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JOSEF KOROUS AND HIS PLACE IN HISTORY OF MATHEMATICS

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ABSTRAKT. *Významný matematik a vysokoškolský učiteľ prof. RNDr. Josef Korous, DrSc. (7. 2. 1906 – 23. 8. 1981) je známy v matematickej komunite hlavne svojou vedeckou prácou v teórii ortogonálnych polynómov. Pre českú a slovenskú matematiku urobil veľa aj ako profesor vysokých škôl, ako školiteľ ašpirantov – matematikov, ale aj ako pomocný školiteľ ašpirantov – inžinierov, ako predseda vedeckých výborov a komisií a ako dlhoročný člen a funkcionár JČSMF a JSMF. V príspevku sa venujeme jeho prínosu pre rozvoj teórie ortogonálnych polynómov v minulom storočí a pripomenieme si jeho život a dielo.*

KĽÚČOVÉ SLOVÁ: *Josef Korous, teória ortogonálnych polynómov, matematik, školiteľ.*

ABSTRACT. *Famous mathematician and university teacher prof. RNDr. Josef Korous, DrSc. (7. 2. 1906 – 23. 8. 1981) is well-known in mathematical community mainly by his scientific work in the theory of orthogonal polynomials. He contributed to Czech and Slovak mathematics a lot of also as professor in higher education at universities and colleges, as supervisor of research work of his followers – mathematicians, as helpful supervisor in applied mathematics of young engineers, as chairman of scientific committees and many years he worked as the member and functionary of the Union of Czechoslovak (Czech and Slovak) mathematicians and physicists. This paper is devoted to his contribution for the development of the theory of orthogonal polynomials in the last century and we remind his life and scientific and educational work.*

KEY WORDS: *Josef Korous, theory of orthogonal polynomials, mathematician, supervisor.*

CLASSIFICATION: *A30, I90*

Short biography of Josef Korous

Famous and talented mathematician prof. RNDr. Josef Korous, DrSc. (1906 – 1981) was the first head of the Department of mathematics and descriptive geometry established in September 1953 at University of railway engineering in Prague what was one of the previous names of the University of Žilina. Before he came to work to the university, he took part at preparatory works for its foundation. The 150th anniversary of the existence of the Union of Czech (Czechoslovak) mathematicians and physicists is the opportunity to remember him.

Josef Korous was born in Prague on February 7, 1906. His father was a civil engineer and the family had 5 children: Josef, Ladislav, Antónie, Veronika and Karel. Josef was the eldest of them. After the primary education he started his secondary education in 1916 at the grammar school in Písek. After the final examination at Jirásek grammar school in Prague in 1924 he entered Charles university in Prague to study mathematics and physics. During this study he was mostly interested in the lectures and seminars of prof. Karel Petr who considered him to be one of his best students. Josef Korous graduated from the university in December 1928, but already in June 1928 he received his degree of Doctor of Natural

Science (RNDr.) on the basis of his work „On expansion of functions of real variable into a series of Hermite polynomials“ published in Rozpravy II. třídy České akademie věd v Praze (Discussions of the II. class of Czech academy of science in Prague), no. 11 (cf. [1]). In the years 1929 – 1930 he was granted a scholarship of the Ministry of Education to study at the University of Göttingen in Germany. The famous mathematicians Hilbert and Landau were his teachers there. Already during his study at Charles university in Prague he worked as a temporary assistent professor of mathematics. After his return from Göttingen he was assistent professor at the Czech technical university in Prague (1930 – 36). Then he worked as the teacher of mathematics and physics at several czech secondary schools till June1953. The last 6 years of this period of his life he was the director of the grammar school in Litvínov.

To the University of railway engineering in Prague he came in September 1, 1953 and he became associated professor (docent) and head of the Department of mathematics and descriptive geometry. In 1959 he was appointed full professor and one year later he moved with the university to Žilina. The university was re-named to the University of transport engineering. In 1962 he defended the thesis and obtained the degree of Doctor of Sciences (DrSc.).

The department that he headed, had to be built from the beginnings, because after the moving of the university from Prague to Žilina many of the teachers refused to follow the department to Žilina. Professor Korous was the first professor of the university who moved there. Some of new teachers of the Department of mathematics and descriptive geometry had no practice in teaching at the university – they came mainly from secondary or primary schools where they had taught before. So there was a very difficult task for professor Korous : to find such teachers who were able and willing to work under new conditions. During the years 1953 – 66 he significantly contributed to the successful development of the department and of the university as a whole. In the academic year 1954 – 55 he was vice-dean at the Faculty of electrical engineering and in the first academic year of the University of transport engineering in Žilina (1960 – 61) he was vice-dean of the Faculty of operation and economics of transport. He had to expend much effort to overcome problems that occured during the moving of the university from Prague to Žilina. In the year 1964 he was awarded the „Medal due to effort at building of University of transport engineering“ which he had got from Town council of Žilina.

Already in the first years of the life of the University in Žilina the Department of mathematics and descriptive geometry became so large that it had to be divided into two departments (in the academic year 1962 - 63). Professor Korous remained the head of the department which was at the Faculty of operation and economics. Other part of the department went to the Faculty of mechanical and electrical engineering.

In the years 1966 - 69 prof. Korous was the head of the Department of mathematical analysis at the Faculty of science, P.J. Šafárik university at Košice, where he moved with all his family besides his daughter Jarmila (he had two children – daughter Jarmila and son Josef). After the death of his wife Milada in 1968 he moved to Prague where he was the head of the Department of mathematics at the Faculty of mechanical engineering of the Czech technical university. Here he worked only three terms and in October 1970 he was back at his previous post in Žilina. Even after his retirement in 1977 he did not give up his work and continued his teaching activities as visiting professor at the Faculty of education in Nitra. This was his last teaching place. Death reached him unexpectedly in the middle of work and creative plans in August 1981 in Žilina.

Although born in Prague, Žilina became his new home for almost 17 years and he let there a deep trace not only with his teaching and organizing activities, but also with his lectures at Seminar on orthogonal polynomials established by him already at the University of railway engineering in Prague. Due to this seminar which continued in Žilina after moving the university from Prague, professor Korous provided his experience with mathematical research in the theory of orthogonal polynomials and related problems to more than twenty his colleagues, young teachers of mathematics and other his followers. His lectures at this seminar were full of new surprising mathematical theorems and their proofs we were excited by, so that some of us started to „love orthogonal polynomials". He did not interrupt to hold this seminar in Žilina even during his employments in Košice and Nitra. That is why we continue it till nowadays.

Josef Korous and orthogonal polynomials

Investigation of special functions is very old part of research in mathematical analysis. Orthogonal polynomials are the important special functions. The results of J. Korous represent a significant contribution to this research. His papers concern of classical and generalized Hermite, Laguerre and Jacobi polynomials. He dealt with various properties of orthogonal polynomials, e.g. the location of their zeros, estimations for the least and the greatest zeros, asymptotic properties for $n \to \infty$ (n is the degree of the polynomial), the differential equations that are satisfied by orthogonal polynomials, expansions of functions of one real variable into series of orthogonal polynomials and their summability.

One of his theorems is in the mathematical literature famous as Korous' theorem. It contains a deep result on the upper bounds of polynomials $\{ p_n(x)\}$ orthogonal in the interval (–1,1) with the weight-function

$$w(x) = \widetilde{w}(x)\,k(x),$$

where $\widetilde{w}(x)$ is the weight-function of another system of polynomials $\{ \widetilde{p}_n(x)\}$ orthogonal in the same interval and $k(x) \geq k > 0$ is a certain function. This theorem was proved in the paper [6] published in the year 1938 and with the name Korous' theorem it appeared in the next year in the monograph „Orthogonal Polynomials" written by Gábor Szegö (cf. [30]). This monograph is considered to be a basic stone of the theory of orthogonal polynomials even in these days. With the name „Teorema Korausa" can this theorem be found in the book „Klasičeskije ortogonaľnyje mnogočleny" written by P.K. Sujetin in the year 1976 (cf. [29]).

Another, very young citation from the year 2001 appeared as Korous' method used in the proof of a theorem on uniform convergence of some functions connected with some class of orthogonal polynomials which was in the book „Orthogonal Polynomials for Exponential Weights" written by Eli Levin and Doron S. Lubinsky and published by Canadian Mathematical Society (cf. [26]).

May be that professor Korous never knew about citations of his research in the works of Paul Nevai from Ohio state university that appeared in 70-ies and 80-ies of the last century. In his booklet „Géza Freud, Orthogonal Polynomials and Christoffel Functions. A Case Study" (1985) Paul Nevai wrote (cf. [28]): „Now let us return to equiconvergence of orthogonal Fourier series. In his seminar paper, A.Haar proved that orthogonal Legendre series and Chebyshev series of integrable functions are equiconvergent; i.e., the difference of the corresponding appropriate partial sums converges to 0. In fact, Haar's method is directly applicable to all classical orthogonal polynomial series, such as Jacobi, Hermite and Laguerre series. The real fun starts when one leaves the road covered by remnants of

classical orthogonal polynomials and starts to examine general orthogonal polynomial series. Here the glory belongs to Szegö, whose results were later recast and generalized by J. Korous, Geronimus and Freud." From that everyone has to see that the research work of Josef Korous is highly esteemed by mathematical community because his name is mentioned in the series of the greatest mathematicians developing the theory of orthogonal polynomials. We can say, that especially his first papers [1], [2], [4], [5], [6] published in the years 1928 – 1938 are cited very often. The little note [3] deals with some problem arising from actuary mathematics.

Next period of his life, till the establishment of the University of railway engineering (1953) he devoted to teaching mathematics and physics at secondary schools, so his research work was a bit interrupted. Only significant article on a generalization of Fourier series (cf. [7]) appeared at this period.

To be the teacher at the university, he had got several recommendations from persons who were significant in the Czech mathematical community. Academician Vojtěch Jarník, professor of Charles university was one of them. In November 1953 he wrote (cf. [25]): „Works of J.Korous concern problems of mathematical analysis, important as for internal development of mathematics and as for applications. They contain significantly new methods and they show also great combinability of author at overcoming no small technical problems in proofs. His works brought many new results. As a proof it is sufficient to refer the standard book „Orthogonal polynomials" of Gábor Szegö (1939), where J. Korous is often cited. Writing this book, Szegö had only the works [1] and [2]. The works [4], [5] and [6] – as he wrote – he had got only after finishing the manuscript. In spite of it, he cited them additionally and he wrote, that Korous' results are more general than the results in the book and also that they are proved by completely new method. Also Natanson in his excellent book „Konstruktivnaja teorija funkcij" refers certain Korous' theorem with its proof, although the book is only a bit connected with the area of Korous' work. From the original Korous' papers it is clear that he is mathematician talented by a creative ability and a great swiftness at doing of uneasy reasonings and computations. His interest in mathematical analysis is an advantage for his acting at the university of technical type, because it is the area that technical sciences are meeting with very often. Although the number of his research works is not high, his excellent qualities completely qualify him to be the professor of mathematics at the university of technical type."

When Josef Korous became the teacher at the university, he was completely absorbed by organizing and teaching activities. His lecture notes from the years 1953 – 1958 are excellent, especially [23] devoted to orthogonal polynomials, which has a character of monograph. Having defended his dissertation [11] for the degree DrSc.(in 1962 in Prague), next period of his life was devoted to supervising of the research work of about twenty his followers. In the years 1957 – 1984 there appeared the articles [8 – 10, 12, 14 – 16] published in the proceedings of the universities where he was active teacher. They also have high scientific value. It is to be regretted that his death did not allow him to fulfil his idea to write a monograph on orthogonal polynomials. Nevertheless, textbook [23] is by people working in orthogonal polynomials considered to be a monograph.

Although this research was mainly theoretical, the results of Josef Korous can be of interest to researchers in approximation theory, mathematical physics, quantum mechanics, electrooptics, statistics and all those who apply orthogonal polynomials. This is the legacy of Josef Korous to applied mathematics – the basis of engineering education and research.

List of significant Korous' articles

[1] On expansion of functions of real variable into series of Hermite polynomials. Rozpravy II. třídy České akademie věd v Praze, No.11 (1928). (Czech).

[2] On series of Laguerre polynomials. Rozpravy II. třídy České akademie věd v Praze, No.40 (1928), 1 – 23. (Czech).

[3] Remarque à propos de l'article de M.Pólya concernant la déduction de la lois des erreurs de Gauss. Aktuárske vědy I (1930), 37 – 41.

[4] Über Reihenentwicklungen nach verallgemeinerten Laguerreschen Polynomen mit drei Parametern.Věstník Král. české společnosti nauk, třída matematicko-přírodovědecká, XIV(1937), 1 – 26.

[5] Über Entwicklungen der Funktion einer reellen Veränderlichen in reihen einer gewissen Klasse orthogonaler Polynome im unendlichen Intervale. Věstník Král. české společnosti nauk, třída matematicko-přírodovědecká, XV (1937), 1 – 19.

[6] On development of functions of one real variable into a series of certain orthogonal polynomials. Rozpravy II.třídy České akademie věd v Praze, No.1(1938), 1 – 11. (Czech).

[7] On a generalization of Fourier series. Časopis pro pěst. mat. a fys. 71 (1946), 1 – 15.

[8] On expansion of functions of one real variable into a series of certain orthogonal polynomials. Strojnický sborník technicko-vědecké práce pracovníků Vysoké školy železniční v Praze, 17 (1957), 45 – 52. (Czech).

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[10] On a generalization of Hermite polynomials. Sborník Vysoké školy dopravní, fakulta provozu a ekonomiky dopravy, Praha (1960), 49 – 117. (Czech).

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[13] The work of Karel Petr in mathematical analysis. Čas. Pěst. Mat. 96 (1971), s. 104 – 108.

[14] On convergence of series of orthogonal polynomials. Zborník IV.ved. konferencie VŠD v Žiline, sekcia matematika-fyzika-kybernetika, Žilina (1973), 25 – 35(Czech).

[15] On the solutions of a second order differential equation. Zborník Pedagogickej fakulty v Nitre 1, Matematika (1980), 51 – 78.

[16] On the polynomials orthogonal in the interval $(-\infty,\infty)$ with the weight $\exp(-x^6)$. Zborník Pedagogickej fakulty v Nitre 2, Matematika (1982), 81 – 100.

[17] On the differential equations of generalized Hermite polynomials. Zborník Pedagogickej fakulty v Nitre 3, Matematika (1984), 1-15. (Czech). (with O. Šedivý).

Lecture notes of Josef Korous (in Czech)

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[19] Úvod do vyšší matematiky. SNTL Praha 1957.

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[21] Úvod do nauky o funkcích komplexní proměnné. SNTL Praha 1957.

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