BROCHURE OF THE MASTER DEGREE PROGRAM “POWER PLANT ENGINEERING”

PREFACE

The Master Degree Programme in Power Plant Engineering includes a wide range of power engineering subjects aimed at theoretical and practical training. This M.Sc. programme covers 4 main study areas and includes modules in: energy technology; electric power engineering; civil engineering; economics and management.

The programme includes a Scientific and Research work, a pedagogic practice, excursions to the energy companies, and possibility for studying abroad within a semester in the partner universities and an individual Thesis which to be carried out during the final (fourth) semester.

The programme takes two years, corresponds to 120 ECTS credits and leads to the degree of Master of Science in Technology.

The programme is implemented with the participation of leading professors of Peter the Great St. Petersburg Polytechnic University and other leading Russian and foreign universities. All lectures and seminars are delivered in English.

Objective of the Master Degree Programme

The master degree programme has been developed to train highly qualified professionals to design, operate and maintain power plants.

Upon graduation the participants will become proficient in the field of modern energy sector. Our graduates of “Power Plant Engineering” Master Programme are highly-trained professional engineer capable of the analysis, evaluation and implementation of the state-of-the-art technical solutions aimed at improving the energy efficiency of power plants. Our graduates develop practical skills and professional competences in the design and operation of power plants, including construction, commissioning, start-up and management; and the capability to simulate and analyze the operation of power plants with the use of up-to-date sophisticated software.

STUDY ENVIRONMENT

Admission requirements: Candidates are required to hold a Bachelor's degree in Energy Technology, Mechanical Engineering, Power Engineering, Electrical Engineering or an equivalent degree according to the educational system of the country they represent, all applicants should demonstrate English language proficiency at B+ level.

Admission tests: Written test and interview in English language with programme coordinator (option - via Skype).

Admission procedure: Written on-line application. Application deadline – June, 30.
International applicants may find additional information concerning admission at the official web-site of SPbPU.

Semester and date begin: Winter semester – September, 1.

Key advantages

1. The programme provides our students with:
    - extensive interaction between lecturers and students during scientific and research work;

- the profound knowledge and wide network of international contacts for further careers in top positions in energy companies;
- tours to industrial facilities.

2. The programme gives foreign students the opportunity to study in international and multinational academic environment, be involved in extracurricular activities at the University;
3. Unique opportunities for international academic mobility. One semester abroad in one of the partner universities.

Length of the programme and format
2 years, classes are held 3-4 times a week

Training methods
Lectures and seminars, case studies, practical studies connected with the subject of lectures, an applied research project.

For further information please contact:

Programme coordinator
Alena Aleshina,
Telephone.: +7 999 208 31 63
E-mail: Alena.Aleshina@spbstu.ru

VISITING LECTURERS

 **Esa Vakkilainen** **Prof., D.Sc. (Tech.)**	**Home university:** Lappeenranta University of Technology, Finland **Research Interests:** "I am interested in thermal processes involving biomass, torrefaction, pyrolysis, gasification and combustion. I was responsible for developing a new generation of dimensioning programs for steam generator thermal design. I work on fluidized bed and recovery boilers. In addition to thermal design of CFB, I am involved with fouling and corrosion of biomass boilers such as Kraft recovery. Other main interests have been delivery, air distribution and combustion. I have been involved with majority of recent worldwide purchases of biomass boilers for pulp and paper industry. Especially their environmental performance and emissions are of better focus. I have lectured on boilers in technical conferences at all major continents and am interested in publishing also for educational purposes" **Courses at SPbPU:** Bioenergy Technology Solutions; Waste Heat Recovery Techniques; Thermal Power Plants; Steam Boilers; Energy Systems Engineering
 **Jari Backman** **Prof., D.Sc. (Tech.)**	**Home university:** Lappeenranta University of Technology, Finland **Research Interests:** "My main research area is high-speed technology, where new innovations, inventions and applications are researched in the areas of combined heat and power production, compressed air production, refrigeration compression and various pumping applications. The goal of the research is to increase the efficiency of small size turbomachinery with oil-free applications that are also kind to the environment. The main research subjects in CHP are Organic Rankine Cycle, micro turbines, steam turbines, turbo chargers in reciprocating engines and fuel cell gas turbines. The research involves process calculation, turbomachinery design (compressors, turbines), cooling design and rotor dynamics. The research is done with various process modelling, flow design and CFD tools using in-house, open foam and commercial codes. More than 30 prototypes have been done in 30 years, so the research involves also deep knowledge in various measurement technologies. In ORC, waste water aeration compression and industrial air compression I have been very involved in commercializing high-speed technology. The research partners are universities of technologies Aalto, Tampere, Delft, Hannover, Stuttgart, Michigan, KTH, VKI, State Polytechnic St. Petersburg and companies Sulzer, Fortum, Wärtsilä, Tri-O-Gen, Sundyne, the Switch, Embraco The research results are also embedded into our teaching" **Course at SPbPU:** Special Chapters in Power Machines

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Jörg Seume

Prof. Dr.-Ing.</td>
<td>Home university: Leibniz University of Hannover, Germany

Research Interests: “The transformation of the energy system in Germany towards renewable energy has a large impact on the design of steam and gas turbines as well as wind turbines. The volatile power-supply from renewable energy resources demands increased flexibility and improved part-load operation of conventional power plants. Many of my research activities aim towards a comprehensive understanding of steady and unsteady flow phenomena in multi-stage axial turbines and diffusers. Related research topics are for example secondary flows in turbine diffusers, windage effects in turbines and the effect of endwall contouring.
Because future wind turbines will have longer and thinner blades aeroelastic effects become increasingly relevant for wind turbine safety and reliability. One of my research projects develops a measurement technique for blade deformation of rotating turbine during field operation. To challenge uncertainties in the design and operation of wind turbines probabilistic, methods and aeroelastic models are developed.
On behalf of the aviation sector and its demands for decreasing fuel consumption and reduced noise emissions, my areas of research are multi-stage axial compressors and low-pressure axial turbines. Active flow control mechanisms were developed, which increase the operating range of axial compressors. Additionally, I am involved in the investigation of surface structures like riblets and complex surface roughness.
The experimental investigations on the various testing facilities investigation are complemented by numerical simulations, ranging from Direct Numerical Simulations to RANS-Simulations, which are widely used in industry. Furthermore, RANS models for turbulence and transition are development at my Institute.
In cooperation with the automotive industry I am working on turbochargers and the benefit of compact turbomachinery for heavy duty vehicles. The main objective of these research activities is the increase of fuel efficiency and the recovering of waste heat energy of combustion by means of an Organic Rankine Cycle”

Course at SPbPU: Special Chapters in Power Machines; Aeroacoustics and Aerodynamics</td>
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Pietro Zunino

Prof.</td>
<td>Home university: University of Genova, Italy

Courses at SPbPU: Special Chapters in Power Machines</td>
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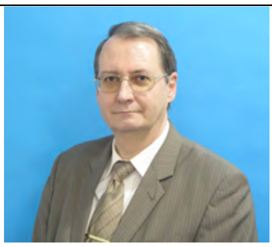
 **Gianguido Piani**	**Home university:** University of Applied Sciences Upper Austria, Wels College, Wels, Austria **Research Interests:** “Renewable energy sources, in particular solar energy and wind energy; power distribution grid control; heat-power co-generation, energy efficiency, district heating and cooling, efficiency in buildings, automation and control. I hold a Licentiate of Technology degree from Lund University in Sweden. After completion of the studies I worked nine years with ABB Utilities, mostly in Russia, and then for more than ten years as free-lance consultant in energy technologies, also in Russia. I have joined the Faculty in Wels in 2014. Because of my industry experience I am used to look at different issues under the point of view of their practical realization, the ways for their financing, their construction, and operation (usability). In Russia the modernization of the energy sector calls today for much better efficiency, in first place in the power generation and the building sector. Another central issue is the opening of the power grid to distributed generation. Without these changes any proposal for the use of renewable sources in Russian wouldn't make any technical and economic sense. Many challenges are ahead, one big asset in the search of solutions is the high quality of Russian education” **Courses at SPbPU:** Renewable Energy: Resources and Technologies
 **Radek Skoda** **Ass. Prof., PhD**	**Home universities:** Czech Technical University in Prague, Czech Republic; North West University Potchefstroom, South Africa **Research Interests:** “Nuclear Fuel Cycle, Neutron Imaging, Fuel Cladding” **Courses at SPbPU:** Nuclear Fuel Cycle
 **Harald Schwarz** **Prof. Dr.-Ing.**	**Home universities:** Brandenburg University of Technology Cottbus-Senftenberg, Germany **Research Interests:** “High Voltage Insulation Systems and Apparatus; Grid Integration of Renewable Energies and e-Mobility; SMART- and Micro Grids; Flexible Loads e.g. Power-to-Gas, Power-to-Heat, Power-to-Vehicles; Electro-Magnetic Compatibility in electric vehicle” **Courses at SPbPU:** Electro-Magnetic Compatibility in Power Systems; Introduction in Electric Power Systems

COURSES DESCRIPTION

THERMAL POWER PLANTS

ECTS Credits	**3.0**
Year and Term	M.Sc. (Tech.), Term 2
Teacher	Person in charge: Senior Assistant, Ph.D. (Tech.) Alena Aleshina Lecturer: Professor, D. Sc. (Tech.) Esa Vakkilainen in the academic years 2014/2015 and 2015/2016
Aims	Upon completion of the course the students will be able: - to understand requirements for thermal power plants, - to dimension power plants, - to conduct and manage power plant selection process, - to describe in detail various types of thermal power plants.
Content	Modern power plants, co-generation, small scale CHP, gasifiers, co-firing, stirling, improving efficiency.
Modes of Study	36 h practical exercises, 18 h written assignment, 18 h practice preparation, 33 h preparation for exam, 3 h exam.
Assessment	0-5, examination 60 %, written assignment 40 %
Study materials	Study material will be announced during lectures

STEAM BOILERS

ECTS Credits	**3.5**
Year and Term	M.Sc. (Tech.), Term 1
Teacher	Person in charge: Senior Assistant, Ph.D. (Tech.) Alena Aleshina Lecturer: Professor, D. Sc. (Tech.) Esa Vakkilainen in the academic years 2014/2015 and 2015/2016
Aims	Upon completion of the course the student will be able to: 1. list typical biomass fuels and their properties, 2. understand the terminology used in maintenance management, 3. understand steam generation processes, especially from biomass, 4. describe the construction of steam boilers, 5. apply different types of steam boilers using different types of fuels, and 6. realize restrictions caused by corrosion, erosion and fouling.
Content	Characteristics of fuels, especially of biofuels. Combustion and gasification. Design of a steam boiler and its components. Energy balances. Solving steam boiler problems by mathematical modeling. Emissions. Biomass handling.
Modes of Study	36 h practical exercises, 30 h written assignment, 15 h practice preparation, 19 h self-study, 33 h preparation for exam, 3 h exam. 18 h lectures, 18 h practice, 28 h written assignment, 18 h practice preparation, 18 h self-study, 9 h preparation for exam, 3 h exam.

Assessment	0-5, examination 60 %, written assignment 40 %
Study materials	Study material will be announced during lectures

POWER MACHINES. TURBINES

ECTS Credits	**3.5**
Year and Term	M.Sc. (Tech.), Term 1
Teacher	Senior Assistant, M. Sc. (Tech.) Yury Matveev, Senior Assistant, M. Sc. (Tech.) Egor Okunev In the year of 2015/2016 Special Chapters in Power Machines are provided by lecturers: - Professor, D. Sc. (Tech.) Jörg Seume (Germany); - Professor, D. Sc. (Tech.) Jari Backman (Finland); - Professor, D. Sc. (Tech.) Pietro Zunino (Italy).
Aims	By the end of the course the student will be able to - use the knowledge of thermodynamics of gases in power machines for calculation and design, - realize algorithms for choosing the optimum design of power machines.
Content	**Convergent and divergent flows in turbomachines.** Expansion and compression processes with friction. Supersonic flow in the nozzles. Deflection of stream after a turbine stage. **Kinematic schemes of turbomachines**. Absolute, relative and tangential movement in turbomachines. Velocity triangles. Kinematic schemes of axial and radial turbomachinery. **Power interaction between the stream and the blade ring.** The forces applying to the grid blades. Torque. Euler equation. Energy equation for the impeller in relative movement. **Kinematic and thermodynamic characteristics of the flow in turbomachines.** Geometric and kinematic similarity in turbomachines. Circulation and flow coefficients. Kinematic and thermodynamic degree of reaction. Characteristic number u/C_0. **Choice of the optimum peripheral speed of turbomachine stage**. Choice of the optimum peripharal velocity of the stage of active type. Dependence of the optimum peripharal velocity of the stage from the degree of reaction. **Basic principles of design of turbomachinery blading along the radius.** Radial balance equation. Twisting the blade in accordance with the order $c_u \cdot r = const$. Changing angles flow, degree of reaction and blade configuration along the height of the stage. **The loss of kinetic energy in the flowing parts of turbomachines.** Aerodynamic losses in greeds of axial turbomachines. Secondary and end losses in turbomachines. The partial inlet of stream. Losses to the output velocity. Tangential and internal efficiency of turbomachine stage. The role of the turbine diffuser. **Characteristics of radial and radial-axial wheels.** Coriolis inertial forces and their role in the working process of radial turbomachines. Relative circular movement. Characteristics of centripetal and centrifugal stage turbomachines. **Multistage turbomachines.** Speed stages, pressure stages, high circulation stages. The distribution of the enthalpies gradients between stages. **The influence of rotor speed on the characteristics turbine stage.** The influence of rotor speed on the main characteristics of the turbine stage. Torque at startup. **Gas turbines.** Classification and requirements for gas turbines. Major operational characteristics of gas turbines. Design features of the gas turbine and its elements. Requirements for gas turbine combustion chambers. Fuel for gas turbines and its characteristics. Work processes in the combustion chambers, the design and

	calculation of the combustion chambers. Cooling of gas turbine components. **Basic principles of steam turbines design.** Design principles of the basic parts of turbines. Design features of steam turbines. Cases of cylinders HP, MP and LP. Design of the diaphragms and nozzles. The rotors of steam turbines. Blades and its mounting method to the disk. Operation life of different types steam turbines. Measures to ensure the reliability of the turbines. Organization of heat extraction in renovated turbines.
Modes of Study	18 h lectures, 36 h practical exercises, 10 h lecture preparation, 6 h exercise preparation, 20 h written assignment; 33 h preparation for exam, 3 h exam.
Assessment	0-5, examination 60 %, written assignment 30 %, homework 10 %
Study materials	Study material will be announced during lectures.

NUMERICAL METHODS IN HEAT AND MASS TRANSFER I, II

ECTS Credits	**3.5**
Year and Term	M.Sc. (Tech.), Term 1
Teacher	Ph.D. (Tech.), Assoc. Prof. Ekaterina Kitanina
Aims	After completion of this course the student will have knowledge on: - the basic equations for fluid mechanics and heat transfer, - numerical methods for solving of Navier-Stokes equations, - numerical solution of systems of linear algebraic equations, - turbulence modeling principles. Upon completion of the course the student will be able to - perform numerical simulation of heat and fluid flow problems, - assess the accuracy of the numerical solution, - interpret the meaning of the numerical results in heat and fluid flow. - explain the main benefits of modern experimental investigations methods (PIV) - perform a comprehensive analyze and verification of calculation results by comparing with both well-know bench-mark solutions and experimental results
Content	The course gives an introduction to numerical simulation of heat and fluid flow problems in industrial and natural processes. Modern methods of numerical simulation will be discussed. A lot of practical trainings of numerical simulation are scheduled. A high attention will be drawn to analyses and verification of calculation results. Verification of some calculation results by comparing with PIV experiments will be fulfilled.
Modes of Study	18 h lectures, 54 h practical exercises, 9 h lecture preparation, 9 h exercise preparation, 33 h preparation for final examination, 3 h exam
Assessment	0-5, examination 70 %, written assignment 20 %, homework 10 %
Study materials	Study material will be announced during lectures

ENERGY EFFICIENCY AND ENERGY SAVING IN INDUSTRY

ECTS Credits	**2.5**
Year and Term	M.Sc. (Tech.), Term 3
Teacher	Professor, D. Sc. (Tech.) Vitaly Sergeev
Aims	The purpose of this course is to provide the necessary knowledge on energy saving and energy efficiency in industry to design of heat-power equipment with desired energy efficiency class. Upon completion of the course the student will be able to describe energy efficiency opportunities in large energy using industry sectors and implement of energy audit in industry.
Content	**Relevance of Energy Efficiency in the World and Russia** Major terms and definition in the field of energy saving and energy efficiency. Energy balances. Prices for primary energy resources in the world and Russia. Environmental factors that contribute to the relevance of energy efficiency and energy saving in the world and Russia. **Energy Efficient Management and Policy Measures in Industry** Legislation in energy efficiency and energy saving in the world and Russia Ecological taxation Institutional and informational approaches Cogeneration Integrated resource planning **Technical Solutions in Order to Raise Energy Efficiency in Industry** **Energy Audit in Industry** Manual for industrial energy audit Inventory and measurement of energy use Energy performance analysis Identification of energy efficiency opportunities Cost-benefit analysis of energy efficiency opportunities Energy audit report
Modes of Study	18 h practical training, 10 h exercise preparation, 26 h written assignment, 9 h self-study, 24 h preparation for the exam, 3 h exam
Assessment	0-5, examination 70 %, written assignment 30 %
Study materials	Study material will be announced during lectures.

MODES OF OPERATION OF THERMAL POWER PLANTS

ECTS Credits	**2.5**
Year and Term	M.Sc. (Tech.), Term 3
Teacher	Docent, PhD (Tech.) Irina Anikina
Aims	The main goals of the course are: - to introduce students to the basic of operation of Thermal Power Plants

	(TPP); - to introduce students to the basic flowsheet of steam-power unit of TPP; - to introduce to different operating mode and calculate different operating modes of TPP; to create the math models of steam-power unit of TPP.
Content	**TPP, mathematical modelling, "CAD United Cycle".** Thermal Power Plants, different type and flowsheets of TPP, the basic concept of mathematical modeling, basic knowledge with "CAD United Cycle", creation of the first math model. **Flowsheets of steam-power unit of TPP.** Steam-power unit, different flowsheets of steam-power unit, cogeneration**. Flowsheets of steam-power unit of TPP (practical training).** Creating of Flowsheet of steam-power unit in CAD United Cycle". **Operating modes of TPP.** Different operating modes of TPP, condensing mode, heat-extraction mode, mixed mode, winter and summer operating mode, mode of "technological minimum"**. Operating modes of TPP (practical training).** Calculation of different operating modes of TPP in CAD United Cycle".
Modes of Study	18 h lectures, 18 h practical exercises, 5 h lecture preparation, 5 h exercise preparation, 10 h written assignment, 7 h project work and presentation, 24 h preparation for exam, 3 h exam.
Assessment	0-5, examination 60 %, project work and presentation 20%, written assignment 10%, homework 10 %
Study materials	Study material will be announced during lectures.

COMBINED CYCLE POWER PLANTS

ECTS Credits	**3.0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 3 Docent, D.Sc. (Tech.) Sergey Olennikov
Aims	Upon completion of the course the student will be able to - explain the difference between steam cycle, gas cycle and combined cycle, - describe construction of combined cycle power plant, - describe technology of combined production of heat and power, - calculate efficiency of combined cycle power plant, - explain the main benefits of combined cycle power plant and its perspectives for world energy industry, - list the main gas turbines manufactures, - utilize the equations in manual and computer calculations, - understand the basic equations used in computer models for the combined cycle power plants.
Content	History of combined cycle technology. Basics of thermodynamics: steam cycle, gas cycle and combined cycle. Gas turbine plant, steam plant, combined cycle power plant. Combined cycle power plant: main equipment, flow diagram, available parameters, implementation. Gas and steam turbines for combined cycle power plants, waste-heat recovery boilers. Basic equations for manual and computer calculations. Indicators of Overall and Thermal Efficiency of Combined Cycle Power Plant. Major benefits of Combined Cycle Power Plant, its perspectives for world energy sector.

Modes of Study	18 h lectures, 18 h practical exercises, 8 h lecture preparation, 24 h exercise preparation, 28 h written assignment, 12 h preparation for test and test.
Assessment	0-5, examination 60 %, written assignment 30%, homework 10 %
Study materials	Study material will be announced during lectures.

RENEWABLE ENERGY: RESOURCES AND TECHNOLOGIES

ECTS Credits **3.0**

Year and Term M.Sc. (Tech.), Term 2

Teacher Person in charge: Senior Assistant, Ph.D. (Tech.) Alena Aleshina
Lecturer: Professor G. Piani (Austria) in the academic year of 2015/2016

Aims

This is an engineering introduction to renewable energy technologies and potentials. The course is aimed at introduction students to the basic concepts of renewable energy. Students will learn about state-of-the-art in renewable energy applications including biomass gasification for heat, electric power, liquid fuels, and bio-SNG as well as wind energy, solar energy, and hydropower. Status of renewable energy in different countries will be outlined. For understanding perspectives of renewable energy in any country renewable energy policy will be discussed within the course.

Upon completion of the course the student will be able to

- discuss the role of renewable sources of energy in the future world energy demand,
- explain the term “green energy”,
- analyze current situation in energy system of any country and suggest strategy for increasing the role of renewable resources,
- describe modern technological solutions used for renewable resources utilization,
- explain process cycle for production fuels from biomass.

Content

The wider context, basics: The energy issue, public approach vs market, supply-side vs demand-side, Cornucopians and Cassandras. Energy paths, energy density, exergy, anergy. Primary energy sources (fossil, wind, hydro) as particular forms of solar energy. Access to fossil resources, their depletion. Environmental problems of fossil fuel use, global warming. Practical use of renewables vs fossil fuels. Reference environment, human needs, ambient temperature, demand/loads. Information sources, relevant websites and reference handbooks on renewable energy systems. Institutional references: IEA, DOE-EIA, IRENA, EWEA, professional and trade associations, dedicated websites. **Renewable energy sources:** The sun, solar radiation, day/ year solar path, solar irradiation over horizontal and inclined surface. Solar energy availability and limitations, shadowing. Solar energy conversion paths: thermal, photovoltaic, wind energy, biomass. Geothermal sources. Solar, wind, hydro, and geothermal resource estimation. Measuring equipment and measurements. TMY models, data detail levels. Resource atlases, online resources (Meteonorm). **Project economics:** Elements of financing, NPV, IRR, payback time, influence of inflation rate, prime rate, WACC and cost of capital on project economic return. Sensitivity analysis. Levelized Cost of Energy (LCOE) by source. The case for renewable energy systems. Emissions trading, economic background (utilization of common goods, “right” to pollute) and practical implementation. Other types of certificates. International aid projects.

	Software tools: Types of software tools: dimensioning, simulation, design and research tools, main characteristics and their scope of application. Spreadsheet tools vs procedural languages. Overview of the most widespread software packages, download resources: RETScreen, EnergyPLAN, EnergyPlus. Online resources: NREL PVWatts, EU tools for renewable resources. **Introduction to the power grid:** Basics of energy transport, comparison of energy transport modes, power grid voltage levels, topology, transmission and distribution, grid protection, generation units. Connection paths, buffers. Reliability of complex systems. Elements of risk, risk probability, system reliability, safe design, redundancies. Quantitative methods of system analysis and risk assessment. SAIDI and SAIFI. Electrical loads, load efficiency, typical loads in cold and warm countries: illumination, cooling, power loads for transport. Load and frequency control, power systems with large in-feeds from external sources. **Power grid integration, distributed generation, smart grids:** Change of generation paradigm, from central to distributed generation. Smart grids. Communication in smart grids, hardware, protocols. Existing power grid standards vs smart grid standards, IEC 61850. Virtual power plants. Tariff Integration of renewable generation in smart grids. Basics of wind and hydro generation considered from the grid. Issues in grid integration, grid codes. Grid integration of solar and wind energy, buffers, practical experience. Technical and economical issues in the EU, discussion of grid integration in different (students' home) countries. **Photovoltaic (PV) generation (1), basics:** Introduction to PV systems, technical components, solar cells types monocristalline, polycristalline, amorphous, production of PV cells. Solar modules. Equivalent circuits of PV cells and modules, serial and parallel connection of cells and modules. Basic design and planning of PV grid-connected and island systems, energy yield estimation, optimal module orientation design of PV plants. PV plants in different climatic areas. Simulation software, web-based software. Exercises, grid-connected systems. **Photovoltaic (PV) generation (2), energy storage, batteries, systems:** Chemical reactions in batteries. Battery types, capacity, charge/ discharge cycle. Practical use of batteries, safety precautions. Battery chargers. Costs of battery storage. Battery storage dimensioning for PV generation, smart grids. Other storage technologies and their role in smart grids. ac/dc conversion, inverters, parametrization. Economics of solar systems, grid parity. PV plants in different climatic areas. Simulation software, web-based software. Exercises, island systems. **Practical examples, solar-powered cooling and climatization:** Physical background for cooling, gas-vapor mixtures, psychrometric charts, computations, energy demand for state changes, building energy requirements for cooling. Comparison of compressor-driven with electric refrigerators under solar power supply. Exercises, simulations. **Energy efficiency in electrical processes, DSM:** The generation-load balance, energy efficiency vs power generation, marginal effects. Match between demand and offer. Short-term and long-term energy efficiency measures. Technical and behavioral energy saving. Demand-response. Demand-Side Management (DSM). **Energy policy instruments:** Energiewende (Germany, Europe), UNFCCC, Kyoto Protocol, the new Protocol to be discussed in Paris 2015. Macroeconomic aspects, social acceptance. Financial incentives as policy instruments, direct payments, tax reductions. Market-based instruments, Kyoto protocol units, green certificates. Wishful thinking, orthogonal solutions: hydrogen, CO_2 sequestration. Brief sketch of energy policies of Austria, Germany, EU, USA, China, Russia, Brazil. A major integrated approach – NYC2030.
Modes of Study	36 h practical exercises, 18 h exercise preparation, 28 h written assignment, 14 h self-study, 14 h preparation for test and test

Assessment	0-5, examination 60 %, written assignment 20 %, activity 20 %
Study materials	Study material will be announced during lectures

WASTE HEAT RECOVERY TECHNIQUES

ECTS Credits	**3,5**
Year and Term **Teacher**	M.Sc. (Tech.), Term 3 Person in charge: Senior Assistant, Ph.D. (Tech.) Alena Aleshina Lecturer: Professor, D. Sc. (Tech.) Esa Vakkilainen in the years of 2014/2015 and 2015/2016.
Aims	The purpose of this course is to identify the opportunities to recover waste heat, and the equipment used to recover waste heat. **Upon completion of the course the student will be able to** - discuss the role of waste heat in different industries, - list major sources of waste heat in industry, - dimension simple waste heat recovery equipment, - basic calculations of amount of waste heat, - promote and manage energy efficiency study in industry, - describe in detail different waste heat recovery techniques.
Content	**Introduction: Main Features of Waste Heat Recovery. Waste Heat Sources:** Steam. Compressed Air. Refrigeration. Flue Gases. High Temperature Grade Heat (Furnaces, Ovens). Low Temperature Grade Heat (Air Conditioning). **Implementation of heat recovery techniques. Waste Heat Recovery Equipment:** Heat Exchangers. Thermal Wheels. Heat Pipes. Economizers. Waste Heat Recovery Boilers. Heat Pumps. **Assessment of Waste Heat Recovery:** Determining the Waste Heat Quality. Determining the Waste Heat Quantity. **Energy efficiency and energy saving programs in industry**. **Dimensioning of waste heat recovery equipment. Waste heat environmental impact.**
Modes of Study	18 h lectures; 18 h practical exercises, 18 h written assignment, 18 h practice preparation, 18 h self-study, 9 h preparation for test and test.
Assessment	0-5, examination 60 %, seminar work and written assignment 40 %
Study materials	Study material will be announced during lectures.

BIOENERGY TECHNOLOGY SOLUTIONS

ECTS Credits	**4,5**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Person in charge: Senior Assistant, Ph.D. (Tech.) Alena Aleshina Lecturer: Professor, D. Sc. (Tech.) Esa Vakkilainen in the years of 2014/2015 and 2015/2016
Aims	The purpose of this course is to give an overview about the basic concepts of biomass energy, biomass feedstocks, and types of the main systems and supply chains that can be used for biomass energy conversion and utilization. Upon completion of this course the student will be able to critically evaluate the environmental benefits and consequences of biomass energy production.

Content	**Introduction to Biomass:** Overview of historic and current biomass consumption and organic waste production. **Bioenergy Status Today:** Trends. Perspectives. Limitations in bioenergy. **Biomass Feedstock:** Agricultural and forestry. Municipal solid waste. Grains, sugar crops. Algae. New biomass feedstocks (fast growing forests, etc.). **Biofuels from Biomass:** Ethanol. Biodiesel. BioOil. Biomass-to-liquid (BTL). Biomethane. **Heat and Power from Biomass:** Available Technologies: Direct combustion, gasification, co-firing of biomass with coal. **Energy from Waste. Environmental Impacts of Biofuel Production**
Modes of Study	36 h practice, 28 h written assignment, 12 h practice preparation, 10 h self-study, 30 h project work, 10 h preparation for test and test.
Assessment	0-5, examination 60 %, written assignment 20 %, project work 20 %
Study materials	Study material will be announced during lectures

ENERGY SYSTEMS ENGINEERING

ECTS Credits	**1.0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Person in charge: Senior Assistant, Ph.D. (Tech.) Alena Aleshina Lecturer: Professor, D. Sc. (Tech.) Esa Vakkilainen in the years of 2014/2015 and 2015/2016
Aims	Upon completion of the course the student will be able to 1. describe different types of energy production processes, 2. utilize thermodynamics and heat and mass balances in the design of small scale energy systems, 3. use a “Systems Engineering” type approach to define the design values for energy production processes, 4. define small scale bioenergy production projects, 5. understand how plant requirements affect the planning and implementation phases of small energy systems, and 6. define economic constraints to small scale energy processes.
Content	History and fundamentals of thermodynamics and energy engineering. Modern problems of power plant engineering, combined heat and power production, especially from biomass. Fundamentals of steam and gas turbines in energy production. Systems engineering. Planning and implementation of energy systems. Economic optimization of energy system projects.
Modes of Study	18 h practice, 4 h written assignment, 10 h project work, 4 h preparation for test and test.
Assessment	0-5, examination 60 %, written assignment 20 %, project work 20 %
Study materials	Study material will be announced during lectures

ELECTRICAL MACHINES

ECTS Credits	**2,5**

Year and Term	M.Sc. (Tech.), Term 1
Teacher	Senior Lecturer Irina Savelieva
Aims	The purpose of this course is to familiarize students with the design features of electric vehicles, with their requirements for electromagnetic loads permissible values and parameters, and the characteristics of long-term operation of TG and SG in nominal, normal and abnormal modes, as well as the generator excitation system.
Content	**1. Modern state and perspectives of development of electric power machines (EPM). Country's power industry structure.** Volumes of power generated by TPP, NPP and HPP, their advantages and disadvantages from the point of view energy sources, start-up time and ecology. **1.2 Modern development end perspectives of EPM.** Modern turbo and hydro generator manufacturing, synchronous compensators, perspectives of further development. EPM cooling systems. **1.3 Problems of development and method for EPM effectiveness increase.** Increase of single EPM power by increasing rotation frequency, size and electromagnetic loads, their mechanic and thermal limitations for different types of EPM. **2. General inductive parameters and power properties of EPM. 2.1. Normal operation conditions.** Influence of series and shunt synchronous impedances on active power generation, static stability and static overload capacity of EPM at normal operation. **2.2 Transient conditions. Inductive subtransient and transient impedances of stator coil.** Expressions for subtransient and transient impedances, their influences on electrodynamic loading and dynamic stability of EPM in transient conditions. **3. Time constants of EPM coils. 3.1. Time constants of EPM coils.** Expressions for time constants of EPM coils for different rotor designs, their estimated values and characterization of different current components decay on rotor and stator coils in transient conditions. **4. Steady non-symmetric conditions. 4.1. Steady non-symmetric conditions.** Expressions for inductive impedances of positive, negative and zero sequence estimation of their influence for different types of stator phase connections. **5. General and additional losses in EPM. 5.1. Fundamental and additional losses in EPM.** Physical explanation of fundamental electric, magnetic and mechanical losses in EPM, their correlation for different EPM designs. Analysis of additional losses from different harmonics of magnetic field and dissipation fields, areas of their manifestation. Measures for decrease of additional losses caused by dissipation fields. **6. Abnormal conditions. 6.1 Short-time rotor and stator current overloads.** Estimation of TG and HG operation duration under overload currents in stator and excitation coil. Recommendations for overload values and durations. **6.2. Non-symmetrical conditions of TG and HG.** Influence of asymmetrical conditions on rotor heating of EPM. Measures for rotor thermal stability increase, criteria for allowed duration of non-symmetrical conditions. Expressions for alternating moments in HGs under nonsymmetrical conditions. **6.3. TG and HG operation in non-linear circuits.** TG and HG operation for rectifying load, additional losses for this case. Relative asymmetry of phase currents for different rectifying systems. **7. Excitation systems. 7.1 Excitation systems with direct and alternating current generators.** Layouts for excitation systems with AC and DC generators, their operation and limitations of use. **7.2. Excitation systems with rotating end static frequency converters.** Layouts of brushless and solid-brush excitation systems, aspects of operation, grade of backup. **7.3. Compound generators with self-excitation.** Layout of synchronous generator with self-excitation through rectifier from voltage and current transformers

	installed in stator circuit. Reaction of system on both voltage and phase of stator **8. Synchronous compensators.** Gemneral information on s.c., principle of operation. Analysis of nominal reactive power consumption in underexcited state.
Modes of Study	18 h lectures, 18 h practical exercises, 18 h practice preparation, 18 h self-study, 9 h preparation for test and test.
Assessment	0-5, examination 60 %, practical work, activity 40 %
Study materials	Study material will be announced during lectures

HIGH VOLTAGE TECHNIQUE

ECTS Credits	**1,5**
Year and Term	M.Sc. (Tech.), Term 3
Teacher	Professor, D. Sc. (Tech.) Vasily Titkov
Aims	The purpose of this course is to provide students knowledge and skills required for successful professional activity concerned with development, design and operation of high-voltage equipment of overhead transmission lines, electric power plants and HV substations.
Content	**1. Basics in physics of HV discharge in gases. 1.1. Basics in physics of HV discharge in gases.** Avalanche discharge in homogeneous field. Streamer discharge in homogeneous field. Discharge in short gaps in strongly inhomogeneous field. Lightning strikes. Discharge on the surface of a solid dielectric. Insulating constructions of overhead lines, power plants and substations. **2. Electric strength and breakdown in solid dielectrics. 2.1. Electric strength and breakdown in solid dielectrics.** Physical processes in solid and liquid dielectrics in strong electric fields. Conductivity and breakdown mechanisms in solid and liquid dielectrics. Partial discharges in solid dielectrics. **3. Construction of internal insulation of high voltage equipment. 3.1. Construction of internal insulation of high voltage equipment.** Insulation of power transformers, power capacitors, power cables, HV bushings, instrument current and voltage transformers. **4. Overvoltages in electric grids and limiting methods. 4.1. Overvoltages in electric grids and limiting methods.** Switching overvoltages: switching of overhead lines, switching of inductances, arc overvoltages. Atmospheric overoltages: voltage waves travelling to substations from lines, direct lightning strike into wire or ground wire. Construction of lightning protection equipment for substation and overhead HV lines. Overvoltage protection equipment and technology. **5. High voltage testing and measuring. 5.1. High voltage testing and measuring.** HV testing installations. Equipment and methods for HV measuring. Testing methods.
Modes of Study	18 h lectures, 18 h practical exercises, 6 h practice preparation, 8 h self-study, 4 h preparation for test and test.
Assessment	0-5, examination 60 %, practical work, activity 40 %
Study materials	Study material will be announced during lectures

ENERGY EFFICIENT HVAC SYSTEMS

ECTS Credits	**2.0**
Year and Term	M.Sc. (Tech.), Term 2
Teacher	Ass. Professor, Ph.D. (Tech.) Marina Petrochenko
Aims	The aim of the course is - to introduce the general principles of ventilation systems and air conditioning, - to learn the basic calculations and basic methods of equipment selection, - to introduce modern means of energy saving in ventilation systems and to present innovative equipment.
Content	Ventilation systems overview. Types of ventilation systems. Sanitary requirements of air environment. Basic properties of humid air. Air exchange calculation. Air distribution in premises. Air diffusers constructive solution. Basic elements of ventilation systems. Ventilation equipment selection. Ducts, ventilation channels. Aerodynamic calculation of ventilation systems. Basics of air conditioning. Chiller principle of operation. Types of air conditioners. Heat load calculation. Ventilation systems fire safety. Smoke protection in case of fire. Energy efficiency. Energy saving in ventilation systems. Ventilation equipment with heat recovery. Practical training includes ventilation system design, air exchange calculation, equipment selection, drawing presentation.
Modes of Study	36 h practical exercises, 12 h practice preparation, 8 h self-study, 16 h preparation for test and test.
Assessment	0-5, examination 60 %, written assignment 40 %
Study materials	Study material will be announced during lectures

ENERGY EFFICIENT BUILDINGS AND STRUCTURES

ECTS Credits	**2,5**
Year and Term	M.Sc. (Tech.), Term 2
Teacher	Ass. Professor, Ph.D. (Tech.) Marina Petrochenko
Aims	The course gives information about energy efficiency of building’s engineering systems and architectural design for improving its economic and environmental benefits.
Content	The course includes legislative regulation of energy efficiency in Russia and in the World, as well as priority technical aspects of the energy efficiency of buildings and structures: 1. Using a new up to date materials in the construction will reduce the heat losses in the walling, as well as use the natural sun exposure and innovation architectural solutions. 2. Improving energy efficiency in engineering systems of the individual and the public buildings, including electrical networks, heating networks, air-conditioning systems, of water supply and canalization. 3. Using renewable energy sources for independent electricity and heat supplying, including solar photovoltaic modules, solar collectors, heat pumps

	and wind turbines. In practice students makes a project of energy efficiency building, using independent renewable energy sources.
Modes of Study	18 h lectures, 18 h practical exercises, 18 h practice preparation, 24 h self-study, 12 h preparation for test and test.
Assessment	0-5, examination 60 %, homework 20 %, activity 20 %
Study materials	Study material will be announced during lectures

ENERGY AUDIT OF BUILDINGS AND CONSTRUCTIONS

ECTS Credits	**2,5**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Ass. Professor, Ph.D. (Tech.) Marina Petrochenko
Aims	The aim of the course is an acquaintance with the basics of civil buildings and structures energy audit.
Content	1. Introduction to the course is an acquaintance with legal and regulatory framework documents for the heat loss calculation and energy audit of buildings and structures. 2. This course includes detailed study of modern energy-efficient materials and technologies in enclosure structures and engineering systems of buildings and structures. 3. Methods for determining irrational energy sources and unjustified loss of energy are considered in detail. Measures to prevent them are analyzed. 4. Preparing of energy passport according to the results of building`s audit is studied. 5. In practice students examine thermal calculation of various designs, as well as the calculation of payback in order to various measures of energy efficiency improvement. 6. It is planned to study modern scientific and technical literature in this course, as well as attending conferences, workshops and exhibitions dedicated to energy-efficiency. 7. Training of enclosure structures thermal performance analysis is conducted as outdoor experiments with the use of modern testing equipment. 8. For participants in a course it is planned to organize meetings with representatives of companies connected to energy audit and energy efficient technologies.
Modes of Study	18 h lectures, 18 h practical exercises, 18 h practice preparation, 24 h self-study, 12 h preparation for test and test
Assessment	0-5, examination 60 %, homework 20 %, activity 20 %
Study materials	Study material will be announced during lectures

MODERN ENERGY PROBLEMS

ECTS Credits	**4,5**
Year and Term	M.Sc. (Tech.), Term 2
Teacher	Docent, D.Sc. (Tech.) Sergey Olennikov
Aims	The purpose of this course is to systematize already obtained knowledge and the acquisition of new knowledge in the field of modern methods of production, conversion, storage and use of energy: - knowledge of the physical laws underlying the current and future energy sector, - understanding the physical principles and technical implementations of the methods and techniques used in the energy sector, - knowledge of the economic, technological and environmental attractiveness of the various methods of current and future power sector. It is expected that students will be guided into the strategies and trends in the global energy sector.
Content	- Classification of energy. Current status of the use of energy in the world and the prospects. - Thermal Power Plants. - Hydropower. - The energy of nuclear fission reactors. - The energy resources of the ocean. - Wind power. - Geothermal energy. - The use of biofuels for energy purposes. - Photovoltaic and photocatalytic conversion of solar energy. - Magneto-hydrodynamic, thermoelectric and thermionic energy converters, fuel cells, hydrogen power. - Nuclear fusion. - The strategy of world energy sector.
Modes of Study	36 h practice, 28 h written assignment, 12 h practice preparation, 10 h self-study, 30 h project work, 10 h preparation for test and test.
Assessment	0-5, examination 60 %, written assignment 40 %
Study materials	Study material will be announced during lectures.

MODELING OF VAPORIZATION PROCESSES

ECTS Credits	**2.0**
Year and Term	M.Sc. (Tech.), Term 2
Teacher	Assoc. Professor, D. Sc. (Tech.) Natalia Agafonova
Aims	By the end of the course the student will be able to - explain the mathematical principles of parametric modeling of vaporization processes, - choose the empirical formulas which is needed for steam generators calculations,

	- use computer programs for modeling of steam generators (by the example of computer program KORSAR)
Content	**Main two-phase flow parameters for description of steam generation.** Superficial and actual parameters. Void fraction. Phase velocities. **Empirical formulas and basic models for pool boiling.** Normative method. Chen's method. **Heat transfer by forced flow boiling.** Effect of convection and boiling processes on heat transfer. **Boiling crisis.** Transition of nucleate boiling in film boiling. Methods of heat transfer coefficient and wall temperature calculations. **Deterioration of heat transfer at dryout.** Evaporation of the liquid film on the wall. Methods of heat transfer coefficient and wall temperature calculations in dispersed steam-water flow. **Computer programs for the best estimation of thermohydraulics in the power equipment flow circuits.** Acquaintance with Russian program KORSAR which is an example of one the best modern estimation programs.
Modes of Study	18 h lectures, 18 h practice, 6 h preparation for exam, 3 h exam.
Assessment	0-5, examination 80 %, written assignment 20 %
Study materials	Study material will be announced during lectures

MATHEMATICAL PHYSICS

ECTS Credits	**2,5**
Year and Term **Teacher**	M.Sc. (Tech.), Term 1 Ass. Prof, PhD Irina Suslova
Aims	By the end of the course the student will be able to use equations and methods of mathematical physics for solving practical problems in engineering field.
Content	**Introduction.** Mathematical physics as an important background in training of modern engineers. **1. Formulation of problems in mathematical physics.** Basic equations of mathematical physics: wave equation for a string, oscillation of a membrane, longitudinal vibrations of a rod, equation of electrostatics, heat conduction equation. Classification of second-order linear partial differential equations. Equations of elliptic, hyperbolic, and parabolic types; various problems connected with those equations. Formulation of problems in mathematical physics depending on the boundary and initial conditions (Dirichlet and Neumann problems etc.) Unicity theorems for the problems posed. **2. Fourier method.** Equations with separable variables. Application of the Fourier method to a classic problem of the string vibration. Elements of eigenfunction theory. Sturm-Liouville problem for linear differential equations of the second order. Eigenvalues and eigenfunctions, their properties. Expansions of arbitrary functions in eigenfunctions. Singular Strurm-Liouville problem. Inhomogeneous problems of mathematical physics. Examples illustrating applicability of the Fourier method to homogeneous and inhomogeneous problems. Method of egenfunctions (Grinberg's method) as applied to inhomogeneous problems. **3. Special functions and their applications.** Cylindrical functions, their representation by series and integrals. Asymptotic representations for small and large arguments. Sturm-Liouville problem associated with the Bessel equation.

	Fourier-Bessel and Dini series. Modified cylindrical functions. Application of cylindrical functions to some selected problems of mathematical physics. Spherical functions. Legendre polynomials and their basic characteristics. Sturm-Liouville problem associated with Legendre equation. Expansion of functions in series of Legendre polynomials. Application to boundary value problems admitting of separation of variables in spherical coordinate system. **4. Mathematical physics problems with the continuous spectrum.** Application of the Fourier method to problems with the continuous spectrum. Representation of arbitrary functions by the Fourier and Hankel integrals. Dirichlet problems for half-plane and half-space. Integral transformation method and its applications.
Modes of Study	18 h lectures, 36 h practical exercises, 18 h exercise preparation, 18 h preparation for the test and test.
Assessment	Graded 0-5 on the basis of activity, assignments given during the lectures and a portfolio composed of them. Case exercises 80 %, active participation and attendance 20 %. Evaluation 0–100 points.
Study materials	Reading material for the course will be provided by the lecturer.

INNOVATION MANAGEMENT IN INDUSTRY

ECTS Credits	**3,0**
Year and Term	M.Sc. (Tech.), Term 3
Teacher	Senior Assistant, M. Sc. (Tech.) Ekaterina Kondratyeva
Aims	By the end of the course the student will be able to - recognize different types and sources of innovations, - understand “creativity” and its components in innovations - reflect individual and team contribution to team innovativeness, - interpret how technology changes and how technologies and society interact, - characterize the key features of an innovative organization, - assess how firms manage both technological and business innovations, - analyze the evolutionary process of innovation development, - synthesize and critically evaluate the commonly available information.
Content	The main goal of this course is to give the overall understanding about what innovations are, how they are made and how they affect industry company’s strategy and performance. Nowadays innovations are critical for success, growth and competitiveness. The course reviews basic ideas and concepts of strategic and operational innovation technology management in industry including: 1. Management of innovation 2. Managing technology and knowledge 3. New product development Must know: - how to identify the main concepts and definitions of innovation and technology management - how to explain the different viewpoints of enterprise operations through the frameworks of new - product/service development as well as explain the phases Nice to know: - How to identify the significance of networks in innovation and technology

	management, and apply the principles of innovation and technology management on selected problem area. - How to understand a build-up of company networks and develop solutions for the issues relating to them.
Modes of Study	36 h practical exercises, 13 h exercise preparation, 12 h written assignment, 20 h project work, 24 h preparation for the exam, 3 h exam
Assessment	Graded 0-5 on the basis of activity, assignments given during the lectures and a portfolio composed of them. Case exercises 80 %, active participation and attendance 20 %. Evaluation 0–100 points.
Study materials	Reading material for the course will be provided by the lecturer.

HISTORY AND PHILOSOPHY OF SCIENCE

ECTS Credits	**1,5**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Ass. Nataliya Donmez
Aims	The aim of the course is: - to introduce students to the history of power engineering; - to illustrate that engineering is one of the main factors that determines the nature of our society and to stress the responsibilities that this places on engineers; - to demonstrate that society driving engineering developments and engineering developments changing society are interrelated and connected features of the history of engineering; - to demonstrate how the operation of engineering devices and processes often reveals problems that were not, and sometimes could not have been, anticipated by the engineers involved in the design and development of the device or process.
Content	This course includes the brief overview of the history of power engineering from Ancient times to the present. History of development of major energy cycles, machines and transport units: gas and steam turbines and its cycles; steam boilers; engines; steam locomotive, aircraft, steamship; the first power plant; technology of combustion and gasification of solid fuels, etc.
Modes of Study	36 h practical training, 9 h written report, 9 h preparation for the presentation and final test
Assessment	0-5, evaluation based on quality of written report and presentation
Study materials	Study material will be announced during lectures.

INTERNATIONAL STANDARDS OF PRODUCTION MANAGEMENT

ECTS Credits	**2,5**
Year and Term **Teacher**	M.Sc. (Tech.), Term 3 Senior lecturer Dmitriy Gavrilov

Aims	Students should know after this course about: - internationally recognized approaches to operations strategy development for industrial enterprises; - internationally recognized methods of mid-term planning for industrial enterprises; - ideas and principles of enterprise manufacturing system productivity improvement incentives; Based on that understanding students should be able to: - develop operations strategy for particular company – by defining performance objectives and by configuring operations resources in order to achieve performance objectives target levels; - adapt mid-term planning process for particular manufacturing environment and particular company's specific features. Students will be familiar with: - approaches to industrial enterprise planning system configuring on strategic, tactical and operational levels; - internationally recognized production management best practice; - production planning and production scheduling methods.
Content	Industrial enterprise planning system. Operations strategy and its linkage with corporate and business strategy. Operations strategy development. Manufacturing strategies/Product positioning strategies. Sales & Operations planning (S&OP process structure, planning parameters, Resource Requirements Planning – RRP). Manufacturing planning and scheduling (MPS, MRP, RCCP, CRP), Production Activity Control (functions; manufacturing reporting, count points, data collection). Productivity systems and Quality Management Systems (Lean/ JIT), 6 Sigma, Theory of Constraints, QFD, TQM).
Modes of Study	36 h practical training, 18 h independent study, 9 h preparation for the presentation, 24 h preparation for the exam, 3 h exam
Assessment	0-5, examination 60 %, presentation 40 %
Study materials	Study material will be announced during lectures.

ENGLISH FOR TECHNICAL COMMUNICATION

ECTS Credits	**3,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 1, 2 Ass. Nataliya Donmez
Aims	The aim of the course is to improve their knowledge and skills in technical English: comprehension, vocabulary, grammar, and writing.
Content	**Technology and Society.** Branches of technology. Technology and work. Technological innovations. **Design and CAD systems.** The design process. Famous designers. Principles and advantages of CAD. Modern CAD systems. **Manufacturing.** Modern manufacturing processes. Machine tools and process planning. **Power Machines.** Different types of power machines. Design and field of application. **Transport.** Different forms of transport (1and, sea and air transport). Safety and efficiency of transport. **The Future of Technology.** Predictions and future developments in technology.

Modes of Study	First semester: 36 h practical training Second semester: 36 h practical training, 3 h independent study, 6 h preparation for the presentation, 24 h preparation for the exam, 3 h exam
Assessment	0-5, examination 60 %, presentation 40 %
Study materials	Study material will be announced during lectures.

COMPUTER TECHNOLOGIES IN SCIENCE AND INDUSTRY

ECTS Credits	**2,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Docent, D. Sc. (Tech.) Elena Semakina
Aims	By the end of the course the student will be able to - explain the mathematical principles of geometric modeling, - choose the CAD-program which is needed for his purposes, - create surface and solid models, - use parametric, programme and projection capabilities of CAD-programmes.
Content	Classification of CAD systems. Coordinate systems. Data structures for CAD systems. Wireframe and surface modeling: graphic primitives and editing techniques. Solid modeling: graphic primitives and editing techniques. Integrated programming language. Parametric possibilities of the CAD systems. Methods of the preparation of the design documentation which are based on solid models using.
Modes of Study	36 h practical exercises, 10 h exercise preparation, 18 h written assignment, 8 h preparation for test and test.
Assessment	0-5, examination 80 %, written assignment 20 %
Study materials	Study material will be announced during lectures.

THEORY OF HYDROSTATIC MACHINES

ECTS Credits	**2,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 1 Docent, D. Sc. (Tech.) Konstantin Lebedev
Aims	The course is aimed at introduction students to the basics of the theory of hydrostatic machines
Content	- The physical nature of the processes, classification, principles of organization and operation of hydrostatic machines are stated. - Questions of the technical application of hydrostatic machines, depending on purpose and range of the main operating parameters, are considered. - In addition, we briefly outline the structure, purpose of the constitutive elements of hydrostatic drive, its characteristics and ways of output velocity regulation and control.
Modes of Study	18 h lectures, 18 h practical exercises, 30 h exercise preparation, 6 h preparation for test and test.

Assessment	0-5, examination 80 %, written assignment 20 %
Study materials	Study material will be announced during lectures.

PUMP EQUIPMENT OF THERMAL POWER PLANTS

ECTS Credits	**2,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Docent, D. Sc. (Tech.) Konstantin Lebedev
Aims	The purpose of this course is to tell about performance of pumps used at power plants, their classification, physical nature of working process, design and operation.
Content	- The physical nature of the processes, classification, principles of organization and operation of hydrostatic machines are stated. - Questions of the technical application of hydrostatic machines, depending on purpose and range of the main operating parameters, are considered. - In addition, we briefly outline the structure, purpose of the constitutive elements of hydrostatic drive, its characteristics and ways of output velocity regulation and control. - Concept of working parameters and characteristics of centrifugal pumps. - The looses of energy in blade pumps, their efficiency. - The issues in the application of the theory of similarity on manufacturing of hydraulic machines. - Problems of cavitation in pumps and reduction of its negative consequences. - Pump working in water supplying system. - Ways of regulating of output and pressure. - Calculating of parameters for parallel and consequential connecting of pumps.
Modes of Study	36 h practical exercises, 30 h exercise preparation, 6 h preparation for test and test.
Assessment	0-5, examination 80 %, written assignment 20 %
Study materials	Study material will be announced during lectures.

MODERN PROBLEMS OF SCIENCE AND INDUSTRY IN ENERGY SECTOR

ECTS Credits	**3,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 Docent, D. Sc. (Tech.) Sergey Olennikov
Aims	The course is aimed at training in work with numerical methods.
Content	1. Impossibility of real experiment. 2. Numerical experiments. 3. Preparation of data for numerical modeling. 4. Reduction of terms of design. 5. Modern commercial software packages and their opportunities.

Modes of Study	36 h practical exercises, 30 h exercise preparation, 6 h preparation for test and test.
Assessment	0-5, examination 80 %, written assignment 20 %
Study materials	Study material will be announced during lectures.

MODELING OF PROCESS ENGINEERING

ECTS Credits	**2,5**
Year and Term	M.Sc. (Tech.), Term 1
Teacher	Prof., D.Sc. (Tech.) R. Izmailov
Aims	Upon completion of the course the student will be able to - create stationary and time dependent mass, momentum and energy balances for various kinds of energy systems; - perform design tasks, to utilize mathematical software in calculation, and to analyze the characteristics of energy systems; - include material property definitions to mathematical software or to own code when simulating energy systems; - create, solve and analyze the set of stationary and time dependent balance equations using Excel and MATLAB.
Content	To introduce advanced problems in modeling of energy systems needed by engineers and researchers. The course lectures provide mathematical basis for problem formulation, and exercises providing a chance to work with various computational packages.
Modes of Study	36 h practical exercises, 10 h exercise preparation, 8 h self-study, 33 h preparation for exam, 3 h exam
Assessment	0-5, examination 70 %, homework 30 %
Study materials	Study material will be announced during lectures

NETWORK PROBLEMS AND ELECTRICAL SYSTEMS TECHNOLOGY

ECTS Credits	**1,5**
Year and Term	M.Sc. (Tech.), Term 3
Teacher	Senior Teacher Eugeny Sheskin
Aims	Develop students' knowledge of modern problems and technologies applied in power systems and related to electric energy production, transmission and distribution process.
Content	**1. High voltage transmission lines series and shunt compensation.** Equations of power transmission lines. Lossless line. Schematic diagram of power transmission line taking into account its wave properties. No load and surge impedance load modes of power transmission line. The effect of shunt and series compensation on transmission line characteristics. **2. Electric network overvoltages.** Overvoltages classification. Temporary and surge overvoltages. Most commonly used means for overvoltage suppression. **3. Controllable**

	shunt reactors. Construction, types and efficiency of controllable shunt reactors application in power systems. Magnetically controlled shunt reactors. Controllable reactors - transformers. Thyristor-controlled shunt reactors. **4. The issues of controllable and fixed shunt reactors' application on power transmission lines.** Temporary overvoltages in transmission lines' no load modes of operation. Switching overvoltages at the energization of power transmission lines with and without shunt reactors. Sinple phase automatic reclosure cycle. **5. Static VAR systems.** Construction, types and efficiency of static VAR systems application. The effect of static VAR systems on power systems stability. **6. Transmission lines' controllable and uncontrollable series compensation.** Construction, types and efficiency of transmission lines' series compensation. The issues of series compensation application. **7. High voltage cable lines application issues.** Transmission capacity of power cable lines. Screen grounding of XLPE cables. Reactive power compensation of power cable lines. **8. SF6 high voltage circuit breakers application issues.** Types of circuit breakers. Specific conditions of their operation in schemes with transmission lines compensated by shunt reactors. **9. System blackouts.** Examples of blackouts. Investigation of triggering events. Prevention of system blackouts.
Modes of Study	318 h lectures, 18 h laboratory work, 15 h self-study, 3 h preparation for test
Assessment	0-5, examination 70 %, homework 30 %
Study materials	Study material will be announced during lectures

TURBINE-DRIVEN COMPRESSORS

ECTS Credits	**3,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 3 Ass. Sergey Kartashov
Aims	The course is aimed at familiarization students with the theory of turbine-driven compressors, principles of its operation and basics of calculation routine.
Content	**Stages of axial and centrifugal turbine-driven compressors.** Schemes of axial and centrifugal compressors stages. Elements of a flow part and their purpose. Comparative parameters of axial and centrifugal compressors. **Construction concept. Coordinate systems. Main equipment for workflow fundamentals of turbine-driven compressors.** Design of axial and centrifugal compressors. Designation and classification of turbine-driven compressors. Relative and absolute coordinate systems. Velocity triangles. Main equipment for workflow fundamentals of turbine-driven compressors. **Channels in turbine-driven compressors.** Flow part of turbine-driven compressors as a system of channels. Non-viscous and viscous flow in channels of turbine-driven compressors. **Methods of designing of flow part.** An overview and introduction to the methods of design of flow parts of turbine-driven compressors. **Nonstationary processes in turbine-driven compressors.** Classification of nonstationary processes. Methods for the diagnosis of nonstationary processes. Methods to reduce the impact of nonstationary processes in the work of the turbine-driven compressors.**The basics of the numerical experiment.** Overview of software complexes for numerical simulation of flow in turbine-driven compressors. The main approaches in setting and the numerical experiment.

Modes of Study	18 h lecturs, 36 h practical exercises, 10 h exercise preparation, 17 h self-study, 24 h preparation for exam, 3 h exam
Assessment	0-5, examination 70 %, homework 30 %
Study materials	Study material will be announced during lectures

SCIENTIFIC AND RESEARCH WORK, PRACTICE, WORK INTERNSHIP

SCIENTIFIC AND RESEARCH WORK

ECTS Credits	**23,5**
Year and Term	M.Sc. (Tech.), Term 1-3
Teacher	Staff of Institute of Energy and Transport Systems
Aims	A methodological aspect of this subject is a close correlation between theoretical and practical knowledge, which is realized in solving problems of an applied nature and individual assignments.
Content	1st stage – Preparation of the personal plan for the Scientific and Research Work. The subject should be chosen from the field of Master's degree student interests. This plan must be approved with student's supervisor. At this stage, goals and objectives of scientific research (theoretical or experimental) should be outlined. 2nd stage – preparation for the research. To prepare the student has to study research methods, methods of experimental work, the rules of safety operation of equipment, techniques of analysis and proceeding of the experimental data, methods of mathematical modeling of physical processes and phenomena related to the object of study, available information technologies and software. 3rd stage – exprimental work or theoreical research. At this stage, the student collects data necessary for the research, develops mathematical model or presents own idea for solving chosen problem. 4th stage – the processing and analysis of the results. At this stage, the student proceeds of the experimental data or collected data from scientific information resources (books, articles, scientific reports, etc.) to make conclusions about validity of developed model; analyzes results, checks the adequacy of the developed model.
Modes of Study	Self-study and work with supervisor
Assessment	0-5, evaluation based on grade for written report
Study materials	Study material will be announced during lectures

EDUCATIONAL PRACTICE

ECTS Credits	**1,5**
Year and Term	M.Sc. (Tech.), Term 4

Teacher	Staff of Institute of Energy and Transport Systems
Aims	This practice is the connecting link between theoretical training and a future independent work of Master's degree students, both in educational institutions and research centers. Pedagogic practice models teaching activity and includes: - Planning of activities for a given discipline; - The development of lecture notes, implementation of the plan; - Solving problems which could appear during the lectures; - The reflexive analysis of educational activities in conjunction with the head of the master's program, aimed at correcting further training; - Self-reflection and self-assessment of own teaching activities.
Content	In the Institute of Energy and Transport Systems there are following areas for the implementation of pedagogic practice: 1. Teaching special disciplines for Bachelor's degree students; 2. Teaching special subjects for students in secondary educational institutions. 3. Development of methods for monitoring of the educational process in the Institute, data processing, and reporting of the obtained data (analytical work). 4. Development of training materials within individual disciplines (guidelines).
Modes of Study	Self-study and work with supervisor
Assessment	0-5, evaluation based on grade for written report
Study materials	Study material will be announced during lectures

INTERNSHIP IN INDUSTRY

ECTS Credits	**6,0**
Year and Term **Teacher**	M.Sc. (Tech.), Term 2 and 4 Staff of Institute of Energy and Transport Systems
Aims	Internship in industry is aimed to prepare highly qualified professionals in engineering, research, development and fitting equipment of Thermal and Nuclear Power Plants. The students usually do practical training in large Russian thermal power plants or at the Department of the Institute of Energy and Transport Systems. Internship in industry aims at: - studying the safety operation; - developing a positive attitude towards the operational staff activities on thermal power plant; - originating interest in finding optimal solutions in the operation, improvimg the efficiency and reliability of power plants; - fuel saving and reducing capital investment cost; - rising the responsibility for quality of work.
Content	**1. General characteristics of the power plant.** The history of the station, power plants island structure and characteristics of power plant permanent equipment. Electrical and thermal loads, trends. Perspectives of power plant development. **2. Organization of proper operation of power plant equipment.** 3. **Operation of boilers.** Requirements for the boiler operation. Boiler regime map and its main technical and economic indicators. Operation of gas-gas flow path components: exhaust fan, external air and gas pipes, exhaust gases clean-up system. 4. **Operation**

	of steam turbines. Running of a steam turbine under steady-state regime. Operation of regenerative feedwater and network water heaters. Deaerators and its characteristics. 5. **Operation of pumps**. Feedwater pumps and its characteristics. Start-up, steady-state operation and shutdown of pumps. Pump head and pumping capacity regulation. Operational features of turbine drive. Emergency shutdown of pumps and drives. Condensate removal pumps, network water pumps, drainage pumps: start-up, shutdown, steady-state regime. Malfunction of the pumps, causes, remedial measures. 6. **Standards for environmental protection**. Maximum allowable emission. Ways to reduce particulate matter, SO_x and NO_x in the exhaust gases. The main provisions for the equipment of exhaust gases cleaning systems. Measures to improve the efficiency of cleaning systems. Protection of water reservoir. Maintaining the temperature of recirculating wastewater. The performance characteristics of cooling towers. 7. **Conclusions and recommendations for enhancing power plant energy efficiency**. Operational measures for heat and fuel storage. The development of power reserves. Optimization of load distribution between power generating equipment. Reduction of accidents. Examples of establishment of new techniques and technologies, including information technologies.
Modes of Study	Self-study and work with supervisor
Assessment	0-5, evaluation based on grade for written report
Study materials	Study material will be announced during lectures