= Vitold Belevitch =

Vitold Belevitch ( 2 March 1921 ? 26 December 1999 ) was a Belgian mathematician and electrical engineer of Russian origin who produced some important work in the field of electrical network theory . Born to parents fleeing the Bolsheviks , he settled in Belgium where he worked on early computer construction projects . Belevitch is responsible for a number of circuit theorems and introduced the now well @-@ known scattering parameters .

Belevitch had an interest in languages and found a mathematical derivation of Zipf 's law . He also published on machine languages . Another field of interest was transmission lines , where he published on line coupling . He worked on telephone conferencing and introduced the mathematical construct of the conference matrix .

= = Early life = =

Belevitch was born 2 March 1921 in Terijoki , Karelia , now incorporated into Russia , but at the time part of Finland . Belevitch 's parents were Russian and his mother was an ethnic Pole . They were attempting to flee from their home in Petrograd ( St Petersburg ) in Russia to escape the Bolshevik revolution , which Belevitch 's father opposed . Belevitch 's heavily pregnant mother succeeded in crossing the border into Finland and continued on to Helsinki after Vitold was born , where the birth was registered . She headed for Helsinki because her husband 's father was principal of the Russian school there . Belevitch 's father was arrested before he could follow and was deported to Siberia , where he died without ever seeing his son .

In 1926 Belevitch , while still a small child , emigrated with his mother to Belgium .

= = Education = =

Belevitch was educated in French in Belgium , until July 1936 at the Notre @-@ Dame de la Paix College at Namur . In 1937 , aged 16 , he enrolled at the Université Catholique de Louvain where he studied electrical and mechanical engineering , graduating in 1942 . Belevitch gained his PhD in applied sciences at the same university in 1945 . His sponsor was Charles Manneback and his second advisor was Wilhelm Cauer , the founder of the field of network synthesis .

From 1953 until 1985 Belevitch lectured at the university . He taught circuit theory and other mathematical subjects related to electrical science . In 1960 he became a special professor ( buitengewoon hoogleraar ) . Although Belevitch worked as an electrical engineer , his primary interest was mathematics , especially algebra . There was a tradition in Belgium of the most gifted mathematicians entering engineering rather than pure mathematics or physics . Belevitch showed his mathematical leanings by preferring the use of blackboard and chalk to any audio @-@ visual aids during lectures . He even lectured in this way when presenting the opening lecture to a large audience at an international conference at the IEE in London .

= = Career = =

After graduating in 1942 , Belevitch joined the Bell Telephone Manufacturing Company ( BTMC ) in Antwerp , originally part of the International Bell Telephone Company headquartered in Brussels but , along with their other European holdings , sold to International Telephone and Telegraph ( ITT ) in 1925 . At BTMC Belevitch became head of the transmission department . It was here that he came into contact with Wilhelm Cauer who became a great influence on him . Cauer was one of the leading circuit theorists of the day and at the time worked for Mix & Genest in Berlin , a sister company under the ITT umbrella . Cauer died during the Second World War but Belevitch long after continued to consider his works to be the highest authority on matters of circuit theory .

From 1951 Belevitch was involved in the design of electronic computers which BTMC were developing for the Belgian government . The purpose of this program was to " catch up " with the advances made in the English @-@ speaking world during the war . It resulted in the construction of

the Machine mathématique IRSIA @-@ FNRS . From 1952 Belevitch represented the electrical engineering aspect of this project . In 1955 Belevitch became director of the Belgian Computing Centre ( Comité d 'Étude et d 'Exploitation des Calculateurs Électroniques ) in Brussels which operated this computer for the government . Initially , only the 17 @-@ rack prototype was operational . One of the first tasks to which it was put was the calculation of Bessel functions . The full 34 @-@ rack machine was moved from Antwerp and put into service in 1957 . Belevitch used this machine to investigate transcendental functions .

In 1963 Belevitch became head of the newly formed Laboratoire de Recherche MBLE ( later Philips Research Laboratories Belgium ) under the Philips director of research Hendrik Casimir in Eindhoven . This facility specialised in applied mathematics for Philips and was heavily involved in computing research . Belevitch stayed in this post until his retirement in November 1984 .

Belevitch died on 26 December 1999 . He is survived by a daughter , but not his wife .

= = Works = =

Belevitch is best known for his contributions to circuit theory , particularly the mathematical basis of filters , modulators , coupled lines , and non @-@ linear circuits . He was on the editorial board of the International Journal of Circuit Theory from its foundation in 1973 . He also made major contributions in information theory , electronic computers , mathematics and linguistics .

Belevitch dominated international conferences and was prone to asking searching questions of the presenters of papers , often causing them some discomfort . The organiser of one conference at Birmingham University in 1959 made Belevitch the chairman of the session in which the organiser gave his own presentation . It seems he did this to restrain Belevitch from asking questions . Belevitch stopped attending conferences in the mid @-@ 1970s with the exception of the IEEE International Symposium on Circuits and Systems in Montreal in 1984 in order to receive the IEEE Centennial Medal .

= = = Circuit theory = = =

= = = = Scattering matrix = = = =

It was in his 1945 dissertation that Belevitch first introduced the important idea of the scattering matrix ( called repartition matrix by Belevitch ) . This work was reproduced in part in a later paper by Belevitch , Transmission Losses in 2n @-@ terminal Networks . Belgium was occupied by Nazi Germany for most of World War II and this prevented Belevitch from any communication with American colleagues . It was only after the war that it was discovered that the same idea , under the scattering matrix name , had independently been used by American scientists developing military radars . The American work by Montgomery , Dicke and Purcell was published in 1948 . Belevitch in his work had applied scattering matrices to lumped circuits and was certainly the first to do so , whereas the Americans were concerned with the distributed circuits used at microwave frequencies in radar .

Belevitch produced a textbook , Classical Network Theory , first published in 1968 which comprehensively covered the field of passive one @-@ port , and multiport circuits . In this work he made extensive use of the now @-@ established S parameters from the scattering matrix concept , thus succeeding in welding the field into a coherent whole . The eponymous Belevitch 's theorem , explained in this book , provides a method of determining whether or not it is possible to construct a passive , lossless circuit from discrete elements ( that is , a circuit consisting only of inductors and capacitors ) that represents a given scattering matrix .

= = = = Telephone conferencing = = = =

Belevitch introduced the mathematical concept of conference matrices in 1950 , so called because

they originally arose in connection with a problem Belevitch was working on concerning telephone conferencing . However , they have applications in a range of other fields as well as being of interest to pure mathematics . Belevitch was studying setting up telephone conferencing by connecting together ideal transformers . It turns out that a necessary condition for setting up a conference with n telephone ports and ideal signal loss is the existence of an n × n conference matrix . Ideal signal loss means the loss is only that due to splitting the signal between conference subscribers ? there is no dissipation within the conference network .

The existence of conference matrices is not a trivial question , they do not exist for all values of n . Values of n for which they exist are always of the form 4k + 2 ( k integer ) but this is not , by itself , a sufficient condition . Conference matrices exist for n of 2 , 6 , 10 , 14 , 18 , 26 , 30 , 38 and 42 . They do not exist for n of 22 or 34 . Belevitch obtained complete solutions for all n up to 38 and also noted that n = 66 had multiple solutions .

= = = = Other work on circuits = = = =

Belevitch wrote a comprehensive summary of the history of circuit theory . He also had an interest in transmission lines , and published several papers on the subject . They include papers on skin effects and coupling between lines ( " crosstalk " ) due to asymmetry .

Belevitch first introduced the great factorization theorem in which he gives a factorization of paraunitary matrices . Paraunitary matrices occur in the construction of filter banks used in multirate digital systems . Apparently , Belevitch 's work is obscure and difficult to understand . A much more frequently cited version of this theorem was later published by P. P. Vaidyanathan .

= = = Linguistics = = =

Belevitch was educated in French but continued to speak Russian to his mother until she died . In fact , he was able to speak many languages , and could read even more . He studied Sanskrit and the etymology of Indo @-@ European languages .

Belevitch wrote a book on human and machine languages in which he explored the idea of applying the mathematics of information theory to obtain results regarding human languages . The book highlighted the difficulties for machine understanding of language for which there was some naive enthusiasm amongst cybernetics researchers in the 1950s .

Belevitch also wrote a paper , On the Statistical Laws of Linguistic Distribution , which gives a derivation for the well @-@ known empirical relationship , Zipf 's law . This law , and the more complex Mandelbrot law , provide a relationship between the frequency of word occurrence in languages and the word 's rank . In the simplest form of Zipf 's law , frequency is inversely proportional to rank . Belevitch expressed a large class of statistical distributions ( not only the normal distribution ) in terms of rank and then expanded each expression into a Taylor series . In every case Belevitch obtained the remarkable result that a first order truncation of the series resulted in Zipf 's law . Further , a second @-@ order truncation of the Taylor series resulted in Mandelbrot 's law . This gives some insight into the reason why Zipf 's law has been found experimentally to hold in such a wide variety of languages .

= = = Control systems = = =

Belevitch played a part in developing a mathematical test for determining the controllability of linear control systems . A system is controllable if it can be moved from one state to another through the system state space in a finite time by application of control inputs . This test is known as the Popov @-@ Belevitch @-@ Hautus , or PBH , test . There is also a PBH test for determining the observability of a system ? that is , the ability to determine the state of a system in finite time solely from the system 's own outputs .

The PBH test was originally discovered by Elmer G. Gilbert in 1963 , but Gilbert 's version only applied to systems that could be represented by a diagonalizable matrix . The test was

subsequently generalised by Vasile M. Popov ( in 1966 ) , Belevitch ( in Classical Network Theory , 1968 ) and Malo Hautus in 1969 .

## = = IEEE and honours = =

Belevitch was a Fellow of the Institute of Electrical and Electronics Engineers ( IEEE ) and was vice @-@ chair of the Benelux section when it was formed in 1959 . He was awarded the IEEE Centennial Medal , and in 1993 , the Society Award ( now called Mac Van Valkenburg Award ) of the IEEE Circuits and Systems Society . He was also a member of the North Rhine @-@ Westphalian Academy of Sciences .

Belevitch received an honorary doctoral degree in 1975 from the Technical University of Munich , and another from the École Polytechnique Fédérale de Lausanne , Switzerland , in 1978 . He was also rewarded with Belgian royal medals .

Since 2003 , the IEEE Circuits and Systems Society has instituted a Vitold Belevitch award for work in circuit theory . The award is presented biennially at the European Conference on Circuit Theory & Design .

## = = Selected publications = =

Belevitch was a prolific publisher with around 4000 pages of scientific output . He was publishing throughout his career right up to , and beyond , his retirement in 1984 .

### = = = Books = = =

Langage des Machines et Langage Humain , Bruxelles : Office de publicité , 1956 OCLC 8998282 ( in French ) .

Théorie des Circuits de Télécommunication , Louvain : Librairie Universitaire , 1957 OCLC 3531476 ( in French ) .

Théorie des Circuits Nonlinéaires en Régime Alternatif : Redresseurs , Modulateurs , Oscillateurs , Louvain : Uystpruyst , 1959 OCLC 637334683 ( in French ) .

Classical Network Theory , San Francisco : Holden @-@ Day , 1968 OCLC 413916 .

### = = = Journal articles = = =

" Extension of Norton 's method of impedance transformation to band @-@ pass filters " , Electrical Communication , vol.24 , no.1 , pp. 59 ? 65 , March 1947 .

" Insertion loss and effective phase shift in composite filters at cut @-@ off frequencies " , Electrical Communication , vol.24 , no.2 , pp. 192 ? 194 , June 1947 .

" Transmission losses in 2n @-@ terminal networks " , Journal of Applied Physics , vol.19 , No. 7 , pp. 636 ? 638 , 1948 .

" Development in the design of filters " , Electrical Communication , vol.26 , no.1 , pp. 84 ? 98 , March 1949 .

" Theory of 2n @-@ terminal networks with application to conference telephony " , Electrical Communication , vol.27 , no.3 , pp. 231 ? 244 , September 1950 .

" Topics in the design of insertion loss filters " , IRE Transactions on Circuit Theory , vol.2 , iss.4 , pp. 337 ? 346 , December 1955 .

" Théorie de l 'information et statistique linguistique " , Académie Royale de Belgique : Bulletin de la Classe des Sciences , series 5 , vol.42 , pp. 419 ? 436 , 1956 . ( in French )

" On the statistical laws of linguistic distribution " , Annales de la Société Scientifique de Bruxelles , vol.3 , iss.73 , pp. 310 ? 326 , 1959 ISSN 0037 @-@ 959X . ( in French )

" Summary of the history of circuit theory " , Proceedings of the IRE , vol.50 , iss.5 , pp. 848 ? 855 , May 1962 .

" Factorization of scattering matrices with applications to passive network synthesis " , Philips

Research Reports , vol.18 , pp. 275 ? 317 , 1963 ISSN 0031 @-@ 7918 .

" Interpolation matrices " , Philips Research Reports , vol.25 , pp. 337 ? 369 , 1970 ISSN 0031 @-@ 7918 .

" On the realizability of non @-@ rational positive real functions " , International Journal of Circuit Theory and Applications , vol.1 , iss.1 , pp. 17 ? 30 , March 1973 .

" Theory of the proximity effect in multiwire cables " , Philips Research Reports , vol.32 , pp. 16 ? 43 , 96 @-@ 177 , 1977 ISSN 0031 @-@ 7918 .

" The Gauss hypergeometric ratio as a positive real function " , SIAM Journal on Mathematical Analysis , vol.13 , pp. 1024 ? 1040 , 1982 .

" Ideal rectifier n @-@ ports are solvable " , International Journal of Circuit Theory and Applications , vol.15 , iss.2 , pp. 171 ? 180 , April 1987 .