PRZEGLĄD NAUK HISTORYCZNYCH
R. XX, nr 1 (2021)
247–270

REVIEW OF HISTORICAL SCIENCES
Vol. XX, No. 1 (2021)
247–270

https://doi.org/10.18778/1644-857X.20.01.09

Maryna Gutnyk
National Technical University
"Kharkiv Polytechnic Institute" /
Krajowy Uniwersytet Techniczny
"Charkowski Instytut Politechniczny"
https://orcid.org/0000-0002-2723-2755

Olena Tverytnykova
National Technical University
"Kharkiv Polytechnic Institute" /
Krajowy Uniwersytet Techniczny
"Charkowski Instytut Politechniczny"
https://orcid.org/0000-0001-6288-7362

Krystian Leonard Chrzan
Wroclaw University of Science and Technology /
Politechnika Wrocławska
https://orcid.org/0000-0002-1316-6806

The origins of electrical engineering studies in the Ukraine and their shaping under the influence of the European scientific school (the end of the 19th and the beginning of the 20th centuries)

Streszczenie

Początki badań elektrotechnicznych na Ukrainie i ich kształtowanie się pod wpływem europejskiej szkoły naukowej (koniec XIX – początek XX wieku)

W tekście przedstawiono rozwój badań elektrotechnicznych w drugiej połowie XIX i na początku XX w. Zwrócono szczególną uwagę na różne uwarunkowania rozwoju elektrotechniki teoretycznej i na wiodącą rolę Politechniki Lwowskiej. Podano nazwiska profesorów, którzy byli pionierami edukacji elektrotechnicznej we Lwowie, Kijowie, Charkowie i Odessie. Wykazano, że Europejska Szkoła Elektrotechniki miała bardzo duży wpływ nie tylko na rozwój elektrotechniki w Galicji, lecz także na Ukrainie pozostającej w granicach Imperium Rosyjskiego.

Słowa kluczowe: elektrotechnika, edukacja, szkoła naukowa, Europa, Ukraina

Received: 2021-04-17. Verified: 2021-04-17. Accepted: 2021-05-27
© by the author, licensee Łódź University – Łódź University Press, Łódź, Poland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license CC BY-NC-ND 4.0 (https://creativecommons.org/licenses/by-nc-nd/4.0/)

Abstract

The deployment of electrical engineering research in the second half of the 19th and at the beginning of the 20th c. is shown. The great attention is focused on the economic circumstances of the development of theoretical electrical engineering. Emphasis is placed on the leading role of Lviv Polytechnic. The names of professors who were at the origins of electrical engineering education in Lviv, Kyiv, Kharkiv and Odesa are given. It is claimed that the European School of Electrical Engineering directly influenced the development of relevant research in Ukraine.

Keywords: electrical science, education, scientific school, Europe, Ukraine

The development of the industrial revolution in Europe was the impetus for the development of new branches of physics. The industry required new power sources. To change the use of water and wind energy, the science of electricity was actively developed, and appropriate technology was created. At the end of the 19th c. in the Russian Empire where Ukraine was a part at the time, a network of higher technical educational institutions began to be established. However, research in the field of electrical engineering lagged far behind European and in Ukrainian institutes began to develop almost half a century later.

Research initiated at Lviv Polytechnic University had great importance for the formation of electrical science and education in Ukraine. The history of this institution has been starting during the Austro-Hungarian rule in Galicia with the reorganization of the Real Trade Academy on November 4, 1844 into the Imperial-Royal Technical Academy, where under the influence of European scientific schools began to emerge and form separate scientific centers in basic technical disciplines: mathematics, technical chemistry, mechanics and electrical engineering[1].

It should be noted, that the system of higher electrical engineering institutions began to take shape in the late 19th c. The first institution that provided specialized education in the field of electrical engineering was opened in France in 1880 and was called the "Higher Telegraph School". The course of study was designed for two years and was based on higher education, i.e. it had the status of retraining courses. Admission was limited to 5-6 people per

[1] K.L. Chrzan, *Lviv Polytechnics as Mother of Polish Technical Universities*, [in:] *Information technologies: science, engineering, technology, education, health. MicroCAD-2019*, ed. Ye. Sokol, Kharkiv 2019, p. 90.

year. A few years later, the Faculty of Electrical Engineering at the Technical University (Liege) was organized in Belgium. In 1886, the Faculty of Electrical Engineering at the Hanover Polytechnic Institute was opened.

In the late 1880s, the electrical engineering faculties began to function at the Zurich Polytechnic Institute and at the Charlottenburg Institute in Berlin. At the Darmstadt Polytechnic Institute, the electrical engineering department at the Faculty of Mechanical Engineering was reorganized into a separate electrical engineering faculty. Electrical engineering was first taught in the Darmstadt Higher Technical School in the 1882/1883 academic year (fig. 1).

The Darmstadt Higher Technical School had the key importance for the formation of the electrical engineering direction not only in Poland, Germany, but also for Ukraine. An important contribution to the development of electrical engineering was made by the first Dean of the Faculty of Electrical Engineering, the rector of the University of Darmstadt during 1887–1889, Professor Erasmus Kittler. He implemented a number of electrification projects in Darmstadt, which allowed the scientist to gain considerable experience in practical electricity. Erasmus Kittler used all his experience in creating modern electrical laboratories and curricula for the electricians training. Professor E. Kittler based his training on practical exercises. An organic combination of theoretical knowledge, practical skills and consultations was the basis of the education system. Innovative approaches to the training of electrical engineers attracted the attention of society so in the late 19th – early 20th c. many students from different countries came to study at the University of Darmstadt. Among others, future professors of Lviv Polytechnic – Oleksandr Rothert, Gabriel Sokolnitski, Wlodzimierz Krukowski, as well as the founder of electrical science and education in Ukraine, Professor Pavlo Kopnyaev studied there.

Under the guidance of Professor Erasmus Kittler, who preferred practical teaching methods, Pavlo Kopnyaev carried out several independent projects of electrical machines and installations in the laboratories of the Electrical Engineering Institute in Darmstadt and in German factories. At the Kharkiv Institute of Technology, Pavlo Kopnyaev used all the experience gained during studying in Darmstadt under the guidance of E. Kittler associated with the development of curricula with a significant block of practical training, organization of electrical laboratories, creation of electrical

laboratories, electrification of the institute. In 1900, the first electrical engineers graduated from the Kharkiv Institute of Technology[2].

In 1893, to teach electrical engineering a special "Electrical Engineering Institute" was established at the Mittweida Polytechnic, a higher technical institution in Germany[3]. It should be emphasized that in the first decades of their existence, these educational institutions aimed to improve the skills of specialists with higher education. These institutions did not have specialized electrical engineering departments.

1. Technical University of Darmstadt (Higher Technical School of Darmstadt in 1877). The photo from free sources – https://www.politikwissenschaft.tu-darmstadt.de/institut/index.en.jsp

The purpose of the article is to analyze the impact of the European Electrotechnical Scientific School on research in the field of electrical engineering, which took place in Ukraine in the first half of the 20th c.

[2] P. Sadłowski, *Erasmus Kittler (1852–1929). Pionier elektrotechniki Erasmus Kittler (1852–1929). Pionier of electrical engineering*, „Maszyny Elektryczne – Zeszyty Problemowe" 2016, No. 4(112), pp. 163–168.

[3] V. Lebedinsky, *Decade of the Higher Electrotechnical School in Paris* „Electricity" 1905, No. 2, pp. 27–28.

In the last quarter of the 19th c. the electricity was used not only in telegraphy, but also in a number of other fields of technology. Interest in electrical engineering was spreading and, as a result, there were educational institutions specializing in the new field. An electrical laboratory was set up in Paris to enable engineers and technicians to gain practical knowledge. In 1894, at the suggestion of the chairman of the International Society of Electricians, Henri-Georges Berger, the Higher Electrical School was opened on the basis of the laboratory. Twelve students were admitted in the first year. The training consisted of theoretical and practical modules[4].

Theoretical training was conducted in the following disciplines: general electrical engineering, electrical measurements, design and calculations of dynamo machines of alternating and direct current, electrical installations, electric traction, electric power transmission, electrochemistry, electric lighting, application of electricity on railways and suchlike. Engineers with experience in production were involved into teaching. The practical part included mandatory laboratory classes, project implementation, visits to enterprises. In the first decade, the number of people who studied at the Paris High School of Electrical Engineering was 572, fifteen of them were from the Russian Empire[5].

The means of communication were also actively developed. So in the middle of the 19th c. the development of telegraphy (maintenance of telegraph lines) intensified the problem of relevant personnel training. Opened telegraph schools for the training of electricians had a low level of training and provided only knowledge of telegraph technology and basic information in the field of electricity. Therefore, the needs of industry in electrical engineering, both higher and lower level, these schools did not meet.

A prominent place in the scientific life of the Russian Empire at that time was occupied by universities. It was there that a large number of specialists received higher education, who later became the organizers of science and founders of its new directions. During the second half of the 19th c. there were twice as many university

[4] A. Butrica, *From inspecteur to ingénieur: telegraphy and the genesis of electrical engineering in France, 1845–1881*, [in:] *Retrospective Theses and Dissertations*, Iowa 1986, No. 7982, pp. 23, 288.

[5] E. Posvyatenko, O. Tverytnykova, N. Posvyatenko, T. Melnyk, *Historical affinity of of applied technical sciences development: monograph*, Kharkiv 2017.

graduates as there were graduates of other higher education institutions (over 58,000). During this period, a system of training was formed, new forms of scientific and pedagogical work were introduced, new scientific publications, research and support structures (museums, laboratories, offices, libraries, scientific student societies, *etc.*) appeared. In particular, the physical laboratory of Moscow University, established by Professor Oleksandr Stoletov in 1872 became a place for experimental research, which was of great importance for the formation of electrical science[6].

In a number of higher educational institutions in Russian Empire, leading teachers of physics courses attached a great importance to electrical engineering: at the Technological Institute of St. Petersburg – Fedir Petrushevsky, Dmytro Lachinov; at St. Petersburg University – Robert Lenz, Ivan Borhman and Orest Hvolson; in Moscow – Oleksander Stoletov, at the University of Kyiv – Mykhailo Avenarius, at the Polytechnic School of Riga – Engelbert Arnold. But the laboratory base of the required level at that time did not exist in the territory of the Russian Empire. University graduates who decided to specialize in electrical engineering were required to receive practical training abroad.

In 1886, a Technical School specializing in telegraphy was opened in St. Petersburg, which in 1891 was reorganized into the Electrical Engineering Institute, which became the first separate independent higher educational institution of electrical engineering in Russia. Mykhailo Shatelen, the first professor of electrical engineering in Russia, organized the systematic teaching of the discipline and created electrical laboratories at the institute. At his initiative, the topics of diploma projects were chosen not only in relation to telecommunications, but also in new areas of the electrical engineering industry that were just emerging. In 1894, Pavlo Voynarovsky defended the diploma project "Complete project of lighting theaters, government agencies, main streets, shops in the central part of Moscow". A similar project was implemented for Kharkiv. Theoretical electrical engineering was taught by Professor Ivan Borhman. He is the author of a fundamental work, which summarized the results of studies of electromagnetic phenomena and their mathematical justification. The appearance of Ivan

[6] O. Simonenko, *History of technology and technical sciences: philosophical and methodological aspect of the evolution of the discipline: monograph*, Moscow 2005.

Borhman's textbook contributed to the development of theoretical issues of applied electrical engineering[7].

At the St. Petersburg Practical Technological Institute, Robert Lenz separated from the physics course sections on the technical application of electric current, including electric lighting, and introduced electrical engineering into the curriculum as an optional subject. In the Institute of Civil Engineers one of the sections of electrical engineering – devices for electric lighting of buildings was taught. An optional telegraphy course was available at the Institute of Engineering. The peculiarity of the organization of the educational process in these educational institutions was the lecture form of education and the lack of industrial practice[8].

In 1904, Academician Volodymyr Mitkevych began teaching the theoretical foundations of electrical engineering at the St. Petersburg Polytechnic Institute at the Faculty of Electromechanics. We should emphasized that similar discipline did not exist in the curricula of Russian or foreign higher technical educational institutions. Volodymyr Mitkevych prepared a special course for electrical engineers, which was based on the section "Electricity and Magnetism" in physics and "Differential and integral calculus and matrix algebra" in mathematics.

Boris Ugrimov, a graduate of the Moscow Higher Technical School, became the first professor of electrical engineering in Moscow. The expansion of the electrical engineering course was carried out by Karl Krug. He was also an author of the first textbooks on the theoretical foundations of electrical engineering, where he proposed a classical scheme for studying of this discipline. The division of the material into three major parts: the physical foundations of electrical engineering, the theory of electric circuits and the theory of the electromagnetic field confirmed the possibility of quality training.

---

[7] M. Shatelen, *The teaching of electrical engineering in higher education institutions in Russia and abroad*, „Electricity" 1898, No. 20, pp. 297–301; S. Radoguz, M. Gutnyk, R. Zaitsev, *The contribution of Kharkiv Practical Technological Institute scientists to electrification of Kharkiv city at the end of XIX – the beginning of XX century*, [in:] *2018 IEEE Ukraine Student, Young Professional and Women in Engineering Congress (UKRSYW)*, Conference proceedings (October 2–6, 2018, Kyiv, Ukraine) 2018, pp. 82–87.

[8] O. Tverytnykova, N. Posvyatenko, T. Melnyk, *Essays on the history of development of applied technical sciences in Ukraine. From the experience of Kharkiv Technological Institute. Monograph*, Kharkiv 2015.

So, at the end of the 19th c. there were more than 7 higher electrical engineering institutions in Europe. But these were electrical engineering faculties or institutes, the curriculum of which was based on the received higher education of a specialist, and therefore they had the character of institutes of advanced training. There was no separate higher education institution except the Higher School of Electrical Engineering in Paris.

In Russian empire, specialized electrical engineering education could be obtained at the Moscow State Technical University and at the Electrical Engineering Institute in St. Petersburg, which had a high level of qualification of teachers and laboratory facilities. There is information about the development of the network of training of electricians in Europe (table 1).

Table 1

Centers of electrical education in Europe

Year of creation	Name of institution	Country
1854	School for the training of electricians who served the electromagnetic telegraphs	Russia
1874	Officer's electrical department, established in the Navy	Russia
1880	Higher Telegraph School, Paris	France
The middle of 1880s	Faculty of Electrical Engineering, Liege	Belgium
1886	Faculty of Electrical Engineering at the Polytechnic Institute, Hanover	Germany
1886	Higher Institute of Electrical Engineering, St. Petersburg	Russia
The end of 1880-s	Faculty of Electrical Engineering at the Polytechnic Institute, Darmstadt	Germany
The end of 1880s	Faculty of Electrical Engineering at the Zurich Polytechnic Institute	Switzerland
The end of 1880-s	Faculty of Electrical Engineering at Charlottenburg Polytechnic Institute, Berlin	Germany

1891	Department of Electrical Engineering at Lviv Polytechnic	Austria–Hungary
1891	Military Electrical Engineering School	Russia
1893	Electrotechnical Institute at Polytechnic Institute, Mittweida	Germany
1894	Higher School of Electricity, Paris	France
1902	Faculty of Electrical Engineering at St. Petersburg Polytechnic Institute	Russia
1909	Electrical specialty at the St. Petersburg Institute of Technology	Russia
1909	Electrical specialty in Riga Polytechnic Institute	Russia
1918	Faculty of Electrical Engineering at Kyiv polytechnic institute, Kyiv	Ukraine
1918	Faculty of Electrical Engineering at the Moscow Higher Technical School	Russia
1920	Department of Energy of Kamyansk Polytechnic and Zaporizhia Industrial College	Ukraine
1921	Electromechanical Department and Department of Mining Electrical Engineering of Katerynoslav Higher Mining School, Dnipro	Ukraine
1921	Faculty of Electrical Engineering, Kharkiv Institute of Technology, Kharkiv	Ukraine
1924	Electric Power Faculty of Odessa Polytechnic Institute, Odessa	Ukraine
1929	Electrical Engineering Faculty of Odessa Polytechnic Institute, Odessa	Ukraine
1929	Department of General Electrical Engineering and Electrical Machines of Donetsk Mining Technical School	Ukraine
1930	Electrical Engineering Institute, Kharkiv	Ukraine

The table source: E.K. Posvyatenko, O.E. Tverytnykova, N.I. Posvyatenko, T.V. Melnyk, *Historical affinity of applied technical sciences development: monograph*, Kharkiv 2017, pp. 169–170.

Training of engineers for the electrical industry of Ukraine

Reforms of the tsarist government of the 60–70's of the 19th c. contributed to the development of Ukraine. In the metallurgical, mining, and machine-building industries, large industrial enterprises were established which used modern technology at the time. Machine-building plants operated in Kyiv, Kharkiv, Mykolayiv, Odesa, Sumy, Mariupol, Bila Tserkva, and Katerynoslav.

In the early 19th c. well-known scientists taught electrical engineering at Kyiv polytechnic institute: professors Mykola Artemyev, Anatoliy Krukovsky, Oleksandr Skomorokhov, and Semen Usatiy. On the initiative of Anatoliy Krukovsky an electrical laboratory was established[9].

Professor Mykola Artemyev had a considerable practical experience, which allowed him to become the head of the Department of Electrical Engineering established in KPI in 1900 and to start teaching this discipline. According to Mykola Artemyev's projects, a central power plant was built in Kyiv in 1890 and a city power grid was laid. Summarizing practical experience, Mykola Artemyev published in 1904 a monograph "Determining the size of dynamos and the effect of voltage on size", in which he systematized the then available methods of calculation and design of electric machines[10].

In 1918, in order to expend the training of engineers of new specialties in KPI (fig. 2), the Faculty of Electrical Engineering was established with departments of Power Plants, Electric Traction and Communication Technology, but in fact nothing has changed. As before, the graduation of electrical engineers was carried out in one specialization in the mechanical department. As before, the graduation of electrical engineers was carried out in one specialization in the mechanical department. The number of students who completed graduate works in electrical design was five to six per year. Since 1921, the general course of electrical engineering has been expanded. Several new disciplines were introduced,

[9] Report of the Kyiv Polytechnic Institute for 1907, State Archives of Kyiv [hereinafter: SAK], Fund 18, Desc. 1, Case 185, sheet 3; Personal file, Central State Archives of Supreme Bodies of Power and Government of Ukraine [hereinafter: CSASBPGU], Fund 116, Desc. 12, Case 7079, 6 sheets.

[10] M. Gutnyk, E. Tverytnykova, V. Sklyar, *Commercialization of Scientific Activity at a Higher Technical School of East Ukraine in the Late 19th and Early 20th century*, „Acta Baltica historiae et philosophiae scientiarum. Estonian Association for the History and Philosophy of Science" 2019, vol. VII, No. 3, pp. 125–138.

including an introduction to electrical engineering, an encyclopedia of electrical engineering, the theoretical foundations of electrical engineering, and the foundations of the theory of alternating currents[11].

2. Kyiv Polytechnic Institute (in the 1900s the Kyiv Polytechnic Institute of Emperor Oleksander II). The photo by the authors

Ukraine had been a part of the Polish Kingdom (Polish–Lithuanian Union called also Rzeczypospolita) and thus a part of Europe for several centuries. The first Universities in Central Europe were founded in 1348 – Prague, 1364 – Krakow, 1365 – Vienna and 1395 – Buda (Budapest). The first Universities in Russia were founded many years later: in 1755 – Moscow, 1819 – St. Petersburg, 1834 – Kyiv. This means that after the fall of the Rzeczypospolita, Ukraine became the part of the backward and tyrannical Russian empire. Only a relatively small part of the former Rzeczypospolita called Galicia with Krakow and Lviv was within the boundaries

[11] E. Tverytnykova, M. Gutnyk, H. Salata, *Professors of the Kharkiv Technological Institute: unknown pages of biograph*, „History of science and technology" 2020, vol. X, issue 2, pp. 383–389; Yu. Demidova, E. Tverytnykova, I. Nikolaie, *The analysis of the professional training features of the Ukraine scientific potential. The experience and prospects*, „Theory and practice of management of social systems" 2019, No. 4, pp. 112–124.

of the Habsburg monarchy. The western part of Galicia, called by the Poles East Malopolska and by the Ukrainians Haliczyna was still part of Europe but the rest of Ukraine belonged to Russia.

At Lviv Polytechnic (fig. 3) the beginning of electrical research was connected with the activity of Professor Feliks Strzelecki. Feliks Strzelecki graduated from the gymnasium in Tarnów and immediately entered the University of Vienna, where his university teachers were the famous German physicist, Baron Andreas Ettingshausen, known in the world as the first developer of the electromagnetic machine (which can run both an electric generator and an electric motor) and physicist-optician Joseph Petzval who was the founder of geometric optics, the author of the revolutionary in photography so-called "Petzval Portrait lens".

Interest in a new field – electrical engineering, showed a talented engineer and scientist Roman Gostkowski. His research focuses on electric motors, DC generators, the use of electricity for rail transport and more. Further research in the field of electrical engineering was continued by Professor Feliks Dobrzynski. He carried out electrical measurements, electric machines, the theory of electric circuits, and so on. As a separate discipline, electrical engineering was introduced into the curriculum of Lviv Polytechnic in 1887.

On October 27, 1890, the Department of Electrical Engineering was established; it was headed by Roman Dzieslewski[12]. He was the first Polish professor of electrical engineering and the author of the first academic textbook "Encyclopedia of Electrical Engineering", published in 1898. On behalf of the Austrian government, the scientist visited the World's Fair in Paris in 1891, as well as studied the scientific experience of leading technical institutions in France, Germany and Spain. During 1891–1892, on behalf of the magistrate of Lviv, Roman Dzeslewski, together with the famous Polish architect Juliusz Karol Hochberger, conducted research related to the construction of an electric tram in the city. At Lviv Polytechnic he organized the first electrical laboratory and expanded the course of electrical engineering. In 1917, the first graduation of electrical engineers took place. And the first student who received a diploma with honors was Stanislaw Fryze.

[12] J. Hickiewicz, P. Sadłowski, *Roman Dzieślewski. Pierwszy polski profesor elektrotechniki i Jego współpracownicy*, Opole 2014.

3. Main building of Lviv Polytechnic built by Julian Zachariewicz in 1877. The photo from free sources – https://photo-lviv.in.ua/lvivska-politehnika-na-45-chorno-bilyh-foto-1900-1939-rokiv/

Stanislaw Fryze was interested in scientific activity from an early age, the result of which was the publication in 1902 of his first scientific work "Electricity and Magnetism". In 1911 he entered the Lviv Polytechnic School at the Faculty of Electrical Engineering. In 1922, Stanislaw Fryze presented his doctoral dissertation "A New Theory of the General Electric Circuit", which he did under the direction of Roman Dzieslevsky. This was the first doctoral dissertation on electrical engineering in Poland. Stanislaw Fryze passed the doctoral exam with honors and in January 1924 received the degree of Doctor of Science. The doctoral dissertations were published in scientific journals in France and Germany[13].

During 1926–1934, the scientist fruitfully worked on writing a large theoretical work "General Electrical Engineering" (in six

[13] T. Kolakowski, *Profesor dr. inz. Stanislaw Fryze (1885–1964). Pionier elektrotechniki. Nauczyciel i wychowawca wielu pokolen polskiej mlodziezy akademickiej. Monografia*, Katowice 2009, p. 199.

volumes, 2445 pages, 2448 drawings), which became the main textbook for students of electrical engineering at that time. Professor Stanislaw Fryze declared his new view on the definition of electrical quantities at the International Congress in Paris in 1933 and the Union of Electrical Engineers in Berlin[14].

At the Lviv Polytechnic S. Fryze worked at the Department of General and Theoretical Electrical Engineering for over 20 years. He developed the theory of electric circuit transfiguration, the theory of active, passive and imaginary power, developed the theory of alternating current circuits using pie charts, and also proposed a system for shooting impulse voltages and currents in direct and alternating current circuits. He introduced the concept of substituting electromotive force, as well as methods of calculation using contour currents and nodal potentials, simplified the theory and methods of analysis of multiphase systems through the introduction of symbolic methods. Professor S. Fryze was a talented electrical engineer. In Lviv, he participated in the electrical equipment of the opera house, the construction of the city power plant, the electrical equipment of elevators, developed high-voltage mercury rectifiers for trams. In 1946 he moved to Gliwice, Poland, where he was appointed professor at the Silesian Polytechnic[15].

We should add that Kazimierz Olearski, Professor of Physics, made an important contribution to the development of electrical engineering at Lviv Polytechnic. He studied at the Faculty of Mathematics at the Jagiellonian University in Krakow. In 1880, Kazimierz Olearski defended his doctoral dissertation at the University of Berlin. From 1885 to 1886, he studied in Paris and Oxford as a fellow of the Polish Academy of Science.

In 1889, he began to work at the Lviv Polytechnic as a professor of physics. On June 30, 1913, Kazimierz Olearski was appointed as a rector of Lviv Polytechnic and worked in this position until 1915. During his fruitful work he represented the Polish School of Physics at scientific congresses in Germany, Austria, France, Great Britain, Switzerland, Czech Republic and Romania. Professor Kazimierz Olearski's scientific works are devoted to the theory of elasticity, different questions of mathematics and electrical

[14] Copies of diplomas of doctors of technical sciences, State Archives of Lviv Region [hereinafter: SALR], Fund 27, Desc. 3, Vol. I, Case 327, 1924, sheet 7.

[15] *To the 125th anniversary of electrical engineering education and science at Lviv Polytechnic*, „Energy and Electrical Engineering" 2017, No. 4(404), pp. 2–11; Personal file of S. Fryze, SALR, Fund 27, Desc. 4, Case 669, sheet 7.

engineering. So he started electrical engineering research at Lviv Polytechnic at a high theoretical level[16].

Another outstanding electrician and specialist in the field of electrometry, teacher and professor of Lviv Polytechnic, a member of the Union of Polish Electricians – Wlodzimierz Krukowski. He began his studies at the Faculty of Physics and Mathematics of St. Petersburg University, but later preferred the technical field and entered the Faculty of Electrical Engineering of Darmstadt Polytechnic. In 1912, W. Krukowski's thesis "Properties of a cylindrical capacitor at high voltage and different degrees of eccentricity of the inner cylinder", performed under the guidance of the famous Professor Waldemar Petersen, got an award at a scientific competition. Later W. Krukowski worked as an engineer in the electrical laboratory of engineer Julius Adolf Mollinger at the Siemens-Schuckert measuring devices factory. In 1930 he was appointed a full professor and headed the Department of Electrical Measurements and Electrical Laboratory of Lviv Polytechnic[17].

Gabriel Sokolnitski made a significant contribution to the development of electrical research at Lviv Polytechnic School. After graduating from the Faculty of Electrical Engineering at the University of Darmstadt, G. Sokolnitski began to work at the Lviv Polytechnic School at the Department of Electrical Engineering under the direction of Roman Dzieslevsky. And since 1921 he has been a professor at the Lviv Polytechnic School and head of the Department of Electrical Devices. In 1931 he was elected as a rector of Lviv Polytechnic (fig. 4). The scientist was at the origins of the electrical industry in Western Ukraine. He designed and supervised the construction of many power plants, designed the Lviv district network, and in 1917–1918 supervised the reconstruction of all electrical lighting installations and the conversion of the L'viv's power grid to three-phase current[18].

---

[16] Personal file of K. Olearski, *ibidem*, Case 992, sheet 5.

[17] J. Hickiewicz, P. Rataj, P. Sadlowski, *Wlodzimier Krukowski (1887–1941) – the founder of the Lviv school of electrical measurements*, „Wrocławskie Studia Wschodnie" 2017, No. 21, pp. 249–279; O. Lavrinenko, *Scientific electrotechnical school of Lviv polytechnical institute at the end of the XIX century – the beginning of the XX century*, „VIRTUS" 2019, No. 38, pp. 172–176; J. Hickiewicz, P. Rataj, *Professor Dr. Eng. Włodzimierz Krukowski (1887–1941) – on 75 anniversary of vuletzki hills tragedy*, „Maszyny Elektryczne – Zeszyty Problemowe" 2016, No. 3, p. 161.

[18] J. Strzałka, *Historia Oddziału Lwowskiego SEP*, „Czasopismo Techniczne" 2009, No. 141, pp. 9, 10.

From 1924 G. Sokolnitski participated in the development of rules and regulations by the Polish Electrotechnical Committee, from 1930 – head of the Electricity Commission of the Polish Energy Committee, and in 1938 for a significant contribution to the development of the electrical industry was elected a full member of the Polish Academy of Engineering Science[19].

4. Administration of Lviv Polytechnic in 1931–1932 academic year, rector – G. Sokolnitski in the middle (materials of the Museum of Wroclaw University of Science and Technology)

The organization of the physical cabinet became the impetus for the formation of electrical research at the Kharkiv Practical Technological Institute (later – Kharkiv Institute of Technology) (fig. 5). By the Ministry of Education on August 5, 1885 at the suggestion of director of Institute Vyktor Kyrpychov, Oleksandr Pohorelko, an associate professor at Kharkiv University, has been appointed adjunct professor of physics. Expansion of teaching electrical engineering at KhPTI belongs to a talented scientist of electrical engineering, Professor Mykola Klobukov. In 1893, the scientist initiated the creation of the Electrical Laboratory. According to his recommendations, the Institute bought new measuring equipment, electric machines of direct and alternating current, a collection of electric resistors, transformers, voltage and current regulators, *etc.* For laboratory work on electrical engineering

[19] Personal file of G. Sokolnitski, SALR, Fund 27, Desc. 4, Vol. 2, Case 600, 29 sheets.

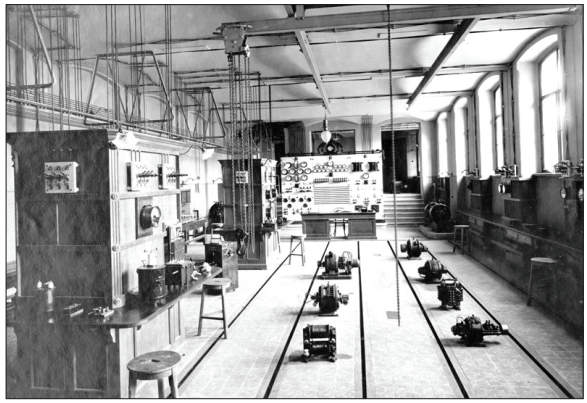
in the mechanical workshops of the institute made "Klobukov apparatus" to demonstrate the laws of the magnetic circuit and determine the magnetic permeability of the body[20].

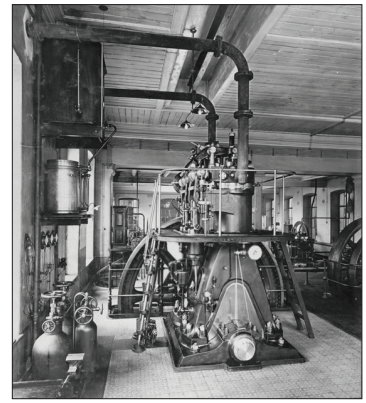
5. The main building of Kharkiv Institute of Technology, 1900s (materials of the Museum of National Technical University "Kharkiv Polytechnic Institute")

The formation of the electrical engineering department at Kharkiv Institute of Technology is associated with Professor Pavlo Kopnyaev. At the suggestion of the scientist in 1921 the Faculty of Electrical Engineering was opened at the institute. And in 1930 the Kharkiv Electrotechnical Institute was organized on the basis of the Faculty of Electrical Engineering. It was the first specialized higher educational institution of electrical engineering profile in Ukraine (fig. 6)[21].

[20] Report of the Kyiv Polytechnic Institute for 1907, State Archives of Kharkiv region [hereinafter: SAKhR], Fund 18, Desc. 1, Case 185, sheet 3; M. Gutnyk, E. Tverytnykova, V. Sklyar, *op. cit.*, pp. 125–138.

[21] Brief information on the history of the Kharkov Electrotechnical Institute (1930–1946), SAKhR, Fund 5404, Desc. 2, Case 59, 14 sheets; O. Tverytnykova, *The development of the scientific electrical engineering school of Professor P.P. Kopnyaev in the second half of the XX century (to the 150th anniversary of the scientist's birth)*, „Res History" 2018, No. 45, pp. 421–433.





6. The Engine room of the electrotechnical laboratory and power plant in Kharkiv Institute of Technology (project by P. Kopnyaev), 1910 (materials of the Museum of National Technical University "Kharkiv Polytechnic Institute")

In 1921, the electrical engineering department of the reorganized Ekaterinoslav Polytechnic Institute was attached to the Faculty of Mechanical Engineering of the Ekaterinoslav Mining School. It was headed by an electrical engineer, professor of electrical engineering since 1928, Grigory Evreinov. He began research in the field of electrification of mining enterprises, the theoretical foundations of electrical engineering and became the founder of the electromechanical specialty at the institute.

The Higher Courses of Telegraph Mechanics were opened in Odessa in 1900. In the following years the courses were expanded and in 1923 the Odessa Electrotechnical School of High Currents was organized. The school trained communications engineers for a period of four years. In 1929 the electrical engineering college was reorganized into the electrical engineering faculty of the Odessa Polytechnic Institute. In the 1920s and 1930s, Leonid Mandelstam and Mykola Papaleksi, well-known radiophysicists, worked at the faculty. In 1930, the Institute of Communication Engineers was established on the basis of the faculty[22].

The formation of electrical engineering education in Ukraine can be traced in table 2.

[22] File of the equipment of laboratories and offices of the Odessa Polytechnic Institute of 1928–1929, State Archives of Odessa region, Fund R-126, Desc. 5, Case 490, 302 sheets.

Table 2

Emergence and development of higher electrical engineering education in Ukraine

Educational institution	Year of establish-ment	Started teaching of electrical engineering	Organized electrical department/ faculty
Lviv polytechnic institute	1844	1887 Feliks Strzelecki Kazimierz Olearski	1890 – Department of Electrical Engi-neering
Kharkiv practical technological institute	1885	1892 Oleksander Pogo-relko Pavlo Kopnyaev	1901 – Department of Electrical Engi-neering 1921 – electrical engineering faculty
Kyiv polytechnic institute	1898	1901 Mykola Artemyev	1918 – electrical engineering faculty
Ekaterinoslav Higher Mining School	1899	1921 Grigory Evreinov	1921 – Electrome-chanical Department and Department of Mining Electrical Engineering
Odessa polytechnic institute	1918	1924 Leonid Mandelstam Mykola Papaleksi	1924 – Faculty of Power Engineering 1929 – electrical engineering faculty

The table source: E.K. Posvyatenko, O.E. Tverytnykova, N.I. Posvyatenko, T.V. Melnyk, *Historical affinity of applied technical sciences development: monograph*, Kharkiv 2017, p. 174.

Conclusions

Thus, the industrial revolution stimulated the development of research in the new energy sector. Leading European institutions have begun research in the field of telegraphy and electricity

transmission. But later, in accordance with the needs of the electrical industry, there was a differentiation of electrical engineering. The successful integration of inventive activity and theoretical knowledge has given impetus to new areas of practical application of electricity: communications, lighting, electroplating, long-distance transmission of electricity, electric transport. At this time, scientific schools of theoretical electrical engineering were formed, first in Germany, France and Belgium. Electrical laboratories were set up to enable engineers and technicians to gain practical knowledge. The acquired European experience was borrowed by scientists of the Russian Empire, of which Ukraine was a part at that time. After the abolition of serfdom and the creation of new types of enterprises in Russia, the question of training qualified personnel arose; this in turn led to the formation of a network of higher technical institutions.

The needs of the electrical industry required qualified professionals at different stages of production. To ensure the technological process, the creation of new equipment required engineers experienced in basic sciences, design, calculation methods, operation of technical devices, means of experimental engineering and researchers capable of leading complex projects. Scientists of Lviv Polytechnic played a leading role in the development of electrical engineering education. Lviv Polytechnics is the mother of Polish Technical Universities and at the same time the oldest Polytechnics of today's Ukraine. This University links the scientific traditions of Ukraine, Poland, Austria and Europe. Despite the fact that due to many events of the first half of the 20th c. most of the teaching staff who conducted research left Lviv Polytechnic, the laboratory base they created and the system of training electricians became the impetus for the development of theoretical electricity in subsequent years. Professor Gabriel Sokolnitski is a figure combining German, Polish and Ukrainian electrical engineering. He is one of many Poles who remained in the lands of his ancestors and made a great contribution to the construction of a modern European Ukraine.

In the next years, similar studies were conducted in Kyiv and Odesa, and the first separate electrical engineering institution of higher education was established in Kharkiv. Special electrical research – in the field of mining electrical engineering, began in Ekaterinoslav (Dnipro city). Development of scientific research

in institutions operating in Ukraine in the late 19th – early 20th c. contributed to the formation of the scientific foundations of the electrical industry of Ukraine. The theoretical basis created during this period became the basis for the formation of a powerful system of scientific support of the electrical industry of Ukraine in subsequent years.

A characteristic feature of this period was that scientific research was conducted by single scientists. However, already in the early 1920's in Ukraine conditions were created for the development of production of various types of electrical products. Therefore, studies of the formation and development of the system "electrical science-engineering-engineering activities" in Ukraine require further in-depth research.

Bibliography

Archival sources

Central State Archives of Supreme Bodies of Power and Government of Ukraine [CSASBPGU]

Personal file, Fund 116, Desc. 12, Case 7079, 6 sheets.

State Archives of Kharkiv region [SAKhR]

Book of Acquired Items in the Electrical Laboratory, 1893, Fund 770, Desc. 1, Case 184, sheet 3.

Brief information on the history of the Kharkov Electrotechnical Institute (1930–1946), Fund 5404, Desc. 2, Case 59, 14 sheets.

Report on the state of the Kharkov Technological Institute for 1891, Fund 770, Desc. 1, Case 156, 18 sheets.

State Archives of Kyiv [SAK]

Report of the Kyiv Polytechnic Institute for 1907, Fund 18, Desc. 1, Case 185, sheet 3.

State Archives of Lviv region [SALR]

Copies of diplomas of doctors of technical sciences 1924, Fund 27, Desc. 3, Vol. I, Case 327, sheet 7.

Personal file of G. Sokolnitski, Fund 27, Desc. 4, Vol. 2, Case 600, 29 sheets.

Personal file of K. Olearski, Fund 27, Desc. 4, Case 992, sheet 5.

Personal file of S. Fryze, Fund 27, Desc. 4, Case 669, sheet 7.

State Archives of Odessa region [SAOR]

File of the equipment of laboratories and offices of the Odessa Polytechnic Institute for 1928–1929, Fund R-126, Desc. 5, Case 490, 302 sheets.

Printed sources

Butrica A.J., *From inspecteur to ingénieur: telegraphy and the genesis of electrical engineering in France, 1845–1881*, [in:] *Retrospective Theses and Dissertations*, Iowa 1986, No. 7982.

Chrzan K.L., *Lviv Polytechnics as Mother of Polish Technical Universities*, [in:] *Information technologies: science, engineering, technology, education, health. MicroCAD-2019*, ed. Ye. Sokol, Kharkiv 2019.

Demidova Y., Tverytnykova E., Nikolaie I., *The analysis of the professional training features of the Ukraine scientific potential. The experience and prospects*, "Theory and practice of management of social systems" 2019, No. 4, pp. 112–124.

Gutnyk M., Tverytnykova E., Sklyar V., *Commercialization of Scientific Activity at a Higher Technical School of East Ukraine in the Late 19th and Early 20th Century*, "Acta Baltica historiae et philosophiae scientiarum. Estonian Association for the History and Philosophy of Science" 2019, vol. VII, No. 3, pp. 125–138.

Hickiewicz J., Rataj P., *Professor Dr. Eng. Włodzimierz Krukowski (1887–1941) – on 75 anniversary of vuletzki hills tragedy*, "Maszyny Elektryczne – Zeszyty Problemowe" 2016, No. 3, pp. 161–168.

Hickiewicz J., Rataj P., Sadlowski P., *Wlodzimier Krukowski (1887–1941) – the founder of the Lviv school of electrical measurements*, "Wrocławskie Studia Wschodnie" 2017, No. 21, pp. 249–279.

Hickiewicz J., Sadłowski P., *Roman Dzieślewski. Pierwszy polski profesor elektrotechniki i Jego współpracownicy*, Opole 2014.

Kolakowski T.E., *Profesor dr. inz. Stanislaw Fryze (1885–1964). Pionier electrotechniki. Nauczyciel i wychowawca wielu pokolen polskiej mlodziezy akademickiej. Monografia*, Katowice 2009.

Lavrinenko O.V., *Scientific electrotechnical school of Lviv polytechnical institute at the end of the XIX century – the beginning of the XX century*, "VIRTUS" 2019, No. 38, pp. 172–176.

Lebedinsky V.K. *Decade of the Higher Electrotechnical School in Paris*, "Electricity" 1905, No. 2, pp. 27–28.

Posvyatenko E.K., Tverytnykova O.E., Posvyatenko N.I., Melnyk T.V., *Historical affinity of applied technical sciences development: monograph*, Kharkiv 2017.

Radoguz S., Gutnyk M., Zaitsev R., *The contribution of Kharkiv Practical Technological Institute scientists to electrification of Kharkiv city at the end of XIX – the beginning of XX century*, [in:] *2018 IEEE Ukraine Student, Young Professional and Women in Engineering Congress (UKRSYW)*, Conference proceedings (October 2–6, 2018, Kyiv, Ukraine) 2018, pp. 82–87.

Sadłowski P., *Erasmus Kittler (1852–1929). Pionier elektrotechniki Erasmus Kittler (1852–1929). Pionier of electrical engineering*, "Maszyny Elektryczne – Zeszyty Problemowe" 2016, No. 4(112), pp. 163–168.

Shatelen M.A., *The teaching of electrical engineering in higher education institutions in Russia and abroad*, "Electricity" 1898, No. 20, pp. 297–301.

Simonenko O.D., *History of technology and technical sciences: philosophical and methodological aspect of the evolution of the discipline: monograph*, Moscow 2005.

Strzałka J., *Historia Oddziału Lwowskiego SEP*, „Czasopismo Techniczne" 2009, No. 141, pp. 9–10.

To the 125th anniversary of electrical engineering education and science at Lviv Polytechnic, "Energy and Electrical Engineering" 2017, No. 4(404), pp. 2–11.

Tverytnykova O.E., Posvyatenko N.I., Melnyk T.V., *Essays on the history of development of applied technical sciences in Ukraine. From the experience of Kharkiv Technological Institute. Monograph*, Kharkiv 2015.

Tverytnykova E., Gutnyk M., Salata H., *Professors of the Kharkiv Technological Institute: unknown pages of biograph*, "History of science and technology" 2020, vol. X, issue 2, pp. 383–389.

Tverytnykova O., *The development of the scientific electrical engineering school of Professor P.P. Kopnyaev in the second half of the XX century (to the 150th anniversary of the scientist's birth)*, "Res History" 2018, No. 45, pp. 421–433.

Notka o autorach:

Assoc. Prof. Maryna Gutnyk – employed at the Ukrainian Studies, Culturology and History of Science Department of the National Technical University "Kharkiv Polytechnic Institute". Ph.D (2010), docent (2014). Author of 130 publications, a member of the editorial board of scientific journals: "History of Science and Technology", "Studies in history and philosophy of science and technology", and "History of Science and Biography". Member of the professional association "Ukrainian Society of Historians of Science"; scientific secretary of the council for Ph.D defense at NTU "KhPI".

Research interest: history of higher technical education, history of material science, history of science.

maryna.gutnyk@khpi.edu.ua

Assoc. Prof. Olena Tverytnykova – employed at the Information and measurement technologies and systems Department of the National Technical University "Kharkiv Polytechnic Institute". Ph.D (2010), D.Sc., specialty History of Science and Technology (2018). Works as the editor-in-chief of the scientific journal "Studies in history and philosophy of science and technology", a member of the editorial board of "Science and Science of Science", "History of Science and Biography". Author of 220 publications, four monographs and five textbooks. Member of the professional association "Ukrainian Society of Historians of Science".

Research interests: history of electrical engineering, history of science and technology, technical Regulation and product quality management.

tveekhpi@ukr.net

Assoc. Prof. Krystian Leonard Chrzan – employed at the High Voltage Laboratory of the Wrocław University of Science and Technology since 1983. Ph.D (1987), D.Sc. (2013). He worked at the Stuttgart University (1988–1989), Technische Hochschule Zittau (1991–1993), Cardiff University (2004–2005) and at various HV laboratories in Germany, Czech Republic, USA, India and South Africa. Author of 350 publications, eight patents and five books. Member of CIGRE, Societas Humboldtiana Polonorum, SEP, the Electrotechnical Committee of the Polish Academy of Sciences, scientific secretary of PKOO.

Research interest: high voltage engineering, lightning protection, outdoor insulation, history of science.

krystian.chrzan@pwr.edu.pl