DEPARTMENT OF POWER SYSTEMS AND ELECTRIC DRIVES

General Information

Department of Power Systems and Electric Drives was founded in the academic year 1955/56 as the Department of Electric Traction and Energetics at the Railway University in Prague.

The department had originally an accreditation in the field of “Electric Traction and Electrical Power Systems”. Graduates of the department were formerly trained mainly for 24 and 12 FMD, for industrial plants producing electric traction equipment, for both urban and industrial transport, and for the scientific and research laboratories in the electro-technical industry.

The highly important period for the department was during years 1991 – 1994. In those years, a TEMPUS project JEP-1939/91-94 was accepted and realized. The project titled "Improvement of Educational Activities in Power Electronics and its Applications" considerably affected the next heading of the department. The aims of the project were: a creation of a new curriculum for Power Electronics, Electric Drives and Electrical Machines, setting up new laboratories, purchase of computing and measuring hardware, mobility of students and staff. The universities in Catania, Roma, London, and Helsinki co-operated and guaranteed this project. The results of the project set the department forward in its effort to become a modern department with a high-level educational program.

Within the latest complex accreditation in 2015, the one study program in bachelor’s degree program, two study programs in the master’s degree program as well as in the doctoral degree program have been accredited at the department. The bachelor’s degree study program provided by the department is Electrical Engineering. The accredited master’s degree study programs are the Electric Power Systems and Electric Drives programs. The Electric Drives study program also includes the possibility of the major in Electric Traction. The study programs accredited in the doctoral degree program are the Power Electrical Engineering and Electric Power Systems.

Department is equipped with a high-quality computer and measuring technology in the area of technical infrastructure. The substantial improvement of the department was achieved mainly with the help of EU Structural Funds.

The main research focus of the Electric Power Systems section is power quality and control and operation of power transmission systems in dynamic as well as steady-state modes. In the field of Electric drives, the research is mainly focused on high dynamic control of AC drives using novel mathematical methods, research and development of the permanent magnet motors and electrically commutated electrical machines, as well as on various traction applications.

Department intensively cooperates with significant companies from Slovakia, as well as from abroad.

Staff of the Department

Head of the Department:	Juraj Altus
Vice-head of the Department:	Alena Otcenasova
Administrative Support:	Darina Rufusova

Sections of the Department

Section of Electric Power Systems

Head of the Section:	Alena Otcenasova
Professors:	Juraj Altus
Associate Professors:	Peter Bracinik, Alena Otcenasova, Marek Roch
Senior Lecturers (with PhD):	Josef Beran, Miloslav Buzek, Marek Hoger, Ivan Litvaj, Michal Regula, Martina Kajanova

Section of Electric Drives and Electric Traction

Head of the Section:	Pavol Makys
Professors:	Pavol Rafajdus, Valeria Hrabovcova – professor emeritus
Associate Professors:	Pavol Makys, Milan Pospisil
Research Fellows:	Pavel Lehocky, Vladimir Vavrus, Lukas Gorel
Senior Lecturers (with PhD):	Matej Pacha, Marek Stulrajter

Postgraduate Students

Internal (full-time):	David Motyka (until September 2020), Marek Novak (until September 2020), Martin Sumega (until September 2020), Patrik Varecha (until September 2020), Simon Zossak (until Septermber 2020), Frantisek Pernis (until July 2020) Marek Siranec, Marian Tomasov, Stefan Kocan, Michal Kovacik, Matej Tazky (from September 2020), Marek Furmanik (from September 2020), Daniel Konvicny (from September 2020), Michal Stano (from September 2020), Michal Vidlak (from September 2020)
External (part-time):	Dávid Kaprál (until September 2020)

Education

Courses in Bachelor, Master and Doctoral Degree Programmes

Bachelor's degree Programmes

Course ID	Name	Sem.	Hours/Week
			L-E-Ls*
Courses at the Faculty of Electrical Engineering and Information Technology			
3B0104	Basics of Electrical Engineering	1	1 – 2 – 0
3B5100	Professional Practice (60 hours)	1	0 – 0 – 0
3B0207	Enterprise Management and Economics	2	2 – 1 – 0
3B0214	Project Learning 2: Solar Team Slovakia	2	1 – 3 – 0
3B5200	Professional Practice (60 hours)	2	0 – 0 – 0
3B0313	Programming Languages	3	1 – 0 – 2
3B0311	Normalization, Metrology, Testing	3	1 – 1 – 0
3B5301	Professional Practice (60 hours)	3	0 – 0 – 0
3B0405	Electric Machines	4	4 – 1 – 2
3B0413	Work Safety in Electrical Engineering	4	2 – 0 – 1

3B0415	Design of electric wiring	4	2 – 1 – 1
3B5404	Electric Machines in English 1	4	1 – 1 – 0
3B5402	Introduction to electric drives	4	2 – 0 – 1
3B5401	Materials and Technologies in Electrical Engineering	4	2 – 1 – 1
3B0416	Project Learning 4: Solar Team Slovakia	4	1 – 3 – 0
3B5405	Professional Practice (60 hours)	4	0 – 0 – 0
3B5504	Electric Traction 1	5	3 – 2 – 0
3B0505	Electric Drives 1	5	2 – 1 – 1
3B0506	Electrical Apparatus	5	2 – 0 – 2
3B0508	Electricity Generation	5	2 – 2 – 1
3B0511	Methods of Quality Management	5	1 – 1 – 0
3B5500	Electricity Transmission	5	2 – 2 – 1
3B5501	Mechanics of electrical overhead lines	5	2 – 2 – 0
3B5502	Selected topics of electric machines	5	2 – 0 – 2
3B5506	Electric Machines in English 2	5	1 – 1 – 0
3B5507	Application of Digital Signal Processors 1	5	0 – 0 – 2
3B5508	Professional Practice (60 hours)	5	0 – 0 – 0
3B5600	Course of state examination in the Specialization	6	0 – 4 – 0
3B5606	Elaboration and Defence of the Bachelor Thesis	6	0 – 17 – 0
3B0606	Electric Drives 2	6	5 – 2 – 2
3B0607	Quality Management	6	4 – 2 – 0
3B5601	Bachelor Project of the Electric Power System	6	0 – 5 – 0
3B5602	Bachelor Project of Electric Drives	6	0 – 5 – 0
3B5603	Bachelor Project Electric Traction	6	0 – 5 – 0
3B5604	Electric Traction 2	6	5 – 0 – 4
3B5609	Basics of Project Documentation Creating	6	0 – 0 – 4
3B0614	Project Learning 6: Solar Team Slovakia	6	2 – 5 – 0
3B5607	Application of Digital Signal Processors 2	6	0 – 0 – 3
3B5608	Professional Practice (60 hours)	6	0 – 0 – 0
Courses at the Faculty of Mechanical Engineering			
211062	Electroenergetics	5	2 - 2 - 0

*(L) lectures - (E) exercises - (Ls) labs

Master's degree Programmes

Course ID	Name	Sem.	Hours/Week
			L-E-Ls*
Courses at the Faculty of Electrical Engineering and Information Technology			
3I4101	Transients in Power Systems	1	2 – 1 – 1
3I4102	Power Plants	1	2 – 2 – 0
3I4103	Electric Substations	1	2 – 1 – 1
3I3104	Professional Practice (60 hours)	1	0 – 0 – 0
3I4106	Professional Practice (60 hours)	1	0 – 0 – 0
3I3100	Analysis of Electrical Machines	1	2 – 0 – 2
3I3101	Control of Electric Drives 1	1	3 – 2 – 0
3I3102	Dynamics and Power Engineering of Electric Traction	1	2 – 2 – 0

3I3103	Vehicles of Electric Traction	1	3 – 0 – 1
3I4200	Power system control	2	3 – 2 – 0
3I4201	Renewable Energy Sources	2	2 – 1 – 1
3I4202	Protective Relaying	2	2 – 1 – 1
3I4203	Electric Drives in Electric Power System	2	2 – 1 – 1
3I4204	Supply of Electric Railways	2	2 – 2 – 0
3I4205	Electric Power Systems in English	2	0 – 2 – 0
3I3200	Control of Electric Drives 2	2	3 – 2 – 0
3I3201	Sensors, interfaces, actuators	2	2 – 0 – 2
3I3203	Electric Traction	2	2 – 1 – 2
3I3204	Professional Practice (60 hours)	2	0 – 0 – 0
3I3206	Professional Practice (60 hours)	2	0 – 0 – 0
3I0211	Electrical machines for special purposes	2	2 – 0 – 2
3I0213	Power system modelling	2	2 – 0 – 2
3I0220	Project Learning 2: Solar Team Slovakia	2	1 – 3 – 0
3I4300	Power quality	3	2 – 2 – 1
3I4301	Feasibility Calculations for Power Networks Development	3	2 – 2 – 0
3I4302	Information Systems for Power System Control and Monitoring	3	2 – 0 – 2
3I4303	Diploma Project of Electric Power Systems 1	3	0 – 2 – 2
3I4304	Reliability of Electric Power Systems	3	2 – 2 – 0
3I4305	Application of Numerical Calculations in Electric Power Systems Operation	3	0 – 0 – 4
3I3303	Professional Practice (60 hours)	3	0 – 0 – 0
3I4307	Professional Practice (60 hours)	3	0 – 0 – 0
3I0306	Programmable Logic Controllers	3	2 – 0 – 2
3I0316	Methods for Systematic Design	3	3 – 1 – 0
3I0319	Electric Energy Utilization	3	2 – 2 – 0
3I3300	Sensorless Control of Electric Drives	3	3 – 1 – 1
3I3301	Discrete Control of Electric Drives	3	3 – 0 – 3
3I3302	Diploma Project of Electric Drives 1	3	0 – 2 – 0
3I9301	Control of Electric Drives 1	3	3 – 2 – 0
3I4400	High Voltage Engineering	4	4 – 0 – 4
3I4401	Diploma Project of Electric Power Systems 2	4	0 – 4 – 2
3I4402	Elaboration and Defence of the MSc Thesis	4	0 – 20 – 0
3I4403	Course of State Examination in the Specialization	4	0 – 4 – 0
3I4404	Economy of Electric Power Systems Operation	4	4 – 4 – 0
3I3403	Professional Practice (60 hours)	4	0 – 0 – 0
3I4405	Professional Practice (60 hours)	4	0 – 0 – 0
3I0403	Corporate Quality Management	4	4 – 4 – 0
3I0408	CAD/CAE Systems	4	0 – 0 – 4
3I0412	Project Learning 4: Solar Team Slovakia	4	2 – 6 – 0
3I3400	Diploma Project of Electric Drives 2	4	0 – 4 – 0
3I3401	Elaboration and Defence of the MSc Thesis	4	0 – 20 – 0

3I3402	Course of State Examination in the Specialization	4	0 – 4 – 0
Courses at the Faculty of Mechanical Engineering			
221197	Electrical Traction Equipment	2	2 – 2 – 0

*(L) lectures - (E) exercises - (Ls) labs

Doctoral Degree Programmes

Course ID	Name	Sem.	Hours/Week
			L-E-Ls*
Courses at the Faculty of Electrical Engineering and Information Technology			
3D1100	Foreign Language		2 - 0 - 0
3D1112	Essay to Dissertation Examination and Defence of Written Project for Dissertation Examination		0 - 0 - 0
3D1113	The Thesis and Dissertation Defence		0 - 0 - 0
3D1101	Economic Aspects of Electric Power Systems Operation		2 - 0 - 0
3D1102	Electromagnetism in Power Systems		2 - 0 - 0
3D1103	Smart Grids		2 - 0 - 0
3D1104	Power Quality		2 - 0 - 0
3D1105	Power Systems Modelling		2 - 0 - 0
3D1106	New Trends in Power Transmission		2 - 0 - 0
3D1107	New Trends in Power Generation		2 - 0 - 0
3D1108	Transients in Power Systems		2 - 0 - 0
3D1109	Power Systems Control		2 - 0 - 0
3D1110	Theory of Electromagnetic Field		2 - 0 - 0
3D1111	Selected Chapters from Mathematics		2 - 0 - 0
3D4101	Electric Drives and Electric Traction		2 - 0 – 0
3D4102	Electrical Machines and Equipments		2 - 0 - 0

*(L) lectures - (E) exercises - (Ls) labs

Research & Development

Research and development activities of the **Electric Power System** section are focused on issues concerning electricity generation, transmission, and distribution. The research activities oriented on electricity generation are mainly focused on a modelling of the operation of renewable energy sources. Simulation results as well as acquired knowledge are used to design simulation models, which are thereafter applied in power system analyses as well as in the optimization of renewable energy sources' deployment within virtual power plants.

Scientific and research activities in the field of electricity transmission and distribution are focused on the modelling of electric power system operation, especially on an application of the concept of intelligent networks (Smart Grids) to the control of both power transmission and distribution networks.

An integral part of the research activities of the department is solving the issue of power quality in the distribution or transmission system. The issue is solved comprehensively. Attention is given to the causes of poor quality of supply, EMC, statistics in different locations of the system, and of course, possibilities for improvement by the application of the appropriate devices or by the design of other feasible measures.

The section of Electric Drives and Electric Traction mainly focuses on control of all types of electrical drives such as DC motors, AC motors, and special drives with different types of rotors (SRM, RSM, BLDC, and Stepper Motor). Research focus can be divided into the following areas:

Sensorless control of electric machines allows increasing the overall drive reliability as well as reducing the drive size. This topic includes research of estimation algorithms and control techniques for DC and AC drives (IM, PMSM, BLDC, RSM, and SRM). Traditional estimation methods are usually applied for the higher speed range of the drive. For the low, even zero speed, there are methods and algorithms which require high-frequency voltage signal injection for the estimation. Currently, the sensorless techniques form the basis of some control systems characterized by system fault tolerance. This means that at least partial operation under any circumstances is ensured. The research results have been presented at significant international conferences.

Design of novel and progressive control methods – the research in this area has been focused on methods that use forced dynamic control or sliding mode control. These control structures do not require the use of PI controllers, which means avoiding the complications associated with their setting (often trial and error setting technique) and their dependence on changing of the controlled system parameters. This category also includes various support control algorithms providing a wider speed range, less torque ripple, and therefore less vibration and noise.

Design and implementation of control algorithms for linear motors drive applications – linear motors are very progressive especially for high dynamic applications. Research activities cover the designing of control methods that have the capability to avoid all adverse effects of linear motors such as non-linear friction, cogging torque, and other problems that need to be eliminated in the highly precise and dynamic applications.

Design of energy flow control in hybrid railway vehicles – hybrid vehicles are today considered as a very progressive type of railway vehicles. The most needed research issues in this area are primary source operation optimization (catenary or a diesel engine) or braking energy storage that is in conventional vehicles lost as heat. Hybrid vehicles assume utilization of modern energy storage systems, mainly supercapacitors or modern electrochemical cells (lithium-based systems). Research results have been published at several international scientific conferences and implemented in an international commercial project.

Within this section, the research is also oriented to electrical machines, mainly modern design and optimization method of any types of electrical machines with the capability of identifying the parameters and characteristics of these machines and their possible utilization in industry, modern drives, or in electric traction.

Laboratory of high voltage

The Laboratory is equipped with measuring and testing devices for testing electrical strength as well as other parameters of insulation materials and elements used in high voltage engineering up to 300 kV.

The laboratory is operated in cooperation with SSD, a.s. and it is utilized mainly for the analyses of materials' characteristics, detecting reasons of the faults of high voltage devices, and the testing of protective means. It is also used for teaching activities.

Laboratory of power quality

The Laboratory of power quality is equipped with measuring devices obtained due to the international project SK-CZ "Cooperation between the University of Zilina and the VŠB-TU Ostrava on the improvement of the quality of education and preparation of researchers in the field of electrical power engineering", which was funded by EU funds. The purchased measuring system is both used in the laboratory as well as in the field measurements. It consists of several power quality analysers from various manufacturers (4x ENA 330 and 3x FLUKE 1760), which can analyse all parameters of voltage quality in the network according to the standard

STN EN 50160. There are also measuring accessories, and software and hardware implementation of SCADA system in the laboratory. This allows online data acquisition of all variables and parameters measured by power quality analysers, their analysis, and graphical presentation through personal computers.

There is a possibility to carry out experiments on models of 110 kV and 22 kV power lines in the laboratory while in the final configuration the system allows monitoring different sources of disturbance, the composition of these disturbances from different sources, and their propagation along modelled power lines for different operation conditions.

The laboratory is also equipped with a workstation for assessing the measurement accuracy of various types of electricity meters using a special programmable source that can generate voltages up to 600 V and 120 A. This generated voltage can be distorted by any ratio of harmonic components up to 50th order and any phase shift between voltage and current can be set.

Laboratory of electric drive control

The Laboratory of electric drive control has been created in cooperation with NXP Semiconductor, Inc. to familiarize students with practical applications of electric drives and all the problems of real applications.

The electric drives laboratory work stations consist of NXP 56F8346 DSC Controller Board or NXP MPC 5567 Controller Board, power converter NXP 16 V/120 W, and a selectable electric machine – asynchronous machine (Siemens, voltage 21/12 V power 90W) or permanent magnet synchronous machine (TG-Drives, voltage 21/12 V, 90W). Each electric drive stand is supplied by a low-voltage source and equipped with the debugging tools USB-TAP.

Students can also use within their work other NXP development tools as the TOWER system, SLK (Student learning kits), etc. The Laboratory also serves as a base for application development and international competition of smart cars NXP Cup. Various examples of results of students' theses and demonstration panels by industry partners are presented in the laboratory.

The lab is also equipped with three research workstations. The first one consists of two synchronous machines connected with a flexible coupling designed for parameters' investigation, and for research and development of control algorithms to eliminate effects of flexible couplings.

The second workstation focuses on the control of a linear permanent magnet synchronous machine of 4 kW. The linear motor is supplied from a three-phase invertor by VONSCH and controlled by a digital signal controller NXP MC56F8346.

The third workstation consists of a 3-axis milling machine with two special linear motors in X and Y axes. Vertical displacement is handled by a step-machine. Horizontal motors have a special construction of the windings with a non-ferrous core on the moving part. These machines have been developed in collaboration with the company EVPÚ, a.s., Nová Dubnica and supported by the Slovak Research and Development Agency (APVV-99-031205). The control of the machines is provided by two EVPÚ's power converters controlled by NXP MC56F8367 processors. Synchronization of commands for the milling machine is done with the CNC interface and Mach3 software.

Laboratory BI003 – Centre of excellence of power electrical systems and materials for their components

Activities of centres of excellence (CEEX I and II CEEX) projects are pursued in the laboratory. These projects were implemented within the Operational Programme of Research and Development, Measure 2.1 - creation and promotion of excellence in research.

The laboratory is equipped with a 330-kW recuperative dynamometer. The equipment of this dynamometer also includes measuring instruments for accurate measurement of power input/power of the tested drive, 6-channel power analyser Yokogawa WT1800, miliohmmeter Resistomat 2316, measuring case for non-contact current measurement up to 1000A, and measuring case for voltage measurement up to 2000V. This dynamometer has a control panel for controlling the measuring/testing process with a PC for automatic testing of drives according to STN standards. The laboratory also has a 100-kW recuperative dynamometer, which is equipped with a high-precision torque sensor with the possibility of analysing the torque ripple of the tested drive. Additionally, there is also a climatic chamber with a volume of 8 m3, in which it is possible to test electrical equipment under different climatic conditions, within the temperature range -55 ° C to 175 ° C and air humidity range from 10% RH up to 95% RH (within temperature range +5 ° C to 95 ° C). This dynamometer is also equipped with a Yokogawa WT1800 power analyser, Resistomat 2316, and a measuring case for non-contact current measurement up to 400 A. The dynamometer control panel allows automatic measurement of drives according to valid STN standards.

The equipment of the lab also consists of adjustable power sources 0 to 600V 50Hz, resp. 0 to 400V, 10 to 60Hz with power up to 100kW. The laboratory also has precise high-performance Teledyne Lecroy oscilloscopes, or Tektronix battery oscilloscopes and hand-held multimeter and Fluke clamp current multimeters.

Created laboratory is used for research and verification of new control structures for drive applications (rotational and linear motion). The proposed algorithms must consider the adverse effects of the power converter (voltage ripple in the DC link, dead time, saturation power components, etc.). For achieving the highest quality of proposed drive, control is necessary to precisely know motor parameters, which can be done by off-line and on-line motor parameter identification methods. Research team also works with new motor control topologies for non-standard types of electrical machines.

The lab also serves for measurements and tests of electronic and electrical equipment based on customer requirements or prototype, serial and climatic tests of equipment according to valid STN standards.

Laboratory of electric traction

The laboratory has a measuring stand for the measurement of traction DC electric motors. The system is supplied by the remotely controlled power supply station, which offers adjustable sources of direct current 0-250 A and direct voltage 0-750 V. The measurements are supported by analogue and digital equipment, high-end oscilloscope Lecroy WaveRunner 44Xi-A, high voltage probe (up to 6 kV), magnetic probe, vector power analyser Zimmer LMG-500 and two electronic power sources (0-600 VDC, 0-25 A and 0-60 VDC, 0-45 A).

The laboratory is equipped with another combined system of two AC induction traction motor in low power connection. This stand was supported by ŠF EÚ, ITMS 26220120003 project and created in cooperation with EVPÚ, a.s., Nová Dubnica. The system also includes two 70 kVA converters, which ensure operation in all required measuring tasks.

The most attractive part of the laboratory is a locomotive simulator of type ZSSK 240, with its main part – the driver's cab. This project was supported by the KEGA agency project 006ŽU-4/2014 since 2014. The simulator was created with the support of NXP Semiconductors, NXP Semiconductors, Rožnov pod Radhoštěm (ČR), Pars NOVA, a.s. Šumperk (ČR) a ČD, a.s., DKV Brno (ČR). The students have also taken part in the creation of the simulator as part of their bachelor's and master's theses. The project is technically supported by the international project OpenRails Train Simulator as well.

Laboratory of electrical machines

This Laboratory is designed for the measurement and identification of the parameters of almost all types of electrical machines and their operating characteristics in motoring and generating mode. The laboratory is equipped with modern measuring instruments and dynamometers up to 7.5 KW output. The laboratory is also used in the teaching process in all three levels of education, and of course, for other research activities at the department.

Projects of National Programmes

Research Projects Funded by the Scientific Grant Agency of the Slovak Republic (VEGA)

1/0774/18: High effeciency electric drives for high speed applications	
Summary:	The main aim of the project is the research and design of the compact high-speed electric drive. The electric drive represents a set of equipment (electric motor, power converter, and control system with an appropriate control structure) that provide energy conversion with some efficiency. Therefore, the project addresses the individual parts of the electric drive focusing on the overall efficiency of the high-speed drive to increase the efficiency of the energy conversion. The project is divided into three key parts. The first part deals with the high-speed electric motor. It is about designing the electro-mechanical motor structure, minimizing the losses in the machine, size proposition, design and verification of mechanical strength and stiffness of the rotor. The second part of the project is focused on the power converter design which is intended to supply the electric motor. The third part of the project discusses the design and implementation of appropriate control algorithms for the high-speed drive.
Realization:	1/2018 – 12/2020
Coordinator:	Pavol Makys
Co-operators:	Pavol Rafajdus, Vladimir Vavrus, Lukas Gorel, Marek, Stulrajter, Jan Vittek, Valeria Hrabovcova, Pavel Lehocky, Juraj Makarovic, Lubos Struharnansky, Milan Diko, Pavel Sovicka

1/0615/19: Scientific research of high-speed drive with minimal torque ripple	
Summary:	The presented project deals with the scientific research of high-speed drive from point of view of reducing torque ripple and minimizing vibrations. The entire electric drive consists of three important components: a high-speed motor, a power inverter and a control system with a suitable control structure. Base on this, the project is divided into the design and optimization of a high speed motor and a power inverter with a suitable control algorithm for sensor and sensorless control of the electric drive. The project will deal with the electromechanical motor design in terms of minimizing the torque ripple, designing and checking the mechanical strength and stiffness of the rotor. Another part of the project solves the power supply of an

	electric motor via a power inverter. The last part of the project focuses on the design and implementation of high speed drive control.
Realization:	01/2019 – 12/2021
Coordinator:	Pavol Rafajdus
Co-operators:	Pavol Makys, Valeria Hrabovcova, Vladimir Vavrus, Lukas Gorel, Pavel Lehocky, Marek Stulrajter, Juraj Makarovic, Martin Sumega, Patrik Varecha, Simon Zossak

1/0371/19: Societal vulnerability assessment due to the failure of important systems and services in the electricity sector	
Summary:	Reducing the level of social vulnerability is one of the main principles of the functioning of society. Social vulnerability is part of the disaster risk assessment and key information needed to assess relevant threats and measures to mitigate their adverse effects. Identifying key dimensions of vulnerability forms the basis for reducing risk and improving society's preparedness for various risk and crisis situations. Part of the vulnerability assessment is the identification of the resources necessary to deal with an adverse event. The project focuses on research into the possibilities of quantifying the vulnerability of society due to the failure of important systems and services in the electricity sub-sector. The main output of the project will be a hierarchical model and methodology of assessing social vulnerability, with practical application for a particular selected area, considering the failure of a part of the electricity system.
Realization:	01/2019 – 12/2021
Coordinator:	Maria Luskova (FBI, UNIZA)
Co-operators:	Peter Bracinik

Projects Funded by the Cultural & Education Grant Agency (KEGA)

026ZU-4/2019: Implementation of GPS specification of products into the teaching process of mechanical engineering study programs and into the technical practice	
Summary:	The goal of the project is modernization, improving, and supplementing of teaching content and form within the study programs of bachelor's and master's studies at the technical universities. The project deals with the implementation of the knowledge's introduced in the latest International Technical Standards from the field of Geometric Product Specification (GPS) into the teaching plans of such subjects as Technical/Engineering Drawing, Methodology of Design, Engineering Metrology, Quality Management in Engineering and Measuring Methods and Instruments. The outcome of the project will be the creation of an educational program that will include the publication of two university textbooks. The project is also focused on internationalization in education, increasing skills and flexibility in technical specializations as well as on increasing university student's linguistic skills.
Realization:	2019-2021
Coordinator:	doc. Ing. Jozef Broncek, PhD. (Faculty of Mechanical Engineering, University of Zilina)
Co-operators:	Ivan Litvaj

011ZU-4/2020: Implementation of on-line education in the field of bearing production technologies with emphasis on the educational process to increase the skills and flexibility of mechanical engineering students	
Summary:	The amount of information that needs to be mastered by students is constantly growing. The processing of teaching material into multimedia courses and their interactive study increases the quality and speed of acquiring knowledge and skills, allows the student to move from the passive role of the listener to the role of an active participant in the educational process. Learning through e-learning is an increasingly preferred method, which is also the focus of the present project. It focuses on the modernization of education and the online approach to the teaching of bearing production technologies, which are an integral part of mechanical engineering. The outputs of the project in the form of multimedia and internet applications in the form of websites can be used not only for the active education of students at the university but also on a national scale and for the general public. In addition, the outputs of the project should serve as important materials in solving research projects and final theses of students in bachelor's and master's study programs.
Realization:	2020-2022
Coordinator:	doc. Ing. Dana Stancekova, PhD. (Faculty of Mechanical Engineering, University of Zilina)
Co-operators:	Ivan Litvaj

045ŽU-4/2019: Innovation of the educational process by modernization of Electrical Machines Laboratory	
Summary:	The aim of the project is a complex modernization of the Electrical Machines Laboratory, where the measurements of electrical machines are done by the Department of Power Electrical Systems at the Faculty of Electrical Engineering of the University of Žilina in bachelor and master studies. The result of the modernization of the laboratory is to reach the national and international standards and industrial standards in terms of further application of graduates. Innovative studding texts on measuring points will be introduced and automated measurements on electric machines will be created. It can be said that study of the field of electric machines is not easy. This subject is an integral part of the study fields for which this issue is a complete foundation without which the understanding of other contexts is very problematic. Its quite clear, that the most proper way how to be success, is to work in practice and various measurements, to simulate different operating states at test benches. For this purpose, three modern measuring instruments will be constructed as a result of the project, where each station includes electrical machine able to work as a motor or generator, variable power sources with appropriate power levels, variable electronic loads, measuring instruments, recording and computing equipment, mechanical equipment for appropriate fixation and mechanical attachment of the measured electrical machine. This technical part of the project will be complemented by lecture scripts - guides for each measurements, which will be processed according to relevant applicable standards and international standards. The measurement test benches thus allow to individual students to realistically measure the relevant electrical machines, and apply the theoretical knowledge in practice where is a huge request for so skilled and erudite experts in the field of electric machines and drives.
Realization:	01/2019 – 12/2021
Coordinator:	Pavol Rafajdus
Co-operators:	Pavel Lehocky, Juraj Makarovic, Rudolf Madaj, Stefan Kocan, Marek Furmanik

Research Projects Funded by the Slovak Research and Development Agency (APVV)

APVV-15-0464: Efficiency increase of electricity transmission in Slovak power transmission system	
Summary:	The present project deals with a research of losses caused by impedance unbalance of selected electrical elements (e.g. transformers, overhead lines and compensation reactors) of Slovak Republic transmission system (SR TS) as a generally unbalanced system, with a research of a suitable approach of specifying impedance and admittance matrices of its individual elements and with a draft of technical measures to mitigate losses caused by impedance unbalance of these elements. The minimization of losses is still considered as a suitable tool for a more efficient use of energy sources that can help to increase overall energy efficiency. The importance of this objective is also supported by the document of the European Council of 23 - 24 October 2014 aimed at the policy framework related to climate and energy that specifies an approximate objective for improving energy efficiency by no less than 27 % by 2030 against the estimated future consumption.
Realization:	1/2016 – 12/2020
Coordinator:	Juraj Altus
Co-operators:	Marek Roch, Marek Hoger, Alena Otcenasova

APVV-16-0505: The short-term PREDICtion of photovoltaic energy production for needs of pOwer supply of Intelligent BuildiNgs - PREDICON	
Summary:	The proposed project is aimed at the developing of method for a very short-term prediction of photovoltaic (PV) power plant output with timescale ranging from 5 to 30 minutes. To forecast the intensity of solar irradiance, as the main factor affecting the performance of PV power plant, the algorithm using analysis of recorded image data representing cloudiness motion above the installation site of PV power plant will be proposed. To achieve the best accuracy of output prediction of PV power plant, local factors affecting solar irradiance and PV power plant operation will be identified. The analysis will be done in order to define correction factors for the adaptation of predicted values of solar irradiance determined by the proposed algorithm to current local conditions at the installation site of PV power plant. The functionality and accuracy of proposed method will be verified by the help of created PV power plant mathematical model as well as by measurements performed on real PV power plant.
Realization:	07/2017 – 06/2020
Coordinator:	Robert Hudec (KMIKT, FEIT, UNIZA)
Co-operators:	Peter Bracinik, Marek Novak

Projects of European Structural Funds

ITMS2014+: 313012N944: Research and development of new plasma milling system PLASMABIT BHA for effective and environmental well plug & abandonment and implementation of the new product to the production process	
Summary:	The main goal of the project is the research and development of plasma milling system PLASMABIT BHA, to perform functional tests of prototype and afterward to implement the new product into the production process. Our new product is intended for plasma milling of the pipeline (steel tube) as a more effective, economic, safer, and moreover, environmental way of tight plugging of depleted oil & gas wells. PLASMABIT BHA will be able to remove part of a pipeline in a contactless

	way and so tightly close the well, thus preventing the leakage of residual fractions of oil or gas.
Realization:	06/2019 – 06/2021
Coordinator:	Pavol Spanik
Co-operators:	Pavol Rafajdus, Vladimir Vavrus, Marek Hoger

Other National Research Projects

GRANT UNIZA: Research into the possibility of using electric vehicle batteries in the form of storage system for an electrical power system regarding the preferences and needs of electric vehicle owners	
Summary:	The main goal of the project is to research the possibilities of using electric vehicle batteries in the form of a storage system for the electrical power system, taking into account the preferences and needs of electric vehicle owners. The project will define a mechanism that will socially divide the required charging/discharging power between electric cars based on the needs of the power system and electric car owners. At the same time, the mechanism will define incentives for EV owners in a way that the participation in this mechanism and a true definition of their needs is the optimal strategy for each of owners. The proposed mechanism will be verified by the simulation and a recommendation for its implementation in practice will be defined based on the obtained results.
Realization:	09/2020 – 08/2021
Coordinator:	Martina Kajanova
Co-operators:	

GRANT UNIZA: Sound modulated Tesla coil for presentation purposes	
Summary:	The project is focused on the construction of a sound modulated Tesla coil, which will be used for presentation purposes. This device will produce electrical discharges, whose sound will change depending on the audio input signal. The functional prototype of the device is ready, but it is not portable and suitable for presentation. The project will address the fine-tuning and improvement of the existing structure so that the resulting device is portable, easy to operate, and safe. The provided funds will be used for the purchase of parts, components, external construction, or for the source of the sound signal, e.g. electronic piano. The tuning of the individual components will be performed by methodical measurements to determine the effect of the different settings on the final audio output. In addition to presentation purposes, the Tesla coil can also be used to test the equipment's tolerance to electromagnetic interference.
Realization:	09/2020 – 08/2021
Coordinator:	Marian Tomasov
Co-operators:	Peter Bracinik, Jural Altus

GRANT UNIZA: Platform stabilization using flywheels	
Summary:	The project focuses on the popularization and attractiveness of subjects with a focus on electric drives, for university and high school students. The aim of the project is to create a functional sample that will use the most advanced control techniques designed for motors with permanent magnets. The functional sample will be in a form of a cube-shaped frame. There will be several motors with permanent magnets with the attached flywheels inside the cube. The functional sample will be able to independently balance on one of its edges and maintain an equilibrium position on

	one of its corners. The whole platform with several degrees of freedom will form a 3D nonlinear system, controlled by a parallel control structure. The behavior of the functional sample will resemble a 3D inverted pendulum. The design and subsequent implementation of stabilization algorithms will form a scientific benefit of the project.
Realization:	09/2020 – 08/2021
Coordinator:	Lukas Gorel
Co-operators:	Vladimir Vavrus

Outputs from Solved Research Tasks

Monographs

[1]	OTCENASOVA, Alena – REPAK, Michal: *Estimácia vybraných parameterov kvality elektrickej energie v distribučnej sieti* (The estimation of selected power quality parameters in a distribution network), Žilina: EDIS, 2020, ISBN 9788055416458, 180 pp.

Books and textbooks

[1]	HRABOVCOVA, Valeria – RAFAJDUS, Pavol – MAKYS, Pavol: Analysis of Electrical Machines, IntechOpen, 2020, ISBN 978-1-83880-208-0, počet strán 225.
[2]	JUNEK, Jiri – STEPAN, Martin – BUZEK, Miloslav: Czechoslovak tinsmiths (1. part - Pardubice region), Regionální muzeum ve Vysokém Mýtě , 2020 ISBN 978-80-907260-1-7, 208 pp.

Current Content Journals

[1]	VARECHA, Patrik. – PACHA, Matej. – SUMEGA, Martin – FURMANIK, Marek.: INFLUENCE OF POWER LINES ARRANGEMENT ON QUALITY AND RELIABILITY OF DC-LINK CURRENT SENSING, In: Electrical Engineering, Archiv für Elektrotechnik, Vol. 102, Iss. 1, 2020, ISSN 0948-7921.
[2]	OTCENASOVA, Alena – BOLF, Andrej – ALTUS, Juraj – REGULA, Michal: Active Power Losses in Three-Phase Cable Power Lines, In: PRZEGLĄD ELEKTROTECHNICZNY, Vol. 2020, No. 2, ISSN 0033-2097.
[3]	KAJANOVA, Martina – BRACINIK, Peter – ROCH, Marek: Utilization of Finite State Machine Approach for Smart Region Modelling, In: Electrical Engineering, Archiv für Elektrotechnik, Vol. 102, Iss. 1, 2020, ISSN 0948-7921.
[4]	SOVICKA, Pavel – RAFAJDUS, Pavol – VAVRUS, Vladimir: Switched Reluctance Motor Drive with Low speed performance improvement, In: Electrical Engineering, Archiv für Elektrotechnik, Vol. 102, Iss. 1, 2020, ISSN 0948-7921.
[5]	SUMEGA, Martin – RAFAJDUS, Pavol – STULRAJTER, Marek: Current Harmonics Controller for Reduction of Acoustic Noise, Vibrations and Torque Ripple Caused by Cogging Torque in PM Motors under FOC Operation, In: MDPI Energies, Vol. 13, No. 10, ISSN: 1996-1073.

Patents, Industrial Designs, Author's Certificates and Discoveries

Granted in 2020:

[1]	Category: patent Application number: US10615737B1 Date of publication of the application: 26.3.2020 Available to the public: 7.4.2020 Authors: Matej Pacha, Branislav Zigmund, Carlos Vasquez Goyarzu, Hubert Martin Bode, Patrik Varecha, Bretislav Zuczek Title: System and method of estimating temperature of a power switch of a power converter without a dedicated sensor Granted by the office: The United States Patent and Trademark Office (USPTO)

Co-operation

Co-operation Partners in Slovakia

- Power System Management, s.r.o. Košice
- Volkswagen Bratislava
- STU Bratislava: Department of Electrical Machines and Devices, Department of Electrical Power Engineering
- TU Košice: Department of Electric Power Engineering, Department of Electrical Engineering and Mechatronics
- ABB Elektro, s.r.o. Žilina
- CE Qualite Slovakia Nová Dubnica
- DOLVAP, Varín
- EVPÚ Nová Dubnica
- ESIN construction, a.s., Považská Bystrica
- Bel Power Solutions, s.r.o., Dubnica nad Váhom
- GI-BON Quality systems Žilina
- HYDAC Electronic, s.r.o., Tvrdošín
- Ineltech, s.r.o.
- MARKAB, s. r.o. Žilina
- NES, Nová Dubnica
- PPA Power DS, s.r.o.
- PV SŽKV, Zvolen
- SIEMENS
- Slovenské centrum produktivity Žilina, University of Zilina
- Stredoslovenská energetika, a.s., Žilina
- SEPS, a.s. Bratislava
- SSD, a.s., Žilina
- Sungwoo hitech, s.r.o., Žilina
- Technický skúšobný ústav, Piešťany
- Vinuta Rajec, s.r.o.
- VUKI, a.s., Bratislava
- VUVT Engineering, a.s., Žilina
- VVÚŽ, Vrútky
- ZSSK, Divízia ŽKV, Bratislava

- ZF Slovakia, Trnava
- CARGO Slovakia, Bratislava
- IPESOFT spol. s r. o., Žilina

International Co-operation Partners

- ABB Brno, s.r.o. PTPM Brno, Czech Republic
- ABD Praha, s.r.o. závod Technika – prof. Kejzlar, Ing. Němeček, Czech Republic
- AD Developments Milton Keynes – p. Frank Shepard, United Kingdom
- Appraisals Services – Znalecký ústav Praha, Ing. Karel Šimek, Czech Republic
- AŽD Praha, dr. Ing. Aleš Lieskovský, dr. Ing Ivo Myslivec, Czech Republic
- Cinvestav Guadalajara, Dr. A. G. Loukjanov, prof. Bernardino Castillo-Toledo, prof. Alexander. G. Loukjanov, Mexico
- Control Technique Dynamics, Andover – p. Suji Jayasoma, United Kingdom
- CZ Loko, a.s., Česká Třebová, Ing. Bohumil Skála, Czech Republic
- České dráhy O12 Praha, Ing. Jan Plomer, Czech Republic
- ELCOM Praha, Ing. Jiří Korenc, Ing. Jiří Holoubek, Czech Republic
- NXP Semiconductors, Rožnov pod Radhoštem, Czech Republic
- ŠKODA Transportation Plzeň, Ing. Milan Šrámek, Czech Republic
- ŠKODA Electric Plzeň, dr. Ing. Ladislav Sobotka,
- Telmining, s.r.o. / T-Machinery, s.r.o., Ratíškovice, Czech Republic
- Železniční zkušební okruh VÚŽ Cerhenice, CZ – Ing. Eduard Novák, CSc., Czech Republic

Non-contractual Cooperation with Academic Institutions

- Aalto University, School of Electrical Engineering, prof. Matti Lehtonen, Finland
- CTU in Prague, Department of Electrical Power Engineering, prof. Tlustý, doc. Müller, Czech Republic
- Lappeenranta University of Technology, Faculty of Electric Engineering – prof. Juha Pyrhőnen, Finland
- Gdańsk University of Technology, Prof. Krzysztof Karwowski, Poland
- Russian Academy of Sciences, Institute of Control Sciences Academician VA Trapeznikov, prof. Ing. Sergej Ryvkin, DrSc., Russia
- TU Graz, Faculty of Electrical and Information Engineering – Prof. Dr. Ing. Manfred Rentmeister; Electric Drives and Machines Institute – Prof. Dr. Ing. Hansjőrg Kőfler, Prof. Dr. Ing. Manfred Sakulin, Austria
- Technical University Cluj-Napoca - prof. Lorand SZABO, prof. Ioan-Adrian Viorel, Romania
- University of Bradford, Leeds, Dr. Li Zhangová, United Kingdom
- University of Maribor, Institute of Electrical Power Engineering - doc. dr. Deželak Klemen, univ.dipl.inž. el., Slovenia
- VSB-TU Ostrava, Faculty of Mechanical Engineering - doc. Ing. Robert Čep, PhD., Ing. Lenka Čepová, PhD., Czech Republic
- VSB-TU Ostrava, Department of Electrical Power Engineering, Czech Republic
- VSB-TU Ostrava, Department of Cybernetics and Biomedical Engineering, Czech Republic
- Brno University of Technology, Department of Electrical Power Engineering, Czech Republic
- University of West Bohemia – doc. Ing. Jiří Danzer, CSc., prof. Ing. Václav Kus, CSc., prof. Ing. Zdeněk Peroutka, PhD., Czech Republic

Other Activities

Membership in International Institutions/Committees

Membership of the Department in international organizations	Membership since
CIRED	2000

Individual membership of employees of international organizations		Function
Peter Bracinik	HORIZONT 2020 – Program committee for safe, clean and effectively used energy, EU, Belgium	National delegate
	IEEE	Senior member
Juraj Altus	IEEE	Senior member
	CIRED, Czechia	University delegate
	IAE, Paris, France	National delegate
Matej Pacha	CZLOKO, Czechia, R&D Committee	Senior member
	IEEE – Region 8	Membership Development Subcommittee
	IEEE Czechoslovakia Section	Chair
	IEEE - IAS/IES Joint Chapter, Czechoslovakia Section	Member
Pavol Rafajdus	IEEE	Senior member
Valeria Hrabovcova	IEEE	Senior member
Pavol Makys	IEEE	Member
Vladimir Vavrus	IEEE	Member
Marek Roch	IEEE	Member
Marek Hoger	IEEE	Senior member
Martina Kajanova	IEEE	Member
Michal Regula	IEEE	Member

Individual membership of employees in scientific committees of international journals		Function
doc. Ing. Peter Bracinik, PhD.	Elektronika ir Elektrotechnika, ISSN 1392-1215, Litva	Editorial board member

Individual membership of employees in the scientific committees of international conferences		Function
Juraj Altus	Electric Power Engineering, EPE 2020, Czechia	Scientific Committee member
Juraj Altus	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific Committee member
Alena Otcenasova	Electric Power Engineering, EPE 2020, Czechia	Scientific Committee member
Alena Otcenasova	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific Committee member
Peter Bracinik	Electric Power Engineering, EPE 2020, Czechia	Scientific Committee member

Peter Bracinik	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific Committee member
Peter Bracinik	ELECTRONICS 2020, Palanga, Litva	Organizing Committee member
Valeria Hrabovcova	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific Committee member
Pavol Rafajdus	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific Committee member
Pavol Rafajdus	25th International Conference SPEEDAM 2020, Sorrento, Italy	Scientific Committee member
Marek Roch	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific and Organizing Committee member
Pavol Makys	13th International Conference ELEKTRO 2020, Taormina, Italy	Scientific and Organizing Committee member
Matej Pacha	13th International Conference ELEKTRO 2020, Taormina, Italy	Organizing Committee member
Michal Regula	13th International Conference ELEKTRO 2020, Taormina, Italy	Organizing Committee member

Individual membership of employees in scientific boards and trade committees abroad		**Function**
Milan Pospisil	Committee for PhD Theses, Power Engineering, TU Ostrava	Vice-chair
Pavol Rafajdus	CTU, FEL, Czechia	Scientific board member

Membership in National Institutions/Committees

Individual membership of employees in organizations of the SR		**Function**
Alena Otcenasova	Teacher's attestation committee	Chair

Individual membership of employees in editorial boards of national journals		**Function**
Pavol Rafajdus	Communications, ISSN 1335-4205	Editorial board member

Contact Address

Department of Power Systems and Electric Drives
Faculty of Electrical Engineering and Information Technology
University of Žilina
Univerzitná 1
010 26 Žilina
Slovak Republic
Phone: +421 41 513 2151
Fax: +421 41 513 1518
E-mail: keep@feit.uniza.sk
www: http://www.keep.uniza.sk