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FACULTY OF ELECTRICAL ENGINEERING

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***Faculty's registrar* - Ferdinand Choluj, M.Sc.**

1. Introduction

The Faculty of Electrical Engineering was founded in 1953 as one of three faculties of the Railway College in Prague, and was re-established during restructuralization changes in 1992. At present the process of faculty development still continues and some new branches of educational, research and technological development complete the traditional educational orientations, namely: information technologies, power electronic systems and modern methods of electric networks control. The interdisciplinary branches as for example mechatronics, telecommunication management and biomedicine are also in progress.

Scientific-research activity is in the centre of attention of the Faculty apart from the educational activities, of course, as its development is a necessary prerequisite of the future development of the Faculty and is closely related with the quality of education. The most important forms of projects are international scientific projects and projects supported by the Scientific Grant Agency of the Ministry of Education (VEGA and KEGA projects). Institutional projects can also be important for the participation in domestic or international grant projects. A special attention is given to the co-operation with companies in the field of applied research that is very important from more points of view.

Scientific-research activity is carried out especially in the form of projects and its orientation is specified by activities within scientific-research activities of individual departments. The main results obtained during last five years are summarized in the following parts.

2. Profile and Structure of the Faculty of Electrical Engineering

2.1 Profile of the Faculty

The Faculty of Electrical Engineering originates back to 1992 after separation of the former Faculty of Mechanical and Electrical Engineering. The departments representing the basis of the faculty have existed for some decades. They continuously created through their activities the main trend of the Faculty both in educational and scientific-research areas. Former activities of the departments were oriented mainly on technical aspects of classical transport and later tasks of communications in the form of technical operation of telecommunications increased.

At present the traditional activities are enriched with some changes characteristic for the development of science and technology in recent period. It involves especially areas of information systems, modern telecommunication technologies, development of power semiconductive systems and modern control of electric networks. The new interdisciplinary branches are also created, namely: mechatronics, telecommunication management, biomedicine engineering and specialization oriented on information systems in electroenergetics.

In the field of electric traction and energetics, the most important problem seems to be a task related to the modern traction drives for all kind of transport, then the system of modern methods of their control, supplying electric traction equipment with emphasis on their back influences on electric power systems. In the field of electroenergy the main emphasis is laid on control of electric power system, transmission and distribution of electric energy and electro-energetic feed of railways. In the area of problems connected with electric drives, the main emphasis is laid on study of new drives structures with new power factors and new kinds of their control; field of power electronic is developed.

The field of telecommunications, which has developed separately at the Department of telecommunication since 1967, is mainly oriented to questions of network and signals, numeric and impulse technology, transmitting and connecting systems, telecommunication networks, in recent years modern field of optoelectronics, digital connecting and transmitting systems, systems of data transmission, radio networks and digital signal processing have developed. In the future the main priority is going to be in the field of broadband networks. In the field of radio communication, it is the area of broadband of solid services, land and satellite mobile and radio networks. Next are optical communication systems.

In the field of control and information systems, the activity is mainly oriented to problems of increasing safety and efficiency of transmitting information within automation system of control of trans-

port, modernisation of safety facilities. Fields of safety and reliable transmission and processing of information as branches of information technologies are considered good prospects for future.

In the field of physics, except teaching basic physics, the main emphasis is laid on experimental control of elementary measurement of physical parameters, study of relevant physical phenomenon and methods of interpretation of experiments. Scientific work is oriented to study of facilities of condensed matters by acoustic and optical methods. Acoustooptical and acoustoelectrical phenomena, critical phenomena and phenomena at interfaces receive much attention, too. Study of wave fields and study in field of elementary particles are parallelly developed.

In the field of theoretical and applied electrical engineering, except teaching theoretical electrical engineering and electric measurement, scientific and technical activities are oriented mainly to optimisation of diagnostic systems in transport and diagnostic of electric traction machines. For some years the staff of the department have been solving problems of non-destructive investigation of electromagnetic and biomedical systems. From newer trends it is necessary to mention some questions from electromagnetic compatibility at chosen electrotechnic facilities, as well as some topics from mechatronics. The newest developed activity at the department is interdisciplinary Biomedical Engineering realized in cooperation with Jesenius Medical Faculty of Comenius University in Martin.

In the field of electronics and electrotechnology, the technical activity is oriented to the monitoring of quality and reliability of electronic components, materials and systems, control of quality and reliability according to IEC norms, application of programmable logical arrays, reconfiguring of circuits considering to computers, as well as diagnostic and analyses of failures and destructive analysis.

The mentioned profile orientations determine also theoretical basis offered by the departments. These also extend their offer of scientific subjects in certain study fields. Except teaching, all employees pay attention to scientific-research activity on basic level and also applied research.

The mission of the Faculty of Electrical Engineering is to provide the highest possible quality of education, training, research and consultancy, in order to meet the needs of individuals, communities and enterprises. The Faculty offers a wide range of courses in electrical engineering, from Bachelor degree courses and Master degree courses to Doctoral postgraduate courses, all of them full-time and part-time.

The accreditation commission – consultative body of the Government of the Slovak Republic carried out accreditation at the Faculty of Electrical Engineering on December 12, 2000 and according to presented materials and verification of facts, the Accreditation commission suggested and the Ministry of Education of the Slovak Republic consequently admitted the right for the Faculty of Electrical Engineering to perform the state final examination in three study subjects of bachelor study and four study subjects of engineering study. The Faculty also received the right to offer doctoral (PhD.) study, dissertation examinations and award an academic degree PhD. in five scientific fields.

The new harmonisation of study plans among faculties with related study programmes of internal regulations of the faculty (the Statute of Faculty, the Study and Exam Regulations, the Organisation Regulations, the Regulations of the Faculty Academic Senate, the Discussion Regulations of Scientific Board, general obligatory regulations) were prepared in 2002.

The Faculty of Electrical Engineering at the University of Žilina in Žilina has at present time the following competences:

1. *to perform state final examinations in these study fields:*
   bachelor studies
   - *Mechatronics*
   - *Telecommunication management*
   - *Electroenergetic engineering*

   engineering studies
   - *Information and safety systems*
   - *Telecommunications*
   - *Electroenergetic and electrical engineering*

   with the following specializations:
   - *Electric Traction*
   - *Electric Power Systems (Electro – energetics)*
   - *Electric Drives*
   - *Power Electronics*
   - *Biomedical engineering*

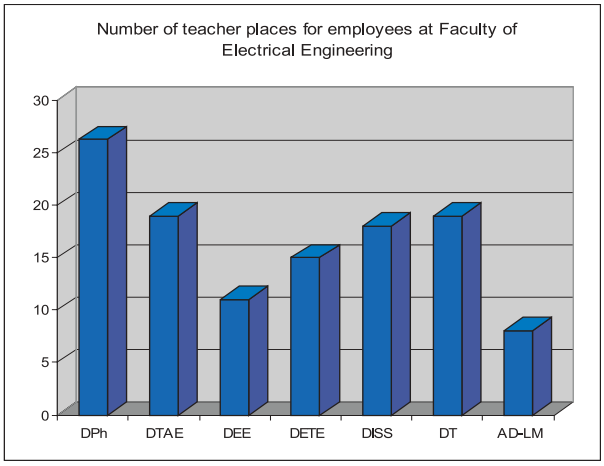
2. *to offer doctoral (PhD.) study, dissertation examinations and award scientific-academic degrees in the scientific fields:*
   - *11-22-9 Physics of Condensed Matter and Acoustics*
   - *26-02-9 Theoretical Electrical Engineering*
   - *26-27-9 Telecommunications*
   - *26-32-9 Electrical Engineering*
     with these specializations: - *Power Electronics*
     - *Electric Machines and Apparatus*
     - *Electric Drives*
     - *Electric Traction*
   - *38-01-9 Automation and Control*
     with specialization: - *Process Control*

2.2 Structure of the Faculty

Composition and structure of the Faculty was again revaluated in recent years according to the analysis of difficult tasks especially in pedagogic and scientific fields. The Faculty of Electrical Engineering (FEE) has six regular departments and one associated department established in September 2002, namely:

Department of Physics (DPh)
Department of Electronics and Electrotechnology (DEE)
Department of Theoretical and Applied Electrical Engineering (DTAEE)
Department of Power Electrical Systems (DPES)
Department of Control and Information Systems (DCIS)
Department of Telecommunications (DT)
Associated Department in Liptovský Mikuláš (AD-LM)

The number of academic staff at the individual departments of the Faulty resulted from the analysis of educational and research activities and the number of academic staff positions at the departments is summarised in the following graph:



The academic staff is actively engaged in a wide range of research programmes funded by the government, industry or the Faculty of Electrical Engineering. Some departments are involved in projects of EU programmes, such as Leonardo da Vinci, SOCRATES, COST, COPERNICUS and 5FP. The Faculty of Electrical Engineering is well equipped with some special laboratories. These include mainly the following:

- *Physics Principles Laboratories*
- *Acoustic Laboratory*
- *Optical Laboratory*
- *Electrical Principles and Electrical Measurements Laboratories*
- *Electronics Laboratories*
- *Telecommunications Laboratories*
- *Power Electronics Laboratory*
- *Electrical Machines Laboratories*
- *Discrete Control Engineering Laboratory*
- *Electrical Drives Laboratories*
- *Electric Power System Laboratory*
- *Electronics and Robotics Research Laboratory*
- *ISDN Laboratory*
- *Computer Control Laboratory*
- *Workstation with Graphicstation and Simulation Laboratory*
- *PC Classroom Laboratory*
- *HV - Electric Substation Laboratory*
- *PLC Controllers Laboratory*
- *Laboratory of Biomedical Engineering*
- *Laboratory of Image Processing and Analysis*

The Faculty of Electrical Engineering has a wide range of high quality industrial scale computing facilities and sophisticated PC, UNIX-based software on the latest specifications, including CAD and E-CAD systems, simulation programmes, PSPICE based Design Lab Development, Programming System, CAD Design and Simulation Tools with PCB Layout, MATLAB with MAPLE, FUZZY and Neural Network Toolboxes, SNNS Neural software package, MS Windows for Workgroups and MS Office Package and many others. The laboratory and computer facilities still require substantial upgrading. Several improvement projects have been completed or are under way. Some of the laboratories listed above have been equipped under the scheme of TEMPUS projects, the others under the co-operation with enterprises, or European partners, e.g. Deutsche TELECOM (ISDN Laboratory), ABB HV Technologies, etc.

2.3 Advances in Electrical and Electronic Engineering

*The first issue of the **Advances in Electrical and Electronic Engineering** that was established by the Faculty of Electrical Engineering of the University of Žilina in cooperation with the Faculty of Mechatronics of the Alexander Dubček University in Trenčín was edited towards the end of 2002 as a scientific journal. The publishing of the journal creates a new opportunity for the latest scientific and research findings in the area of electrical engineering and electronics and also provides conditions for a closer cooperation among domestic institutions of similar orientation and in the future also international ones.*

The journal will serve as a means of presentation of new results of research and science mainly in the areas such as energetics, power systems, information and communication technologies, safety systems, automation and control systems, mechatronics, electromagnetic theory and applications, applied physics and biomedical engineering. The journal will also provide opportunity for progressive industrial application presentations.

The establishment of the new journal will provide also the space for young science and research workers to present results obtained in both basic and applied research that should be subjected to critical evaluations. The journal will inform on awarded PhD degrees after a successful defence of the thesis.

*We believe that the journal **Advances of Electrical and Electronic Engineering** will be an additional and permanently utilized source of the latest findings in the area of electrical and electronic engineering both for publishers and readers.*

2.4 Development and Results in Scientific-Research Field of Faculty of Electrical Engineering

Scientific research is the second basic activity in addition to education in the Faculty and its development is necessary for future development of the Faculty and is also closely related with quality of education. Important types of research projects are international scientific projects and projects supported by the Scientific Grant Agency of Ministry of Education (VEGA and KEGA projects). However, the institutional projects can be important preparation for the entrance to domestic or international grant projects. A special attention is given to the co-operation with companies in the field of applied research.

Scientific-research work is mostly realized through the projects and their orientation is determined by scientific-research trends followed by individual departments. The main results obtained during last five years are summarized in the following sections.

J. Altus – J. Vittek – V. Hrabovcová

ELECTRIC DRIVES AND ELECTRIC MOTORS

Department of Power Electrical Systems

The research tasks from many branches of power electrotechnics have been solved and well developed in co-operation of DPES in the field of electric drives especially with Prof. S. J. Dodds, University of East London, School of Engineering, GB, and with Dr. Utkin, Institute of Scientific Management of Russian Academy of Science. The collaboration led to setting-up a novel AC drive control named "Forced dynamic control".

After the first simulation experiments passed, the drive was realized for induction motors with a lower power level. Good results led to the cooperation with three possible producers (EVPÚ Nová Dubnica, Slovakia, ELVIC Moscow, Russian and MTE Leigh on Sea, GB) and to asking the European commission for an INCO-Copernicus project grant. The project duration will be three years with the target to develop novel kinds of electric drives for industry applications as well as the hybrid simulator for drives testing. Prof. Dodds was appointed the main coordinator and Prof. Vittek was the vice-coordinator.

In the frame of the UCODRIVE project the developed control algorithm was successfully applied to a synchronous drive. The original constant-torque first-order dynamics was improved to the second-order dynamics with the variable motor revolutions acceleration. The collaboration on the national level brought very good relations between EVPÚ and the University. A hybrid simulator with 3-phases nominal power inverter developed by EVPÚ was transferred to the University where the DPES completed it by a universal drive control system inclusive software. The task was continuously solved in the frame of the Slovak project grant VEGA. The synchronous motor vector control was extended by forced dynamics and a new synchronous reluctance drive control including forced dynamics was developed. A new application of the control methods for locomotive auxiliary drives was found in the frame of this research. [1–9].

Regarding electric machines, the research is focused to the parameters and performance investigation of the modern electronically-commutated electric machines such as PM brushless machines, switched reluctance machines, step machines, synchronous reluctance machines and inverter-fed induction machines. Excellent results were achieved with reluctance synchronous machines by creating a method for the new axial-laminated rotor design based on an analytical description of electro-magnetic field. A new rotor was constructed according to this method, which during work with the original stator shows improved characteristics – namely the output power, efficiency and power factor. A detailed analysis and properties examination of one type of the switched reluctance machine and its industry and electric traction applications is in progress. A great attention is given to parameters determination of converter-fed induction machines used for control parameters designation by deterministic and stochastic on-line and off-line methods. [1-16]

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B. Dobrucký – J. Altus

POWER ELECTRONICS, ELECTRO-ENERGETICS AND ELECTRIC TRACTIONS

Department of Power Electrical Systems

In the power electronics field, the research was oriented on the power electronics and electro-energetics synergy area. Special attention was paid to the influence of semiconductor converters in electric traction on energy supply network being solved in the frame of VEGA project "The research of Active Filters". Prof. Branislav Dobrucky is responsible for this task. Physical samples of the 1-phase and 3-phases active filters were built at the University with the EVPÚ Nová Dubnica support. The co-operation with EVPÚ continues successfully so that some device prototypes work in the Slovak electricity network at present. Other activities in power electronics are oriented to power loss reduction in various converter topologies, mainly soft-switched circuits such as resonant circuits and highly-stable power supplies. A special measurement instrument ICM1.1 was designed and produced by DPES for measuring the capacitance current in the 22 kV electricity network according to the Middle Slovak Power Plants, Ltd. order. [1–8].

The research in the electro-energetics branch is focused on upgrading the electric energy quality. The DPES is the only Department in Slovakia concerning the complex problems involving the quality of electric energy supply. The DPES-staff investigates the electric energy quality parameters in nearly all-important nodes of the Slovak electric energy supply network. Another important group of tasks is done for the electricity network control. The DPES cooperated by establishing the tertiary regulation in the Slovak energy supply network. A significant work was done for setting-up the Slovak electricity network model for the time space from 2010 to 2015 enabling the network operation computation. The results enable to evaluate the energy transit possibilities of the Slovak energy supply network as well as to optimize the network operation in this period. [9–12].

In the electric traction area, the DPES helps in rationalization and modernization of electric traction equipment. The trains/vehicles movement PC-simulations for the traction fixed installations and rolling stock design optimization are very important research activity. These simulations are also used for the automatic train leading and target braking enabling energy supply savings systems (EMU series 471 ČD). The department participates in TEŽ (Tatra's electric railway) traction vehicle modernization. Very important function of the department is creation of Slovak Technical Standards and for the EN-CENELEC/TC9X-Standards adoption into the Slovak National Standards (STN) system.

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J. Dúha – M. Dado – R. Jarina

COMMUNICATION TECHNOLOGIES AND SERVICES

Department of Telecommunications

1. Investigation of Optical Fibres Parameters

The determination of optical fibres parameters using mainly the intermodal interference was the goal of the two EU projects COST 241 (1996–98) and lately COST 265 (2000–2002) solved by the Department of Physics and Department of Telecommunications.

The first stage of the project COST 241: Characterisation of Advanced Fibres for the New Photonic Network (prof. Dado – representative of SR) was oriented on measurements of transmission function and absorbtance of Erbium dopped optical fibres. The results were presented at COST 241 workshops in Aarhus (1996) and Budapest (1997)

Next stage, the project COST 265 (2000-2002): Measurement Techniques for Active and Passive Fibres to support Future Telecommunications, (prof. Dado – representative of SR) was pointed to measurements of cut-off wavelength, core symmetry and core diameter of optical fibres. The presented results enable to specify more accurately measurement methods of optical fibres parameters. [1–7].

2. New Multimedia Technologies and Services

A research on new multimedia technologies at the DT is carried out in three directions.

The first direction presents research on network architecture and services for Interactive Information Systems focused on Cable Television (CaTV) [36–38]. Another direction presents an application of advanced multimedia networks to Security and Information systems [8–12]. The research incorporates also speech recognition tasks for interactive dialogue systems. A new method of speech analysis based on modulation cepstrum was successfully applied to robust isolated word recognition [13].

The third direction is an ongoing research in multimodal semantic analysis, audio-content based analysis and recognition of multimedia content [14].

Innovation of radiocommunication networks infrastructure was solved both within a national project and two EU funded TEMPUS projects. Methods of dynamic and hybrid channel allocation both to increase network capacity and reduced interference were investigated [43–45]. Information Process Management and Optimisation is adapted to the processes and multipoint routing in broadband Telecommunication Networks [18–19].

3. Circuits Designs

The research carried out in co-operation with the Czech Technical University (ČVUT) in Prague is supported by the Czech Grant Agency. The research is pointed to development of optimum-design methods suitable for modern analog circuits. They are realized in the form of mixed-mode switch-current circuits, where analog and digital parts are integrated together. A novel high-efficiency algorithm based on differential evolution algorithms was proposed [20–22]. This non-conventional solution provides better performance by suggestive decrease of the absolute influence of circuit elements and simplification of circuit structure in comparison to the conventional design methods. Recently, the research was extended by a design of the analog wave ARC filters that are derived from a wave description of the LC-prototype [23].

4. New Trends in Teaching Innovation at DT

An international cooperation and participation in the EU Tempus projects has strong influence on innovation and modernization of teaching as well as research facilities at DT. Two EU projects are worth mentioning: TEMPUS-TELECOMNET (1996–98) and TEMPUS-TELEEDUCA (1999–2001). The first one was solved by the Department of Telecommunication in the University of Žilina jointly with other two Slovak Universities (STU Bratislava – project coordinator, TU Košice) and UPC Barcelona and Politecnico di Torino. Research activities incorporate digital signal processing, telecommunication networks and services. Results were presented at the Tempus workshops (Barcelona, Bratislava, Smolenice) e.g. [13, 16]. A fund from the project helped to purchase and upgrade computing and laboratory equipment (image and audio processing, optical and radio transmission, ISDN, etc.). A support of Deutche Telecom in building an ISDN laboratory is highly acknowledged. Very recently, the ISDN laboratory was extended by switching system S12 that was supplied by Alcatel Slovakia.

The project TEMPUS-TELEEDUCA was oriented to distance education and e-learning of employees of Slovak Telecom and the Department of Home Affairs of SR. The education institutions mentioned above together with Slovak Telecom and the Department of Home Affairs of SR participated in the project. A form of the study was chosen to utilize new information technologies. Web-based electronic study materials available via Internet and on CDs, were developed. More than 900 people have taken the courses that were developed within the project.

The DT also partially participated (together with FMI) in the following Int. projects: COST 239 (1996-98): Ultra-High Capacity Optical Transmission Network, and COPERNICUS: High-speed Communication System Support. WDM solution for optical transport networks was introduced in [24-25].

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J. Zahradník – K. Rástočný – J. Spalek – M. Balažovičová

INFORMATION AND CONTROL – RELATED SYSTEMS ANALYSIS

Department of Control and Information Systems

1. Introduction

Research activities of the Department of Control and Information Systems (DCIS) are oriented to the sphere of information and safety-related system analysis and synthesis from theoretical models solving to answering the current short-term projects of operation including their implementation. There are many sectors of activities in which the DISS has exclusive position in the Slovak Republic, especially in expertise processing in the field of analysis and synthesis of railway interlocking systems.

The sphere of reliable and safe information transmission in control of selected critical processes both in safety-related systems for all kinds of transport, complex technologies and in security systems for protection of humans and property provides dynamic incentive for all the staff. Realisation of information services for operative control supported by automation and computer technology is critical in decisive branches of the national economy.

In research and scientific projects the DCIS co-operates in a long term with partners abroad, especially with the Technical University in Budapest (Hungary), the Technical University in Braunschweig (Germany), companies such as: Scheidt & Bachmann GmbH (Germany), AŽD Prague, s.r.o. (Czech Republic), SIEMENS Building technologies (Switzerland), etc.

2. Risk analysis and modelling of the control and transmission systems safety properties

Transitions of control systems for safety-related critical processes to a new technological level require the application of sets of models, which allow for the exact risk execution at critical process controlling and execution of the safety indicators of the control, information and transmission systems. The control task with fixed-end is set so that the integral criterion of the optimality is the value of the expectable risk at fixed value of effectiveness. The outputs of the modelling are comparable with the results of the present methods based on experiential principles. These kinds of models could be used in analysis and synthesis problems [1–7].

3. Formalisation and modelling of the control systems functional properties

The use of new technologies is accompanied with increasing the complexity of designed hardware and software solutions. Systems complexity and functional safety requirements call out a necessity of new approaches to functional requirements specifications. In this field, formal methods based on mathematical modelling, formal logic and graphical notations are applied. One of the perspective and well-known graphical notation is an object-oriented unified modelling language – UML. This language provides a wide range

of means (diagrams) for writing formalised function requirements specifications. In connection with some of standard formal methods UML-based specifications of control systems can be subject to formal verifications, too [8-10].

4. Artificial Intelligence Elements in Control of Critical Processes

Both basic and applied research in this field is oriented to the theory and taxonomy of the critical processes, their position in technological and manufacturing processes (both control and controlled) regarding the risk being used. The results of scientific and research activities in this area were verified by modelling and dynamic systems simulation in discrete state space in MATLAB – Simulink – Fuzzy Logic Toolbox environment. It is indicated, that using selected tools of artificial intelligence permits refining of the safety-related critical process controlling with quantified credibility value of the input variables and modification of the elementary control functions according to the present risk level of the given process [11–14].

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S. Kmeť – J. Čuntala – M. Hrianka

SYSTEM AND TECHNICAL APPROACHES TO QUALITY MANAGEMENT IN ELECTRICAL INDUSTRY

Department of Electronics and Electrotechnology

The aim of the research project solved in the department of electronics and electrical technology of the Faculty of Electrical Engineering since 1999 is a scientific contribution to providing and improving quality of products and services mainly in electrical small and medium- sized enterprises. Quality of products and services even in electrical engineering is an important tool for competiveness, exporting, increasing national economy effectiveness and improving life quality of our population. Development of sci-

entific knowledge of quality gives rise to such fundamental transformations in well-developed economies the access of which is changed fundamentally. Science orientated to quality management changes the structure of production force, perfects working means and technical- organizational changes connected with them, including the changes in qualification and organization of companies.

The PHARE project titled "Total Quality Management" was the point of departure to educative activities of our teachers in twenty electrical firms where the principles of total quality management – TQM were explained and practised in a progressive way to the extent of 56 hours in each company.

International collaboration in the given sphere was realized successfully within the framework of the Leonardo da Vinci project. Two workshops were arranged at the University of Zilina in the framework of the project. The experts from schools and industry of five West European countries took part in the workshops. The result of the project was significant from the viewpoint of common approach to the increasing performance of firms in the European area. The result was drawn up in collaboration also with the Slovak electrical firms, which applied the results. The evaluation of quality and reliability of the high voltage equipment produced conditions to realise the testing stand that was built in collaboration with Stredoslovenska Energetika a.s. Zilina. The grant KEGA being solved at the present is a continuing application of the achieved results in the field of university educational system by introducing the Quality Management Systems at the faculties of electrical engineering.

In the framework of the VEGA grant, which is coordinated by the Slovak Technical University Bratislava, the technical aspects of evaluating and increasing quality of microelectronic systems are elaborated further on. The researchers, under the management of assistant Professor PhD. Miroslav Hrianka, achieved significant results in image analysis, which are applicable in the biomedicine as well. [1–2]

Realization of the achieved results in the sphere of quality management consists mainly in creation and improvement of Quality Management Systems in SME, in the sphere of education of managers and auditors and in consultation activities for some companies. Practical realization of the achieved research results is particularly significant for standardization, metrology, safety and dependability, environment as well as for the preparation of experts for area of quality management in companies of electrical industry.

The titles as Total Quality Management, Quality Management in the Sector of Services, Providing and Improving Quality, Corporate Quality Management can be found among the publications issued for economic sector, and in one breath they are also the titles of textbooks. The details about Collaboration of the department in the area of quality management with companies and another universities can be found on the web-site www.kvalita.sk.

The research in the field of microelectronics in the Department of Electronics and Electrotechnology is oriented to application of perspective programmable logic devices. One of the most significant project presents the small intelligent graphical microcomputer (Fig. 1). The heart of the microcomputer is built on a signal processor and programmable logic device. The electronic system was created by connection of two different architectures, microcomputer on one side and programmable device on the other side. This system gains high flexibility because its features can be adapted by reprogramming not only on structural but also on procedural level [3].

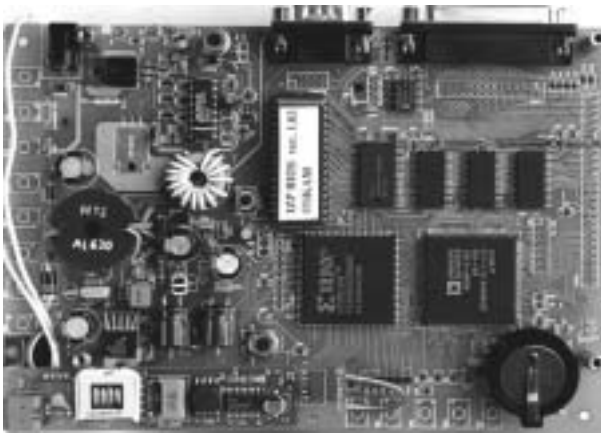

Fig. 1. IGC unit – view from component side

The Department of Electronics and Electrotechnology in the frame of the Universities programmes can use the access to the last CAE development means for Field Programmable Gate Arrays design provided by the world leaders producers – companies Xilinx and Altera. In this field of semi customize devices design we have worked out the joint projects of LON interface circuit design in an association with the company Datatherm s.r.o. as well as the semi customize communication module of optical network designed with company Elteco a.s.

The main goal of the team of Department is to continue the study and research in the field of programmable logic devices and their software implementations of reconfigurable applications in the branch of telecommunications and control systems.

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K. Čápová – J. Michalík – M. Šimko – M. Gutten

DIAGNOSTICS AND NON-DESTRUCTIVE TESTING

Department of Theoretical and Applied Electrical Engineering

1. Diagnostics Methods for some Electronics Equipment

The research project, whose main aim is to create a computer controlled open measurement system for continual insulation state monitoring of transformer, was solved. The attribute "open system" represents a possibility of the system adaptation for more type devices or measured quantities and outputs interpretation according to measured device. The priority in this case is to find relation between specific device parameters evolution and insulation state of device.

The transformer diagnostic system was developed in collaboration with the company Lambda Control s.r.o Liptovsky Hradok. This diagnostic system (Fig. 1) can serve both for transformer producers and services. It is successfully installed in Calibration and Transformer Repair Company in Hlohovec ZSE, g.e. [1–7].

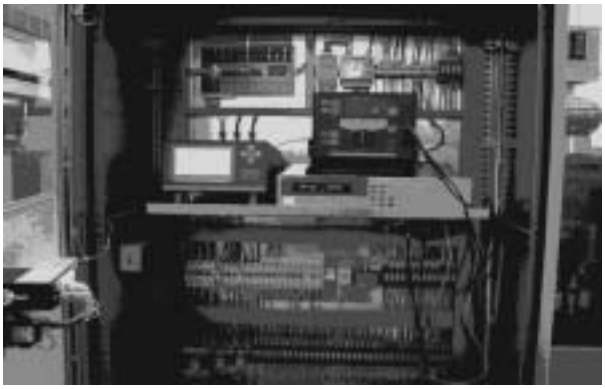

Fig. 1 The Transformer Diagnostic System

2. Non-Destructive Investigation in Electrical and Biomedical Applications

Within the framework of several projects solved at the Department of Theoretical and Applied Electrical Engineering two main problems were investigated. The first issue was connected with non-destructive testing of materials and especially with the electromagnetic acoustic transducer (EMAT) utilised for materials characteristics investigation. Especially the elastic anisotropy and defects position in the anisotropic aluminium sample and in t GaAs sample with thin metal layer were evaluated. Except the ultrasonic testing methods the electromagnetic non-destructive evaluation of conductive materials by eddy current testing was developed. The obtained results were published e.g. in [8–10]

The second investigated problem was in the field of biomedical applications where modelling and simulation of physiological dynamic systems by analogous electromagnetic characteristics were performed. The results and recommendations for computer aided non-invasive diagnostics for cardiovascular system were discussed [11–12].

Within the VEGA project "Monitoring, Processing and Modelling of Electric Signals of Biological Objects" the system for monitoring electric signals of biological objects on the basis of streamlined electronic parts was created, necessary set of sensors for monitoring electric signals of biological objects and possibilities of exploitation of new principle to obtain electric signals of biological objects were analysed. [13–14]

The problem of remote insulation state measurement of electrical machines was solved and the new measurement system was developed and verified [15–16]. This system under a test went in EVPU Nova Dubnica and was installed in Duslo Šaľa Inc.

In the field of non-destructive detection of insulating degradation in power network and antenna systems the thermo-vision camera is used at the DTAE. Within the frame of the research project the camera is utilized for visualization and quantification of thermal effects, e.g. uncovered diagnostics, control and monitoring of product processes. Recently the thermo-vision technology has been used also for biomedical application [17–18].

Research activity established on EMC monitoring is also electromagnetic field detection and quantification of its influence on biological subjects. Electromagnetic field levels in control rooms for very high voltage power network and its influence on attendant staff were investigated and obtained results were evaluated according to valid STN, as well as the influence of mobile phones on human body was measured [19].

3. Design of Transport Vehicle Products

The research and development of the principles of synergy effect on mechatronical approach to the design of transport vehicles products applying CA. technologies in virtual reality design methods and development of cognitive unit of mechatronical system for software complete locomotive control were carried out, too.

The research and development of sophisticated diesel electric locomotives (DEL) – Virtual Reality Design (methodology and application, no-conversion data flow in design of products, Rapid

Prototyping Technology application in mechatronical concept, distance concurrent engineering in products development, etc.), progressive testing methodology of DEL and tuning software of DEL, modularisation and unification of locomotives parts and units (power-pack, complete locomotive control units for wide range of locomotive power, research and development of sophisticated no-barrier light vehicle railcar based on e-transport concept, transfer of technological knowledge to methodology of automotive products development, etc.), were the results of other projects oriented on mechatronics [20].

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STUDY OF PHYSICAL PROPERTIES OF PERSPECTIVE MATERIALS USING ACOUSTIC METHODS

Department of Physics

Acoustical methods have been used for a long time at DPh to study physical properties of solid states. In last years the attention was oriented to the investigation of acoustoelectric and acoustooptical interaction in semiconductors and semiconductors structures to study deep centers (vaconcies, ontisite defects, self-interstitials, etc.) that can play an important role in both substrate materials quality and microelectronic device performance.

Recently, the acoustoelectric effect in semiconductor structures has shown to be a useful tool for the experimental study of deep centres and two basic modifications of acoustic deep-level transient spectroscopy (A-DLTS) were introduced. The former surface acoustic wave (SAW) technique uses a nonlinear acoustoelectric interaction between the SAW electric field and the free carriers in an interface region, which generates a transverse acoustoelectric signal (TAS) across the structure. Transient measurements of the rise or fall times of the resulting dc and hf part of the TAS have been used to study charged traps [1–2]. The latter longitudinal acoustic wave (LAW) technique uses an acoustoelectric response signal (ARS) observed at the interface of the semiconductor structure when a longitudinal acoustic wave propagates through the structure [2–4].

Both ARS and TAS are extremely sensitive to any changes in the space charge distribution in the interface region especially due to the trapped charge after an injection pulse has been applied. Their time development represents acoustoelectric transients, which reflect relaxation processes associated with the thermal recombination of excited carriers moving towards their equilibrium state. Using a method of computer evaluation of isothermal acoustoelectric transients by applying a data compression algorithm [5] the activation energies and corresponding capture cross-sections can be determined from transient measurements of acoustoelectric response amplitudes as a technique of A-DLTS. The technique of acoustic transient spectroscopy based on the utilization of space charge inhomogenity in high resistivity semiconductors produced by non-uniform illumination can be used to bulk deep centers investigation, too. The space charge inhomogenity can generate in proper conditions both the longitudinal and transversal or surface acoustic wave by applying a high frequency electric field [6]. The A-DLTS technique consists then in the analysis of the amplitude time development of such generated acoustic wave after the light is turned off and that is detected by the receiving transducer.

The principle of the A-DLTS technique as the acoustic spectroscopy technique using both SAW and LAW as well as the experimental procedures based on the computer evaluation of isothermal acoustoelectric transients by applying a data compression algorithm and method of digital filtering by convolution has been applied for several kinds of semiconductor structures including Si MIS structures [1, 5], GaAs/AlGaAs heterostructures [1, 2, 8] and high resistivity semiconductors [6, 7] to determine deep center parameters and proved to be an effective method to study deep centres that can play an important role in substrate materials used for electronic devices.

Representative A-DLTS spectra of Cr-Doped high-resistivity GaAs obtained for various generated acoustic waves (fast transversal T1, slow transversal T2, longitudinal L and SAW) and illustrated in Fig. 1.

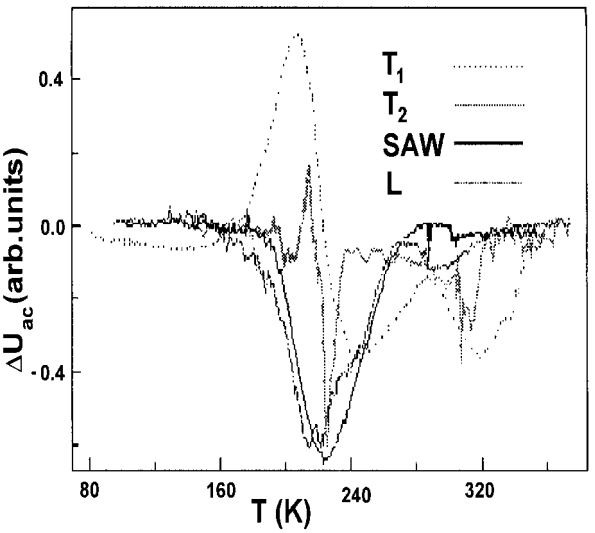

Fig. 1 A-DLTS spectra of Cr-doped GaAs obtained for various generated acoustic waves

Further attention was given to experimental study of glassy materials with the fast ion transport because they play an important role in a number of modern electrochemical devices, such as solid-state batteries, electrochronic displays, and sensors as well as for fundamental interest in their ion transport mechanisms. The ion conductive glasses have several advantages comparing with crystalline materials because of their easy preparation, their stability and the large available composition ranges.

It is known that the investigation of conductivity spectra of ionic glasses can reflect basic features of relaxation and transport mechanisms of mobile ions and the high ion conductivity at room temperature is the most important criterion which should be meet the fast ion conductive glasses. However, transport mechanisms can be investigated also by acoustic methods that can have some advantages comparing to electrical ones as the high sensitivity, absence of contact phenomena and so on.

The main purpose of acoustical investigation was to investigate ion transport mechanisms and to determine the relation between acoustical and electrical properties for various glass composition in glasses prepared in the systems CuI–CuBr–Cu_2O–M_mO_n where M_mO_n is P_2O_5 and/or MoO_3.

The experimental investigation of acoustical and electrical properties of ion conductive glasses in system CuI–CuBr–Cu_2O–(P_2O_5+MoO_3) represented by eight various samples showed an important influence of chemical composition and ion transport mechanisms and indicated more than one transport mechanism [9, 10]. The fact that activation energies determined from both electrical conductivity measurement and acoustical attenuation spectra have very similar values proved that the mechanisms can influence electrical and acoustical losses in ion conductive glasses.

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I. Turek – J. Štelina – C. Musil

EXAMINATION OF SELF-DIFFRACTION IN MAGNETIC FLUIDS AND PHOTOREFRACTIVE EFFECT

Department of Physics

The main attention was paid to experimental investigation of self-diffraction of two interfering Ar coherent laser beams in the samples of magnetic fluids based on water or kerosene. Using the simple description of the obtained results when the interference field creates a space periodic temperature grating by thermo-diffusion distribution of magnetic particles, good accordance with experimental results was achieved.

The time dependence of the diffracted beam intensity after the interference field is switch off informs about the diffusion process of the magnetic particle or aggregates forming the optical grating. The distribution of particles with respect to their size was determined. The self structuralization of magnetic particles after application of homogenous and strong illumination of magnetic fluid were observed [1–3].

The research project "Investigation of nonlinear optical and acoustooptical effects in tendensed matter and fluids" involved the following issues:

1. The investigation of magnetic fluids based on single-domain particles Fe_30_4 dispersed in kerosene or water and the temperal dyestuff dispersed in water. The experimental arrangement with Ar laser was used (Fig. 1).

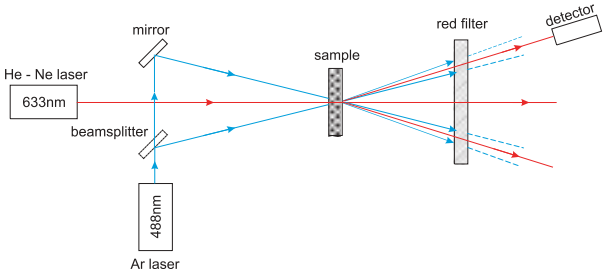

Fig. 1 Experimental set up for self-diffraction investigation.

The experiments confirm that the self – diffraction effect in samples of magnetic fluid is connected with the distribution of

colloidal particles and temperature modulation of refractive index, too. The quadratic dependence of time constant of disappearing first diffraction beam on grating constant was confirmed and it self structuralization of magnetic particles caused probably by negative Soret constant was observed.

2. The photorefractive effect was studied in $LiNbO_3$.The optical field created by the interference of two coherent beams of Ar laser was recorded that arises due to the redistribution of space charge on at least two levels, which are presented in the gap.
3. The original nontraditional method of investigation of electron relaxation processes in surface electron states was made. The measurement connected with the generation of acoustic wave at the end of the depletion layer was made. The electron surface states were calenlated, too [4].
4. The Si thin film and thin film doped by TiO_3 deposited on ceramic substrates were studied by X- ray profile analysis using the special program made for the separation of the diffusion and coherent scattering.

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I. Turek

INTERMODAL INETRFERENCE IN THE OPTICAL FIBRES

Department of Physics

One of the main tasks of teamwork in the common optical laboratory of the Department of Physics and Department of Telecommunications devoted to fibre parameter is investigation of intermodal interference.

It is well known that if the wavelength of light introduced into an optical fibre is smaller than the *cut-off* wavelength λ_c of the LP_{11} mode, more than one mode can propagate in the fibre. The fact that these modes propagate with different phase velocities yields the effect of intermodal interference, which is manifested by adding an interference term to the signal consisting from the sum of intensities of the interfering modes.

If the signal at the end of the fibre is detected by a detector with sensitivity independent on coordinates, the interference term is zero because the eigenfunctions of interfering modes are orthogonal. But where the detection of the optical field is restricted on a matching place (Fig. 1) the interference term appears on the spectral dependence of the signal [1].

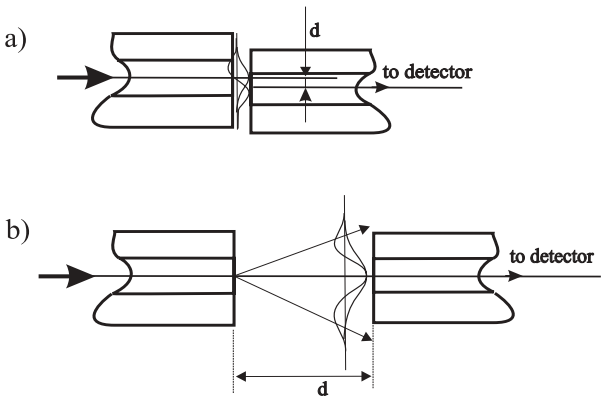

Fig. 1 The detection suitable for interefernce of symmetric and antisymmetric modes (a) and two symmetric modes (b)

In Fig. 2 there are shown as examples spectral dependences of signals containing interference of the first and the second, and the first and the forth modes in two different fibres. As it can be seen from the figure the characteristic "wavelength of interference centres" (marked as λ_{12} and λ_{14}) is different in different fibres. This fact indicates that intermodal interference can be used for diagnostic of the fibres.

Intermodal interference is very sensitive to the variation of refractive index profile. It allows one to discover changes of the

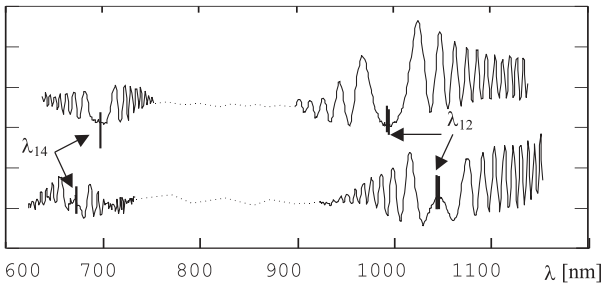

Fig. 2 The spectral dependence of signals containing interferenceof the first and the second and the first and the fourth modes in two different fibres

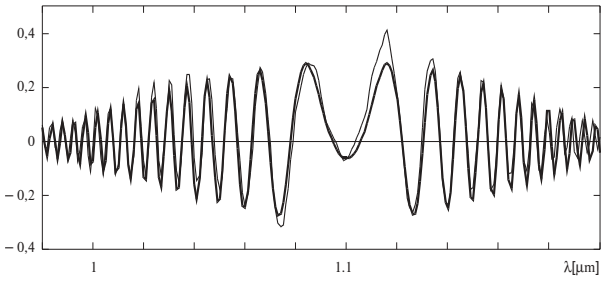

Fig. 3 Comparison of measured spectral dependence and dependence calculated assuming linear dispersion of the refractive indices

fibre parameters before a significant mutation of their customer parameters occurs [2].

A theoretical treatment showed that the ratio $L_{.} = \lambda_{12} / \lambda_{14}$ of experimentally measured values λ_{12} and λ_{14} can give an information about fibre refractive index profile [3]. Because the determination of the interference centres is not a difficult it can be used for control at the fibres fabrication. As the wavelength of the light can be measured with high precision the precise determination of periodicity of the interference term is possible. That can give another information about the fibre. The comparison of measured spectral dependence and dependence calculated assuming a linear spectral dependence of refractive index of core and cladding of the fibre (fig. 3) confirms it.

Assumption of quadratic dependence of the refractive indices can give accordance of these dependences in quite wide spectral region. The good accordance between measured and calculated curves means that the intermodal interference can be used also as a tool of dispersion determination [4].

The examples of use of the intermodal interference given in previous paragraphs do not represent all possibilities of intermodal investigation. Not either all topics of the group working in our laboratory but we hope that they illustrate results of the laboratory.

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I. Melo – M. Gintner

PHENOMENOLOGICAL STUDIES OF THE ROLE OF THE TOP QUARK IN THE STRONG ELECTROWEAK SYMMETRY BREAKING

Department of Physics

The goal of this project was to find signatures of the strong electroweak symmetry breaking at future electron-position colliders. We namely looked for signatures of a new vector resonance ζ and a scalar resonance S in the process $e+e- \rightarrow \_\_-tt-$. We constructed Lagrangian that describes interactions of the new resonances with particles of Standard Model and found cross sections and event numbers for future $e+e-$ collider working at energies above 800 GeV. We also found (in collaboration with CERN and IEP SAS Košice) the relevant backgrounds for the signal process [1].

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