MASTER STUDY-PROGRAMME IN INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL PROTECTION «GREEN MASTER»

DEVELOPED IN THE FRAMEWORK OF THE
TEMPUS PROJECT 530620-TEMPUS-1-2012-1-IT-TEMPUS-JPCR "LLL TRAINING AND MASTER IN INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL CONTROL FOR RUSSIAN UNIVERSITIES, INVOLVING STAKEHOLDERS - GREENMA"

PROGRAMME HANDBOOK

in cooperation with
D. Mendeleyev University of Chemical Technology of Russia
Ivanovo State University of Architecture and Civil Engineering
Ivanovo State University of Chemistry and Technology
North Ossetian State University in Vladikavkaz
Perm National Research Polytechnic University
Stavropol State Agrarian University
Tambov State Technical University
Tyumen State University of Architecture and Civil Engineering
Ural Federal University n.a. Boris Eltsin, Yekaterinburg
Vladimir State University n.a. Stoletovs
Voronezh State University of Architecture and Civil Engineering

and
City University of London, United Kingdom
Silesian University of Technology in Katowice, Poland
Universidad de Alicante, Spain
University of Genova, Italy

URAL FEDERAL UNIVERSITY N.A. BORIS ELTSIN, YEKATERINBURG
2014

University	**Ural Federal University n.a. Boris Eltsin, Yekaterinburg, Russia**
Programme level	**Master level**
Status	**Joint International Programme**
Name of the course	**Design and operation of heating systems, gas supply, ventilation and air conditioning** **270800.68 (Russian education classification code)**
Field and classification code	**Civil Engineering** **270800 (Russian education classification code)**
Qualification	**Master of Engineering and Technology**
Web-site	http://urfu.ru/international/tempus0/aida/
Faculty	**Institute of Civil Engineering**
Address	**620002, 19 Mira street, Ekaterinburg, Russia**
Course length	**2 years**
Workload	**120 credits (in accordance with ECTS)** **4 320 academic hours (in accordance with Russian education standard)**
Start date	**September 2014**
Professional recognition	**Stakeholders consulted for the designing of the study-programme:** - **Institute of Energy Saving of Sverdlovsk Oblast, Yekaterinburg** - **Federal Service on Customers' Rights Protection & Human Well-Being in Vladimir** - **Union of Constructors of Sverdlovsk Region, Yekaterinburg** - **Tambov Regional Administration** - **Energomera JSC in Stavropol**
Teaching organization	**Semester modules, front lectures, field visits, laboratory works, individual work, scientific supervising, Master thesis preparation.**

Preliminary statement:

The students' workload in Russian Federation is based upon academic hours. An academic hour means 45 minutes according to the regulations for Higher Education. These measures are settled in order to harmonize the Russian Federation academic systems with the one of the Bologna Declaration. The following methodology guidelines are suggested from the Russian Ministry of Education and Science in order to boost the introduction of the ECTS to Russian universities.

The term "Zachetnaya edinitsa" ("Passing unit") was introduced and so-called "Russian credit unit" (RCU). One RCU is considered equal to 1 ECTS credit unit.

According to the methodology suggested by the Russian Ministry of Education and Science:

1 Russian credit unit (RCU) = 36 academic hours

1 academic week = 54 academic hours = 1,5 RCU

Discipline workload is calculated by dividing academic hours by 36

1 practice week = 1,5 RCU

1 exam = 1 RCU

Final qualification work (project), (1 week = 1,5 RCU)

Aims of the programme and competences:
Preparing graduates for productive activities to meet the challenges related to the development and operation energy efficiency systems, heating, ventilation and air-conditioning
Preparing graduates for productive activities to meet the challenges related to the development and operation of energy-efficient heating, ventilation and air-conditioning
Preparing graduates for research activities for solving problems related to the modernization and improvement of existing systems, heating, ventilation and air-conditioning in the direction of improving their energy efficiency.
Preparing graduates for teaching activities related to the training of specialists in the indicated direction.
The study-programme will develop the following competences (or generic skills):

- collect, organize and analyze raw data for the design of energy efficient buildings, engineering systems and equipment
- feasibility study and adoption of design solutions
- preparation of technical specifications for the design of heating systems, gas supply, ventilation and air conditioning
- effective cooperation with specialists from related sections of the project
- correct interpretation of the results of calculations performed with the software for computer-aided design and mathematical modeling.
- development and improvement of the quality control methods of design, construction and operation heating systems, gas supply, ventilation and air conditioning
- organization of experimental testing and technological support
- experimental verification of the organization and technological support this systems
- development and use of databases and information technology solutions for the analysis of scientific, technical and techno-economic problems in this field

Programme languages: Russian and English

Admission criteria:

- **Bachelor or Specialist degree** in a relevant branch of Science or Engineering, with specific reference to heating, ventilation, air conditioning and etc; work experience in the field is appreciated.
- **English language** (to be assessed by an interview).
- **Foreign** candidates are required to have the certificate of Russian language course attendance.

Teaching methods
Seminars, research supervision, practices, creative workshops, problem solution classes, laboratory classes, internships, mobilities, field practice, e-learning.

The peculiar feature of the programme is introducing the **latest international education** achievements into it, with specific reference to:

1. Tuning methodology
2. Dublin descriptors
3. ECTS

In accordance with the "Dublin Descriptors", Qualifications that signify completion of the second cycle are awarded to students who have completed a programme of study that enables them to show:

- knowledge and comprehension that is founded upon, extends and enhances that associated with the Bachelor's level and is at the forefront of a field of learning;
- a critical awareness of current problems and new insights, new tools and new processes within their field of learning, or the development of professional skills;
- that they can apply their knowledge and comprehension, their critical awareness and problem solving abilities, within the context of research, or in the development of professional skills, in broader or multidisciplinary areas related to their fields of study;
- that they have the ability to integrate knowledge and handle complexity, to formulate judgements with incomplete or limited information, either individually or in groups, which includes (where relevant) reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements;
- that they can lead or initiate activity, and take responsibility for the intellectual activities of individuals or groups;
- that they can communicate their conclusions, and knowledge, rationale and processes underpinning these, to specialist and non-specialist audiences clearly and unambiguously;
- that they possess the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

Programme structure

Compulsory subjects (SES – discipline, regulated by the State educational standards Russian Ministry of Education and Science)

- Philosophical problems of science and technology **(**SES)
- The methodology of scientific research **(**SES)
- Special sections of mathematics **(**SES)
- Mathematical modeling **(**SES)
- Basics of pedagogy and androgogics **(**SES)
- Business foreign language **(**SES)
- Information technology in civil engineering **(**SES)
- Methods for solving scientific and technical problems in construction
- Practice and research experience **(**SES)
- Master's thesis **(**SES)

Elective subjects

- Stability and reliability of energy saving systems
- Fundamentals of energy conservation in the design and operation of building structures and buildings
- Modern methods of calculation heat supply systems, ventilation and air-conditioning
- Calculation and design of ventilation systems
- Calculation and design of heating systems
- Calculation and design of air conditioning systems
- Automation and control of energy-saving technological processes

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Programme Outcomes

Knowledge and understanding Basic physical laws and their application in the field of mechanics, hydraulics, heating, electricity related to professional activities Contemporary issues of science and technology, forms and methods of scientific knowledge, the development of science and changing types of scientific rationality; Basic requirements to the design of heating, ventilation and air conditioning systems for industrial and civil facilities with regard to energy savings Modern information technologies and methods for their use in professional activities Requirements of environmental and industrial safety Technique techno-economic analysis and evaluation systems of heat, ventilation and air conditioning with regard to energy savings	**Teaching/learning methods** · lectures · laboratory works · seminars · project work · simulation technology (business, role-playing games, etc.) · methods of problem-based learning (discussion, prospecting, research method, etc.) · virtual workshops and simulators **Assessment method** · oral presentations · professional portfolio · tests after each topic · course exams
Practical skills Be able to provide technical and managerial input into the planning of energy saving projects and facilities Be able to solve engineering problems through the application of theoretical concepts and practical knowledge in industrial setting Conduct laboratory and field experiments, collect, analyse and interpret data Select and use appropriate methods and technologies to conserve heat and power, heat recovery, use of renewable energy Use appropriate information technology for professional and management purposes Be able carry out mathematical modeling of thermodynamic processes of heat and mass transfer	**Teaching/learning methods** · lectures · laboratory works · seminars · project work · simulation technology (business, role-playing games, etc.) · methods of problem-based learning (discussion, prospecting, research method, etc.) · virtual workshops and simulators **Assessment method** · oral presentations · field practice reports · professional portfolio · written reports, essays (including references, etc.) · tests after each topic · master thesis assessment

Graduate skills	**Teaching/learning methods**
Develop critical thinking and critically evaluate the results of the research Identify and use various learning sources in students' scientific occupations Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written, and electronic modes of communication Make informed professional decisions based on scientific knowledge and appropriate criteria Work effectively individually or in groups to accomplish assigned tasks. Appreciate the social impact of research and practical work in the field of study Reflect and evaluate on own learning and evaluate peers in a professional manner	· lectures · laboratory works · seminars · project work **Assessment method** · oral presentations · field practice reports · professional portfolio · written reports, essays (including references, etc.) · master thesis assessment.

COMPULSORY SUBJECTS

Module 1 **Title**	**Philosophical problems of science and technology**
Credits	4 ECTS credits, 144 academic hours
Module leader **and assistant (if any)**	Teacher of Institute of Social and Political Studies
Study terms	Year 2, semester 3

Aim of the module

The course introduces students to the current problems of scientific and technological development of modern society. In a systematic form a snapshot of the device and the main trends in the development of modern science. Demonstrates the relationship between science and other spheres of human activity, especially the interpenetration of modern science and technology. Analyses the problems of scientific and technological development of modern society.

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	72 hours

Learning outcomes

Knowledge and understanding:

- forms and methods of scientific knowledge
- direction of scientific knowledge
- types of scientific rationality

Practical skills

- selection and implementation of methods of scientific research
- analysis of the problems of scientific and technological development of modern society
- development trends and perspectives of technological society

Graduate (or Transferable) skills

- methods of theoretical and empirical research methods of general logical knowledge
- methods of scientific explanation and prediction
- apply them in daily life and their work

Assessment method

- student presentations
- examinations

Module 2 **Title**	**The methodology of scientific research**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Prof. A. F. Nikiforov (Prof. Y. O. Grigoriev), Institute of Civil Engineering
Study terms	Year 1, semester 2

Aim of the module

Draw students' attention to the current and future challenges of science, show them new areas of research, especially in the field of energy saving and environmental protection, both in Russia and abroad. Submit research methodology and analysis problems and explain the facts.

Lectures	18 hours
Laboratory works, seminars	18 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- contemporary issues of science and technology
- detection and analysis of current problems in the field of scientific interests
- search hypotheses for containing an explanation of problematic facts

Practical skills

- selection and implementation of methods of scientific research
- analysis and generalisation of the results of scientific research
- ability and willingness to apply knowledge about modern methods of scientific research

Graduate (or Transferable) skills

- the choice of methods of theoretical and experimental verification of the adequacy of hypotheses
- skills to deep into the new modelling problem using information from the literature.

Assessment method

- student presentations
- tests

Module 3 **Title**	**Special sections of mathematics**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Prof. A.S. Noskov (prof. A.V. Nekrasov, ass. prof. A.V. Khait) Institute of Civil Engineering
Study terms	Year 1, semester 2

Aim of the module

Objectives of the course are to develop the culture of engineering thinking , skills to use methods for determining the parameters of the optimal proportions of different systems, construction and use of models to describe and predict various phenomena and processes in technical systems.

Discusses the principles of descriptive models based on differential equations, algebra of logic, fuzzy logic methods for solving optimisation problems, including genetic algorithms

Lectures	18 hours
Laboratory works	
Individual work	54 hours

Learning outcomes

Knowledge and understanding:

- general principles of descriptive models based on differential equations of various types
- methods of discrete mathematics
- methods of fuzzy logic
- methods of multivariate optimisation

Practical skills

- select a method for solving a specific problems
- formalisation of the problems
- algorithmisation problems
- analysis of the results

Graduate (or Transferable) skills

- select software for solving math problems
- skills determine the initial and boundary conditions
- skills to evaluate the adequacy and accuracy of the solutions

Assessment method

- case study analysis
- tests

Module 4 **Title**	**Mathematical modeling**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Ass. prof. A.V. Khait Institute of Civil Engineering
Study terms	Year 1, semester 2

Aim of the module

The main aim of the module is teaching the methodology of mathematical modeling. Students should get general knowledge and skills on mathematical formulation of physical problem, deriving governing equations in differential or integral form, analytical analysis of the equations. Numerical methods have to be considered because the most of engineering cases have no analytical solution and they can be solved only numerically. Estimation of divergence of the mathematical modelling results from experimental measurements should be also described.

Lectures	
Laboratory works	18 hours
Individual work	54 hours

Learning outcomes

Knowledge and understanding:

- Methods of mathematical modelling
- General types of governing equations
- Numerical methods of estimation of solution of the equations
- Methods of divergence estimation

Practical skills

- To formulate physical problematic
- To derive governing equation for general case
- To perform the analysis of the system of governing equations
- To estimate the numerical solution of the system of governing equations and to estimate its divergence

Graduate (or Transferable) skills

- To perform independent mathematical analysis of the physical problem
- To manage the process of mathematical modelling in engineering companies
- Skills to deep into the new modelling problem using information from the literature.

Assessment method

- case study analysis
- tests

Module 5 **Title**	**Basics of pedagogy and androgogics**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Teacher of Institute of Social and Political Studies
Study terms	Year 1, semester 2

Aim of the module

Discipline devoted to the study of concepts and categories of the educational process, psychological and physiological bases of education for children and adults of different ages. Considered fundamental differences pedagogical and andragogical approaches, forms, methods, technologies and models of education

Lectures	18 hours
Laboratory works, seminars	18 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- foundations of education of children and adults of different ages
- the different learning technologies
- various methods of providing educational materials
- e-learning technology

Practical skills

- develop critical thinking and the ability to critically assess learning outcomes
- public speaking skills and their correct logical construction
- create oral and on-line presentations
- methods of organising and conducting webinars and interactive learning

Graduate (or Transferable) skills

- skills creating educational programs
- create models and structure of personnel management in enterprises of various sizes and industry sector
- communicate and negotiate effectively with different stakeholders individually and in-group

Assessment method

- student presentations
- tests

Module 6 **Title**	**Business foreign language**
Credits	6 ECTS credits, 216 academic hours
Module leader **and assistant (if any)**	Prof. G Khramushna (ass. prof. T. Pirkova) Institute of Fundamental Education
Study terms	Year 1, semester 1. Year 1, semester 2

Aim of the module

This program for students for whom English or German is the second or additional language. This programme can help students to build their foreign language skills for success in university, research or career. The course includes an important engineering vocabulary and texts on heat and mass transfer, energy saving, information about of Bologna Process for higher education development and etc. The teaching process comprises communicative activities, practical exercises, group work, presentations and assignments.

Lectures	
Laboratory works, seminars	108 hours
Individual work	108 hours

Learning outcomes

Knowledge and understanding:

- demonstrate the confidence and listening/speaking skills necessary to participate successfully in spontaneous oral exchanges with native speakers of foreign language in a variety of personal, professional, and/or academic settings;
- demonstrate reading comprehension of foreign language texts intended for developmental (or higher level) foreign language courses.

Practical skills

- respond appropriately to written or spoken foreign language by writing paragraphs or short essays that communicate ideas clearly.
- use language to think and reason, as well as to access, process and use information for learning.

Graduate (or Transferable) skills

- respond appropriately to written or spoken foreign language by writing paragraphs or short essays that communicate ideas clearly.
- communicate and negotiate effectively in foreign language with different stakeholders

Assessment method

- student presentations
- tests
- examinations

Module 7 **Title**	**Information technology in civil engineering**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Prof. A.V. Nekrasov Institute of Civil Engineering
Study terms	Year 1, semester 1

Aim of the module

Ability to purchase their own with the help of information technology and use in practice new knowledge and skills, including in new areas of knowledge that are not directly related to the scope of activities to broaden and deepen their scientific outlook

Discipline devoted to the study of the basic principles of modern information technologies in the design and mathematical modeling of water and heat networks and related software.

The course includes the study of a number of computer programs under the guidance of a teacher, as well as their individual work and study using appropriate teaching materials.

Lectures	
Laboratory works, seminars	36 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- capabilities of modern software in the field of heat supply
- basic principles for the use of modern software for calculations and modelling of hydraulic networks in static conditions and transients
- basic principles of interaction between different software

Practical skills

- self build computational models newly designed and existing facilities heating, ventilation and air-conditioning
- assess the quality of the obtained solutions, including taking into account the economic criteria

Graduate (or Transferable) skills

- skills to work with two - three programs for calculations and modelling of objects in relation to a professional activities
- skills of the export (import) data in various software tools.

Assessment method

- projects
- tests

Module 8 **Title**	**Methods for solving scientific and technical problems in construction**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Prof. A.V. Nekrasov Institute of Civil Engineering
Study terms	Year 1, semester 2

Aim of the module

Ability to collect, analyse and systematise information about the study, to prepare scientific and technical reports, review of publications on the topic of research. Ability to analyse the process as an object of management. Ability to purchase their own with the help of information technology and use in practice new knowledge and skills, including in new areas of knowledge that are not directly related to the scope of activities to broaden and deepen their scientific outlook

Lectures	
Laboratory works, seminars	36 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- statistical methods of experimental results with mathematical models
- basics of correlation, regression and analysis of variance
- basic methods for solving ordinary differential equations and their systems
- basic methods for solving differential partial differential equations and their systems
- methods of mathematical programming

Practical skills

- assess the quality of the obtained solutions
- statistical methods for testing hypotheses
- formulate the initial and boundary conditions for the solution of differential equations
- solution of mathematical programming problems

Graduate (or Transferable) skills

- skills to work with two - three programs for calculations and modelling of objects in relation to a professional activities;
- be able to construct the regression equations and evaluate the significance of its components

Assessment method

- projects
- tests

Module 9 **Title**	**Scientific and practical problems of energy saving and economic sustainability of the construction industry**
Credits	2 ECTS credits, 216 academic hours
Module leader **and assistant (if any)**	Prof. S. Y. Pleshkov Institute of Civil Engineering
Study terms	Year 1, semester 2

Aim of the module

Will be carried out examines the economic aspects of the use of energy saving technologies and renewable energy sources, ways to ensure the economic sustainability of companies and enterprises, identify areas for improving the economic stability of the enterprises in the market economy in Russia

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	144 hours

Learning outcomes

Knowledge and understanding:

- guidelines for the development of models of economic sustainability of the enterprise
- basic approaches domestic and foreign economists to sustainability assessment
- allowable range of operation studied construction enterprises
- methods for analszing the financial performance of the company
- indices change certain economic indicators

Practical skills

- analyse the current state of the economy enterprise, region, country
- современные методы оценки и управления устойчивостью и эффективностью работы строительного предприятия
- organisations overall assessment of the impact of external and internal environment of the state of the construction company with the help of an expert method

Graduate (or Transferable) skills

- determine the overall level of economic stability concept company
- form factor space, which affects the level of economic sustainability of the construction company.
- analyse the financial and economic indicators of construction enterprises

Assessment method

- student presentations
- case study analysis
- examinations

Module 10 **Title**	**Practice and research experience**
Credits	57 ECTS credits, 2052 academic hours
Module leader **and assistant (if any)**	Leaders of Master thesis Institute of Civil Engineering
Study terms	Year 1, semester 1. Year 1, semester 2 Year 2, semester 3. Year 2, semester 4

Aim of the module

The module will be carried out, in cooperation with a scientific supervisor, in industrial organisations / research centres / university laboratories during all the study terms. The student will be inserted into research and practical activities, then in employment perspective. The student will undertake projects and tasks assigned by the organisations. This experience will allow to the student the opportunity to take initiatives as well as to develop the self-confidence, interpersonal and adaptation skills.

Learning outcomes

To carry out projects and tasks given by a lead organisation during the period of Master's internship. To conduct research-based experimental work, results receiving, accuracy and authenticity proving, review of data, discovering cause-effect relations, determination of research innovative and relevant features.

Assessment method

- student presentations
- test

Module 11 **Title**	**Master thesis**
Credits	3 ECTS credits,108 academic hours
Module leader **and assistant (if any)**	Leaders of Master thesis
Study terms	Year 2, semester 2.

Aim of the module

Development of the original theme based on practical experience in industry, government agencies, as well as policies that are related to energy saving, research laboratories public university laboratories under the supervision of a university professor. Practical experience will be focused on solving the problems associated with the development of energy-efficient heating, ventilation and air conditioning of buildings.

Learning outcomes

Preparation of the Master's thesis.
Valuable practical results of the Master thesis and their application for the regional economy and the socioeconomic environment.

ELECTIVE SUBJECTS

Module 1E **Title**	**Stability and reliability of energy saving systems**
Credits	7 ECTS credits, 252 academic hours
Module leader **and assistant (if any)**	Prof. V. A. Doroshenko Institute of Civil Engineering
Study terms	Year 1, semester 1; Year 1, semester 2

Aim of the module

The module will be carried out, foundations of the theory and practice of quality assurance and reliability of equipment
types of maintenance, its organisation and regulation,
maintenance heating, ventilation and air conditioning systems,
the basic theory and practice of technical condition and diagnostic methods,
principles of forecasting resource unit and diagnostic tools

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	198 hours

Learning outcomes

Knowledge and understanding:

- Basic methods of evaluation of the technical state of the systems of heat, ventilation and air conditioning industrial and civil objects
- Basic requirements to the design of heating, ventilation and air conditioning systems for industrial and civil facilities with regard to energy savings

Practical skills

- Be able to solve engineering problems through the application of theoretical concepts and practical knowledge in industrial setting
- Select and use appropriate methods and technologies to conserve heat and power, heat recovery, use of renewable energy
- Be able carry out mathematical modelling of thermodynamic processes of heat and mass transfer

Graduate (or Transferable) skills

- Make informed professional decisions based on scientific knowledge and appropriate criterials
- Appreciate the social impact of research and practical work in the field of study

Assessment method

- case study analysis
- tests

Module 2E **Title**	**Fundamentals of energy conservation in the design and operation of building structures and buildings**
Credits	8 ECTS credits, 288 academic hours
Module leader **and assistant (if any)**	Prof. E. V. Mikhailishin Institute of Civil Engineering
Study terms	Year 1, semester 1.

Aim of the module

Formation of future masters of the conscious attitude to the priority issues for the effective use of energy resources, which is one of the most important principles of state policy of Russia in the field of energy saving.

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	216 hours

Learning outcomes

Knowledge and understanding:

- public policies, legislation and regional legal frame work in the field of energy saving;
- modern energy - saving technologies, materials and equipment in the field of design and operation of objects of construction;
- methods of rational and efficient use of fuel and energy resources.

Practical skills

- mastery of technical and economic analysis of energy saving measures, connected with designing and operation of objects of construction;
- implementation of energy survey, preparation of energy passports for buildings;
- development of energy saving programmers.

Graduate (or Transferable) skills

- to conduct a feasibility analysis of the activities and projects related to problems of energy saving;
- designing energy-efficient buildings and constructions;
- organisation of works on saving of fuel and energy resources in existing building.

Assessment method

- case study analysis
- student presentations
- examinations

Module 3E **Title**	**Modern methods of calculation heat supply systems, ventilation and air-conditioning**
Credits	8 ECTS credits, 288 academic hours
Module leader **and assistant (if any)**	Prof. E. V. Mikhailishin Institute of Civil Engineering
Study terms	Year 1, semester 1.

Aim of the module

Prepare masters, are able to use modern methods of calculation, the use of which is at the stage of designing allows to receive energy efficient solutions of systems heat supply, ventilation and air conditioning.

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	216 hours

Learning outcomes

Knowledge and understanding:

- the value of the mathematical modelling by computer;
- theoretical fundamentals of mathematical modelling of hydraulic and ventilating processes;
- program complexes for calculation of hydrodynamic flows and the processes of heat and mass exchange;
- modeling of ventilation of industrial and public buildings.

Practical skills

- correctly formulate a problem and choose the best method of its solution;
- reasonably identify all the dimensional and dimensionless parameters that you want to set in the mathematical formulation of the problem;
- correct statement of the boundary conditions;
- perform analysis of the results of mathematical modeling.

Graduate (or Transferable) skills

- the ability to conduct calculations variables hydraulic regimes in heat supply systems;
- how to use well – known software packages for solving tasks heat and transfer ventilation of industrial and public buildings.

Assessment method

- case study analysis
- student presentations
- examinations

Module 4E **Title**	**Calculation and design of ventilation systems**
Credits	5 ECTS credits, 180 academic hours
Module leader **and assistant (if any)**	Prof. L.G. Pastukhova Institute of Civil Engineering
Study terms	Year 2, semester 3.

Aim of the module

Studying sanitary and technological methods of ventilation design and definition of the required and calculated indoor air on the basis of energy using principals by means of physical and mathematical modeling of aerodynamics premises, buildings and industrial sites methods.

Lectures	18 hours
Laboratory works, seminars	18 hours
Individual work	144 hours

Learning outcomes

Knowledge and understanding:

- aerodynamics of air-jets,
- aerodynamic principles of indoor ventilation
- mathematical ventilation modelling principles
- Modern means of automated calculation and design of ventilation systems

Practical skills

- design of ventilation systems for various applications
- Automated design options choice and using
- aerodynamic calculation of ventilation systems with gravitational and mechanical drive of air movement
- selection air movement facialiator, cleaning devices, air heating devices and heat recovery devices
- calculation of dispersion of harmful emissions into the atmosphere

Graduate (or Transferable) skills

- proficiency in methods of automated calculation and design of ventilation systems for various applications
- proficiency in methods of numerical modeling of indoor air flow and external building flow
- proficiency in evaluation methods for ventilation systems in terms of energy efficiency,
- proficiency in environmental evaluation methods for ventilation systems.

Assessment method

- case study analysis
- projects
- tests

Module 5E **Title**	**Calculation and design of heating systems**
Credits	6 ECTS credits, 216 academic hours
Module leader **and assistant (if any)**	Prof. L.G. Pastukhova Institute of Civil Engineering
Study terms	Year 2, semester 3.
Aim of the module Study of thermal and hydraulic design approaches for heating systems in order to optimize design solutions and operating conditions in terms of their energy-efficiency reliable operation.	
Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	144 hours

Learning outcomes

Knowledge and understanding:

- hydraulic basis of heating networks operating
- mathematical modelling methods for heating networks
- structure, components and equipment of heating networks
- methods of heating regulation and automation
- schemes of renewable thermal energy for heating using
- automated systems for design and calculation of heat networks.

Practical skills

- design of heating systems,
- hydraulic calculation, hydraulic modes of heating network operation analysis
- thermotechnical calculation, thermal modes of the heating network analysis
- mains water temperature graphs building
- hydraulic modes of heating network piezometric graphs building
- heating networks automated calculation and design methods choice and using

Graduate (or Transferable) skills

- proficiency in methods of automated calculation and design of heating systems for various purposes
- proficiency in methods of numerical modeling of the thermal and hydraulic modes of heating network
- proficiency in methods of design solutions evaluation in terms of energy efficiency,
- proficiency in methods of environmental evaluation of the heating systems design

Assessment method

- case study analysis
- projects
- tests

Module 6E **Title**	**Calculation and design of air conditioning systems**
Credits	6 ECTS credits, 216 academic hours
Module leader **and assistant (if any)**	Prof. A.V. Nekrasov Institute of Civil Engineering
Study terms	Year 2, semester 3.

Aim of the module

Discipline devoted to the study of theoretical foundations of air conditioning and refrigeration: the basic processes of air treatment, their calculation, selection, design and analysis of air conditioning systems in various conditions. Particular attention is paid to the savings of electricity and heat in the implementation of air treatment in various buildings

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	144 hours

Learning outcomes

Knowledge and understanding:

- basic requirements for air conditioning and cooling systems
- basic treatment processes in air conditioners
- thermodynamic principles of refrigeration machines and their main characteristics
- calculation principles conditioning systems according to the requirements of the process air at different conditions with regard to economy of electric power and heat recovery

Practical skills

- determine the physical characteristics of moist air
- determine the required input data for the design or the air conditioning system
- prepare terms of reference for the development of air conditioning systems

Graduate (or Transferable) skills

- skills in the processing of the calculation of air conditioners using graph-analytical techniques and software
- skills of choice of equipment depending on the requirements of the air processed

Assessment method

- case study analysis
- projects
- tests

Module 7E **Title**	**Automation and control of energy-saving technological processes**
Credits	6 ECTS credits, 216 academic hours
Module leader **and assistant (if any)**	Prof. A.V. Nekrasov Institute of Civil Engineering
Study terms	Year 2, semester 3.

Aim of the module

Discipline devoted to the study of the principles of management of technical systems, structures and capabilities of process automation and individual units that make up the heat and gas systems, heating, ventilation and air conditioning systems, including the use of programmable controllers.

Formation literacy skills and informed choices of elements of automation systems.

Lectures	18 hours
Laboratory works, seminars	54 hours
Individual work	144 hours

Learning outcomes

Knowledge and understanding: знания и понимания (знать

- main components of the automatic control system
- basic control laws
- interrelation of the elements of the system of automatic control
- principles of operation of the programmable controllers (PLC)
- principles of operation of electrical relay-contact circuit
-

Practical skills практические навыки (уметь

- understand (read) a simple electrical relay-contact circuit
- constitute control algorithms
- prepare terms of reference for PLC programming

Graduate (or Transferable) skills (владеть

- select sensors for measuring process parameters
- make a table of variables for PLC
- select controls for automation systems

Assessment method

- case study analysis
- projects
- tests

Assessment strategy and methods

- Internal current control of student progress according to IQ-net and ISO-9000 procedures (at the end of semester)
- Oral presentations
- Field practice reports
- Professional portfolio
- Written reports, essays (including references, etc.)
- Tests after each topic, course exams, Master thesis assessment.
- Posters
- Peer review and evaluation by the group
- Self-evaluation

Quality assurance

Internal

- General expert evaluation by the Tempus project Evaluation board
- Students feedback

External

- Evaluation by European academics from partner universities
- Accreditation of the programme by _____ _____)
- Ministry of Education and Science of Russian Federation official recognition (licensing)
- Evaluation by employers

Employment opportunities

A graduate with this educational program can carry out professional activities in the field

- design, construction, operation and reconstruction of engineering systems of buildings and structures
- engineering and equipment construction projects
- development of machinery, equipment and technology needed for the construction and building materials, components and structures
- research and educational activities

Professional activity of graduates will be able to perform in the production, design and research organizations working in the construction field, in scientific and research activities

Learning resources available at the Chair (bought in the framework of the project)

1. Complex for study and research «Exploration of the energy reliability (stability) of heat supply systems", Ltd. "Mir novyh tehnologij», Orel city (Учебно-исследовательский комплекс «Исследование энергетической надежности (устойчивости) систем теплоснабжения», ООО «Мир новых технологий», г. Орел)
2. Computer program «Calculation of the load on the air conditioning system at non-stationary heat-gain, Ltd. "AVOK", Moscow city» (Компьютерная программа «Расчет нагрузки на систему кондиционирования воздуха при нестационарных теплопоступлениях», ООО «АВОК», г. Москва)
3. Computer program « ASPO-PRIS. Engineering networks design», as part of the calculation and exploitation modules of the heat and gas supply networks, ZAO "ASPO", Saint-Petersburg city (Компьютерная программа «АСПО-ПРИС. Проектирование инженерных сетей», г. Санкт-Петербург).

Recommended literature

1. Y. Sibikin, M. Sibikin. Alternatives and Renewables energy sources, 2012. (Ю.Сибикин, М. Сибикин. Нетрадиционные и возобновляемые источники энергии, изд-во «КноРус», 2012г.)
2. V.I.Vissarionov, G.V.Deriugina etc. Solar energy, 2011 (В.И. Виссарионов, Г.В. Дерюгина и др. Солнечная энергетика, 2011г.)
3. A.B. Alhasov. Renewable power generation, 2010 (А.Б. Алхасов. Возобновляемая энергетика, 2010г.)
4. O.D. Samarin. Thermo-physical and technical- economic foundations of Thermal Engineering safety and energy efficiency in buildings, 2007 (О.Д. Самарин. Теплофизические и технико-экономические основы теплотехнической безопасности и энергосбережения в зданиях. 2007г.)
5. A.N. Dmitriev, Y.A. Tabunshikov etc. Manual on estimation of economical efficiency of investment in energy-efficiency, 2010 (А.Н. Дмитриев, Ю.А. Табунщиков и др. Руководство по оценке экономической эффективности инвестиций в энергосберегающие мероприятия, изд-во «АВОК»)
6. I.M. Kvashnin. Emission limited values of plants into the atmosphere. Dispersion and establishment of standards. 2011 (И.М. Квашнин. Предельно допустимые выбросы предприятия в атмосферу. Рассеивание и установление нормативов, изд-во «АВОК»
7. M.M.Brodach. Industrial emission into the atmosphere. Engineering analyses and inventory, 2011 (Промышленные выбросы в атмосферу. Инженерные расчеты и инвентаризация, изд-во «АВОК», 2011г)
8. Y.A. Tabushnikov, M.M. Borodach. Mathematical modeling and optimization of buildings' thermal effectiveness, 2012 (Ю.А. Табунщиков, М.М. Бродач. Математическое моделирование и оптимизация тепловой эффективности зданий. Электронная книга, изд-во «АВОК», 2012г.)
9. V.N. Karpov. Hot water heating systems of multi-storey buildings. Technical guidelines for the design, 2012 (В.Н. Карпов. Системы водяного отопления многоэтажных зданий. Технические рекомендации по проектированию, изд-во «АВОК», 2012г.)
10. Instruction on the calculation of heat loss in rooms and thermal loads on the heating of residential and public buildings, 2012 (Руководство по расчету теплопотерь помещений и тепловых нагрузок на систему отопления жилых и общественных зданий, изд-во «АВОК», 2012г.)
11. New English- Russian , Russian -English dictionary of technical terms and phrases for Heating, Ventilation , Air-Conditioning , and Thermal Physics, 2011 (Новый англо-русский, русско-английский словарь технических терминов и словосочетаний по отоплению, вентиляции, кондиционированию воздуха, теплоснабжения и строительной теплофизике, изд-во «АВОК», 2011г.)
12. M.M. Brodach. Engineering equipment of high-rise buildings, 2011 (М.М. Бродач. Инженерное оборудование высотных зданий, изд-во «АВОК», 2011г.)
13. Technical guideline on the organization of ventilation in the apartments of residential buildings, 2011 (Технические рекомендации по организации воздухообмена в квартирах жилых зданий, изд-во «АВОК», 2011г.)
14. V.N. Posohin. Aerodynamics of ventilation, 2012 (В.Н. Посохин. Аэродинамика вентиляции, изд-во «АВОК», 2012г.)
15. V.M.Magadeev. Sources of heat supply system , 2013 (В. Магадеев. Источники систем теплоснабжения, изд-во «Энергия», 2013)
16. A.Salihov. Unvalued and unrecognized "small" energy, 2009. (А.Салихов. Неоцененная и непризнанная «малая» энергетика, изд-во «Новости теплоснабжения», 2009)

17. V.Sharapov, P. Rotov. Load regulation of heating systems, 2007 (В. Шарапов. П. Ротов. Регулирование нагрузки систем теплоснабжения, изд-во «Новости теплоснабжения», 2007)
18. V. Zelikov. Handbook of Heating , Ventilation and Air Conditioning . Heat and air balance of buildings, 2011 (В. Зеликов. Справочник инженера по отоплению, вентиляции и кондиционированию. Тепловой и воздушный баланс зданий, изд-во «Инфра-Инженерия», 2011)
19. V. Polushkin ,S. Anisimov etc. Ventilation, 2011 (В. Полушкин, С. Анисимов и др. Вентиляция, изд-во «Академия», 2011)
20. M. Trutnev In Polonsky. Energy-saving, 2005 (М. Трутнева, В Полонский. Энергосбережение, изд-во «АСВ», 2005)
21. A. Danilov , A Gareev etc. Energy savings in heat-power engineering and technology, 2011 (О. Данилов, А Гареев и др. Энергосбережение в теплоэнергетике и технологиях, изд-во: МЭИ, 2011)
22. Residential and public buildings. Standards of ventilation. 2011 (Здания жилые, общественные. Нормы воздухообмена, изд-во «АВОК»)
23. V.G. Karadzhi , J.G. Moskovko. Ventilation equipment . Technical guidelines for designers and installers, 2011 (В.Г. Караджи, Ю.Г. Московко. Вентиляционное оборудование. Технические рекомендации для проектировщиков и монтажников, изд-во «АВОК», 2011)
24. Mark E. Schaffer. Protection against noise and vibration in HVAC systems . A practical guide, 2012 (М. Шаффер. Защита от шума и вибраций в системах ОВК. Практическое руководство, изд-во «АВОК», 2012)
25. A.P. Borisoglebskaya. Prevention and treatment facilities . General requirements for the design of HVAC systems, 2012 (А.П. Борисоглебская. Лечебно-профилактические учреждения. Общие требования к проектированию систем ОВиК, изд-во «АВОК», 2012)
26. Donald Ross. Design of HVAC systems of high-rise mixed-use public buildings, 2011 (Д. Росс . Проектирование систем ОВК высотных общественных многофункциональных зданий, изд-во «АВОК», 2011)
27. A.M. Protasevich. Energy saving in heating, gas supply, ventilation, 2012 (А.М. Протасевич. Энергосбережение в системах теплогазоснабжения, вентиляции, изд-во «Инфра-М», 2012)
28. A. Eremkin , T.I.Koroleva etc. The economy of energy saving in heating, ventilation, 2008. (А.И. Еремкин, Т.И. Королева и др. Экономика энергосбережения в системах отопления, вентиляции, изд-во «АСВ», 2008)
29. V.D. Karminsky , V.I. Kolesnikov, etc. Ecological problems of energy saving, 2004 (В.Д. Карминский, В.И. Колесников и др. Экологические проблемы энергосбережения, изд-во «Маршрут», 2004)
30. Y.Sibikin. Energy saving technology, 2013 (Ю.Сибикин. Технология энергосбережения, изд-во «ИНФРА-М», 2013)
31. Heat and Mass Transfer: A Practical Approach Y. Cengel - McGraw-Hill, 2007
32. Thermodynamics: An Engineering Approach Yunus A. Cengel, Michael A. Boles - McGraw Hill Higher Education; 7th Revised edition edition 2010
33. Fundamentals of Engineering Thermodynamics Michael J. Moran, Howard N. Shapiro Publisher: Wiley; 5 edition, 2003
34. Entropy Generation Minimization: The Method of Thermodynamic Optimization of Finite-Size Systems and Finite-Time Processes Adrian Bejan - CRC Press; 1 edition, 1995
35. Thermal Design and Optimization Adrian Bejan, George Tsatsaronis, Michael Moran Publisher: Wiley-Interscience; 1 edition, 1995

36. Life cycle energy. Energy management and making optimal decisions / Edited Nina Ihiryaeva (Жизненный цикл энергии. Энергетический менеджмент и принятие оптимальных решений/ Под ред. Н. П. Ширяевой

Curriculum map for Master Study-Programme in Innovative Technologies for Energy Saving and Environmental Protection, «Green Master»

Module	A1	A2	A3	A4	A5	A6	A7	A8	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	C7	C8
Philosophical problems of science and technology		X													X	X	X	X	X	X	X	X
The methodology of scientific research	X	X						X				X	X		X		X	X	X		X	X
Special sections of mathematics														X	X	X		X		X		X
Mathematical modeling	X	X		X								X	X	X	X	X		X		X		X
Basics of pedagogy and androgogics															X	X	X	X	X	X	X	X
Business foreign language		X													X	X	X	X	X	X	X	X
Information technology in civil engineering		X		X								X	X	X	X	X		X		X		X
Methods for solving scientific and technical problems in construction	X	X		X						X		X	X	X	X	X		X		X		X
Scientific and practical problems of the economic sustainability of the construction industry	X		X						X	X					X		X	X	X		X	X
Stability and reliability of energy saving systems	X		X	X	X	X	X	X		X			X	X	X	X		X	X	X		
Stability and reliability of heat supply, ventilation and air-conditioning	X		X	X	X	X	X	X		X			X	X	X	X		X	X	X		
Fundamentals of energy conservation in the design and operation of building structures and buildings	X		X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X		
Modern methods of calculation heat supply systems, ventilation and air-conditioning	X		X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X		
Calculation and design of ventilation systems	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		
Calculation and design of heating systems	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		
Calculation and design of air conditioning systems	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		
Automation and control of energy-saving technological processes	X		X	X	X	X	X	X	X	X			X	X	X	X		X	X	X		
Practice and research			X	X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Preparation and defense of master's thesis									X	X	X	X	X	X	X	X	X	X	X	X	X	X

Programme outcomes:

	Knowledge and understanding		**B4**	Select and use appropriate methods and technologies to conserve heat and power, heat recovery, use of renewable energy *Осуществлять выбор и использовать соответствующие методы и технологии для экономии тепла и электроэнергии, рекуперации тепла, использования возобновляемых источников энергии*
A1	Basic physical laws and their application in the field of mechanics, hydraulics, heating, electricity related to professional activities *Основные физические законы и их применение в области механики, гидравлики, теплоснабжения, электроснабжения, связанные с профессиональной деятельность*		**B5**	Use appropriate information technology for professional and management purposes *Использовать соответствующие информационные технологии при профессиональной и управленческой деятельности*
A2	Contemporary issues of science and technology, forms and methods of scientific knowledge, the development of science and changing types of scientific rationality; *Современные проблемы науки и техники, формы и методы научного познания, направление развития науки и изменения типов научной рациональности*		**B6**	Be able carry out mathematical modeling of thermodynamic processes of heat and mass transfer *Уметь выполнять математическое моделирование термодинамических процессов тепло- и массообмена*
A3	Basic requirements to the design of heating, ventilation and air conditioning systems for industrial and civil facilities with regard to energy savings *Основные требования к проектированию систем теплоснабжения, вентиляции и кондиционирования промышленных и гражданских объектов с учетом энерго сбережения*			**Graduate skills**
A4	Modern information technologies and methods for their use in professional activities *Современные информационные технологии и способы их использования в профессиональной деятельности*		**C1**	Develop critical thinking and critically evaluate the results of the research *Развивать критическое мышление и способность критически оценивать результаты исследования*
A5	Requirements of environmental and industrial safety *Требования экологической и промышленной безопасности*		**C2**	Identify and use various learning sources in students' scientific occupations *Выявлять и использовать различные источники информации при проведении научных исследований*
A6	Technique techno-economic analysis and evaluation systems of heat, ventilation and air conditioning with regard to energy savings *Методики технико-экономического анализа и оценки систем теплогазоснабжения, вентиляции и кондиционирования с учетом энерго сбережения*		**C3**	Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written, and electronic modes of communication *Общаться и эффективно вести переговоры с различными заинтересованными сторонами по отдельности и в группе устно, письменно или с помощью электронных способов общения*
A7	Basic methods of evaluation of the technical state of the systems of heat, ventilation and air conditioning industrial and civil objects *Основные методы оценки технического состояния систем теплогазоснабжения, вентиляции и кондиционирования промышленных и гражданских объектов*		**C4**	Make informed professional decisions based on scientific knowledge and appropriate criteria *Принимать обоснованные профессиональные решения, основанные на научных знаниях и соответствующих критериях*

A8	Formulate physical and mathematical formulation of the research problem, choose and implement methods of conducting research, analyze and summarize the results of research, bring them to the practical implementation *Формулировать физическую и математическую постановку задачи исследования, выбрать и реализовать методы проведения исследований, анализировать и обобщать результаты исследований, доводить их до практической реализации*		**C5**	Work effectively individually or in groups to accomplish assigned tasks. *Эффективно работать как индивидуально, так и в группах с целью решения поставленных задач.*
	Practical skills		**C6**	Develop efficient time management skills *Равивать навыки эффективного управления временем*
B1	Be able to provide technical and managerial input into the planning of energy saving projects and facilities (in native language and in English) *Уметь оказывать техническую и управленческую поддержку при планировании энергосберегающих проектов и сооружений*		**C7**	Appreciate the social impact of research and practical work in the field of study *Оценивать социальные последствия исследований и практической работы в области своей деятельности*
B2	Be able to solve engineering problems through the application of theoretical concepts and practical knowledge in industrial setting *Умение решать инженерные задачи на основе применения теоретических концепций и практических знаний в промышленных условиях*		**C8**	Reflect and evaluate on own learning and evaluate peers in a professional manner *Отражать и профессионально оценивать уровень собственного обучение и его оценку коллегами*
B3	Conduct laboratory and field experiments, collect, analyse and interpret data *Умение проводить лабораторные и полевые исследования, осуществлять сбор, анализ и интерпретацию данных*			

Master-program developed:
Prof. A. V. Nekrasov,
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