

**Key areas of research and development at the VŠB-
Technical University of Ostrava**



Key areas of research:

- Raw materials, energy, ecology
- Information technologies
- New materials, structures, technologies
- Safety and security research
- Modern mechanical engineering
- Management, decision-making and modelling of economic and financial processes

Raw materials, energy, ecology

Description:

Research of raw materials, energy and ecology at the VŠB-Technical University of Ostrava is focused on an integrated complex of interrelated disciplines which are essential for achieving future sustainable development:

- Research of the extraction and use of energy resources and other utilizations of mineral wealth while achieving sustainable development and maximum self-sufficiency in raw materials.
- Research of environmental pollution sources with a focus on the effects of industrial technologies. Quality and quantity of environmental emissions – design of model and experimental methods for verifying minimization of effects.
- Development of mathematical models of spatial phenomena for assessing the effects of technologies on the environment. Models of emissions/imissions in the context of air pollution, models of noise propagation in the environment, models for the calculation of emissions from large area sources.
- Development of physical models of equipment for thermic methods of waste processing and metal recycling.
- Development and technical application of new methods for processing brown and black coal, involving desulphurization, flotation, bacterial leaching, bioflotation and bioflotoflocculation.
- Research and development of biotechnological methods for removal of inorganic pollutants and study of the effects of anthropogenic pollutants in agriculture.
- Development of technologies for water processing and purification – clarification, flocculation, filtration, flotation, flotoflocculation.
- Research and development of new-generation flotation agents for flotation of coal sludge.
- Development of methods and testing equipment for waste water flotation purification and sludge liquidation.
- Development of new methods for utilizing alternative fuels in energy generation – biomass, waste, hydrogen.
- Study of energy savings including technologies and methods for utilizing residual and lost heat and energy.
- Development of methods and technologies for reducing environmental burdens caused by energy generation.

An integral part of energy generation and ecology is the application in civil engineering of principles based on sustainable construction. Sustainably constructed buildings have a low impact on the environment and focus on energy conservation, high-quality exterior and interior environments, design methods and material effectiveness.

Areas of research:

- Monitoring of residential buildings and civic amenities built using sustainable

construction principles; verification of design principles (no results of long-term measurements are yet available in the Czech Republic).

- Design and reconstruction of buildings by applying principles of sustainable construction on former industrial sites; conversion of current buildings with respect to the economics of a building's life cycle.
- Research and experimental development of new, highly efficient energy technologies and equipment using traditional and alternative sources of energy, research of ecological aspects of energy resource utilization, improvements in energy transformation efficiency, reduction in energy demands of power generation facilities, reduction of heat losses, research and development of methods to minimize emissions from thermic processes when utilizing alternative and renewable energy resources. This research is carried out primarily at the ENET regional center of excellence (Energy Units for Utilization of Non-Traditional Energy Resources).

Information technologies

Description:

Research and development connected with information technologies at the VŠB-Technical University of Ostrava focuses mainly on the following areas:

- Analysis of extensive data collections using linear algebra methods, neuron networks and other biologically inspired computation techniques, data compression.
- Verification of systems from the perspective of decidability and computational complexity.
- Application of methods of logic and artificial intelligence in the development of multi-agent systems, research of logical analysis of natural language, solution of problems of knowledge representation and derivation of relevant consequences from explicit knowledge bases.
- Development of tools and methods for facilitating the development, analysis, implementation and verification of parallel algorithms.
- Modelling of software processes. Knowledge-based approach to modelling, simulation and visualization of software processes.
- Multi-dimensional indexing data structures, development of XML databases, compression of data structures.
- Algorithms for image processing – segmentation, item monitoring, computation of movement field. Algorithms for visualization and computer graphics.
- Distributed and parallel computation systems, computer networks and communication infrastructure, mobile and operating systems.

New materials, structures, technologies

Description:

Research for the development of new materials, preparation technologies and the study of material properties focuses on the following areas:

- Study of properties of intensively formed materials, determination of their structural strength potential.
- Development and study of behaviours of nanostructural materials with a focus on nanolayers, periodic structures with horizontal and vertical configuration, and nanoparticles. Processes for preparation, refining and crystallization of pure metals and special alloys.
- Evaluation of degradation process of structural materials in relation to their technical applications, estimates of residual lifespan of structures.
- Study of distribution of trace elements in coal matter, ash, metallurgical materials – sorption and intercalation of substances into phyllosilicates, preparation of nanostructural materials.
- Research of physical-chemical processes in gas-melt-solid systems in metals and inorganic substances.
- Development of new technologies for decomposition of industrial waste gases using heterogeneous catalysis methods.
- Development of new technologies for iron and steel production, refining and casting applying mathematical-physical models.

Safety and security research

Description:

Research related to safety and security at the VŠB-Technical University of Ostrava focuses on the following areas:

- Methods for assessing safety/security of critical infrastructure elements.
- Fire safety in tunnels.
- Action of synergic effects in industrial zones.
- Protection against terrorism and eco-terrorism involving CBRN substances.
- Accident prevention methods, modelling of leaks and dispersion of toxic substances in accident situations.
- Fire and explosion prevention in technological processes.
- Study of technical-safety parameters of flammable substances.
- Strategies and methods for modelling fires using infrared flame thermography.
- Physical-chemical atmospheric processes.
- Occupational safety and health protection.

- Crisis management.

Modern mechanical engineering

Description:

Research and development in essential disciplines for the development of a competitive mechanical engineering sector focuses primarily on structural and process engineering for general mechanical engineering, power engineering and the automotive industry.

- Development of new technologies for the construction and design of machines and equipment for deep and surface raw material extraction, machinery for waste processing, construction and earthmoving machinery, machinery for metal production and subsequent processing, furnace aggregates for heating materials, equipment for the preparation of high-purity structurally defined materials including related technologies for technical diagnostics and maintenance.
- Development of new functional coatings for machine parts based on nanopigments and nanoinhibitors. Research of methods for evaluating formability, weldability and machinability of highly exposed materials in power engineering. Development of progressive technologies for high-speed machining, research of methods for online testing of products, tools and workpieces.
- Research in applied mechanics, theory of elasticity and fracture mechanics, study of limit states in structures, development of methods for evaluation stress deformation states in structures under complex load conditions, assessment of residual lifespan of structures, optimization of liquid flow for heat conduction and combustion, conditions of cavitation and hydraulic impact.
- Research of theoretical knowledge for optimum management of machinery and processes, including development of technical and programming tools for machine control and performance measurement of production processes and key production indicators. This research is closely connected with all other areas of research in mechanical engineering.
- Research and development in geared transmissions. The research centre at the Faculty of Mechanical Engineering (FME) is renowned for its work in this field, including leading theoretical applications (J. Božek Research Centre) and widespread cooperation with industry (Škoda Auto, MB Tech, Jungheinrich etc.). The centre has achieved outstanding results developing non-standard modified geared transmissions for the automotive industry and developing gear systems with extreme parameters.
- Development of transport machinery and systems for handling and transporting items and bulk materials in deep mines, quarries, metallurgical installations, power generation facilities and processing plants, in the mechanical engineering sector and in waste processing plants. Research and development in this area includes studying the behaviour of bulk materials, monitoring the geometric and mechanical-physical parameters of particulate matter (granulometry, particle shape, flow curves, powder rheology) within a unique range of sizes from 2 nanometres to 4 cm, plus carrying out measurements for a range of University workplaces and commercial partners.
- Research and development of service robots and mechatronic systems, studies of their

applications in industry, households, health care and safety engineering. Research and development of methods for the creation and optimization of mechatronic subsystems with computer support.

- Research and development of automotive technologies, development of electric vehicles with smart chassis and 4-wheel drive, research and development of drive systems and charging systems for electric vehicles.

Management, decision-making and modelling of economic and financial processes

Description:

Research in economic disciplines at the VŠB-Technical University of Ostrava focuses on the evaluation of economic and financial processes in the following areas:

- Research of economic and financial systems on the national, sector and company levels.
- Modelling of economic and financial processes in manufacturing and commercial non-financial institutions.
- Modelling of economic and financial processes in financial institutions such as banks, investment companies and insurers.
- Development and application of dynamic methods for multi-criteria decision-making on the basis of optimization under risk and flexibility.
- Development of methods for valuation of financial derivatives, application of stochastic processes and fuzzy stochastic models of decision-making and valuation.