

MODERN PROGRESS OF ELECTRICAL ENGINEERING EDUCATION AND SCIENCE AT LVIV POLYTECHNIC NATIONAL UNIVERSITY

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Abstract. The main trends and tasks entrusted to the staff of the Department of Theoretical and General Electrical Engineering at the current stage of the development of science and education in Ukraine within the Strategic Plan of Development of the Institute of Energy and Control systems of Lviv Polytechnic National University are considered. The importance of historical inheritance of the educational and research activity of the Department, its cooperation with scientists of both domestic and foreign research institutions, and prospects of the development of the Department in the coming years are discussed.

Key words: electrical engineering, educational process, history of science.

Origins of electrical engineering education and science at Lviv Polytechnic National University

Lviv Electrotechnical School has come a long way since its foundation in the late years of the 19th century till now. In spite of the political winds during this period, it has confirmed its high scientific potential, promptly reacting to the challenges of time. Lviv has always been an important political, scientific and industrial center at various authorities attracting the most active and capable people.

It should be noted that at Lviv Polytechnic due to the efforts of enthusiasts, electrical engineering as a separate discipline began to be taught in the 1887/1888 academic year by privat-docent Franciszek Dobrzyński. In 1891/1892, the Department of Electrical Engineering came into existence headed by Professor Roman Dzieślewski. His merit was the creation of a exemplary at that time electrical laboratory where students were provided with great opportunities of doing practical research work.

The importance of the organizational measures introduced at that time can be proved by the fact that Lviv Polytechnic became the seventh educational institution in the world and the fifth one in Europe to start teaching electrical engineering. It was the Department of Electrical Engineering that became the third after the similar at Technical University of Darmstadt (Germany, 1882) and University College of London (Great Britain, 1885). The Electrotechnical

Faculty set up at Lviv Polytechnic in 1911 was the fourth after Technical University of Darmstadt (Germany, 1882), University of Missouri (USA, 1886) and Czech Technical University in Prague (Czech Republic, 1902).



Professor Roman Dzieślewski
(1891–1924)



Professor Stanisław Fryze
(1925–1941)

Scientific and technical staff trained in the first academic years contributed to the formation of the Lviv Electrotechnical School, which is primarily associated with the name of the successor of Prof. R. Dzyslejewski – Professor Stanisław Fryze. His contribution to the electrical theory and practice is huge and recognized all over the world. In particular, he developed the theory of transfiguration of electric circuits, the theory of active, passive and imaginary power in electric circuits. He introduced the concept of equivalent electromotive electric power and the system of voltage arrowing, as well as the methods of electric circuits calculation with the help of mesh currents and nodal potentials. Professor Stanisław Fryze simplified the theory and methods of multiphase systems analysis by introducing the symbolic method that became the basis of modern electrical engineering science.

The grim years of World War II were hard times in the history of the Lviv Electrotechnical School. The revival of its teaching and research activity in the post-war period began due to considerable assistance provided by the Academy of Sciences of the former USSR, Kyiv and Leningrad Polytechnic Institutes, etc.

Such outstanding scientists as academicians O. Kharkevych, G. Pukhov, professors Yu. Velychko, K. Karandeyev, M. Kyianytsya and others expressed the wish to work at Lviv polytechnic.



Academician of the Academy of Sciences of the USSR
Oleksandr Kharkevych
(1946–1948)



Academician of the Academy of Sciences of the Academy of Sciences
Georgiy Pukhov
(1949–1950)

In 1946 the Electrical Engineering Department was headed by Doctor of Technical Sciences, Professor **Oleksandr Kharkevych** – electroacoustic, alumnus of the Leningrad Scientific School who had a positive influence on the formation of the renewed department. Having united the gifted young scientists and engineers, despite the difficult post-war time, he managed to organize the educational process in September 1944. However, his research interests were focused mainly on the research into electrical acoustics, the theory of physical converters (sensors), theory of communications, information theory, the theory of signal processing and other fields of technology. For the high achievements in this field of knowledge, Professor Kharkevych was elected a correspondent member of the Academy of Sciences of the USSR, and subsequently appointed Director of the Institute of Problems of Information Transmission of the USSR and academician as of the Academy of Sciences of the USSR.

In 1948 the Department of Theoretical and General Electrical Engineering was headed for a short time by an alumnus of Tomsk Polytechnic Institute, Candidate of Technical Sciences, associate professor Georgiy Pukhov. He focused on raising the level of the educational process, organizing scientific seminars at the Department, prompt publication of scientific papers.

Alumnus of pre-war Lviv Polytechnic, Doctor of Technical Sciences, Professor Mykola Maksymovych headed the Department in 1950–1964. He was a versatile personality who significantly influenced the development of education and science in Western Ukraine.

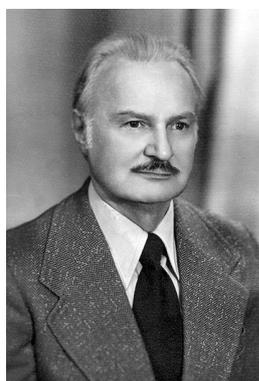
Holding the post of rector at Lviv Polytechnic Institute, later rector of Ivan Franko Lviv State University, he considerably enriched the scientific achievements of the Department, expanded the training of scientific and pedagogical staff of the Department, in particular through postgraduate studies. Together with Prof. B. Blazhkevych, he is one of the most prominent representatives of the Lviv Electrotechnical School.

During 1964–1975 the Department of Theoretical and General Electrical Engineering was headed by Candidate of Technical Sciences, Associate Professor Serafym Kirpatovsky, a graduate of Kharkiv Polytechnic Institute. He was focused on the scientific works devoted to the creation and improvement of converters and complex measuring instruments for selective measurement of individual components of multicomponent streams on the basis of Engineering Research Laboratory № 47 founded at the Department of Theoretical and General Electrical Engineering in 1964.

In 1975–1986 under the leadership of the Head of the Department, associate professor Oleksandr Shehedyn, graduate of Lviv Polytechnic Institute, computerization of educational process was initiated, and appropriate mathematical methods of modeling and computer simulation were developed.



Prof. Mykola Maksymovych
(1950–1963)



Prof. Serafym Kirpatoskyi
(1964–1975)



Ass. Prof. Oleksandr Shehedyn
(1975–1986)



Prof. Volodymyr Perkhach
(1986–1996)

In October 1986 D. Sc., Professor Volodymyr Perkhach became the Head of the Department. The ten-year period of his work was devoted to particularly intensive scientific and pedagogical activity, aimed to form the theoretical and methodological foundations for providing educational process in electrical power engineering disciplines and publishing relevant textbooks and manuals.

On the basis of the Department in September 1995 the First International Scientific and Technical Conference “Mathematical Modelling in Electrical and Power Engineering” was held.

New stage of development of electrical engineering education and science at Lviv Polytechnic

As the development of industry during the post-war years gathered pace, technically qualified experts in electrical engineering were needed. To satisfy that demand, the organization of electrical engineering education at Lviv Polytechnic required continuous improvement. At the same time, the organizational structure of the Lviv Electrotechnical School has been changed (Fig. 1). Now it is one of the schools working at the Institute of Electric Power Engineering and Control systems (Fig. 2).

A new stage in the development of the Department of Theoretical and General Electrical Engineering began after its being headed in autumn 1996 by Doctor of Technical Sciences, Professor Petro Stakhiv, a disciple of Prof. Mykola Maksymovych. Before, he headed the Department of Theoretical Fundamentals of Electrical Radio Engineering at the Ivan Franko Lviv State University.

- 1939 – Electrotechnical Faculty
- 1952 – Radioengineering Faculty
- 1956 – Electric Power Engineering Faculty
- 1962 – Electromechanical Faculty
- 1978 – Electric Power Engineering Faculty
- 1971 – Thermal Heating Faculty
- **2001 – Institute of Electric Power Engineering and Control Systems**

Fig. 1

- Department of Theoretical and General Electric Engineering (T3E)
- Department of Electromechatronics and Computerized Electromechanical Systems
- Department of Electric Power Engineering and Control Systems
- Department of Heat Engineering and Thermal and Nuclear Power Plants
- Department of Automation and Computer-Integrated Technologies

Fig. 2



Professor Petro Stakhiv
(1996–2019)



Associate Professor
Oksana Hoholyuk (2019–present)

New textbooks and manuals for students, as well as scientific monographs have been published during this time. Dozens of instructions, methodical guidelines for laboratory works and course projects have been developed, published and implemented into the educational process. Given the high authority the Ministry of Education and Science of Ukraine commissioned the Department to annually hold (1997–2004) the second (final) stage of the All-Ukrainian student contest of Theoretical fundamentals of electrical engineering.



Prof. Yu Bobalo (Rector of the University) and Prof. Orest Lozynsky (Director of the Institute) are acquainted with a new computerized laboratory of the theory of electric circuits (May 8, 2014)

For the quality and objectivity of the contest, the department was highly appreciated by the participants from all over Ukraine. Practical tasks tested and verified during numerous contests were included into the first (2004) and the second (2014) parts of the textbooks in theoretical electrical engineering.

The Department is actively introducing computer methods of learning into the educational process. In particular, a laboratory has been founded and methodological support in fundamentals of microprocessor equipment (assoc. prof Orest Hamola) has been developed, a cycle of simulation laboratory works on the theory of electric circuits (prof. P. Stakhiv, prof.

S. Rendzinyak) has been introduced. Software and methodical recommendations concerning the students' using of computer means while preparing individual tasks have been developed by assoc. prof. Mariya Howykovych. This was largely facilitated by creation of a modern computer laboratory at the Department, equipped with the assistance of the University administration and the Directorate of the Institute of Electric Power Engineering and Control Systems.



Laboratory lesson is conducted by Prof. S. Rendziniak (2017)

In recent years, the Department has significantly enhanced the quality of training research staff of higher qualification. This is facilitated by the active functioning of the Specialized Scientific Council for the defence of Doctoral and PhD theses in electrical engineering disciplines chaired by prof. P. Stakhiv since 1995. During that time, Doctoral theses were defended by V. Malyar, V. Hudym, S. Rendzinyak, O. Hoholyuk, and Ph.D. theses by V. Horiachko, V. Maday and Yu. Kozak. Scientific research is carried out in the following fields:

- methods and models of computer analysis of electric circuits and electromechanical systems;
- mathematical modelling of processes of dynamic circles and electric systems with different type elements;
- macromodelling of electronic, electric and power systems;
- mathematical modelling of processes in the electromagnetic field;
- developing an automated learning system in the field of electrical engineering.

An important achievement of the Department during this period is the international cooperation. Thus, together with Polish scholars, the joint Ukrainian-Polish school-seminars “Actual problems of theoretical electrical engineering: science and didactics” were conducted in Alushta (Ukraine, 1999, 2001) and in Solina (Poland, 2000). Besides, two International seminars “Computational Problems of Electrical Engineering” were held under the auspices of IEEE

in Zakopane (Poland) in 2002 and near Buchach (Ukraine) in 2003. Czech and Slovak scientists have now joined the collaboration, and with our joint efforts made, the international scientific and technical conferences “Computational Problems of Electrical Engineering” (CPEE) are regularly organized. The scientists of the Department took part in the work of all those conferences, since the first in 1999, as organizers and co-organizers (Fig. 3).

The Main tasks of electrical engineering education and science

In recent years, fundamental educational reforms are taking place in Ukraine, in particular, it concerns higher educational institutions. A task set before the institutions of higher education is that to improve significantly the cooperation of Ukrainian education and science with the world one.

	UPSS 1999 – Alushta, Ukraine
	UPSS 2000 – Solina, Poland
	UPSS 2001 – Alushta, Ukraine
	CPEE 2002 – Zakopane, Poland
	CPEE 2003 – Jazleevets, Ukraine
	CPEE 2004 – Zakopane, Poland
	CPEE 2006 – Odessa, Ukraine
	CPEE 2007 – Wilkasy, Poland
	CPEE 2008 – Alushta, Ukraine
	CPEE 2009 – Waplewo, Poland
	CPEE 2010 – Lázně Kynžvart, Czech Republic
	CPEE 2011 – Kostryna, Ukraine
	CPEE 2012 – Grybow, Poland
	CPEE 2013 – Rostoky u Křivoklátu, Czech Republic
	CPEE 2014 – Terchová-Vrátna dolina, Slovak Republic
	CPEE 2015 – Lviv, Ukraine
	CPEE 2016 – Sandomierz, Poland
	CPEE 2017 – Kutná Hora, Czech Republic
	CPEE 2018 – Banská Štavnica, Slovak Republik
	CPEE 2019 – Slavske - Lviv, Ukraine
	CPEE 2020 – Pińczów, Poland

Fig. 3

In response to the challenges of time, since September 2019, the Department of Theoretical and General Electrical Engineering has been headed by D.Sc., associate professor **Oksana Hoholyuk**. Now the department is to fulfill goals, tasks and achieve high specific values of indicators according to the Strategic Plan of Development of the Institute of Electric Power Engineering and Control Systems of Lviv Polytechnic National University.

To encourage talented youth to study at the University, it is necessary to provide a student-centered

approach to educational activities. This goal can be accomplished by improving the teaching and learning processes, introducing new technologies, training methodologies, placing of electronic educational and methodical complexes of all disciplines in the Virtual Educational Environment. It is necessary to introduce various forms of context and problematic learning, as well as (inclusion of) research components into educational courses.

The important task of the integration of educational programs is the use of training programs for specialists, first of all Masters, materials of educational courses of distance education of the world's leading universities, as well as the experience of research centers of leading companies for the purpose of forming an open educational environment and integration into international educational space.

The department is developing on-line courses of certain disciplines to provide distance learning students with advanced training.

To improve the learning and research work outcomes, it is necessary to increase the proportion of students able to take subjects delivered in a foreign language preferably English as a medium of instruction. To attract international students to the idea of studying at Lviv Polytechnic, some educational programs are required to be taught in English.

The important achievements of the Department to be supported and developed is that our students become the winners of the final stage of the All-Ukrainian contests of theoretical fundamentals of theoretical electrical engineering and general electrical engineering.

To enhance the quality of teaching and research staff, it is necessary to increase the percentage of young scientists of the highest qualification for the creation and development of research schools.

Besides, it is important to continue the practice of publishing scientific publications in editions of Scientometric databases such as Scopus and Web of Science. In order to increase the number of scientists who have at least five cited publications.

Another important task set before the Department is to increase the number of published monographs, papers and conference abstracts in the English language. The authority of our researchers and the demand for research results is evidenced by the increase in the h-indices of the department faculty in the Scopus and Web of Science databases, as well as the growth of the number of articles published by our academic staff. One of the primary tasks is to create professional profiles of the Institute lecturers in the ResearchGate system and other systems of this kind in order to promote their scientific achievements.

The Department publishes the professional and scientific journal "Computational Problems of Electrical Engineering". Our goal is to be included into the Scopus and Web of Science databases. Under the same title the scientific conference mentioned above is held under the auspices of the IEEE and organized by the Department of Theoretical and General Electrical Engineering and Institute of Electric Power Engineering and Control Systems. This Conference have been held for more than 20 years as the international scientific and practical event launched back in 1999 by scientists of the Department and our colleagues from Warsaw University of Technology. The proceedings of this Conference have been indexed in the Scopus database for a long time. We need to keep this tradition.

Deepening cooperation with academic institutions of Ukraine, attracting leading scientists of the National Academy of Sciences of Ukraine to conducting scientific seminars is also of great importance.



Participants of the International Scientific and Technical Conference "Computational Problems of Electrical Engineering" CPEE-2019, September 15 – 18, 2019, Slavske-Lviv (Ukraine)

Presenting reports by leading scientists, professors of the department at scientific seminars is a good practice interesting not only for students but also for colleagues – scientists and lecturers. At these seminars, they present the results of their own research obtained over the last five years and analyze the global trends in the development of research in the field, as well as new promising areas.

In the framework of the academic mobility, it is necessary to increase the participation of the Department staff in the programs of exchange of scientific advances with leading scientists from foreign educational and scientific institutions, to stimulate the department faculty to take professional development courses or trainings at leading universities and scientific centers. It is necessary to introduce participation in scientific schools in order to perform joint scientific researches, improve cooperation with foreign universities for joint researches and publication of their results.

In spite of the difficulties with financing of science, it is necessary to submit regular requests for participation in the competition of researches and developments funded by the Ministry of Science and Education of Ukraine, as well as for government grants, the National Research Fund, grants of the President, etc.

In order to increase the presence of the Department of Theoretical and General Electrical Engineering in the international information space, we are to ensure a stable flow of information to the scientific environment, coverage of the achievements of the Department in Mass media. One of these steps was the widespread celebration of the 125th Anniversary of the Department as one of the oldest departments of the university. Besides, the information on the Internet Web page of the Department is systematically updated. Therefore, the staff of the Department have important tasks, there is no doubt that we shall fulfill them with enthusiasm and belief in a successful future

СУЧАСНИЙ ПОСТУП ЕЛЕКТРОТЕХНІЧНОЇ ОСВІТИ І НАУКИ У НАЦІОНАЛЬНОМУ УНІВЕРСИТЕТІ “ЛЬВІВСЬКА ПОЛІТЕХНІКА”

**Оксана Гоголюк, Сергій Рендзіняк,
Петро Стахів, Всеволод Горячко, Тарас Рижий,
Любов Балацька**

Розглянуто основні тенденції і завдання, які покладено на колектив кафедри на сучасному етапі розвитку науки і освіти в Україні в рамках стратегічного плану розвитку Інституту енергетики та систем керування Національного університету “Львівська політехніка”. Визначено важливість історичної спадковості освітньої і наукової діяльності кафедри, її співпраці з науковцями і вітчизняних, і закордонних наукових установ, перспективи розвитку кафедри в найближчі роки.



Oksana Hoholyuk – D. Sc., Ass. Professor, graduated from Department of Radiophysics and electronics of Ivan Franko State University of Lviv, Ukraine. She received her Ph. D. and D. Sc degrees in the field of theoretical electrical engineering. Since 2004 she has been working at the Department of Theoretical Electrical Engineering at Lviv Polytechnic National University, Ukraine. Her scientific interests are focused on mathematical modelling of electric circuits and systems.



Serhiy Rendzinyak – Ph. D., D. Sc, Professor graduated from Ivan Franko State University, Lviv, Ukraine as a specialist in the field of Radiophysics and Electronics. He defended his Ph. D. thesis at Ivan Franko State University, Ukraine, and D. Sc thesis in Theoretical Electrical Engineering at Lviv Polytechnic National University. He worked at Lviv Polytechnic National University as Associate Professor from 1997 to 2008; since 2008 he has held the position of Professor at the Department of Theoretical and General Electrical Engineering, Lviv Polytechnic National University.



Petro Stakhiv – Ph. D., D. Sc., Professor, graduated from Lviv State University, Department of Physics, Ukraine in 1970, and received his M. Sc. degree in Radio Physics and Electronics. In 1975 he received his Ph. D. degree in theoretical electrical engineering. The theme of his Ph.D. work was “Synthesis of linear electric circuits (method of state variables)”. In 1992 he received his D. Sc. degree in the same specialty after defending his doctor thesis on “Analysis of dynamic regimes in electric and electronic circuits with multiterminal elements”. From 1973 to 1996 he worked as Assistant Professor, as Associate Professor, Professor and Head of Department of Theoretical Electro and Radio Engineering at Lviv State University. In 1996 became a Head of Department of Theoretical and General Electrical Engineering. His scientific interests are mainly concerned with mathematical modelling and simulation of dynamic processes in electrical engineering systems, numerical methods, optimization techniques, system theory, and parallel programming.



Vsevolod Horyachko – Ph. D., Assoc. Professor graduated from biological faculty of Ivan Franko State University of Lviv and electric power engineering faculty of Lviv Polytechnic Institute, Ukraine. He received his Ph. D. degree in the field of theoretical electrical engineering. Since 1983 he has been

working at the Department of Theoretical Electrical Engineering at Lviv Polytechnic National University.



Taras Rzyzi – Senior Lecturer graduated from electric power engineering faculty of Lviv Polytechnic Institute, Ukraine. Since 1983 he has been working at the Department of Theoretical Electrical Engineering at Lviv Polytechnic National University.



Liubov Balatska – a senior lecturer graduated from the Faculty of Foreign Languages of Ivan Franko State University of Lviv. Since 1993 she has been working as a lecturer, senior lecturer of English at the Department of Foreign Languages of Lviv Polytechnic National University. Her research interests are focused on educational role of students' group work; translation as one of the methods of learning a foreign language; modern methods of professional literature translation.