



## **Professor Boris Grigoryevich Galerkin (1871 – 1945)**

From Wikipedia, the free encyclopedia: [http://en.wikipedia.org/wiki/Boris\\_Galerkin](http://en.wikipedia.org/wiki/Boris_Galerkin)

born in Polozk, Belarus, Russian Empire was a Russian/Soviet mathematician and an engineer.

### **Biography**

#### **Early days**

Galerkin was born on March 4, 1871 in Polotsk, Russian Empire, now part of Belarus. His parents owned a house in the town, but the homecraft they made did not bring enough money, so at the age of 12, Boris started working as calligrapher in the court. He had finished school in Polotsk, but still needed the exams from an additional year that granted him the right to continue education at a higher level. He passed those in Minsk in 1893, as an external student. The same year he was enrolled at the St. Petersburg Technological Institute, at the mechanics department. Due to the lack of funds Boris Grigoryevich had to combine studying at the institute with working as a draftsman and giving private lessons.

## **Political activities and imprisonment**

Like many other students/technologists, he was involved in political activities, and joined the social-democratic group. In 1899, the year of graduating from the institute, he became a member of the Russian Social-Democratic Party (future Communist Party). This provides a plausible explanation for his frequent job changes. The first three years after graduation Boris Grigoryevich was an engineer at the Russian Mechanical and Steam-locomotive Union factory in Kharkov, while simultaneously teaching workers at special courses. From the end of 1903 he was an engineer on the construction of the China Far East Railway, half a year later he became the technical head at the 'North mechanical and boiler factory'. He participated in organizing the Union of Engineers in St. Petersburg and, in 1905 he was arrested for organizing a strike among the engineers. In 1906, Boris Grigoryevich became a member of the Social-Democratic Party's St. Petersburg Committee and did not work anywhere else.

On August 5, 1906 the police surrounded his house No.13 in Alexeyevskaya Street, not far from Udelnaya railway station and arrested almost everyone of the Committee members. On March 26, 1907, the St. Petersburg Court Chamber passed a sentence, which was surprisingly light, taken into account that at the moment of arrest some of the Committee members fired at policemen. One of the 19 Committee members was imprisoned for two years, 8, including B.G.Galerkin (or "Zakhar", according to his underground nickname) - for 1.5 years, others were discharged.

In prison, known under the name "Kresty", Boris Grigoryevich had lost interest in revolutionary activities and devoted himself to science and engineering. Prison conditions of that time were giving such opportunities. And what is more, in his work-book it is written that Boris Grigoryevich worked as an engineer at designing and constructing the boiler power plant from 1907. This fact was not explained, and Boris Grigoryevich did not like to remind others about his revolutionary youth. Later, in Soviet questionnaires he would not give clear answers on the persistent questions about membership in different parties. Of course, he was familiar with the fate of old Party members, but the main reason for it was that he had been elected to the Committee from the Mensheviks (a Party group with non-radical views, which members later were accused of contra-revolutionary activities and repressed). Galerkin's life could become the price if this fact became known to the public.

## **Academic**

Same year his first scientific work was published by the institutes "Transactions". The article was titled "A theory of longitudinal curving and an experience of longitudinal curving theory application to many-storied frames, frames with rigid junctions and frame systems". The length of the title was indicative of the length of the work itself, 130 pages. It was written in the "Kresty" prison. In the summer of 1909 Boris Grigoryevich had a trip abroad to see constructions and buildings that interested him. During the next four years, i.e., before World War I, he, as well as many other institute staff, visited Europe to

stimulate their scientific interests. Galerkin visited Germany, Austria, Switzerland, Belgium and Sweden.

Galerkin taught students at the mechanical department structural mechanics, i.e., conducted exercises and designing. The lecturer was professor V.L.Kirpichov - a famous scientist in the field of mechanics and per se the head of the Petersburg mechanical scientific school. However, most members also worked in the Polytechnical Institute, for example: I.G. Bubnov, A.N. Krylov, I.V. Meshcherskiy and S.P. Timoshenko.

From autumn 1911, Galerkin also worked at the Women's Polytechnical Institute. In 1913 he worked with the design of the metallic frame for a boiler power plant in St. Petersburg - the first building with metallic frame under big loads in Russia. Later it was considered to be one of the unique European engineering objects. Galerkin regularly published his works in the institute's "Transactions", and since 1915 - also in Engineering News. Before 1915 pivot systems were at the center of his scientific interest, later he started researching plates.

In 1915 Galerkin published an article in which he put forward an idea of an approximate method for differential equations, in particular boundary value problems. He had applied his method to a big number of pivot and plate analysis problems. Some time before I.G.Bubnov developed a similar approach for the variational problem solution, which he interpreted as a variant of Ritz method algorithm. The distinguishing features of Galerkin's method were the following: he did not associate the method, developed by him, with any variational problem direct solution, but considered it to be common for solving differential equations. He interpreted it, using the probable displacements principle. These ideas showed to be very productive, not only in structural mechanics, but for mathematical physics at large.

The Galerkin method (or Bubnov-Galerkin method) with Galerkin's (or "weak") differential equations problem statement form are known all over the world. Nowadays they provide a foundation for algorithms in the fields of mechanics, thermodynamics, electromagnetism, hydrodynamics and many others.

In January 1919, Galerkin became a professor in the 2nd (formerly Women's) Polytechnical Institute, remaining a teacher of structural mechanics in the 1st Polytechnical Institute (at that time the Polytechnical Institute was named so) mechanical department. In March 1920, a professor chair in structural mechanics was established at the department, and Boris Grigoryevich won it in a competition. In Summer 1921, S.P. Belzetskiy, a famous scientist in the field of structural mechanics and theory of elasticity, who was holding a similar chair at the civil engineering faculty, emigrated to Poland. Galerkin took part in a competition for his chair and in the beginning of 1922 he left the mechanical faculty for the civil engineering faculty, which was nearer to him in his scientific and engineering activities.

However his talent at that time was not wanted by anyone and he could concentrate his attention towards scientific problems. Before, in 1917-1919 Galerkin published a series

of works on rectangular and triangular plates that appeared in scientific periodicals, mentioned above, and in the "Russian Academy of Sciences Transactions". Later he had a break in publications, and only in 1922 he began publishing again, but only in foreign magazines (in Soviet Russia there was not enough paper for scientific literature).

In December 1923 Galerkin was elected dean of the Polytechnical Institutes civil engineering faculty. It happened during a very important period of the institute's history, when a group of deans resigned from their posts, protesting from unceremonious intervention of so called "student' representatives", controlled by the trade-unions and the Communist party committees, into the educational process. Galerkin showed to be a talented leader of the faculty. He managed to neutralize too active "assistants", who were appointed against his will, and he did not hurry to fulfill the orders of incompetent leaders, who were conducting infinite experiments in the higher school at that time. In 1924 - 1929 Galerkin was also a professor in the Railway Engineers Institute and in the St. Petersburg University. In 1924 he made his last trip abroad - he participated in the Congress on applied mechanics in the Netherlands.

In spring 1926 Galerkin learned that Narkompros (Ministry of education) had adopted a decision to close the road-making section at his faculty. This decision was prepared and adopted secretly from the dean by the institute Communist party committee in the connection with the company on elimination of parallel specialties. Meanwhile, there were no other faculties in the country training specialists in the construction of electrified railways, urban railways and subways (the faculty had worked on this since 1907). Galerkin managed to cancel this rash decision by Moscow. During the period of Galerkin at the dean post, the first laboratory at the faculty was created. He also managed to receive governmental approval of the idea to build some other big laboratories for the faculty (the Hydrotechnical Research Institute was later established on their base).

In January 1928 Galerkin was appointed as a corresponding member-elected at the USSR Academy of sciences. His candidature was nominated by academicians A.F. Yoffe (Abram Ioffe), A.N. Krylov, P.P. Lazarev. In October 1929 he left the dean's post. After this the civil engineering faculty was divided into two parts: the hydrotechnical and irrigation sections became the water industry faculty, and the rest that became a part of the civil engineering faculty. was soon left out of the Polytechnical Institute and became the Civil and Industrial Engineering Institute, which however does not exist anymore. The water industry faculty soon became the Hydrotechnical institute. Galerkin was a professor at both institutes.

By the 1920s, Galerkin was already a world-famous scientist. He had become an authority among engineers-designers. He was often recruited as a consultant to the designing and construction of serious industrial objects in the northwest Russia (heat power plants, Volkhov hydro power plant, Kondopoga pulp and paper mill and others). He was a member of the technical Councils of the designing institutes Giprometz and Giprotsvetmet, a member of the academic councils in the research institutes: Irrigation Institute (later - Hydrotechnical Research Institute), Institute of Structures. After the end of the Dnieper Hydroelectric Station construction Boris Grigoryevich also became a

member of the governmental commission.

In 1934, Galerkin got two doctoral degrees in technics and mathematics and the Honoured Worker in Science and Engineering title. In the beginning of 1936 he was elected a member of the USSR Academy of sciences. He also became a member of the highest Certifying Commission in the State Committee on higher technical education, a chairman of the technical mechanics group in the USSR Academy of sciences technical section, the headmaster of the USSR Academy of sciences Institute of Mechanics, the chairman of the Civil engineers scientific society and its Leningrad section. In April 1936 according to a governmental order Galerkin was appointed chairman of the Governmental Commission for the examination of the Moscow Palace of Soviets steel frame walls and overlappings initial project.

Though having so many titles, Galerkin remained a professor of the structural mechanics and theory of elasticity department at the hydrotechnical faculty (the Hydrotechnical Institute was returned to the Polytechnical (at that time - Industrial) Institute as a faculty in 1934). Mostly he taught the course of the theory of elasticity, which was very difficult for the students of that time, who had a very weak training in mathematics. Students were visiting his lectures to look at the "real academician", but he disappointed them. He was short, puny, had a weak voice. His image did not correspond to the status of serious scientist with big authority, received from the government. At one time the academician was even pulled out of a tram by other well-grown passengers, and after this "accident" the institute administration applied to the authorities for a car.

### **War times and death**

Galerkin drew in general's uniform in 1939, when the VITU of Navy, previously was known as the Nikolaevsky Engineering Academy (now Military engineering-technical university, was revival on the base of Civil and Industrial Engineering Institute, as the head of its structural mechanics department and the academician became a lieutenant general. Boris Grigoryevich had never been in the army before, but had to wear the general's uniform. He was shy and when someone saluted to him he usually got frightened and waved his hands.

In the summer of 1941 after the beginning of the war the Commission on the defensive installations construction was created by the city government. Some academicians and prominent scientists became members (almost everyone was from the Polytechnical Institute), but only Boris Grigoryevich was involved with construction engineering. Practically he became the supervisor of the work for the Commission. Simultaneously Boris Grigoryevich was the city engineering defense department experts group head.

Later he was evacuated to Moscow, where he joined the military engineering commission of the Academy of Sciences of the USSR. Hard non-stop work was undermining the scientist's health. Not long after the Great Victory, on July 12, 1945 Galerkin died in Moscow.

## **Mathematical contributions**

Galerkin's name is forever attached to the finite element method, which is a way to numerically solve partial differential equations

Galerkin methods include:

- 1 The Galerkin method - A method for approximating the solution to a problem in weak form. Most well known in the finite element method.
- 2 The Petrov-Galerkin method
- 3 The Streamline upwind Petrov-Galerkin method (SUPG)
- 4 The Discontinuous Galerkin method