
# MASTER STUDY-PROGRAMME IN INNOVATIVE TECHNOLOGIES FOR ENERGY SAVING AND ENVIRONMENTAL CONTROL «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
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 Genoa, Italy


VLADIMIR STATE UNIVERSITY NAMED AFTER ALEXANDER AND NIKOLAY STOLETOVS
2014

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|---|---|
| University | **Vladimir State University named after Alexander And Nikolay Stoletovs, Vladimir, Russia** |
| Programme level | **Master level** |
| Status | **Joint International Programme** |
| Name of the course | **Innovative Technologies for Energy Saving and Environmental Control** |
| Field and classification code | **Energy and Resource Saving Processes in Chemical Engineering, Petrol Chemistry and Biotechnology (18.04.02)** |
| Qualification | **Master** |
| Web-site | http://fhe.vlsu.ru/index.php?option=com_content&view=article&id=187&Itemid=129 |
| Institute | **Department of Chemical Engineering** |
| Address | **87 Gorkiy St., Vladimir, 600000** |
| Course length | **2 years** |
| Workload | **120 credits (in accordance with ECTS)**<br>**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:**<br>- **BMT - Baromembrannaya Technologya Ltd in Vladimir (BMT)**<br>- **Research and Manufacturing Plant "Technofilter"**<br>- **Federal Service on Customers' Rights Protection & Human Well-Being in Vladimir**<br>- **Institute of Energy Saving of Sverdlovsk Oblast, Yekaterinburg**<br>- **Union of Constructors of Sverdlovsk Region, Yekaterinburg**<br>- **Tambov Regional Administration**<br>- **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 the 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 system 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) is considered to be 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 practical training week = 1.5 RCU

1 exam = 1 RCU

Final qualification work (project), (1 week = 1.5 RCU)

**Aims of the programme:**
The programme aims to:
1) provide master students with the opportunity to deepen their knowledge of innovative technologies for energy saving in chemical engineering and environmental protection;
2) provide students with the special knowledge and understanding of sustainable development concerning efficient use of energy resources;
3) provide students with the knowledge and skills needed to develop a career in the field of alternative and renewable energy sources as well as innovative membrane technologies;
4) develop student competence in physical and chemical research methodologies, in optimal solutions for chemical engineering processes;
5) develop student abilities to solve problems of energy saving in chemical engineering industry concerning polymer membrane application;
6) develop the analytical skills needed at an advanced level to manage, critically evaluate and assess development in the area of energy saving and efficient use of natural resources to improve competitiveness due to cost reduction;
7) develop students' ability to critically review the links between global problems and policies and local management actions;
8) adopt a broad analytical approach to sustainable management in energy saving and environmental control which integrates theory and practice in a holistic manner.

**Programme languages:** Russian and English

**Admission criteria:**
- **Bachelor or Specialist degree** in a relevant branch of Science or Engineering; 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, academic advising, practical work, creative workshops, problem solution classes, laboratory classes, internships, mobilities, industrial placement, 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 based upon those associated with the Bachelor's level and are at the forefront of the field studied;
- 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.

**Considering the above-mentioned guidelines, the study-programme will develop the following competences (or generic skills):**

- problem solving based on critical thinking and including 'question typing' i.e. 'how should I do this question?' and decision making based on scientific approach for sustainable development;
- strategic, management and engineering skills in energy and resource saving technologies necessary for employment in chemical engineering and environmental protection;
- understanding of the impact of innovative engineering solutions in the field of alternative and renewable energy sources, membrane technologies in terms of environment and society;
- teamwork, i.e. be able to communicate effectively and work in multidisciplinary teams aimed at making best decisions for chemical engineering processes;
- understanding of professional and ethical responsibility, ability to review the links between global problems and local policies;
- time management and ability to learn on his/her own and realize the necessity of life-long learning to keep up to an advanced level to manage, critically evaluate and assess development in the area of energy saving and efficient use of natural resources.

**Programme structure**

**Compulsory subjects**

- Green Technologies and Sustainable Development
- Basic Environmental Legislation and Audit
- Economics and Natural Management Forecast
- Energy Management and Making Best Decisions
- Modelling of Engineering and Natural Systems
- Optimization Approach and Methods of Energy and Recourse Saving Processes Management
- Current Methods of Environmental Objects Analysis
- English Language
- Approved Practical Research Experience

**Elective subjects**

- Current Membrane Technologies / *Water Engineering*
- Membrane Processes Application for Energy and Recourse Saving / *Monitoring and Water Quality Control*
- Recoverable Recourses. Application Problems / *Water and Waste Water Treatment.*

**Programme Outcomes**

| **A. Knowledge and understanding** | **Teaching/learning methods** |
|---|---|
| 1. Fundamental knowledge and understanding of innovative technologies in energy saving and environmental control.<br>2. Understanding of optimization approach and methods of energy and resource saving processes.<br>3. Understanding of energy saving as the basis of green technologies development<br>4. Knowledge of administrative authorities and legislation in the field of environmental protection<br>5. In-depth knowledge of energy saving technologies.<br>6. In-depth knowledge of innovative membrane technologies.<br>7. Knowledge of the appropriate theory, mathematical and analytical concepts and models for solving energy saving problems<br>8. Critical evaluation of current methods of energy production and use. | Students gain knowledge and understanding through lectures, seminars and laboratories attendance. Besides a variety of learning activities is conducted, such as: group projects, case study analysis, field trips, industrial placement and student presentations.<br>Electronic resources will be used to enhance student learning experiences.<br>Students will be directed to explore a wide range of various learning materials, such as books, journals, patents, as well as electronic sources and web links.<br><br>**Assessment methods**<br>Students' knowledge and understanding are assessed by a variety of methods such as tests, laboratory reports, case study analysis, student presentations and examinations. |
| **B. Practical skills** | **Teaching/learning methods** |
| 1 Ability to provide engineering and managerial input into planning of energy and resource saving projects and facilities (both in the Russian and English language).<br>2 Ability to solve engineering problems through the application of theoretical knowledge and practical skills in industrial environment.<br>3 Ability to carry out laboratory and field experiments, collect, analyse and interpret data.<br>4 Select and use appropriate methods and technologies for energy and resource saving.<br>5 Use appropriate Information Technology for engineering and management purposes (e.g. risk analysis)<br>6 Modelling of natural and industrial systems optimization. | Students acquire cognitive skills through participating in seminars and laboratories, doing group and mini group projects, making case study analysis, having field trips, preparing student presentations.<br>Electronic resources will also be used to enhance student cognitive skills.<br>**Assessment method**<br>Students' cognitive skills are assessed by a variety of methods such as examinations, tests, laboratory reports, case study analysis and presentations. A specific accent in the assessment is made on the ability of a student to classify, assess, discuss, interpret and manipulate. |

| C. Graduate skills | Teaching/learning methods |
|---|---|
| 1 Develop critical thinking and carry out research (e.g. compare their views and those that differ from their own both in Russian and English).<br>2 Identify and use various learning sources in learning activities<br>3 Communicate and negotiate effectively with different stakeholders individually and in-group using verbal, written, and electronic ways of communication (both in Russian and English).<br>4 Make professional decisions based on scientific knowledge and appropriate criteria.<br>5 Work effectively individually or in groups to accomplish assigned tasks.<br>6 Develop efficient time management skills.<br>7 Evaluate social impact of research and practical work in the field of study<br>8 Personal and peers' reflection and evaluation of learning outcomes. | Students acquire graduate skills through participation in seminars and laboratories, doing group and mini group projects, case study analysis, field trips, student presentations, completion of dissertation module, and specific modules attendance. Electronic resources will also be used to enhance student cognitive skills.<br><br>**Assessment method**<br><br>Students' graduation skills are assessed by dissertation module, laboratory reports, essays, group project and data analysis assessment. |

# COMPULSORY SUBJECTS

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| **Module 1**<br>**Title** | Green Technologies and Sustainable Development |
| **Credits** | 4 ECTS credits, 144 academic hours |
| **Module leader and assistant (if any)** | Professor Boris Kukhtin, PhD, Department of Chemistry |
| **Study terms** | Year I, semester I. |

**Aim of the module**

The main objective of the module is to form basis for understanding modern strategic concept of balanced development taking into account social interests, solving economic tasks, making environmental decisions and developing green technologies as urgent need for the mankind to survive and save environmental sustainability on the Earth

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| **Lectures** | 18 hours |
| **Laboratory works** | 18 hours |
| **Individual work** | 108 hours |

**Learning outcomes**

**Knowledge and understanding:**

- Gain knowledge of current state and dynamics of atmosphere, lithosphere, hydrosphere and biosphere of the Earth and factors, including anthropogenous, causing their changes
- Acquire knowledge and awareness of social, economic and ecological contradictions in mankind development means of their overcoming
- Get knowledge of objective preconditions, main mechanisms and key technologies of sustainable development
- Study managerial, economic and legal means of sustainable development support
- Acquire knowledge of main international decisions in the field of sustainable development including international conventions related to the sphere of social and ecological problems solution.
- Study international quality standards
- Gain knowledge and understanding of geographical basis for developing regional programs of sustainable development.
- Acquire knowledge of green technologies development.

**Practical skills**

- Carry out complex research of regional, national problems in the field of nature management
- Evaluate human being impact on the environment
- Develop and carry out monitoring in nature management
- Analyse social and economic factors of regional sustainable development
- Correlate supposed activities in nature management and recommendations of international conventions and other agreements ratified by the Russian Federation
- Develop green technologies to replace current ones taking into account main statements of the sustainable development concept

**Graduate (or Transferable) skills**

- Make decisions
- Team work
- Time management
- Carry out research and develop critical thinking

**Assessment methods**

Essays, presentations, exam

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|---|---|
| **Module 2**<br>**Title** | Basic Environmental Legislation and Audit |
| **Credits** | 3 ECTS credits, 108 academic hours |
| **Module leader**<br>**and assistant (if any)** | Professor Evgeniy Lisitsin |
| **Study terms** | Year I, semester II. |

**Aim of the module**

The objective of the module is to gain knowledge of environmental legislation and skills necessary for checking and evaluating activities of legal entities and private businesses in terms of efficient nature management and environmental protection including treatment and engineering equipment testing, fostering the requirements of the Russian legislation, identifying environmentally meaningful problems, developing recommendations for their solving.

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| **Lectures** | 18 hours |
| **Laboratory works** | |
| **Individual work** | 90 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge of environmental legislation basics
- acquire knowledge and develop understanding of the content and objectives of ecological audit

**Practical skills**

- Evaluate activities of legal entities and private businesses in terms of efficient nature management and environmental protection as well as their compliance with the requirements of the Russian legislation
- Determine the degradation level of the environment of the unit carrying out activities causing harmful impact on the environment
- Identify environment wasted, types and scale of contamination
- Find out necessity for additional ecologically important data of the object.

**Graduate (or Transferable) skills**

- Make considerate decisions resulted from ecological audit
- Summarize professional activities in reports, prepare conference minutes, etc.
- Effectively work in a team

**Assessment methods**

Pass/fail exam, presentations, data analysis

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|---|---|
| **Module 3**<br>**Title** | Economics and Natural Management Forecast |
| **Credits** | 2 ECTS credits, 72 academic hours |
| **Module leader**<br>**and assistant (if any)** | Professor Nina Selivanova, Department of Ecology |
| **Study terms** | Year I, semester II. |

**Aim of the module**

The module is aimed at studying ecological and economic problems arising at different stages of investing design, construction, functioning and liquidation of industrial enterprises; at economic, legal, regulatory and procedural, managerial, information, economical and mathematical aspects of these problems and means for their solving, The subject of the study includes current forecasting and planning methodology, methods of analysis of ecological and economic outcomes of nature management, functioning of different manufacturers, application of low waste technology, implementation of nature management.

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| **Lectures** | 18 hours |
| **Laboratory works** | 18 hours |
| **Individual work** | 36 hours |

**Learning outcomes**

**Knowledge and understanding:**

- Gain knowledge of economic methods and tasks for nature management
- Understand the role of natural conditions and resources in the development of society
- Understand interdisciplinary character of problems and economic mechanism in nature management
- Get knowledge of main points and economic basis of efficient nature management

**Practical skills**

- evaluate environmental conditions; forecast and evaluate negative consequences related to anthropogenic factor, classify and identify natural resources
- evaluate the level of natural resources management efficiency and environment pollution resulted from one's personal and corporate activities
- carry out environmental assessment of engineering processes and calculation of cost of environmental protection measures aimed at reduction or elimination of harmful impact of the enterprise on the environment

**Graduate (or Transferable) skills**

- make reports on professional activities at conferences and meetings, participate in discussions, etc.

**Assessment methods**

Pass/fail exam with grades, data analysis, test

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|---|---|
| **Module 4**<br>**Title** | Energy Management and Making Best Decisions |
| **Credits** | 3 ECTS credits, 108 academic hours |
| **Module leader**<br>**and assistant (if any)** | Professor Alexander Khristoforov, Department of Chemical Engineering |
| **Study terms** | Year I, semester III. |

**Aim of the module**

The aim of the module is to introduce energy management as a combination of managerial methods for enhancing energy efficiency of engineering processes. Emphasising managerial (organisational, administrative) impact on energy efficiency one should understand that it is the combination of different methods, both managerial and engineering, identified particularly to match the case, which can provide optimum result/ The module is aimed at studying main stages of enterprise energy management development as well as managerial methods of energy efficiency enhancement and energy consumption optimisation.

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| **Lectures** | 18 hours |
| **Laboratory works** | 18 hours |
| **Individual work** | 72 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge of administrative and organisational methods of impact on energy efficiency of technological processes
- understand necessity of complex impact of managerial and engineering measures on energy efficiency on technological process
- gain knowledge of main stages in forming energy management

**Practical skills**

- apply managerial and engineering methods to enhance energy efficiency of technological processes
- evaluate efficiency of methods aimed at energy efficiency of technological processes
- make optimal decisions in terms of energy consumption

**Graduate (or Transferable) skills**

- analyse research results and make new decisions
- make revision of professional activities in reports, minutes, etc.

**Assessment methods**

Laboratory reports, essays, tests, exam

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|---|---|
| **Module 5**<br>**Title** | Modelling of Engineering and Natural Systems |
| **Credits** | 5 ECTS credits, 180 academic hours |
| **Module leader**<br>**and assistant (if any)** | Associate Professor Valentina Zemskova, Department of Chemical Engineering |
| **Study terms** | Year I, semester I. |

**Aim of the module**

This module is aimed at getting skills in making mathematical models of particular technological and natural systems; application of main methods of experimental data processing, using advantages of IT in the process of solving technological tasks.

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| **Lectures** | 18 hours |
| **Laboratory works** | 18 hours |
| **Individual work** | 144 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge and understanding of principles of modelling technological and natural systems
- acquire knowledge of methods used to assess settings of mathematical models and identify their adequacy for real objects;
- get knowledge of artificial intellect theory (AI theory)

**Practical skills**

- apply methods and principles of modelling to develop energy saving and ecologically safe technological systems

**Graduate (or Transferable) skills**

- use applied software packs to solve energy saving tasks
- use methods of comparative analysis of applied software
- evaluate efficiency of applied software

**Assessment methods**

Laboratory reports, tests, exam

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| **Module 6**<br>**Title** | Optimization Approach and Methods of Energy and Recourse Saving Processes Management |
| **Credits** | 4 ECTS credits, 144 academic hours |
| **Module leader and assistant (if any)** | Associate Professor Valentina Zemskova, Department of Chemical Engineering |
| **Study terms** | Year I, semester II. |

**Aim of the module**

The module is aimed at providing students with knowledge of current optimization methods for the design of new technological processes and reconstruction of working enterprises; with IT skills for solving technological tasks

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| **Lectures** | 18 hours |
| **Laboratory works** | 36 hours |
| **Individual work** | 126 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge of one- and multicriteria optimization methods for energy saving processes

**Practical skills**

- apply methods and principles of optimization to design energy saving and ecologically safe technological systems

**Graduate (or Transferable) skills**

- use applied software packs to solve energy saving tasks
- use methods of comparative analysis of applied software
- evaluate efficiency of applied software

**Assessment methods**

Laboratory reports, presentations, term paper, exam

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|---|---|
| **Module 7**<br>**Title** | Current Methods of Environmental Objects Analysis |
| **Credits** | 5 ECTS credits, 180 academic hours |
| **Module leader**<br>**and assistant (if any)** | Associate Professor Valentina Alyoshina, Department of Chemical Engineering |
| **Study terms** | Year I, semester II. |

**Aim of the module**

The aim of the module is to provide students with knowledge of principles of current chemical and physical methods for analysis of environmental objects, to introduce natural science experiments based on chemical and physical methods of research related to the field of major

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| **Lectures** | 18 hours |
| **Laboratory works** | 36 hours |
| **Individual work** | 126 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge and understanding of chemical and physical phenomena making the basis of research methods;
- get knowledge and understanding of main methods for physical research of the environment;
- get acquaintance to particular examples of application of current physical methods of research in natural sciences.

**Practical skills**

- select and apply appropriate methods of analysis;
- be able to select and prepare samples of environmental objects;
- apply metrological basics of analysis;
- solve research and applied tasks requiring depth-in professional knowledge;
- use modern IT methods to prepare and collect research and methodological materials;
- get information through research, popular books and journals, the Internet and assess its scientific certainty;
- solve theoretical and practical tasks;
- process experimental data and make appropriate conclusions.

**Graduate (or Transferable) skills**

- apply decisions made on industrial equipment usage;
- understand social impact of the object;
- work in team;
- apply research results in practice.

**Assessment methods**

Laboratory reports, tests, summaries, exam

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|---|---|
| **Module 8**<br>**Title** | **English Language** |
| **Credits** | 4 ECTS credits, 144 academic hours |
| **Module leader**<br>**and assistant (if any)** | Associate professor Galina Zamaraeva,<br>Department of Foreign Languages for Professional Communication |
| **Study terms** | Year I, semester I. |

**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 at the university, in research or/and in career involving energy and resource saving technologies in particular.

The course includes important energy and resource saving, as well as membrane processes vocabulary and texts on Innovative Resource Saving Technologies in Chemical Engineering and Membrane Processes; Mathematical Modelling and Sustainable Development topics.

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.

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| **Lectures** | - |
| **Laboratory works** | 72 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 methods**

Pass/fail exam, presentations, tests, essays

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|---|---|
| **Module 9**<br>**Title** | **Approved practical research experience** |
| **Credits** | 54 ECTS credits, 1944 academic hours |
| **Module leader and assistant (if any)** | All the teaching staff involved in the programme implementing |
| **Study terms** | Year I, semester I, II. Year II, semester III. |
| **Aim of the module**<br>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.<br>**Learning outcomes**<br>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. | |
| **Assessment methods**<br>Data analysis, presentations, pass/fail exam | |

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| **Module 10**<br>**Title** | **Master thesis** |
| **Credits** | 6 ECTS credits, 216 academic hours |
| **Module leader and assistant (if any)** | Every teacher involved in the Programme implementing supervises several students |
| **Study terms** | Year II, semester IV. |
| **Aim of the module**<br>The aim of the final master thesis is to solve one of the following professional tasks:<br>- develop energy saving environmentally safe technologies based on research results, processing and analysis of research and engineering data;<br>- develop new engineering and technological decisions based on research results;<br>- make theoretical model of technological processes providing opportunity to forecast technological sets as well as se characteristics of equipment operating and properties of resulted substances, materials and products;<br>- develop algorithms and programmes, carry out applied research, process and analyze the results obtained, represent conclusions and recommendations;<br>- develop intellectual systems for research;<br>- solve tasks for optimization of technological processes and systems in terms of energy saving.<br>**Learning outcomes**<br>Preparation of the Master's thesis.<br>Valuable practical results of the Master thesis research and their application for the regional economy and the socioeconomic environment. | |
| **Assessment methods**<br>Master thesis defending | |

# ELECTIVE SUBJECTS

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| **Module 1E (1.1)**<br>**Title** | Current Membrane Technologies |
| **Credits** | 10 ECTS credits, 360 academic hours |
| **Module leader**<br>**and assistant (if any)** | Professor Yury Panov, Department of Chemical Engineering |
| **Study terms** | Year I, semester II. Year II, semester III. |

**Aim of the module**

The aim of the module is to provide students with fundamental knowledge of membrane science and application of membrane technologies for environmental protection and in energy saving processes. Topics of the module include types of membranes and membrane construction, main principles of membrane manufacturing, general theory of membrane transport, membrane separation process, membrane impurity. Membrane processes are to be studied in laboratories and industrial enterprises.

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| **Lectures** | 54 hours |
| **Laboratory works** | 72 hours |
| **Individual work** | 234 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge and understanding of main physical, chemical and physic-chemical membrane processes;
- gain knowledge of different types of membranes and membrane devices.

**Practical skills**

- apply membrane processes;
- carry out experimental research aimed at solving problems of energy saving and environmental protection.

**Graduate (or Transferable) skills**

- make decisions on application of membrane equipment;
- realise social impact of the subject studied;
- work in team;
- application of research results in practice.

**Assessment methods**

Laboratory reports, presentations, summaries, pass/fail exam

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|---|---|
| **Module 1E (1.2)**<br>**Title** | *Water Engineering* |
| **Credits** | 10 ECTS credits, 360 academic hours |
| **Module leader**<br>**and assistant (if any)** | Professor Irina Khristophorova, Department of Chemical Engineering |
| **Study terms** | Year I, semester II. Year II, semester III. |

**Aim of the module**

The aim of the module is to provide students with fundamental knowledge of hydraulic principles and concepts necessary for studying water and water treatment technologies. Topics of the module include liquid properties, manometry, hydrostatics and liquid flow principles. Pipe loss, pipe construction, flow parameters measurement and pipeline systems are among issues to be studied. Students study surface drainage and design of surface drainage system, transport phenomena in liquid and porous media, consecutive and parallel processes; limiting factors; principals of mass, fuel and energy balance and multiphase reactions.

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| **Lectures** | 54 hours |
| **Laboratory works** | 72 hours |
| **Individual work** | 234 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge and understanding of engineering processes relating to water management such as hydraulic calculating, heat-balance calculating;
- gain knowledge of terms and theories of water supply engineering;
- gain knowledge of hydraulic equipment of different types used in water supply systems;
- get understanding of main directions and potentials in water supply development.

**Practical skills**

- apply engineering processes relating to water management including hydraulic calculating, heat-balance calculating;
- carry out research in water supply engineering; collect, process and analyse data;
- apply information received, equations and formulae in water supply engineering.

**Graduate (or Transferable) skills**

- make decisions on the choice of standard equipment and measurement and control methods for main processing parameters;
- self-study;
- transfer knowledge;
- make reports on professional activities, prepare minutes at conferences, etc.;
- effective work in team.

**Assessment methods**

Laboratory reports, presentations, summaries, pass/fail exam

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|---|---|
| **Module 2E (2.1)**<br>**Title** | Membrane Processes Application for Energy and Recourse Saving |
| **Credits** | 11 ECTS credits, 396 academic hours |
| **Module leader**<br>**and assistant (if any)** | Professor Yury Panov, Department of Chemical Engineering |
| **Study terms** | Year I, semester II. Year II, semester III. |

**Aim of the module**

The module is aimed at providing students with practical knowledge and skills in the field of membrane application in energy saving processes of substance separation, controlled mass transport, in membrane reactors and various conversion systems. The topics of the module include fundamentals of one- and multistage membrane plants design; calculation of membrane plants; selection of operating modes; economic effectiveness of membrane systems; case studies on membrane application in different fields of economics. Membrane processes application is to be studied at industrial plants.

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|---|---|
| **Lectures** | 54 hours |
| **Laboratory works** | 72 hours |
| **Individual work** | 270 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge of fundamental processes in membrane plants;
- acquire knowledge of methods of calculation and design of one- and multistage membrane plants;
- get knowledge of methods of separation process quality control

**Practical skills**

- carry out calculations of one- and multistage membrane plants;
- choose operating modes of membrane plants;
- apply membrane technologies;
- apply appropriate equipment for energy saving processes.

**Graduate (or Transferable) skills**

- make decisions on membrane equipment use;
- realise social impact of the subject studied;
- work in team;
- apply research results in practice.

**Assessment methods**

Laboratory reports, project work, pass/fail exam, exam

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| **Module 2E (2.2)**<br>**Title** | *Monitoring and Water Quality Control* |
| **Credits** | 11 ECTS credits, 396 academic hours |
| **Module leader**<br>**and assistant (if any)** | Associate Professor Aleksey Tretyakov,<br>Department of Chemistry |
| **Study terms** | Year I, semester II. Year II, semester III. |

**Aim of the module**

The module is aimed at providing students with the knowledge of environmental protection and technologies for pollution control and water pollution monitoring in particular. Students study applied environmental chemistry, quantitative methods for air, water and water pollution measurement and analysis. Measurement principles, tools and specific-oriented analysis are emphasized. Laboratories in analytical chemistry are carried out.

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| **Lectures** | 54 hours |
| **Laboratory works** | 72 hours |
| **Individual work** | 270 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge of environmental chemistry;
- acquire knowledge of quantitative methods for air, water and waste water measurement and analysis ;
- get knowledge of principles, approaches, methods and equipment for water quality control;

**Practical skills**

- apply appropriate methods of analysis;
- carry out monitoring of water systems for industrial pollution;
- carry out analytical assessment of water quality;
- compare, evaluate and apply different monitoring systems structures;
- carry out tests and laboratory experiments.

**Graduate (or Transferable) skills**

- make decisions on application of appropriate methods and facilities;
- work in team;
- time management;
- carry out research and develop critical thinking.

**Assessment methods**

Laboratory reports, term paper, oral exam

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|---|---|
| **Module 3E (3.1)**<br>**Title** | Recoverable Recourses. Application Problems |
| **Credits** | 9 ECTS credits, 324 academic hours |
| **Module leader**<br>**and assistant (if any)** | Associate Professor Evgeniy Pikalov,<br>Department of Chemical Engineering |
| **Study terms** | Year II, semester III. |

**Aim of the module**

The module provides students with knowledge of recoverable resources including energy resources and principles of developing wasteless technologies and their prospective implementation.

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| **Lectures** | 36 hours |
| **Laboratory works** | 54 hours |
| **Individual work** | 234 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge and understanding of technological and economic problems of usage of recyclable material and energy resources;
- get knowledge of fundamentals of low-waste, waste free and energy saving technologies development.

**Practical skills**

- develop and implement technological processes involving complex utilisation of secondary resources

**Graduate (or Transferable) skills**

- realise social impact of the subject studied;
- work in team;
- apply research results in practice.

**Assessment methods**

Summaries, data analysis, exam

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|---|---|
| **Module 3E (3.2)**<br>**Title** | *Water and Waste Water Treatment* |
| **Credits** | 9 ECTS credits, 324 academic hours |
| **Module leader**<br>**and assistant (if any)** | Associate Professor Aleksey Tretyakov,<br>Department of Chemistry |
| **Study terms** | Year II, semester III. |

**Aim of the module**

The module provides students with knowledge of raw water treatment resulted in fresh water production. Students study qualitative characteristics of raw water, treatment methods, and systems for monitoring and running water treatment plants. The emphasis is on conventional technologies for water treatment. Special attention is paid to chemical coagulation and flocculation as means for suspended and colloidal particles removal. The topics studied include technology of raw water treatment, sedimentation, coagulation, flocculation, filtration and disinfection.

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|---|---|
| **Lectures** | 36 hours |
| **Laboratory works** | 54 hours |
| **Individual work** | 234 hours |

**Learning outcomes**

**Knowledge and understanding:**

- gain knowledge of current technologies and methods of wastewater collecting, treatment and sewage;
- acquire understanding of application of theory in designing commercial operating systems;
- gain knowledge of unit processes and design technologies for drainage systems and waste water treatment;
- acquire understanding of design and analysis methods for water supply system.

**Practical skills**

- improve effectiveness of water treatment due to advanced equipment operation;
- design and carry out laboratory tests;
- analyse and interpret test results;
- identify needed characteristics and technical characteristics and specification in advanced water treatment processes using appropriate methods and technologies;
- analyse and choose up-to-date methods to design water purifying facilities and water treatment plants.

**Graduate (or Transferable) skills**

- realise social impact of the subject studied;
- work in team;
- apply research results in practice;
- time management.

**Assessment methods**

Summaries, data analysis, exam

**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-assessment

**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 the Academic Council of Vladimir State University
- Ministry of Education and Science of Russian Federation official recognition (licensing)
- Evaluation by employers

**Employment opportunities**

Chemical industry, pharmaceutical industry, municipal and communal service, food industry, textile manufacturing, research and quality control processes; public administration related to environmental protection; institutions and enterprises applying energy saving and membrane technologies. Graduates can work as industrial consultants for environmental protection.

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


1. Baker, Richard W. Membrane Technology and Applications. 2nd edition. – John Wiley&Sons, Ltd. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, 2004. – 538 pp.
2. Ibbotson, Mark. Cambridge English for Engineering. Cambridge University Press, 2008. – 112 pp.
3. Алексеев Е.В. Основы технологии очистки сточных вод флотацией
4. Бойкова И.Г., Волшаник В.В. Эксплуатация, реконструкция и охрана водных объектов в городе.
5. Брянская Ю.В. Гидравлика водных и взвесенесущих потоков в жестких и деформируемых границах
6. Волшаник В.В. Классификация городских водных объектов
7. Воронов Ю.В. Водоотведение и очистка сточных вод
8. Григорьева Л.С. Физико-химическая оценка качества и водоподготовка природных вод
9. Журба М.Г. Водозаборно-очистные сооружения и устройства.
10. Журба М.Г. Том 1. Водоснабжение. Проектирование систем и сооружений. /М.: Ассоциация строительных университетов
11. Журба М.Г. Том 2. Водоснабжение. Проектирование систем и сооружений. /М.: Ассоциация строительных университетов
12. Журба М.Г. Том 3. Водоснабжение. Проектирование систем и сооружений. /М.: Ассоциация строительных университетов
13. Кичигин В.И. Водоотводящие системы промышленных предприятий
14. Кичигин В.И. Моделирование процессов очистки воды: учебник для вузов-М.: Ассоциация строительных
15. Колесников В.А. Анализ, проектирование технологий и оборудования для очистки сточных вод
16. М. Хенце, П. Армоэс, Й. Ля-Кур-Янсен, Э. Арван Очистка сточных вод: Биологические и химические процессы: Учебное издание для вузов (пер. с англ. Мосоловой Т.П.)/ Изд-во «Мир», 2004. ISBN 5-03-003430-7
17. М. Хенце, П. Армоэс, Й. Ля-Кур-Янсен, Э. Арван. Очистка сточных вод: Биологические и химические процессы
18. Молчанова Я.П. Гидрохимические показатели состояния окружающей среды
19. Первов А.Г. Современные высокоэффективные технологии очистки воды с применением мембран
20. Практикум по переводу с английского языка на русский» Учебное пособие. Издательство Флинта. Наука. Москва 2009.
21. Пугачев В.А. Процессы и аппараты обработки осадков сточных вод
22. Пугачев В.А. Технология эффективного водопользования в промышленности
23. Рябчиков, Б. Е. Современные методы подготовки воды для промышленного и бытового использования: питьевая вода; пищевая промышленность; энергетика /ДеЛи Принт, ISBN 5-94343-079-2
24. Сайриддинов С.Ш. Гидравлика систем водоснабжения и водоотведения
25. Сафроненко О.И., Макарова Ж.И, Малащенко М,В, Английский язык для аспирантов естественных факультетов университетов. М., Высшая Школа. – 2005.
26. Серпокрылов Н.С.Экология очистки сточных вод физ-хим методами
27. Соколов Л.И. Ресурсосберегающие технологии в системе водного хозяйства промышленных предприятий
28. Сомов М.А. Водоснабжение.Ч.1
29. Сомов М.А.Водоснабжение.Ч.2
30. Турин О.Г. Управление потенциально опасными технологиями

31. Туровский И.С. Осадки сточных вод. Обезвоживание и обеззараживание

## Recommended Literature

1. Biswas A.K. Water Resources: environmental planning, management and development. Mc. Graw Hill, 1996.-737 p.
2. Grigg N.S. Water resources management: principles, regulations and cases. Mc.Graw Hill, 1996.-540 p.
3. Бертокс П., Радд Д. Стратегия защиты окружающей среды от загрязнения. - М.: Мир, 1989.-606 с.
4. Брагинский Л.Н., Евилевич М.А., Бегачев В.И. и др. Моделирование аэрационных сооружений для очистки сточных вод.- Л.: Химия, 1980.-144 с.
5. Голубовская Э.К. Биологические основы очистки воды.- М.: Высшая школа, 1987.-268с.
6. Гордин И. Технологические системы водообработки.- Л.: Химия, 1987.-264 с.
7. Железняков Г.В, Неговская Т.А., Овчаров Е.Е. Гидрология, гидрометрия и регулирование стока. – М.: Колос,1984.-432 с.
8. Заиков Г.Е., Маслов С.А., Рубайло В.Л. Кислотные дожди и окружающая среда.- М.: Химия, 1991.-144 с.
9. Ковалева Н.Г., Ковалев В.Г. Биохимическая очистка сточных вод предприятий химической промышленности. - М.: Химия, 1987.-180 с.
10. Мур Дж. В. Тяжелые металлы в природных водах. - М.: Мир, 1987.-286 с.
11. Найденко В.В., Кулакова А.П., Шеренков И.А. Оптимизация процессов очистки природных и сточных вод. – М.: Стройиздат , 1984.-151 с.
12. Никифорова Л.О., Белопольский Л.М. Влияние тяжелых металлов на процессы биохимического окисления органических веществ. - М.: Бином, 2007.-78 с.
13. Пойта Л.Л., Новосельцев В.Г., Ковальчук В.Л., Головач Т.И. Городская очистная станция. Брест, 2004.-118 с.
14. Попов Е. Г. Гидрологические прогнозы. – Л.: Гидрометеоиздат, 1979. -256 с.
15. Попов Н.С., Козачек А.В., Шолтесз А. Экологический менеджмент и защита водосборного бассейна. Тамбов, «Юлис», 2007.-192 с.
16. Прогноз изменения гидрогеологических условий под влиянием водохозяйственных мероприятий. - М.: Недра, 1987.-205 с.
17. Прогноз качества подземных вод в связи с их охраной от загрязнения. - М.: Наука, 1978.-208 с.
18. Проскуряков В.А., Шмидт Л.И. Очистка сточных вод в химической промышленности. - Л.: Химия, 1977.-464 с.
19. Родзиллер И.Д. Прогноз количества воды водоемов- приемников сточных вод. –М.: Стройиздат , 1984.-263 с.
20. Смирнов Д.Н., Дмитриев А.С. Автоматизация процессов очистки сточных вод химической промышленности. - Л.: Химия, 1981.-198 с.
21. Страшкраба М.,. Гнаук А. Пресноводные экосистемы. Математическое моделирование. - М.: Мир, 1989.-373 с.
22. Трегубенко Н.С. Водоснабжение и водоотведение. Примеры расчетов. - М.: Высшая школа, 1989.-352 с.
23. Фрид Ж. Загрязнение подземных вод. Теория, методика, моделирование и практические приемы. – М.: Недра, 1981.-304 с.
24. Химия промышленных сточных вод. – М.: Химия, 1983.-360 с.
25. Чеботарев А.И. Гидрологический словарь. - Л.: Гидрометеоиздат, 1978. -308 с.
26. Чедгаев Р.Р. Гидравлические термины. - М.: Высшая школа, 1974.-104 с.
27. Эббот М.Б. Гидравлика открытого потока. - М.: Энергоатомиздат, 1983.-272 с.

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Green Technologies and Sustainable Development | X | X | X | | X | | | | | | | X | | | | | X | X | X | X | X | |
| Basic Environmental Legislation and Audit | | | X | X | | | | | | | | | | | | | X | | X | X | X | |
| Economics and Natural Management Forecast | X | | X | X | | | | X | | | | | | | | | X | X | X | X | | |
| Energy Management and Making Best Decisions | X | | X | X | | | | X | X | | X | | X | | X | X | X | X | X | X | X | |
| Modelling of Engineering and Natural Systems | | X | | | X | | X | | | X | | | | X | | | X | | X | X | | |
| Optimization Approach and Methods of Energy and Recourse Saving Processes Management | X | X | | | X | | X | | X | X | X | X | | | | X | X | X | X | X | | |
| Current Methods of Environmental Objects Analysis | | X | | | | | X | | | | X | | | | | | X | X | X | X | | |
| English Language | | | | | | | | | X | | | | X | | X | X | | X | X | X | | |
| Approved Practical Research Experience | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Current Membrane Technologies | X | | | | X | X | | | | | | | | | | | X | | X | X | X | |
| *Water Engineering* | X | | | | X | X | | | | | | | | | | | X | | X | X | X | |
| Membrane Processes Application for Energy and Recourse Saving | X | | | | X | X | | | X | X | | | | | | | X | X | X | X | X | |
| *Monitoring and Water Quality Control* | X | | | | X | X | | | X | X | | | | | | | X | X | X | X | X | |
| Recoverable Recourses. Application Problems. | X | | | | | | | X | X | X | | X | | | | | X | X | X | X | X | |
| *Water and Waste Water Treatment* | X | | | | | | | X | X | X | | X | | | | | X | X | X | X | X | |
| Master Thesis | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

**Programme outcomes:**

| | |
|---|---|
| | **Knowledge and understanding** |
| **A1** | Fundamental knowledge and understanding of innovative technologies in energy saving and environmental control. |
| **A2** | Understanding of optimization approach and methods of energy and resource saving processes. |
| **A3** | Understanding of energy saving as the basis of green technologies development |
| **A4** | Knowledge of administrative authorities and legislation in the field of environmental protection |
| **A5** | In-depth knowledge of energy saving technologies. |
| **A6** | In-depth knowledge of innovative membrane technologies. |
| **A7** | Knowledge of the appropriate theory, mathematical and analytical concepts and models for solving energy saving problems |
| **A8** | Critical evaluation of current methods of energy production and use. |
| | **Practical skills** |
| **B1** | Be able to provide technical and managerial input into planning of water projects and facilities (in native language and in English) |
| **B2** | Solve engineering problems through the application of theoretical concepts and practical knowledge in industrial setting |
| **B3** | Conduct laboratory and field experiments, collect, analyse and interpret data |
| **B4** | Select and use appropriate methods and technologies for water use, reuse, recycling and purification |
| **B5** | Use appropriate information technology for professional and management purposes (e/g/risk analysis |
| **B6** | Modelling a variety of natural and industrial water systems |
| | **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 |
| **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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