatment of sewage and natural waters.

6) Application of coagulants, flocculants, catalysts, sorbents and other reagents for purification of sewage and natural waters, treatment of slimes and sediments.

7) Hydraulic regularities that determine the efficiency of the operation of water supply and sewerage facilities and devices, their individual elements, water supply and sanitation systems.

8) Norms and regimes of water consumption and sanitation. Hydrological and hydrogeological regularities that determine the availability of water supply and sanitation.

9) Closed water management systems of industrial complexes and industrial enterprises working on wasteless or low-waste technology.

10) Methods of cooling water in closed and open circulating cycles, types and designs of used structures, installations, apparatus and mechanisms.

11) Technical and economic efficiency and reliability of water management systems of cities, industrial complexes and industrial enterprises, optimization of design solutions for the construction of new, technical re-equipment and reconstruction of existing systems, optimization of the operating mode of systems and their individual components in accordance with the actual regime of water consumption and received wastewater.

12) Methods for obtaining water from surface and underground sources, types and structures of the structures and devices used, and their equipment.

13) Interaction of water intakes and water supply systems for stationary and transient modes of operation.

14) Use of automatic control and management tools to increase the efficiency of the operation of structures and devices of water management systems.

15) Improving the design of pipes, pipeline fittings and tubing equipment of water management systems, the use of new materials for this purpose.

16) Prevention of deposits, biological fouling, corrosion of pipelines and structural materials in water management systems.

17) Operation of water management systems, use of mechanisms and means of auto-matization to eliminate manual labor when performing labor-intensive and harmful to health operations.

18) Specificity of the work on the construction, installation and adjustment of structures and devices of water management systems.

**7 METHODICAL AND INFORMATION SUPPORT**

**7.4. Search systems, databases, information and reference systems**

1. Search system «Google» (<https://www.google.ru/>). Free access from the Internet.
2. Search system «Scholar Google» (<https://scholar.google.ru/>). Free access from the Internet.
3. Electronic Scientific Archive of UrFU (<http://elar.urfu.ru/>). Free access from the Internet.
4. Scientific electronic library «eLIBRARY.ru» (<http://elibrary.ru/>). Free access from the Internet.
5. Scientific electronic library «CyberLeninka » (<http://cyberleninka.ru/>). Free access from the Internet.
6. Full-text database "SpringerLink" (https://rd.springer.com/). Free access from the UrFU corporate network.
7. Scopus reference database (http://www.scopus.com/). Free access from the UrFU corporate network.
8. The Abstract Database "Web of Science Core Collection" (http://apps.webofknowledge.com/). Free access from the UrFU corporate network.
9. Electronic library system “Lan” (http://e.lanbook.com/). Access: 1) free from the UrFU corporate network; 2) remote access via the Internet using logins and passwords. To obtain a login and password, you must register using any computer on the UrFU corporate network.
10. University Library Online Electronic Library System (http://biblioclub.ru/). Access: 1) free from the UrFU corporate network; 2) remote access via the Internet using logins and passwords. To obtain a login and password, you must register using any computer on the UrFU corporate network.
11. Electronic library system "Library Packer" (http://www.bibliocomplectator.ru). Access: 1) free from the UrFU corporate network; 2) remote access via the Internet using logins and passwords. To obtain a login and password, you must register using any computer on the UrFU corporate network.
12. Electronic database Polpred.com (http://polpred.com/). Access: 1) free from the UrFU corporate network; 2) remote access via the Internet using logins and passwords. To obtain a login and password, you must register using any computer on the UrFU corporate network.
13. Professional reference system"TechExpert". Access from any computer of the UrFU corporate network via the link posted on the Internet site of the National Security Service of UrFU (<http://lib.urfu.ru/>).

**8 base of materials for current academic performance Evaluation and interim assessment**

**8.2.4. Sample credit questions**

1) The objectives of the development of mathematical models of water management systems and individual elements of such systems. The main tasks solved by modeling.

2) Modeling and calculation of water supply and drainage systems for industrial enterprises of various industries.

3) Modeling and calculation of "open" turnaround cycles of water supply at industrial enterprises.

4) Modeling and calculation of "closed" turnaround cycles of water supply at industrial enterprises.

5) Modeling and calculation of traditional water treatment technologies for industrial water supply and their hardware design.

6) Modeling and calculation of special technologies for water treatment for industrial water supply and their instrumentation.

7) Modeling and calculation of traditional technologies for the purification of industrial wastewater and their instrumentation.

8) Modeling and calculations of special technologies for purification of industrial wastewater and their instrumentation.

9) Methodology for the development of technological models of water management systems for industrial enterprises and individual elements of such systems (circulating cycles, water treatment facilities and wastewater treatment, etc.).

10) Calculations of technical and economic performance indicators of water management systems of industrial enterprises.

11) Simulation modeling of water management systems’ elements in industrial enterprises.