

DEPARTMENT of ELECTRICAL DRIVES
FACULTY of ELECTRICAL ENGINEERING
TECHNICAL UNIVERSITY of KOSICE

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INTRODUCTION

The Department of Electrical Drives is one of eight departments of the Faculty of Electrical Engineering (FEE) of the Technical University of Kosice (TUK). The TUK, founded in 1952, is situated in Kosice, the historical, cultural and industrial center of East Slovakia. There are four other faculties besides the FEE: of the Mechanical, Metallurgical, Mining and Civil Construction Engineering. There are presently approximately 6.000 students studying for the Master's Degree (Engineer) at TUK.

The Faculty of Electrical Engineering was founded in 1969 as the fourth faculty of TUK. The FEE consists of eight specialized departments (Physics, Theoretical Electrotechnics and Circuit Theory, Radioelectronics, Cybernetics and Artificial Intelligence, Computers and Informatics, Electrical Drives, and Power-plant Engineering) and a High Voltage Laboratory. The total undergraduate body numbers about 1.900 students. There are in addition approximately 110 students, mostly from the staff preparing doctorate work (C.Sc., the Czechoslovak equivalent of Ph.D.)

The Department of Electrical Drives is one of the largest departments of the FEE. It was created in 1969 from the original Department of General Electrotechnics which was a part of the Faculty of Mechanical Engineering from 1953. The first class of ten students graduated from the Department in 1972. Their number has increased gradually year by year and at present there are between eighty and hundred graduates in Heavy-Current Electrical Engineering annually. As of the beginning of the 1990-91 academic year more than thousand students have completed master's thesis work in the Department. At present, the total number of staff members (scientific, technical and administrative) in the Department is sixty, including thirty teachers, nine full-time students preparing for the Ph.D. Degree, six research fellows and four graduated technicians.

The evolution of the Department in recent years has been shaped by the rapid development of the electrotechnical industry in Slovakia. Today, the Department of Electrical Drives plays an important role in electrical engineering of Czechoslovakia and is a recognized institution in the field of electrical drives and power electronics.

MANAGEMENT

The first heads of the Department were Prof. Frantisek POLIAK (1969-1979), simultaneously the first dean of the FEE) and Prof. Jaroslav TIMKO, Ph.D. (1979-1989).

The present state:

Head of department: Associate Professor Jozef FEDOR, Ph.D.
 Deputies:
 - for education: Associate Professor Jan FETYKO, Ph.D.
 - for research : Associate Professor Viliam FEDAK, Ph.D.

PROGRAM OF STUDY

The Technical University of Kosice offers a five-year program leading to the Engineer's degree (Ing.; approximately corresponding to the degree Master of Science) in certain branches of engineering. At the present time lower degrees (such as Bachelor of Science) are offered but a three-year undergraduate program is under consideration, perhaps leading to changes in the structure of study in the near future.

The Department of Electrical Drives is responsible for instruction in the field of Heavy-Current Electrical Engineering. The aim in the first two years of study is to give students a wide basic knowledge of engineering. During this time all the students follow the same course of study to include: Linear Algebra, Mathematical Analysis and Statistics, Physics, Materials and Technology, Theoretical Electronics, Computers, Programming Languages, Electrical Measurement, Microprocessor Technics and Social Sciences. Strong specialization occurs in the third, fourth and fifth years of study when students are taught directly under the guidance of the Department. The emphasis of this specialized study is on an up-to-date appreciation of theory and practice in the chosen field. Within the Department a student may choose one of four specialized lines of study:

1. Electrical Drives (ED)
2. Power Electronics (PE)
3. Electrical Machines and Apparatus (EMA)
4. Control of Drives and Manufacturing Systems (CDMS)

1. **Electrical Drives (ED).** The students are prepared for the design and operation of electrical drives used for the driving of various working mechanisms. During the study the students are made acquainted with a knowledge of power and control electronics and computer technics.

2. **Power Electronics (PE).** Besides the common subjects the students are prepared for the investigation, construction and design of power semiconductor converters, control technique and the control and modelling of converters.

3. **Electrical Machines and Apparatus (EM).** In the framework of this program, the students are prepared in the sphere of theory, design, technology and construction of electrical machines and apparatus using computer aided design methods.

4. **Control of Drives and Manufacturing Systems (CDMS)**
The stress is focused on the subjects concerning electronics, control theory, computer technics, control of large plants and design of control systems (both software and hardware).

In the 1990-90 academic year the following specialized subjects are to be taught by the department:

Subjects	Course Hours per week of study				lectures-exercercises
	ED	PE	EM	CDMS	
the 4th term:					
Microprocessor Techniques	x	x	x	x	2-2
the 5th term:					
Power Electronics	x	x	x	(x)	3-4(3)
Electrical Machines I.	x	x	x		4-3
✓ Computers in El. Engineering	x	x	x		3-3
Electrical Machines				x	3-3
Control Systems Software				x	2-2
Electronics				x	3-3
the 6th term:					
Electrical Machines II.	x	x	x		2-3
✓ Electronics	x	x	x		3-4
Microelectronics				x	3-3
the 7th term:					
Electrical Drives	x	x	x	x	4-4
Electrical Apparatus	x	x	x		3-3
✓ Special Parts from Control or: Theory of Variable Speed Drives	x			x	3-3
✓ Control Electronics (Theory)			x		3-3
Electrical Machines Design I.				x	4-2
Control System Design				x	3-3
Software of Control Systems or: Modelling of Drive Systems				x	2-2
the 8th term:					
✓ Variable Speed Drives	x	x		x	4-3
Electrical Drives Laboratory	x				2-2
✓ Electrical Drives Design	x				3-3
Power Electronics I.			x		3-3
Microcomp. Control of Inverters			x		2-2
Electrical Machines Design II.				x	3-3
Electrical Apparatus Design				x	4-3
Control Elements of El. Drives				x	2-3
Production Processes Identification				x	3-3
Control Electronic Circuits or: Computer Aided Design				x	2-2
the 9th term:					
Control of Complex Drive Systems	x				3-3
Control of Robots	x				3-3
Industrial Drives Applications	x				2-2
Power Electronics II.			x		2-3
✓ Semiconductor Inverters Design			x		4-3
Modeling of Power El. Circuits			x		2-2
Electrical Machines Production				x	3-3
CAD of Electrical Machines				x	3-3
Special Machines and Apparatus				x	2-2
Control of Complex Drive Systems				x	3-3
✓ Control Systems of Technol. Plants				x	2-3
Robot Control				x	3-2
Operational Systems for Control				x	2-3

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At present all course documentation and lectures are conducted in the Slovak language. English-language lectures are under preparation for some courses and will be made a part of the curriculum in the future.

In addition to the regular course program, a part of the educational activity is performed within the framework of postgraduate education leading to a C.Sc. (Ph.D.) Degree. The Department is authorized to provide doctoral education in the following areas of study:

- Electrical Traction and Electrical Drives
- Power Electronics Systems
- Electrical Machines

The length of study for these programs is three years for full-time doctoral candidates (Ph.D. students) and five years for part-time doctoral candidates from the staff and industry. Each candidate works under the guidance of individual tutors (drawn from the professors and associate professors). Full time Ph.D. students receive a scholarship and a temporary staff position. At present there are 8 full-time and 22 part time Ph.D students. Ph.D. study is closely bound with research work in the framework of advanced research projects.

SCIENTIFIC RESEARCH

The research, carried out at the Department of Electrical Drives, covers a broad field of interest. It is concentrated on a controllable electrical drives, power electronics converters with improved dynamic properties, applicability studies of control theories to the control of complicated drives (multi-motor drives of manufacturing lines, drives of robots and manipulators) and on microcomputer implementation of control algorithms and their hardware realizations. During the past five years the research has been carried out mainly in collaboration with the Electrotechnical Institute of the Czechoslovak Academy of Sciences in Prague under the program entitled. "New directions of power electronics development and control of electrical drives". The research project was divided into three parts:

1. Control of electrical drives

The purpose of this part of project was the application of new synthesis methods and realization of designed drives. In the framework of project the following subjects were included in the research program:

- Fully digitally controlled adaptive DC drive
- Fully digitally controlled adaptive AC drive
- DC drive with converter on the basis of MOSFETS
- Nonlinear state control of DC motor with variable structure

2. Power and control circuits of semiconductor converters

Next converters have been realized:

- Four quadrant impulse converter with linear characteristic

- Impulse converter with MOSFETS
- Transistor frequency converter controlled by the single-chip microcomputer with both-side PWM
- Resonant frequency converters - analysis and simulation
- Transistor frequency converter for induction heating
- Three-phase rectifier with ONN commutation

3. Control of technological processes

- Design of main controllers for multimotor drives with mechanical coupling
- Design of configuration of microcomputer controlling system for the control of technological lines
- Microcomputer controlling system for the pearlite production line
- Digital model of two-mill tandem

The main results of project have been reported in the final report (in Slovak), published in scientific journals and presented in the international conferences.

In addition to these studies, a considerable part of the research has been carried out in a number of application oriented projects mostly in cooperation with industry and other research institutes.

From the beginning 1991 new rules for the financing of research activity financing will be in effect and the following research projects have for the period 1991-93.

1. State control of electrical drives

(Chief: Prof. Ladislav ZBORAY)

In this project the research will cover the following subjects:

- Control design and realization of laboratory prototypes of nonlinear drives by means of the feedback linearisation method
- Nonlinear observer design for A.C. drives
- Variable structure state control
- Control of drives with elastic mechanical connection

2. Control of AC drives fed by frequency converters

(Chief: Prof. Jaroslav TIMKO)

- Research and development of frequency converters with switched-off power semiconductor devices (bipolar transistors, MOSFETS, IGBTs and GTO thyristors)
- New control structures of AC drives
- Development and construction of laboratory prototypes of power frequency converters
- Realization of laboratory prototypes of control circuits of AC drives

3. Software and hardware development for distributed control systems for multimotor drives and drive complexes

(Chief: Ass.Prof. Michal GIRMAN)

- Mathematical description of multimotor drives and appropriate production technology from the view of control algorithms design

- Control algorithms derivation on the basis of extension and application of existing multivariable control theories
- Development of corresponding software for automated design control algorithms using CAD
- Realization of laboratory prototype of multimotor drive and designed control system

4. Modern types of AC drives

(Chief: Ass.Prof. Jozef FEDOR)

- Controlled electrical drive with switched reluctance motor:
 - a) Laboratory prototype realization with SRM containing the radial air gap: $2P_1/2P_2=6/4$, $P=3kW$
 - b) Modified drive with SRM containing the axial air gap
- Analysis of properties of AC drives with new types of converter
 - a) Asynchronous motor fed by an indirect frequency converter with a parallel high-frequency resonant circuit
 - b) Noise dampening in asynchronous motors fed by new types of converters

INTERNATIONAL CONFERENCE

The International Conference on Electrical Drives and Power Electronics ED&PE'90 has been successfully organized by the Department in the High Tatras, in November 5-7, 1990. The conference dealt with the latest results in the field of static power converters, electrical machines and controlled electrical drives - theory and applications as well as with power semiconductor switching devices and technologies related to the topics. Altogether 88 contributions from eleven states of Europe were presented in four plenary sessions, eight oral and two poster sessions. The "ED&PE'90" conference was the ninth in the order, organized by the Department since 1973, but it was the first conference in Czechoslovakia, held in this field. The period of conference two years and it can be expected that the following one will be held in 1992.

SOME RECENT PUBLICATIONS

- Bauer, P.: Resonant link converter. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.1, pp.84-89
- Fedák, V.-Fedor, P.: Design of multivariable controller for complex drive system. Proceedings of ICED'88, Brasov 1988, Part D., pp.1-8.
- Fedor, P.-Fedak, V.: Decentralized controllers for the multimotor drive of a continuous production line. Elektrotechnický časopis 41(journal), 1990, pp.417-431
- Fedor, P.-Fedak, V.: Design of the decentralized control structure for the multimotor drive. Proc. of PEMC'90, Budapest, 1990, pp. 187-191
- Fetyko, J.-Durcansky, I.: Control trajectories of robots under

- obstacle consideration in robot environment. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.2, pp.238-243
- Dudrik, J.-Ondera, J.: Contribution to the design of bipolar transistor converters. Proc. of ED&PE'90 Conf., vol.1, pp.32-38
- Kiovsy, L.: Microcomputer-based control of transistor converter for switched reluctance motor drive. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.2, pp.42-48
- Kováč, D.-Kováčová, I.: Four quadrant converter with field effect transistor. Proc. of PEMC'90, Budapest, pp.918-920.
- Kovalcin, S.: Double-side digital PWM and its realization with single chip microcomputer family 8048. Proc. of ED&PE'90 Conf., vol.1, pp.27-31
- Milly, D.: An AC to DC converter with output current reversal. Proc. of EPE '89, Aachen, pp.813-817.
- Milly, D.: An AC to DC converter with sinusoidal AC currents. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.1, pp.39-44
- Perdukova, D.-Fedor, P.-Fedak, V.: Centralized multivariable controller design for the multimotor drive. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.2, pp.114-121
- Timko, J.-Girman, M.-Haluska, J.: Design of control systems of technologic lines with multiple processor structure. Proceedings of PEMC '90, Budapest, p.200-202.
- Timko, J.-Girman, M.-Harcarufka, R.-Haluska, J.-Kiovsy, L.: Pearlite production line control. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.2, pp.211-218
- Visnyi, P.: Digital current control of a DC thyristor drive. Proceedings of ICED '88, Brasov 1988, Part C., p.1-5.
- Visnyi, P.: A digital control of an induction motor drive. Proc. of ED&PE'90 Conf., Kosice, vol.1, pp.122-127
- Zboray, L.: Speed state control for a twin drive. Elektrotechnický časopis 41 (journal), 1990, pp.665-674
- Zboray, L.: Control design for a DC series motor. Proc. of ED&PE'90 Conf., Kosice, 1990, vol.2, pp.52-59