D. Mendeleev University of Chemical Technology of Russia

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

Tempus

D. Mendeleyev University of Chemical Technology of Russia
2014

University	D. Mendeleyev University of Chemical Technology of Russia **Moscow, Russia**
Programme level	**Master level**
Status	**Joint International Programme**
Name of the course	**Innovative technologies for energy saving and environmental protection** **022000.68 (Russian education classification code)**
Field and classification code	**Ecology and nature management** **022000 (Russian education classification code)**
Qualification	**Master of Ecology and Nature Management**
Web-site	**http://www.muctr.ru/en/** **http://pur.muctr.ru_____ _____**
Faculty	**Institute of Chemistry and Problems of Sustainable Development**
Address	**Miusskaya sq. 9, Moscow, Russia**
Course length	**2 years**
Workload	**120 credits (in accordance with ECTS)**
Start date	**September 2014**
Professional recognition	**Stakeholders consulted for the design of the study-programme:** - **Union of Russian Chemists** - **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.**

Aims of the programme:

The program will provide the necessary learning outcomes to researchers and experts in the field of environmental protection and management, owning modern approaches to the description of physical and chemical processes in the environment, the development of the technologies that have a minimal impact on the environment, taking into account modern trends in energy efficiency, owning methods for the monitoring of the environment and of the socio-economic sphere in the interests of sustainable development.

The program will provide development and formation of professional knowledge in the field of the analysis of transformation of various kinds of energy in technological processes and skills in one of the most important interdisciplinary areas of a science and modern technologies - energy savings.

Program development will allow future Master of Ecology and Nature Management not only to define anthropogenic sources of the pollution and its' causes, but also to minimize the impact, on the basis of knowledge of technological processes and physical and chemical transformations of pollutants in the environment, taking into account the modern trends in sustainable development and in "green" chemistry.

Programme languages: Russian and English

Admission criteria:

- **Bachelor or Specialist degree** in a relevant branch of Science or Engineering, with specific reference (green chemistry, rational use of natural resources, industrial ecology); 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, small group workshops, problem solving classes, laboratory classes, internships, motilities, field practice, e-learning.

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

1. Tuning methodology
2. Dublin descriptors
3. ECTS

Programme structure

Compulsory subjects

General scientific cycle
Basic unit (7 credits (in accordance with ECTS)

- Philosophic problems of natural sciences
- Foreign language
- Computer technologies and statistical methods in ecology and environmental management

Obligatory disciplines (8, 5 credits (in accordance with ECTS))

- Chemical problems of the environment
- Modern technologies of energy saving and environmental protection
- Fundamentals of power and energy saving

Professional cycle

Basic unit (5 credits (in accordance with ECTS))

- Modern environmental problems and environmental management
- The international cooperation in the field of environmental protection
- Sustainable development

Obligatory disciplines (19 credits (in accordance with ECTS))

- Complex environmental monitoring
- Technologenic risks assessment and management
- Green energy
- Mathematical modeling to promote sustainable development
- Principles and methods of green chemistry

Elective subjects (16, 5 credits (in accordance with ECTS))

- Basic principles of systems dynamics
- Fundamentals of the ecology
- Life cycle of production and green standards
- Green economy
- Ecological rationing for green energy production
- The logistics of energy saving

Programme Outcomes

A. Knowledge and understanding	Teaching/learning methods
1. Gain knowledge of types of energy, energy generation peculiarities and transfer 2. Gain knowledge in energy production from traditional fossil and renewable resources 3. Gain knowledge in thermodynamics and energy saving. Understand interrelations between energy and ecology. Gain knowledge of energy saving systems and equipment. 4. Understand the dissipation of pollutants from fixed (conveyed and non-conveyed), mobile and diffuse sources. 5. Understand methods of system approach to analysis and synthesis of energy consumption processes 6. Consider methods of technical and economical analysis of energy consumption processes 7. Acquire knowledge of methods of numerical solution of model equations. Understand methods of optimal decisions search. Understanding mathematical modelling opportunities and the types of models. 8. Understand necessity of complex study of research objects. Management and processing of the acquired data, statistical analysis and their use in the assessment of the pollution degree, techniques for finding and determining the pollution sources	Lectures, seminars and laboratories, group projects, case study analysis, field trips, and students' presentations. Electronic resources will be used to enhance students' learning experiences. **Assessment method** Students' knowledge and understanding is assessed by a variety of methods such as examinations, tests, laboratory reports, case study analysis and student presentations

B. Practical skills	**Teaching/learning methods**
1. Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety 2. Use tools of power economy and industrial ecology diagnostics 3. Conduct energy and exergy balances of research objects 4. Choose criteria for solution assessment in ecological and power systems. Analyse potential energy saving opportunities 5. Organize creative teamwork for complex inspection of industrial processes. Develop work plans in energy saving 6. Assess environmental consequences of energy saving activities	Seminars and laboratories, doing group and small group projects, case study analysis, field trips, student presentations. Electronic resources will also be used to enhance student cognitive skills. **Assessment method** Examinations, tests, laboratory reports, case study analysis and presentations. A specific accent in the assessment is made on the ability of a student to critically classify, asses, debate, interpret and operate the data.

C. Graduate skills	Teaching/learning methods
1. Develop critical thinking and carry out research (in Russian language and in English). 2. Identify and use various learning sources in students' scientific occupations. 3. Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written and electronic modes of communication (in Russian language and in English). 4. Make informed professional decisions based on scientific knowledge and appropriate criteria. 5. Work effectively individually or in groups to accomplish assigned tasks. 6. Develop efficient time management skills. 7. Appreciate the social impact of research and practical work in the field of study 8. Reflect and evaluate on own learning and evaluate peers in a professional manner	Seminars and laboratories, doing group and mini group projects, case study analysis, field trips, student presentations. Electronic resources will also be used to enhance students' cognitive skills. **Assessment method** Examinations, tests, laboratory reports, case study analysis and presentations. A specific accent in the assessment is made on the ability of a student to critically classify, asses, debate, interpret and operate the data.

COMPULSORY SUBJECTS

General scientific cycle

Basic unit (7 credits (in accordance with ECTS))

Module 1 **Title**	**Philosophic problems of natural sciences**
Credits	2 ECTS credits,72 academic hours
Module leader **and assistant (if any)**	
Study terms	Year 1, semester 1

Aim of the module

The course introduces students to the current problems of natural sciences and energy saving in the modern society. In a systematic form a snapshot of the device and the main trends in the development of modern science is given. The course 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, highlights the history and significance of Bologna Process for the development of higher education.

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

Learning outcomes

Knowledge and understanding:

- forms and methods of scientific knowledge
- directions 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 the modern society
- understanding of 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
- application of them in daily life and professional work

Assessment method

- student presentations
- examinations

Module 2 **Title**	**English Language for Environmental Studies**
Credits	3 ECTS credits, 108 academic hours
Module leader **and assistant (if any)**	teacher of Foreign Languages Department
Study terms	Year 1, semester 1.

Aim of the module

This is an intensive programme for students for whom English is a second or additional language. This intensive programme can help students to build their English language skills for success in university, research or career and in environmental carrier in particular.

The course includes important environmental vocabulary and texts, topics, information about Bologna Process for higher education development

The program emphasizes highly effective academic communication skills by focusing on four skill areas – reading, writing, speaking and listening, as well as academic study skills. The teaching process comprises communicative activities, practical exercises, group work, presentations and assignments.

Lectures	36 hours
Laboratory works	XX hours
Individual work	72 hours

Learning outcomes

Skills and competences:

- demonstrate the confidence and listening/speaking skills necessary to participate successfully in spontaneous oral exchanges with native speakers of English in a variety of personal, professional, and/or academic settings;
- demonstrate reading comprehension of English texts intended for developmental (or higher level) English courses;
- respond appropriately to written or spoken English by writing paragraphs or short essays that communicate ideas clearly.

Graduate skills

- make professional presentations in English;
- communicate and negotiate effectively in English with different stakeholders;
- use language to think and reason, as well as to access, process and use information for learning.

Assessment method

- student presentations;
- examinations.

Module 3 **Title**	**Computer technologies and statistical methods in ecology and environmental management**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	
Study terms	Year 1, semester 2

Aim of the module

The main aim of the module is teaching the methodology of mathematical modelling. Students should get general knowledge and skills on mathematical formulation of energy production and environmental protections problems, deriving governing equations in differential or integral form, analytical analysis of the equations. Estimation of divergence of the mathematical modelling results from experimental measurements should be also described.

Lectures	18 hours
Laboratory works	18 hours
Individual work	36 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 or chemical 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

- student presentations
- examinations

Obligatory disciplines
(8, 5 credits (in accordance with ECTS))

Module 4 **Title**	**Chemical problems of the environment**
Credits	2,5 ECTS credits, 90 academic hours
Module leader **and assistant (if any)**	Prof. Kuznetsov V.A.
Study terms	Year 1, semester 1.

Aim of the module

The environment chemistry represents the integrated scientific discipline, which is based on fundamental laws and concepts of classical chemistry. The subject of studying are the processes of migration and transformation of chemical compounds of a natural and anthropogenic origin in the lithosphere, the atmosphere and the hydrosphere. The main method of the description of the phenomena is the method of system dynamics.

Lectures	27 hours
Laboratory works	16 hours
Individual work	47 hours

Learning outcomes

Knowledge and understanding:

- basic concepts of the discipline;
- mechanisms of physical and chemical processes in the atmosphere, the hydrosphere, and the lithosphere.

Practical skills

- to apply mathematical methods to calculation of power and radiation dose;
- to solve standard problems of the main sections of the course;
- to possess skills of forecasting possible ways of migration and transformation of chemical compounds in the environment and of the assessment of their impact on a biota;

Graduate (or Transferable) skills

- team work skills during the preparation of course case studies;
- public speaking skills developed during the presentation of course case studies;
- realization of individual research.

Assessment method

- student presentations;
- examination/s

Module 5 **Title**	**Fundamentals of power and energy saving**
Credits	3 ECTS credits, 108 academic hours
Module leader **and assistant (if any)**	Associate Professor Zanin A.A.
Study terms	Year 1, semester1.

Aim of the module

This module depicts objective demands of the countries in different energy sources. Master students acquire knowledge of the global problems of energy generation, transportation and use in different spheres of human activity; realize the necessity of "green technologies" application to increase energy efficiency of natural and industrial systems.

The present module shows specificity of energy consumption in chemical industry. Set-theoretical formalization is given. Master students face the problems of sustainable energy and environment management. They gain the knowledge of a single scientific approach to solve the problems of the study programme.

Lectures	27 hours
Laboratory works	18 hours
Individual work	63 hours

Learning outcomes

Knowledge and understanding:

- understand features of environmental and industrial objects interrelation;
- acquire knowledge of quality indicators of natural and industrial systems;
- acquire knowledge of the global problems of energy generation, transportation and use in different spheres of human activity;
- understand interconnection of chemical reactor and ecological reactor theories;
- consider opportunities of mathematical analysis for energy and resource saving problems.

Practical skills

- develop structural schemes for natural and industrial subsystems interaction;
- formalize energy saving and environment safety problems;
- define energy consumption standards;
- use technical means to control environment safety and power losses;
- conduct reports.

Graduate (or Transferable) skills

- define research objectives;
- consult in research groups;
- develop the plan of a defined problems solution;
- analyse the references.

Assessment method

- student presentations;
- examinations.

Module 6 **Title**	**Modern technologies of energy saving and environmental protection**
Credits	3 ECTS credits,108 academic hours
Module leader **and assistant (if any)**	Prof. Zaitsev V.A.
Study terms	Year 1, semester 2.

Aim of the module

Master students have to gain theoretical knowledge and practical skills in the field of waste-free, or pure, productions as the bases for power - and resource-saving and rational use of natural resources. The course is focused on the formation of the idea that the whole range of the modern technologies should provide waste-free, or pure, production, and also on the obtaining practical skills of the application of the key technologies. As a result of development of a material of a course, the graduate has to gain competence in environmental protection by rational and complex use of raw materials and energy resources in a cycle: primary raw material resources - production - consumption - secondary raw material resources,- and finally the development of the technogenic circulation of substances (by the analogy to its biogeochemical circulation in natural ecological systems). Special importance of such an approach was emphasized by the academician V. I. Vernadsky who was pointing out that the transition "to the new evolutionary state -the noosphere- is possible only with the preservation of cycles of matter and energy, existing in the biosphere".

Lectures	27 hours
Laboratory works	18 hours
Individual work	63 hours

Learning outcomes

Knowledge and understanding:

- the knowledge in the field of industrial ecology which considers interrelation and interdependence of materials' flow (industrial production, in particular), humans and other living species and the environment of their habitats;
- the understanding of ecologic-economic systems;
- the skills of systems analysis, while taking into account the variety of technological, economic, biological, social and other relationships between the individuals, the objects of economic activity and environment.

Practical skills

- to be able to find the technical solution, allowing to neutralize the negative impact of wastes regardless of their structure and quantity;
- to be able to organize the closed production cycles.

Graduate (or Transferable) skills

- team work skills during the preparation of course case studies;
- public speaking skills developed during the presentation of course case study;
- realization of individual research.

Assessment method

- case study analysis;
- tests.

Professional cycle
Basic unit (5 credits (in accordance with ECTS))

Module 8 title	T**he international cooperation in the field of environmental protection**
Credits	1 credit, 36 academic hours
Module leader and assistant (if any)	
Study terms	1st year, 2rd semester

Aim of the module

The aim of this module is to provide formation of professional competences and skills of future master in the field of environmental protection and the international cooperation in energy saving.

Lectures	18 hours
Laboratory works	-
Individual work	18 hours

Knowledge and understanding:

- understanding methods and systems of the international cooperation in the field of environmental protection and energy consumption processes in different countries;
- understanding the specific systems of energy production from traditional fossil and renewable resources in differed regions and countries.

Practical skills

- selection of country- and region-sensitive criteria for the assessment of ecological and power systems. Analysis of the potential energy saving opportunities.
- organization of creative teamwork for complex inspection of industrial processes for multinational companies.
- development of the work plans in energy saving

Graduate (or Transferable) skills

- team work skills during the preparation of course case studies;
- public speaking skills developed during the presentation of course case study;
- realization of individual research.

Assessment method

- case study analysis;
- tests.

Module 9 title	**Sustainable development**
Credits	2 credits, 72 academic hours
Module leader and assistant (if any)	
Study terms	1st year, 2rd semester

Aim of the module

Students receive knowledge about processes underlying the sustainability of life support systems of the Earth, of the history of the concept of sustainable development. Indices and indicators of sustainable development are introduced. The principles of the multi stakeholders' dialog are taught to be used.

Lectures	36 hours
Laboratory works	18 hours
Individual work	18 hours

Knowledge and understanding:

- main principal, indices and indicators of sustainable development;
- energy production from traditional fossil and renewable resources for sustainable development;
- understanding the methods of systems approach to the analysis of global problems, including the problem of energy production and consumption processes.

Practical skills

- choose criteria for the assessment of complex systems, including ecological and technogenic systems. Analyse potential energy saving opportunities for sustainable development;
- organize creative teamwork for complex inspection of social and industrial processes. develop work plans in energy saving for sustainable development

Graduate (or Transferable) skills

- team work skills during the preparation of course case studies;
- public speaking skills developed during the presentation of course case study;
- realization of individual research.

Assessment method

- case study analysis;
- tests.

Professional cycle

Obligatory disciplines (19 credits (in accordance with ECTS)

Module 10 **Title**	**Complex environmental monitoring**
Credits	4 ECTS credits, 144 academic hours
Module leader **and assistant (if any)**	Prof. Purtova E.E.
Study terms	1st year, 2nd semester; 2nd year, 1st semester
Aim of the module Master students receive idea of the physical and chemical processes causing stability of systems of maintenance of life on the Earth, of features of behavior of impurities of an anthropogenic origin in geospheres, about methods of minimization of negative impact of production of chemical and petrochemical complexes on environment	
Lectures	72 hours
Laboratory works	36 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- dissipation of pollutants from fixed (conveyed and non-conveyed), mobile and diffuse sources;
- uderstand methods of system approach to analysis and synthesis of energy consumption processes.

Practical skills:

- be able to inspect energy consumption systems to improve their energy efficiency and ecological safety;
- organize creative teamwork for complex inspection of industrial processes. Develop work plans in energy saving;
- assess environmental consequences of energy saving activities.

Graduate (or Transferable) skills:

- team work skills during the preparation of course case studies;
- public speaking skills developed during the presentation of course case study;
- realization of individual research.

Assessment method:

- students' presentations;
- examinations.

Module 11 **Title**	**Technological risks assessment and management**
Credits	3 ECTS credits, 108 academic hours
Module leader **and assistant (if any)**	Associate professor Dodonova A.A.
Study terms	Year 2, semester 3

Aim of the module

The purpose of the course is to teach students to apply methods of assessment of anthropogenic impact on the state of environment.

The problem of studying of the course is reduced to deepening of the gained knowledge in the field of chemical toxicology and to acquisition of skills of the analysis of the situations connected with risk. The purposes and problems of a course are reached with the help:

- acquaintance with the basic concepts of dangers and risks of chemical productions;
- acquaintance with chemical influence, with influence of electromagnetic radiations of various energies, ionizing radiation on the humans and environment;
- discussions of features of a nuclear fuel cycle, problems of the fulfilled nuclear fuel and burial of radioactive waste;
- acquaintance with concepts of stochastic and not stochastic consequences of influence of radiations on the person and environment;
- studying of techniques of an assessment of ecologic-economic efficiency of nature protection actions and rationing of load on the biosphere.

Lectures	36 hours
Laboratory works	18 hours
Individual work	54 hours

Learning outcomes

Knowledge and understanding:

- technological risks energy generation peculiarities and transfer energy;
- assessment and management energy production from traditional fossil and renewable resources.

Practical skills:

- be able to inspect technological risks energy consumption systems to improve their energy efficiency and ecological safety;
- choose criteria for assessment and management of energy production in ecological and power systems.

Graduate (or Transferable) skills:

- team work skills during the preparation of course case studies;
- public speaking skills developed during the presentation of course case study;
- realization of individual research.

Assessment method:

- students' presentations
- examinations.

Module 12 Title	**Green Energy**
Credits	4 ECTS credits, 144 academic hours
Module leader and assistant (if any)	Associate Professor Zanin A.A.
Study terms	Year 2, semester 3.

Aim of the module

This module to provide formation of professional competences in interdisciplinary areas of science and modern technologies – energy saving,- taking into account current trends in sustainable environmental management with application of the principles of "green" chemistry.

Master students acquire knowledge of the global problems of energy generation and objective demands of the countries in different energy sources.

Master students face the problems of sustainable energy and environmental management.

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Lectures	27 hours
Laboratory works	18 hours
Individual work	63 hours

Learning outcomes

Knowledge and understanding:

D. Knowledge and understanding:

- gain knowledge of types of green energy generation from traditional fossil and renewable resources;
- thermodynamics and energy saving. Understand interrelations of energy and ecology. Gain knowledge of energy saving systems and equipment;
- understand methods of system approach to analysis and synthesis of energy consumption processes.

Practical skills:

- conduct energy and exergy balances of research objects;
- be able to inspect energy consumption systems to improve their energy efficiency and ecological safety;
- choose criteria for solution assessment in green energy production.

Graduate (or Transferable) skills:

- define research objectives;
- consult in research groups;
- develop the plan in defined problems solution;
- analyse the references.

Assessment method

- students' presentations;
- examinations.

Module 13 **Title**	**Mathematical modeling to promote sustainable development**
Credits	4 ECTS credits, 144 academic hours
Module leader **and assistant (if any)**	Prof. Malkovsky V. I. Associate Professor Oganesiyn E.S.
Study terms	1Year, semester 2. Year 2, semester 1

Aim of the module:

Formation of ideas of modern methods of mathematical modeling and numerical data processing, their areas of use, opportunities and restrictions, and also of mastering skills of their application for the solution of applied tasks for sustainable development.

Lectures	72 hours
Laboratory works	36 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- Studying of the approaches applied in mathematical and computer modeling, types and options of classification of models;
- studying (on examples) the basic models used in biology, ecology, economy, a demography and other areas, numerical criteria and information processing methods at construction and use of models for a sustainable development;
- studying of a structure and features of application of difficult ekologo-economic models on the example of global development of the last decades; use of models for a sustainable development;
- studying of basic tools of mathematical modeling and creation of computer models;
- performance of practical tasks by calculation of numerical indicators and indicators of a sustainable development, construction and debugging of own models.

Practical skills

- Assess environmental consequences of energy saving activities
- Development of use of computing tools for the analysis of available data, information processing, creation of mathematical models for the purpose of their subsequent application for the solution of applied tasks

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- case study analysis
- tests
- examinations

Module 14 Title	**Principles and methods of green chemistry**
Credits	4 ECTS credits, 144 academic hours
Module leader and assistant (if any)	Member of RAS prof. Tarasova N.P. Associate Professor Zanin A.A.
Study terms	Year1, semester 2. Year 2, semester3

Aim of the module

To study processes in the environment, proceeding under the influence of natural and anthropogenous factors, methods of creation of the technologies making the minimum impact on environment, methods of complex researches of a condition of environment

To master the principles and chemistry methods, including use of "green" solvents instead of organic, carrying out reactions in lack of solvent. The undergraduate will acquire the new directions of designing of the "green" processes, numbers of stages of the most chemical process including reduction and cleaning and allocation stages, replacement of reactions with participation of heavy metals on safer.

[not more than 500 characters including spaces].

Lectures	72 hours
Laboratory works	36 hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- the basic principles of "green" chemistry and to be able to apply them in practical activities,
- to own theoretical bases of modern methods of the analysis of natural objects,
- to know features of modeling of physical and chemical processes in environment,
- to be able to analyze interrelation of natural and socioeconomic processes on the basis of computer models,
- to be able to choose the operating influences which aren't reducing size of buffer capacity of the biosphere.

Practical skills

- Use tools of power economy and industrial ecology diagnostics
- Choose criteria for solution assessment in ecological and power systems. Analyse potential energy saving opportunities
- Organize creative teamwork for complex inspection of industrial processes. Develop work plans in energy saving

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- student presentations
- examinations

Module 15 **Title**	**Approved practical research experience**
Credits	60 ECTS credits, 2160 academic hours
Module leader **and assistant (if any)**	Member of RAS prof. Tarasova N.P. Prof. Purtova E.E. Prof. Zaitsev V.A. Prof. Kuznetsov V.A. Associate Professor Oganesiyn E.S. Associate Professor Zanin A.A.
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 organizations / 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 organizations. 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 organization 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.	

Module 16 **Title**	**Master thesis**
Credits	4 ECTS credits,144 academic hours
Module leader **and assistant (if any)**	Member of RAS prof. Tarasova N.P. Prof. Purtova E.E. Prof. Zaitsev V.A. Prof. Kuznetsov V.A. Associate Professor Oganesiyn E.S. Associate Professor Zanin A.A.
Study terms	Year 2, semester 2.
Aim of the module Application of theoretical knowledge and the practical skills received during development this program, for performance of final research work and dissertation preparation	
Learning outcomes Preparation of the Master's thesis and final State examination. Valuable practical results of the Master thesis and their application for the regional economy and the socioeconomic environment.	

ELECTIVE SUBJECTS

16,5 credits (in accordance with ECTS

Module 1E **Title**	**Basic principles of system dynamics**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Member of RAS prof Tarasova N.P. Associate Professor Oganesiyn E.S.
Study terms	Year 1, semester 2.

Aim of the module

Master students receive idea of the physical and chemical processes causing stability of systems of maintenance of life on Earth.

Methods of complex researches of a condition of environment and dynamics of the social and economic sphere in interests of a sustainable development.

Lectures	18 hours
Laboratory works	18 hours -
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- understand methods of system approach to analysis and synthesis of energy production and consumption processes as the system
- consider methods of technical and economical analysis of energy consumption processes
- understanding mathematical modelling opportunities. Types of models
- understand necessity of complex study of research objects.

Practical skills

- be able to inspect energy consumption systems to improve their energy efficiency and ecological safety as the system
- choose criteria for solution assessment in ecological and power systems. Analyse potential energy saving opportunities
- assess environmental consequences of energy saving activities

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- case study analysis
- tests

Module 2E **Title**	**Fundamentals of the ecology**
Credits	2,5 ECTS credits, 90 academic hours
Module leader **and assistant (if any)**	Prof. Zigarev I.A.
Study terms	Year 1, semester 1.

Aim of the module

The discipline forms knowledge in the basic directions of the modern
Fundamental ecology; provides guidance on leading scientific concepts
And concepts, about interrelation and interconditionality of the phenomena in biosphere, about Laws of interaction of live organisms with ecological factors, including the anthropogenous.
The module is directed on the preparation and training of chemists of a different profile and experts in the field of environmental management

Lectures	54 hours
Laboratory works	XX hours
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- system is natural-scientific representations about ecological laws of existence of individuals, populations and communities live organism, modern problems of anthropogenous dynamics of ecosystems
- gain knowledge of types of energy, energy generation peculiarities and transfer energy in ecosystems
- understand necessity of complex study of research objects ecosystems

Practical skills

- ability to apply theoretical knowledge for the decision of nature protection problems
- to apply the received theoretical knowledge in practice of ecological researches.
- to own methods of processing and synthesis of the field and laboratory ecological information.
- be able to inspect efficiency and ecological safety ecosystems

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- case study analysis
- tests

Module 3E **Title**	**Life cycle of production and green standards**
Credits	4 ECTS credits, 144 academic hours
Module leader **and assistant (if any)**	Associate Professor Makarova A.S.
Study terms	Year 2, semester 3.

Aim of the module

Master students taking into account current trends in steady environmental management with application of the principles of "green" chemistry.

The module is directed on the preparation and training of chemists of methods of creation of the technologies making the minimum impact on environment taking into account current trends in energy saving, methods of complex researches of a condition of environment and dynamics of the social and economic sphere in interests of a sustainable development.

Lectures	36 hours
Laboratory works	36 hours -
Individual work	72 hours

Learning outcomes

Knowledge and understanding:

- dissipation of pollutants from fixed (conveyed and non-conveyed), mobile and diffuse sources.
- understand methods of system approach to analysis life cycle production according green standards
- understand methods of optimal decisions search.
- understand necessity of complex study of research objects.

Practical skills

- be able to inspect life cycle production according green standards
- assess environmental consequences life cycle

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- student presentations
- examinations

Module 4E **Title**	**Green economy**
Credits	2 ECTS credits, 72 academic hours
Module leader **and assistant (if any)**	Associate Professor Kruchina E.B.
Study terms	Year 2, semester 3.

Aim of the module

The program is directed on the preparation and training of chemists of a different profile and experts in the field of environmental management to modern approaches to the description of green economy

Lectures	36 hours
Laboratory works	36 hours -
Individual work	72 hours

Learning outcomes

Knowledge and understanding:

- Consider methods of technical and economical analysis of energy consumption processes
- understand methods of system approach to economy for sustainable development
- understand methods of optimal economy decisions search.

Practical skills

- use tools green economy for sustainable development
- make analyse potential energy saving opportunities
- organize creative teamwork for green economy inspection of industrial processes.

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- case study analysis
- tests

Module 5E **Title**	**Ecological rationing for green energy production**
Credits	4 ECTS credits, 144 academic hours
Module leader **and assistant (if any)**	Professor Leykin U.A.
Study terms	Year 2, semester 3.

Aim of the module

the module has to provide formation of professional competences and skills of future master in one of the most important interdisciplinary areas as ecological rationing for green energy production

Lectures	36 hours
Laboratory works	36 hours -
Individual work	72 hours

Learning outcomes

Knowledge and understanding:

- understand methods of system approach to analysis and synthesis of ecological rationing for green energy production
- understand methods of optimal ecological rationing for green energy production decisions search.

Practical skills

- be able to inspect ecological rationing for green energy
- use tools of power economy and industrial ecology diagnostics for ecological rationing for green energy

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- case study analysis
- tests

Module 6E **Title**	**The logistics of energy saving**
Credits	72 ECTS credits, 2 academic hours
Module leader **and assistant (if any)**	Member of RAS prof. Meshslkin V.P.
Study terms	Year 2, semester 3.

Aim of the module

Studying of ways of minimization of a waste and losses in chains of deliveries, optimization of logistical expenses: the organization of logistical processes of return of a waste and used production for processing in a direct chain of deliveries

The module is directed on the preparation and training of chemists of a different profile and experts in the field of environmental management to optimization of physical and chemical processes in the environment, proceeding under the influence of natural and anthropogenous factors.

Lectures	36 hours
Laboratory works	-
Individual work	36 hours

Learning outcomes

Knowledge and understanding:

- Management methods logistical streams at the enterprise, synchronisation and optimisation of process of manufacture and logistical operations in the interconnected divisions with use of methods energy saving.
- Base questions of logistics energy saving

Practical skills

- methods of an estimation of reserves of economy at the enterprises from optimisation of movement and use of a material stream, other kinds of streams
- optimisation of material streams, estimations of quality of movement and use of the limited resources of the enterprise with use of principles of logistics for energy saving.

Graduate (or Transferable) skills

- Team work skills during the preparation of course case studies;
- Public speaking skills developed during the presentation of course case study;
- Realization of individual researches

Assessment method

- case study analysis
- 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.В.А Зайцев. Промышленная экология: учебное пособие, - М.: БИНОМ. Лаборатория знаний, 2012. - 382 г

2.Н.П. Тарасова, В.А. Кузнецов. Химия окружающей среды. Атмосфера . ИКЦ "/Академкнига/2007

3.Г.А. Ягодин, Е.Е. Пуртова. Устойчивое развитие. Человек и биосфера. , - М.: БИНОМ. Лаборатория знаний, 2013 -110 с.

4.Innovations in Green Chemistry and Green Engineering. Selected Entries from the Encyclopedia of Sustainability Science and Technology Anastas, Paul T.; Zimmerman, Julie B. (Eds.) 2013, V,

5.Гигиенические нормативы. Химические факторы окружающей среды. Санкт-Петербург, НПО «Профессионал».

6.Green Energy: Technology, Economics and Policy // U. Aswathanarayana , Tulsidas Harikrishnan, Thayyib S. Kadher-Mohien //

7.Green Chemistry: Theory and Practice // Paul T. Anastas, John C. Warner// 2000

8.Green Building: Principles and Practices in Residential Construction (Go Green with Renewable Energy Resources) // Abe Kruger, Carl Seville //2012

9.Renewable Energy for Unleashing Sustainable Development (Green Energy and Technology) // Emanuela Colombo, Stefano Bologna, Diego Masera //2013

10.Energy: Production, Conversion, Storage, Conservation, and Coupling (Green Energy and Technology) // Yasar Demirel //2012

11.Sustainability in the Chemical Industry (Green Energy and Technology) // Eric Johnson// 2012

12.Green Technology: An A-to-Z Guide (The SAGE Reference Series on Green Society: Toward a Sustainable Future-Series Editor: Paul Robbins) //Dustin R. Mulvaney// 2011

13.Life Cycle Assessment of Renewable Energy Sources (Green Energy and Technology) //Anoop Singh, Deepak Pant, Stig Irving Olsen// 2013

14.Environmental Chemistry // Colin Baird, Michael Cann //2012

15.Green Chemistry for Environmental Sustainability //Sanjay K. Sharma, Ackmez Mudhoo //2010

16.Unintended Consequences of Renewable Energy: Problems to be Solved (Green Energy and Technology) // Otto Andersen // 2013

17.Согласованная на глобальном уровне система классификации и маркировки химических веществ (СГС). Организация Объединенных Наций.

18.American National Standard. NSF/GCI/ANSI 355-2011 «Greener chemicals and processes information»

19.Recommendations on the Transport of Dangerous Goods, Model Regulations Организация Объединенных Наций. ISBN 978-92-1-139146-6.

20.Серия «Вредные вещества в окружающей среде». Под редакцией Филова. Санкт-Петербург, НПО «Профессионал».

- Кислородосодержащие органические соединения. Часть I,
- Кислородосодержащие органические соединения. Часть II,
- Кислородосодержащие органические соединения. Часть III,
- Элементы I-IV групп Периодической системы и их неорганические соединения.
- Радиоактивные вещества
- Элементы V-VIII групп Периодической системы и их неорганические соединения.
- Элементорганические соединения веществ I-IV групп Периодической системы.
- Элементорганические соединения веществ V-VI групп Периодической системы (без соединения серы).
- Элементорганические соединения серы и веществ VI-VIII групп Периодической системы.
- Азотосодержащие органические соединения. Часть I.

- Азотосодержащие органические соединения. Часть II.

21. Y. Sibikin, M. Sibikin. Alternatives and Renewables energy sources, 2012. (Ю.Сибикин, М. Сибикин. Нетрадиционные и возобновляемые источники энергии, изд-во «КноРус», 2012г.)
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24. 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»)
25. Y.Sibikin. Energy saving technology, 2013 (Ю.Сибикин. Технология энергосбережения, изд-во «ИНФРА-М», 2013)
26. 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
Philosophic problems of natural sciences					X								X						X			X
Foreign language															X					X		
Computer technologies and statistical methods in ecology and environmental management				X		X	X					X							X			
Chemical problems of environment				X			X		X							X					X	
Modern technologies of energy saving and environmental protection	X	X	X						X	X					X			X				
Fundamentals of power and energy saving	X	X	X								X			X		X	X					

Module	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
Modern environmental problems and environmental management			**X**					**X**					**X**						**X**			
The international cooperation in the field of environmental protection					**X**									**X**	**X**							
Sustainable development				**X**				**X**						**X**		**X**						**X**
Complex environmental monitoring				**X**	**X**									**X**			**X**					
Technological risks assessment and management					**X**	**X**			**X**		**X**									**X**		
Green energy	**X**	**X**			**X**							**X**				**X**						
Mathematical modeling to promote sustainable development	**X**	**X**	**X**								**X**									**X**		

Module	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
Principles and methods of green chemistry				**X**			**X**					**X**									**X**	
Basic principles of system dynamics								**X**						**X**								**X**
Fundamentals of the ecology				**X**										**X**						**X**		
Life cycle of production and green standards					**X**			**X**						**X**							**X**	
Green economy						**X**				**X**										**X**		
Ecological rationing for green energy production				**X**	**X**								**X**					**X**				
The logistics of energy saving						**X**	**X**			**X**		**X**					**X**	**X**				

Programme outcomes:

	Knowledge and understanding
A1	Gain knowledge of types of energy, energy generation peculiarities and transfer energy generation peculiarities and transfer
A2	Energy production from traditional fossil and renewable resources
A3	Thermodynamics and energy saving. Understand interrelations of energy and ecology. Gain knowledge of energy saving systems and equipment
A4	Dissipation of pollutants from fixed (conveyed and non-conveyed), mobile and diffuse sources.
A5	Understand methods of system approach to analysis and synthesis of energy consumption processes
A6	Consider methods of technical and economical analysis of energy consumption processes
A7	Acquire knowledge of methods of numerical solution of model equations. Understand methods of optimal decisions search. Understanding mathematical modelling opportunities. Types of models

B4	Choose criteria for solution assessment in ecological and power systems. Analyse potential energy saving opportunities
B5	Organize creative teamwork for complex inspection of industrial processes. Develop work plans in energy saving
B6	Assess environmental consequences of energy saving activities
	Graduate skills
C1	Develop critical thinking and carry out research (e.g. present critically and compare their own views and those that differ from their own (in native language and in English)).
C2	Identify and use various learning sources in students' scientific occupations
C3	Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written, and electronic modes of communication (in native language and in English)
C4	Make informed professional decisions based on scientific knowledge and appropriate criteria

A8	Understand necessity of complex study of research objects. Management and processing of the acqured data, statistical analysis and their use in the assessment of the pollution degree, techniques for finding and determining the pollution sources
	Practical skills
B1	Be able to inspect energy consumption systems to improve their energy efficiency and ecological safety
B2	Use tools of power economy and industrial ecology diagnostics
B3	Conduct energy and exergy balances of research objects

C5	Work effectively individually or in groups to accomplish assigned tasks.
C6	Develop efficient time management skills
C7	Appreciate the social impact of research and practical work in the field of study
C8	Reflect and evaluate on own learning and evaluate peers in a professional manner

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