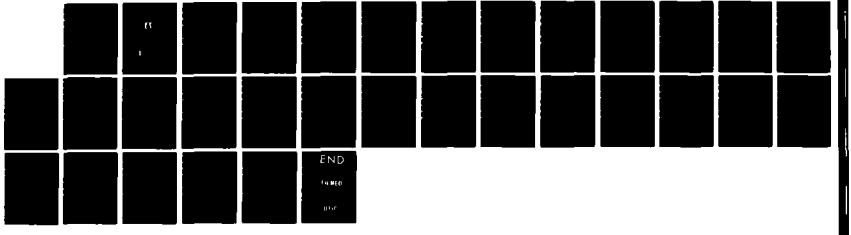
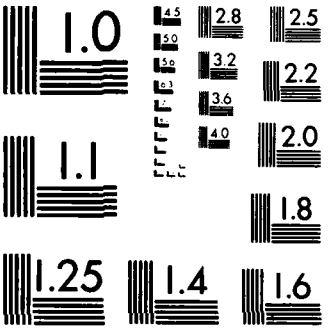
AD-A155 323 THE CONTRIBUTION OF THE SOVIET HIGHER ELECTRICAL ENGINEERING SCHOOL TO SC..(U) FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OH V A VENIKOV ET AL. 16 APR 85 1/1

UNCLASSIFIED FTD-ID(RS)T-0161-85 F/G 9/3 NL





FTD-ID(RS)T-0161-85

FOREIGN TECHNOLOGY DIVISION

THE CONTRIBUTION OF THE SOVIET HIGHER ELECTRICAL ENGINEERING SCHOOL TO SCIENTIFIC RESEARCH ON ELECTRICAL ENGINEERING AND POWER ENGINEERING FOR 50 YEARS

BY

V.A. Venikov, B.A. Knyazevskiy, V.I. Sokolov

EDITED TRANSLATION

FTD-85-C-000208L

FTD-ID(RS)T-0161-85 16 April 1985

THE CONTRIBUTION OF THE SOVIET HIGHER ELECTRICAL ENGINEERING SCHOOL TO SCIENTIFIC RESEARCH ON ELECTRICAL ENGINEERING AND POWER ENGINEERING FOR 50 YEARS

By: V.A. Venikov, B.A. Knyazevskiy, V.I. Sokolov

English pages: 28

Source: Izvestiya Vysshikh Uchebnykh Zavedeniy, Energetika, Nr. 11, 1967, pp. 1-13

Country of origin: USSR
Translated by: FLS, INC
F33657-85-D-2079
Requester: FTD/TQTD

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

THE CONTRIBUTION OF THE SOVIET HIGHER ELECTRICAL ENGINEERING SCHOOL TO SCIENTIFIC RESEARCH ON ELECTRICAL ENGINEERING AND POWER ENGINEERING FOR 50 YEARS

Professor V. A. Venikov, Lenin Prize laureate and doctor of technical sciences, Professor B. A. Knyazevskiy, and Senior Scientific Fellow V. I. Sokolov, candidate of technical sciences

Scientific and Technical Council of the USSR Ministry of Higher and Secondary Specialized Education

The Soviet advanced technical school has played a decisive role in the development of electrical engineering and power engineering in this country.

Over the last 50 years, scientists of higher educational institutions of this country have made a large contribution to the business of development of science and technical progress involved with electrical engineering and power engineering. Approximately 40% of all scientific work on electrical engineering and power engineering has been done in departments and laboratories of higher educational institutions. If we add to this the research which is being conducted intensively by more than a thousand graduate students and power engineers working at educational and scientific laboratories of electrical engineering and power engineering in departments at vuz [higher educational institutions] and take into account the research performed by students participating directly in scientific work, the contribution which vuz have made and are

making to the development of scientific research in the Soviet Union becomes even more estimable.[1]

Features of scientific research work at higher educational institutions are dictated above all by the requirements of the educational process. Scientific work at the best departments is always structured in such a way as to produce not only a definite scientific and practical contribution in connection with accomplishment of the work and based on the work but simultaneous development and improvement of laboratories, research training work, course and thesis work and courses presented in the departments.

The fundamental direction of scientific work at higher educational institutions is involved with solving problems of training of engineering and scientific personnel. In recent years 6-7 thousand former students of higher educational institutions annually have become specialists in electrical engineering and power engineering. These are specialists who bring to life and industry the knowledge which they have gained during training most closely involved with scientific research work at higher educational institutions. This

[1]This article only includes information on departments which sent replies to the inquiry of the combined section for power engineering and electrical engineering of the NTS [Scientific and Technical Council] of the USSR and RSFSR Ministry of ViSSO [Higher and Secondary Specialized Education].
Since not all the higher educational institutions provided sufficiently comprehensive responses, the data cited make it possible to evaluate only approximately the results with which higher educational institutions have arrived at the anniversary of the Soviet state. This information must be considered as an illustration for the conclusions of the article but by no means as exhaustive material.

relationship of the advanced school to production holds one of the effects of scientific research work of higher educational institutions: the transfer by graduates of higher educational institutions to industry and NII [scientific research institutes] of habits of scientific work and information on scientific research in which they have participated at departments of the vuz. Thousands of graduates directly or indirectly carry the results of scientific research of the vuz to different branches of the national economy, and the effect of vuz research is strengthened immeasurably in this way.

In discussing the application of results of scientific research, one cannot fail to mention the fact that handbooks written as textbooks or monographs which are used by students and engineers reflect to a considerable degree the results of scientific research which has been done by vuz workers. This research, which is reflected in the pages of training manuals, thus gains rapid and effective although indirect introduction into the scientific and industrial activity of an enormous mass of researchers and engineers, who solve practical problems of modern technology. It is appropriate to emphasize here that 90% of such manuals and monographs have been created by the advanced school workers themselves. And although they are intended primarily for the vuz, a whole army of engineering and scientific workers of this country make use of them.

After this discussion of general characteristics of the participation of scientific vuz in solving problems of technical progress, we shall attempt to indicate in a number of specific examples the contribution which vuz have made and are making to technical progress. It is clear that this contribution is different at different vuz, and that the greatest

successes are achieved where the conditions are created for conducting scientific work, where there are modern experimental facilities and equipment and auxiliary engineering and scientific personnel, and where the necessary financing for scientific work is provided.

Problems laboratories, which have been created at a whole series of vuz, have been an extremely successful form for the organization of scientific work. It has been possible to increase significantly the volume of scientific research and to introduce the results into production work more rapidly based on problems laboratories.

The examples given below, of course, cannot cover the entire variety of vuz work, and the following exposition cannot pretend to be complete. However, the work of vuz and their contribution to scientific research in the field of electrical engineering and power engineering can still be characterized and evaluated adequately even with these specific examples.

STAGES OF THE DEVELOPMENT OF SCIENTIFIC TRENDS AND SCIENTIFIC SCHOOLS IN THE FIELD OF ELECTRICAL ENGINEERING AND POWER ENGINEERING AT HIGHER EDUCATIONAL INSTITUTIONS OF THE SOVIET UNION OVER 50 YEARS

The role of educational institutions in the creation of scientific trends and scientific schools in the last 50 years has been very great. It is just the specific characteristics of an advanced school, the need for delivering lectures and creating educational manuals and textbooks which sum up the stages of development of science in the field in question and indicate paths for its further development and practical applications, which have played a significant role in shaping scientific trends. The latter have undergone further development at specialized scientific research institutes, at com-

mercial laboratories and in industry and have provided the creation of the Soviet scientific school of electrical engineering.

The theoretical bases of electrical engineering have been fully formed in the last 50 years as an independent discipline, although the first theoretical courses were created in the nineties of the last century by M. A. Shatelen and V. F. Mitkevich in Petersburg (Leningrad) and K. A. Krug and B. I. Ugrimov in Moscow, at the Moscow Advanced Technical School, where they began delivering lectures on electrical engineering. The main courses on the theory of alternating currents and electrical measurements at the MVTU [Moscow Advanced Technical School] were delivered by K. A. Krug. His course on the theory of alternating currents was published for the first time in 1906.

Two electrical engineering *schools, Moscow and Leningrad,* thus began to take shape; they have had a further decisive influence on the development of the theory of electrical engineering in the USSR and of practical problems in the use of electricity in the national economy. Later the development of electrical engineering demanded the development of a theory of complex electrical circuits and the development of problems not only of analysis but of synthesis of circuits according to predetermined characteristics. Research on electrical circuits by means of modern mathematical apparatus began to take on greater and greater importance.

Advanced school workers were responsible for basic research on all these problems. They created the theory and techniques and methods for calculating transition processes in linear and nonlinear circuits. The first research and hypotheses on the

so-called symbolic method were established at the Khar'kov Polytechnic Institute by M. Ye. Vashchenko-Zakharchenko, who basically suggested using methods which have come to be called operator calculus, which subsequently has been linked only with the name of the English engineer Heaviside. Later frequency methods came to be applied extensively to the investigation of transition processes along with the operator method; the development and systematization of frequency methods were accomplished primarily at higher educational institutions.

Problems of field theory and applied field theory have undergone intensive development at the Leningrad Polytechnic Institute, the Moscow Power Engineering Institute, the Khar'kov Polytechnic Institute, and recently at the Ural Polytechnic Institute and on a somewhat smaller scale at a number of other institutes. The theoretical research which has been conducted and the development of practical methods for electrical calculations of high-voltage fields have been used extensively by scientific research and industrial laboratories for specific solutions in the development of generators, various installations, cables and high-voltage instruments. The work of scientific vuz on holding more than one position at NII and in industry has played an important role in the comprehensive development of the problem.

Experimental and computer facilities of modern technology have undergone development and advancement of their own within the walls of higher educational institutions. For example, Moscow Power Engineering Institute Professor and now Academician S. A. Lebedev has played a large role in the development of digital computers in this country. Although work on further development and evolution of these methods, which has required major financing, has subsequently been done

by other organizations, it is easy to find the sources of research directed at solving this problem within the higher educational institutions.

Ideas of both physical and mathematical modeling have been developed and realized primarily at the Moscow Power Engineering and Leningrad, Khar'kov and Kiev Polytechnic Institutes.

The contribution of higher educational institutions is also extremely significant in the field of development of the science of power engineering and energy systems, although, of course, the practical side of these problems has evolved at planning and research institutes to a greater degree than at higher educational institutions. Numerous articles, manuals and monographs have presented solutions to practical as well as general theoretical problems which have been applied directly in commercial practice under the direction of vuz teachers. For example, an exceptionally important problem put forward by early Soviet power engineering, the development of simple designs for wood supports for electrical transmission lines, was worked out under the direction of professors A. A. Glazunov in Moscow and A. Ya. Vinogradov in Leningrad. Basic works of Professors A. A. Gorev, L. I. Sirotinskiy and A. A. Smurov were devoted to protecting power engineering structures against overvoltages and lightning strikes; these professors did serious commercial work along with their work at vuz.

Among the complex problems which engineers working on the operation and design of electrical systems were forced to confront in the twenties were calculations of short circuiting and calculations of the stability of parallel operation of electric power plants. Electricians in the USA encountered

the phenomenon of instability of power plants for the first time in their work in 1920-1922. This problem emerged later in power systems of Western Europe and the Soviet Union. The basic work which has served as reference material for planning organizations and practical workers was done at higher educational institutions. One of the first publications (1922) on this problem was an article by Professor L. N. Lyust entitled "Parallel Operation of High-Power Central Stations," and another was a work of V. P. Khashchinskiy entitled "Connection of Large Networks." Later the theory of electrical transmission lines and electrical networks was established based on research and publications by teachers of higher educational institutions. For example, questions of the development of optimum conditions in the design of electrical networks, selection of the most profitable number of transformer points and the distribution of power sources were solved under the leadership of A. A. Glazunov in Moscow, M. D. Kamenskiy in Leningrad and V. M. Khrushchev in Khar'kov. We must also take note of the work of Professor N. N. Shchedrin in the field of methods for calculating short circuiting currents in electrical systems and monographs and textbooks of D. A. Gorodskiy, S. A. Ul'yanov, S. V. Strakhov, A. B. Chernin and others.

The calculation of high-voltage electrical transmissions was created and established based on research conducted by A. A. Smurov in Leningrad, A. Ya. Ryabkov in Moscow and V. M. Khrushchev in Khar'kov, among others. All these methods have found direct application in planning calculations and have been reflected directly in textbooks and training manuals.

Electrical machine building in its practical aspect naturally has developed and is developing due to research done mainly in planning and plant organizations. However, scientific

research institutes did not exist at the very beginning of the development of electrical machine building, and plant laboratories pursued only purely practical goals involved with inspection testing of products. Therefore, it was the higher educational institutions which had adequately equipped laboratories, such as the Leningrad Polytechnic Institute and the Moscow Advanced Technical School, which were forced to conduct not only theoretical but practical developments in the design and investigation of electrical machines. This research formed the foundation for the modern theoretical and practical school of electrical machine building.

The training of electrical machine building specialists, which has been fully developed in the 50 years of the Soviet regime, has taken its final direction from vuz of Moscow, Leningrad, Khar'kov, Kiev and Novocherkassk. The creation of scientific schools in the field of electrical machine building is linked specifically to educational institutions of these cities and to the names of Professors K. I. Shenfer, S. A. Kurbatov, V. S. Kulebakin, M. P. Kostenko, A. Ye. Alekseyev, G. N. Petrov, I. M. Postnikov and others. Practical confirmation of results has been achieved by the cooperation of these educational institutions with such great plants as "Elektrosila" in Leningrad, KhEMZ [Khar'kov Electrical Machine Plant], "Dinamo" and MTZ [Moscow Transformer Plant] in Moscow, etc. Scientific directions and scientific schools have also been created in recent years in Siberia: the Novosibirsk Electrical Engineering and Tomsk Polytechnic Institutes.

Research conducted previously and research which is going on now at the Leningrad Polytechnic, the Leningrad Electrical Engineering, the Moscow Power Engineering, the Ural Polytechnic and the Khar'kov Polytechnic Institutes is worthy of note in

the development of electrical engineering instruments. This research, directly involved with practical problems which arise in industry, has made it possible to accomplish considerable modernization of working instruments and has made a substantial contribution to the creation of new instruments.

V. F. Mitkevich at the Leningrad Polytechnic Institute and V. P. Vologdin at the Leningrad Electrical Engineering Institute did important work at the very beginning of the development of this branch of technology in developing designs for ionic converters and investigating the properties of electrolytic rectifiers. Professors A. N. Larionov, K. A. Krug and I. L. Kaganov of the Moscow Power Engineering Institute, M. P. Kostenko and L. P. Neyman of the Leningrad Polytechnic Institute, I. M. Chizhenko of the Kiev Polytecynic Institute and others developed the theory of rectification and rectification circuits. Specialties and research laboratories created in 1927 at the Leningrad Electrical Engineering Institute, the MVTU, the Plekhanov Institute and later at the Moscow Power Engineering Institute played a large role in the field of development of light technology.

The contribution of higher educational institutions has been extremely great in scientific development and training of personnel in the electric drive field. For example, a discipline was introduced under the title "Electrical transmission and the distribution of mechanical energy" into the curriculum of the oldest electrical engineering vuz, the Petersburg Electrical Engineering Institute, as early as 1898. Further training of electrical engineers specializing in the electric drive and related scientific research work have provided a definite level of electric drive development in this country. Electric drive departments headed by Professor S. A.

Rinkevich were organized in 1920-1922. The first Soviet electric drive textbook, written by Rinkevich and entitled "Electrical Distribution of Mechanical Energy," was published in 1925. A series of works on starting and controlling apparatus and special electric drive problems, including operating modes of synchronous and asynchronous motors, appeared later. The monographs of VZEP [expansion unknown] Professor I. A. Syromyatnikov should be noted in particular among these works. Almost all advanced electrical engineering and polytechnic educational institutions are working on electric drive problems at present. Leningrad, Moscow and Kiev scientific schools are doing the most important scientific research in this field. Important work on the electric drive problem is also being done at the Novocherkassk, Ural and L'vov Polytechnic Institutes, among others.

We must note in conclusion that scientific organizational and planning work in this country at the very beginning of the development of power engineering was involved with vuz and with professors teaching there. For example, MVTU Professors (later fellows and teachers of the MEI [Moscow Power Engineering Institute]) A. A. Glazunov, L. I. Sirotinskiy, K. A. Krug, K. I. Shenfer, V. S. Kulebakin, M. A. Perekalin, P. G. Grudinskiy and N. N. Kubshinskiy and Leningrad Polytechnic Institute Professors M. A. Shatelen, A. A. Gorev, A. A. Smurov, V. A. Tolvinskiy and others participated actively in the development of the plan of GOELRO [State Commission for the Electrification of Russia]. Workers of vuz also participated intensively in working out problems of the development of power engineering in subsequent five-year plans.

BASIC SCIENTIFIC RESEARCH IN THE FIELD OF POWER ENGINEERING BEING CONDUCTED BY HIGHER EDUCATIONAL INSTITUTIONS AT PRESENT

Training of engineers in electrical engineering and power

engineering specialties is going on at more than 60 vuz of this country, and all these vuz are doing scientific research. Clearly it is impossible to give any sort of comprehensive survey of this scientific within the scope of a journal article. Therefore, only the most substantial research on which the USSR MViSSO [Ministry of Higher and Secondary Specialized Education] NTS has received the appropriate information from the departments will be commented on here.

A large number of departments and laboratories are doing various research on electric power plants, networks and systems. For example, the department of electric power plants of the Moscow Power Engineering Institute is doing scientific research in different directions of great importance for further development of power engineering and the electrification of our country. One can include in this category research intended:

1) to improve the operational electrical characteristics and modes of operation of synchronous generators at electric power plants and to study the effect of the excitation system on the operational characteristics of generators;

2) to study the modes of operation and improve the reliability of high-powered synchronous and asynchronous motors and their effect on the process of self-starting of groups of motors and on the process of short circuiting;

3) to study the electromagnetic transition processes in electrical machines, electrical systems and systems for the needs of electric power plants themselves.

Problems of the optimum distribution of loads in complex electrical systems are also being solved at many vuz. The department of electric power plants of the Leningrad Polytechnic Institute (the department head is Professor S. V. Usov) has developed a specialized analog computer for the most profitable

distribution of active loads, which is in operation in the Ural unified power system. The department of electric power systems and networks of the Kiev Polytechnic Institute (department head Professor V. G. Kholmskiy) is working sucessfully on the most profitable distribution of reactive loads in active and planned electrical systems and on optimizing municipal electrical networks.

The department of electric power plants of the Belorussian Polytechnic Institute (department head Professor A. I. Rutskiy) and a number of other vuz are working on problems of the distribution of loads and voltages in power systems and on investigation of busbar designs.

Study of the optimum structure of electrical networks and systems and control of them is going on at departments of electrical networks and systems of the Tomsk Polytechnic Institute (Associate Professor R. I. Borisov), the Riga Polytechnic Institute (Associate Professors Ya. F. Kuz'min and G. I. Obushchev), the Belorussian Polytechnic Institute (Professor G. Ye. Pospelov) and the Ural Polytechnic Institute (Associate Professor D. A. Arzamastsev). The Georgian Polytechnic Institute (Professor N. V. Gabashvili), the L'vov Polytechnic Institute (Professor G. I. Denisenko) and other institutes are also devoting a great deal of attention to the problem of optimizing modes of power systems.

Research on transition processes and the stability of electrical systems occupies a large place in the scientific work of electric power engineering vuz and departments: extensive research on stability theory, based on methods of analysis of synchronous machines developed previously by Professor A. A. Gorev, has been done at the Leningrad

Polytechnic Institute (Associate Professors M. L. Levinshteyn and O. N. Shcherbachev).

The Ivanovo Power Engineering Institute (department of electrical networks and systems, Professor D. P. Ledyankin) is doing research and development in the field of methods for refined calculation of parameters and starting and frequency characteristics and is synthesizing systems according to these characteristics.

Various problems of relay protection and automation of power systems are being investigating by scientists of more than ten different institutes. For example, the department of automation and relay protection of power systems of the MEI (department head Professor I. I. Solov'yev, Professor A. M. Fedoseyev and others) is developing principles and devices for relay protection and automation of alternating and direct current electrical transmissions based on the use of magnetic and semiconductor instruments. The Riga Polytechnic Institute (Professor V. L. Fabrikant) is also working intensively on the use of semiconductors in relay protection and automatics of power systems, and the Novocherkassk Polytechnic Institute (Professor A. D. Drozdov) has achieved considerable success in relay design. Extensive research on various problems of relay protection and automation of power systems is going on at the Tomsk, Gor'kiy and Tallin Polytechnic Institutes, the Novosibirsk Electrical Engineering Institute, the Ivanovo Power Engineering Institute and other institutes.

MEI Professor G. I. Atabekov has done a great deal of work in the field of the theory of electrical circuits and of relay protection and automatics.

The development of general power engineering as a science

begun 50 years ago in the work of G. M. Krzhizhanovskiy is being continued by a whole series of departments. For example, Professors S. A. Kukel'-Krayevskiy, V. I. Veyts, V. V. Bolotov and others are working at vuz and creating textbooks and training manuals.

A number of departments, such as the MEI department of the economics of industry and the organization of enterprises (department head Professor D. G. Zhimerin) and the Yerevan Polytechnic Institute (Professor Ye. D. Safarov), are working at present on investigating problems of the economics of power engineering in future design of power systems and developing theoretical bases for scientific analysis of repair economy and analysis of economic activity of electrical network enterprises and electric power plants. Technical and economic problems and other problems of supplying electricity to industrial enterprises are being investigated at power supply departments at the Novosibirsk Electrical Engineering Institute (Associate Professor B. I. Kletenik), the Gor'kiy Polytechnic Institute (Professor Yu. L. Mukoseyev), the Georgian Polytechnic Institute (Associate Professor G. D. Kupradze) and the Rostov Institute of Railroad Transportion Engineers (Professor G. M. Kayalov).

The department of hydraulic power engineering of the MEI, created by Professor T. L. Zolotarev (present department head Professor V. I. Obrezkov), and the department of economics of power engineering and hydraulic power engineering of the Novosibirsk Electrical Engineering Institute (Associate Professor T. A. Filippova) are investigating a broad range of problems of the optimization of parameters and modes of hydroelectric power plants.

Electrical machines and instruments are the subject of

research at present for a large number of vuz departments and laboratories. Designs are being developed for a high-voltage generator for 20,000 kVA (the MEI problems laboratory of electrical machines, scientific director Professor G. N. Petrov); electrostatic generators (the NII of High Voltages of the Tomsk Polytechnic Institute, scientific director Associate Professor I. I. Kalyatskiy); MHD generators (KPI [Kiev Polytechnic Institute] Professor I. M. Postnikov; the MEI department of electrical instrument building, where Professors M. A. Babikov, N. Ye. Lysov and G. V. Butkevich are conducting research and Professor B. K. Bul' heads the department at present); converters and electrical filter feeding units (Gor'kiy Polytechnic Institute problems laboratory scientific director Professor A. M. Bamdas); a controlled alternating current electric drive (Belorussian Polytechnic Institute Professor L. B. Geyler).

A number of projects going on at transport, aviation and marine institutes, academies and schools are devoted to problems of the theory and practice of the newest electrical machines for special purposes. The basic works in this area include work by A. N. Larionov (MEI), V. S. Kulebakin (VVA [air force academy]), A. Ye. Alekseyev (LIIZhT [Leningrad Institute of Railroad Transportation Engineers]), A. I. Bertinov (MAI [Moscow Aviation Institute]) and others.

The vuz are developing methods for calculations of designs and transition processes and are investigating models of electric motors (the Moscow and Ivanovo Power Engineering Institutes, the Tomsk, L'vov, Kiev and Khar'kov Polytechnic Institutes and the Leningrad Electrical Engineering Institute). These and certain other institutes are doing research on frequency converters.

Perhaps the greatest number of departments at electrical power engineering vuz are working on various problems of the application of electric drives in different branches of industry and of their automation. For example, at the MEI, the department of EPP [electrification of industrial establishments] and the automated electric drive problems laboratory are investigating problems of regulated throttle and thyristor electric drives and drives with step motors (scientific director Professor M. G. Chilikin). Development of systems for pulse control of direct current electrical machines and machines for feeding induction accelerators is going on at the Tomsk Polytechnic Institute (Associate Professors A. I. Zaytsev and G. A. Sipaylov). Theoretical and experimental research on electric drills and electric drives for mining machines is being done at the L'vov Polytechnic Institute (Professor T. P. Gubenko), the Azerbaydzhan Oil and Chemistry Institute (Professor F. G. Guseynov), the Georgian Polytechnic Institute and a number of other institutes.

Professors L. I. Sirotinskiy, D. V. Razevig, N. G. Grozdov (MEI), B. M. Tareyev (VZEI [All-Union Correspondence Power Engineering Institute]), M. M. Akodis (UPI [Ural Polytechnic Institute]), M. V. Kostenko (LPI [Leningrad Polytechnic Institute]), A. D. Fedchenko (KPI) and N. P. Bogoroditskiy (LETI [Leningrad Electrical Engineering Institute]) have worked and are working on problems of high-voltage technology, including problems of protection against overvoltages, the physics of insulators, electrical materials and insulation reliability. Problems of the theory and practice of cable technology and capacitor design have been developed in works of Professors S. M. Bragin, V. A. Privezentsev (MEI), V. T. Renne (LPI) and others.

BRIEF CHARACTERISTICS OF DEPARTMENTS TRAINING SPECIALISTS IN THE FIELD OF POWER ENGINEERING AND ELECTRICAL ENGINEERING

The department of the theoretical bases of electrical engineering of the Leningrad Polytechnic Institute was organized in 1902 by Academician V. F. Mitkevich. There are now 19 teachers working in the department (the department head is Professor L. R. Neyman). Department workers in recent years have published 6 monographs and 3 textbooks. The department has trained 9 doctors and 45 candidates of technical sciences. The main direction of scientific research work of the department is development of the theory and methods of calculation of electromagnetic fields and electromagnetic processes in linear circuits with valves, and the development of components for electrical measurement devices and automatic systems.

The department of theoretical bases of electrical engineering of the Moscow Power Engineering Institute, headed by Professor K. M. Polivanov, has published 35 textbooks and training manuals. These include a book by K. A. Krug entitled "Electrical Engineering Fundamentals" (1916), which has been reprinted 6 times. Ten monographs and about 500 articles have been published as a result of scientific research conducted at the department. Forty graduate students and 20 staff members have completed graduate studies and defended candidates' dissertations at the department. The scientific degree of doctor of technical sciences has been awarded to 8 staff members of the department. The department now has 65 instructors, including 3 professors and 21 associate professors. Fifteen graduate students are studying in the department.

The department of electrical machines of the Moscow Power Engineering Institute, created during the thirties, was headed

by Professor K. I. Shenfer. The department now includes 5 professors (Professor G. N. Petrov is the head of the department and the associated problems laboratory), 25 associate professors and 8 assistants. The department has 38 graduate students being trained in graduate studies. The department graduates 60-70 electrical engineers annually; 2 doctors and 65 candidates of technical sciences have been trained. About 30 textbooks and a large number of training manuals and articles have been published. Two scientific works of the department have earned the State Prize.

The department of electrical machines and instruments of the L'vov Polytechnic Institute was founded in 1944. More than 600 electrical engineers, 1 doctor and 27 candidates of technical sciences have been trained since that time. The department now has 17 teachers, including Doctor of Technical Sciences Professor T. P. Gubenko, the department head, and 8 associate professors and 8 assistants. Industry laboratories, an electric drive laboratory and a direct current electric drill laboratory, have been organized under the department, and 110 people work at these laboratories. The main direction of the scientific work of the department is the development of automated electric drives and electrical machines for the oil production industry.

The department of electrical systems and networks of the Kiev Polytechnic Institute was organized in 1930. The department now has 32 workers, including 1 professor, 4 associate professors and 4 assistants. Professor V. G. Kholmskiy, doctor of technical sciences, heads the department. The department is doing scientific research work on the theory of electrical networks, the application of digital computers for solving power engineering problems, and optimization of operational and

planning solutions in regard to reactive power distribution in power systems. Workers of the department have published 2 training manuals and have trained 2 doctors and 13 candidates of technical sciences.

The department of electrical systems of the Moscow Power Engineering Institute, created in 1930 (department heads Professor A. A. Glazunov, Professor P. S. Zhdanov and now Professor V. A. Venikov), and the problems laboratory of the same name have conducted more than 300 research projects on electrical networks, electric systems and the supply of electric power to cities and industrial enterprises and, in particular, on physical modeling in the field of power engineering during their existence.

Department members have been awarded two Lenin and three State Prizes and Yablochkov Prizes of the USSR Academy of Sciences for research work.

By the anniversary year of 1967, the department had graduated more than 2000 engineers specializing in design, operation and investigation of electric systems, electrical networks and power supplies for cities and industrial enterprises. The department has trained 100 candidates of technical sciences through the level of graduate study. Doctoral candidate members of the department have prepared 2 doctoral dissertations and have helped in training for defense of 3 doctoral and 20 candidates' dissertations. The department has published 37 training manuals and monographs. Representatives of 23 different states have gone through practical training and graduate studies at the department, and the department is constantly maintaining correspondence and organizing exchange of scientific research results with many of them. There are

108 people working in the department, including 40 graduate students and trainees.

A number of new courses have been established at the department in recent years, and two new specialties have been organized; the establishment of these courses and specialties has gone on in close connection with scientific research work. The subject matter of the new courses has developed based on materials of just this scientific research. The specialty "Electrical Systems and Networks" (0302) which existed previously at the department has been supplemented with specialties "Power Supply for Industrial Enterprises and Cities" (0303) and "Electrical System Cybernetics" (0304). Such new courses as "Introduction to Electrical System Cybernetics," "Mathematical Bases of the Theory of Transition Processes in Electrical Systems," "Information Theory as Applied to Problems of Electrical Systems," "Design of Control and Regulation Devices," "Power Supply for Cities," "Local Electrical Networks," "Optimization of Modes of Electrical Systems," among others, have been established in recent years.

The main scientific direction of the department, reflected in the training of power engineers, can be formulated briefly as investigation of the modes of complex electrical systems and networks which transmit and distribute electric power. Two new themes occupy a central place in this main direction: the application of the methods of cybernetics in electrical systems, and the theory and practice of design of complex closed local electrical networks.

Subject matter related to the problem of "Cybernetics of Electrical Systems" (scientific director Professor V. A. Venikov) includes research in several scientific directions.

Development of the methodology for analyzing modes of complex automated electrical systems, establishment of criteria for their optimization and discovery of possibilities and ways of gradual transition to cybernetic control of such systems should be noted above all in this connection. The field includes research involved with the development of procedures for economic optimization of the modes of a system both in its design and in its operation (scientific directors Professor I. M. Markovich and Associate Professor D. A. Fedorov). Physical modeling has been used for testing the precision of different optimization methods; i.e., the optimum modes of a complex system have been investigated on a dynamic model. An investigation of a new technique for optimizing the mode of a power system in regard to direct minimization of total calculated expenses for active and reactive power generation with consideration for damage to users as a result of deviations in voltages from the optimum values has been performed.

Work pertaining to the methodology of analysis of the modes of complex systems also includes research which has been carried on by the department for many years on the application of methods of similarity theory and physical and mathematical modeling to problems of power engineering. The development of cybernetics of electrical systems envisages simulation and similarity and the basis for research.

The department is conducting extensive research work on voltage regulation and new methods for calculations of complex electrical networks (Professor N. A. Mel'nikov, Associate Professor L. A. Soldatkina). Methods for quantitative evaluation of voltage quality based on integral criteria are being developed. Such technical and economic evaluation of voltage quality has now reached the first experiments of the application

of these methods in the unified power system of Western Siberia. Methods being developed at the department for calculations of complex electrical networks based on modern computer technology have been improved substantially due to the use of matrix methods. The department has been conducting important scientific research in recent years on problems of power supply for industrial enterprises and cities (Professor B. A. Knyazevskiy, Associate Professor A. A. Glazunov).

Most of the scientific research in the department has been conducted on the following subjects: development of the theory of small oscillations and stability, based on work of S. A. Lebedev and P. S. Zhdanov, and optimization of devices and conditions for long-range electric power transmission (Professor V. A. Venikov, Associate Professor I. V. Litkens, Associate Professor L. A. Zhukov, Associate Professor N. D. Anisimova, and others). New courses and training manuals have been created based on these scientific works, suggestions have been made for practical application of the results in power engineering, authors' certificates have been obtained for invention of new devices for reactive power compensation in long-range electrical transmissions, etc. Of course, many other departments are creating and developing new scientific directions and specialties. For example, problems of engineering electrophysics are being worked out at the MEI under the direction of Professors D. V. Razevig and P. A. Ionkin. One could cite many such examples.

However, since it is impossible to present a description of all the departments and laboratories of power engineering and electrical engineering vuz and departments, we shall give some characteristic data on a number of other departments in the table.

It is understood that in large-scale scientific research which has been put into practice to one degree or another, it is very difficult to distinguish some independent vuz group of research projects which would be the concern only of vuz scientists. It would be quite improper in our era of interaction and cooperation to distinguish in individual works any new developments or their implementation for which vuz have been totally and exclusively responsible. A large number of associates of commercial enterprises and scientific research institutions participate in any large scientific research development.

This article emphasizes and illustrates with specific examples the leading and decisive importance of vuz scientific research. Scientific developments which emerge within the walls of vuz provide an impetus for further research which goes beyond the vuz. Therefore, research begun at vuz but continued and put into practice by other organizations often is not considered as vuz work, which is quite inaccurate. In addition, the role of vuz in developing scientific work in this country must be evaluated not only in regard to results of direct production implementation of the research which has been done; the indirect effect conditioned by teaching students and graduate students the methods of scientific research based on scientific work of the faculty and by the transfer of scientific achievements and experience of faculty members directly to industry and to scientific research organizations must also be taken into consideration. Such an approach will yield a valid evaluation of the large role of vuz in the achievements of the Soviet electrical engineering and power engineering school, which is observing its anniversary and the fiftieth anniversary of the Soviet State.

Table 1.

Name of department, institute, department head	year of creation of department	Number of teachers on faculty including: total number	professors	associates	number of graduate students	doctors of technical sciences trained	candidates of technical sciences trained	large-scale scientific projects completed	textbooks and monographs published
1	2	3	4	5	6	7	8	9	10
Electrical machines, Leningrad Electrical Engineering Institute, Professor N. I. Yermolin	1899	19	2	9	12	3	20	-	66
Electrical machines, Leningrad Polytechnic Institute, Professor A. I. Vol'dek	1918	19	3	8	17	12	80	4	5
Electrical machines, Leningrad Institute of Railroad Transportation Engineers, Professor A. Ye. Alekseyev, correspondent member of USSR Academy of Sciences	1932	9	1	7	9	2	20	-	9
Electrical machines, Kiev Polytechnic Institute, Professor I. M. Postnikov	1937	19	1	8	-	1	40	11	8
Electrical machines and instruments, Azerbaydzhan									

Oil and Chemistry Institute, Professor F. G. Guseynov	1962	19	1	6	-	1	4	13	1
Electrical machines, Ural Polytechnic Institute, Professor N. S. Siunov	1931	14	1	6	12	1	35	6	4
Theoretical bases of electrical engineering, Moscow Aviation Institute, Professor S. P. Kolosov	1944	50	1	16	23	1	15	-	10
Theoretical bases of electrical engineering, Moscow Institute of Electronic Machine Building, Associate Professor P. P. Klimentov	1964	13	1	3	-	-	1	2	1
Theoretical electrical engineering, Riga Polytechnic Institute, Associate Professor K. K. Tabaks	1958	20	1	2	7	-	2	3	-
Theoretical bases of electrical engineering, Kuybyshev Polytechnic Institute, Associate Professor O. Ya. Novikov	1932	28	-	11	-	-	11	3	-
Electric power stations, Leningrad Polytechnic Institute, Professor S. V. Usov	1920	13	-	8	12	4	23	3	1

Electric power stations, Kiev Polytechnic Institute, Professor M. L. Kalnibolotskiy	1930	8	1	3	-	1	7	1	3
Electric power stations, Belorussian Polytechnic Institute, Professor A. I. Rutskiy	1946	15	1	4	5	-	4	8	5
Central electric stations, Khar'kov Polytechnic Institute, Associate Professor L. L. Rozhanskiy	1932	13	1	4	-	1	12	5	3
Electric power stations, networks and systems, Novocherkassk Polytechnic Institute, Professor A. D. Drozdov	1932	20	2	7	-	2	15	10	3
Electric power stations, Tomsk Polytechnic Institute, Professor I. D. Kutyavin	1930	15	1	3	-	1	17	3	-
Electric power stations, networks and systems, Chelyabinsk Polytechnic Institute, Associate Professor Yu. N. Katargin	1954	17	-	8	3	-	2	7	-
Electrical systems and networks, Belorussian Polytechnic Institute, Professor G. Ye. Pospelov	1963	8	1	2	5	-	2	4	3
Electrical systems and networks, Tomsk Polytechnic Institute, Associate Professor R. I. Borisov	1932	10	-	2	3	2	15	2	-

Electrical systems, Kaunas Polytechnic Institute, Associate Professor L. I. Kaulakis	1940	17	-	1	8	1	2	1	-
Electric power supply for industrial enterprises and cities, Gor'kiy Polytechnic Institute, Professor Yu. L. Mukoseyev	1964	10	1	1	3	-	-	-	-
Electric power supply for industrial enterprises and information and measurement technology, Omsk Polytechnic Institute, Associate Professor V. I. Starostin	1964	16	-	3	-	-	-	1	1
Electrical machines and electric drive, Belorussian Polytechnic Institute, Professor L. B. Geyler	1946	18	1	7	7	-	12	8	15.

END

FILMED

7-85

DTIC