

## Doctoral study programs –P2301 Machine and Equipment Design 2302V10 Equipment for thermal technique

Doctoral study is the highest type of study at university. Study programs are focused on scientific research and independent creative activity in the field of technical research and development. Graduates can work as researchers and developers in industry, research institutes, Academy institutes and at universities.

### RESOURCES AND ENERGY CONVERSION

Energy and power engineering. Classes and basic properties of fossil fuels. Heat cycles, heat - energy transformations to mechanical energy and reverse change. Heat turbines. Nuclear power engineering Alternative energy sources. Energy and power engineering, fossil fuels (refinement, combustion), heat cycles, transformation of energy, nuclear power engineering, renewable energy sources.

### EXPERIMENTAL METHODS

The systems of data processing, the analysis of experiment, the measurement of noise and vibration, the analysis of combustion gases, the methods of visualization, the hydrodynamic analogy, the thermoanemometry, the optic measurement method of the temperature and velocity fields. Errors of measurements dynamic characteristics of measuring systems. Fluid flow visualisation, analogue methods of flow, LDA, PIV method. Noise and Vibration.

### ELECTED TOPICS IN THERMODYNAMICS

The extension of the basic knowledge from the subjects of the Bc: Thermodynamics and heat transfer and Fluid mechanics. The Thermodynamics of the multicomponent systems, unsteady heat transfer, radiation, the basic of thermochemistry. The conservation equations of the fluid flow - derivation, energy equation, turbulent shear layers, gas dynamics, relative flow, non-stationarity of the flow.

### NUMERICAL METHODS IN FLUID DYNAMICS

Numerical simulation systems in fluid dynamics. Formulation of a system of starting equations for initial and boundary value problem. Methods of time and spatial discretisation. Boundary layers approximation. Introduction for turbulence modelling. Unsteady case simulation in fluid mechanics. Theoretical and practical education.

### TRANSFER PHENOMENA IN THE HEAT ENGINEERING

Transport phenomena in fluids, mathematical formulations, relevant parameters in flows, multiphase flows, buoyancy effect in the natural convection, magnetohydrodynamics and aero-acoustics, turbulence modelling - basic transport equations for turbulence models, numerical simulations of the particular technical problem using FLUENT.

### REGULATION AND CONTROL

The subject Dispatching and control of Energy apparatus give information about hydronics of heating systems, control heating systems, control boilers water and steam, basics control of air conditioner, dispatching of central power heating supply. Regulation armature, actuators, design and mutual interaction, control systems.

### ENVIRONMENTAL ENGINEERING

The lectures introduce into a special issue of the energy recovery from waste. The design of the waste to energy plants is explained. In the lectures are introduced: description of the fuel and the feed water preparation, the transformation of the waste energy - combustion process, the kettle construction, the cleaning process of the combustion products and emission limits. Also the issue of the waste management with the application of the international knowledge of the design, the operation and newest research in this area is explained. The energy recovery from waste is explained as the necessary tool and scale for the sustainable development. The issue includes the description of the phenomena of communal wastes, industrial wastes and cleaning plant sediments.

### ENERGY AND ENVIRONMENT

Clean Air act. Emissions from processes of energy production (CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>). Control methods of Particulate and Gaseous Pollution. Ecological Consequences of Energy Production in Nuclear Power Plants. Greenhouse gases in atmosphere, principles of separation methods, technical equipment for separation of particulate and gaseous pollutants, ecology of nuclear power cycle.

### SELECTED TOPICS IN ENERGY MACHINES

Thermodynamics properties of the real matter. Energetic and entropy form of the Gibbs fundamental equations and the use of the energetic function properties to the thermodynamics properties. Thermo-dynamics properties during the phase changes. Thermodynamics properties of the mixture of the ideal and real gases. The Selected Parts of the Thermodynamics of the multi-component system with chemical reactions. The application of the method of solution to the technical problem.

### NUMERICAL METHODS IN THERMAL TECHNOLOGY

Formulation of the mathematical models for mass and heat transfer in fluids (Navier-Stokes equations and equations for energy), initial and boundary conditions, numerical methods for solving of mathematical models, iterative techniques, generation of computational grids, turbulence modelling, visualization techniques, numerical simulation of the particular flow problems in heat technical applications using FLUENT.

TECHNICAL THERMODYNAMICS

INTERNAL AND EXTERNAL AERODYNAMICS