# Steinitz, Ernst | Encyclopedia.com



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(*b*. Laurahütte, Silesia, Germany [now Huta Laura, Poland], 13 June 1871; *d*. Kiel, Germany, 29 September 1928)

*mathematics*.

Steinitz began the study of mathematics in 1890 at the University of Breslau (now Wroclaw, Poland). A year later he went to Berlin and in 1893 returned to Breslau, where he received the Ph.D. in 1894. Two years later he began his teaching career as *Privatdozent* in mathematics at the Technical College in Berlin-Charlottenburg. In 1910 he was appointed professor at the Technical College in Breslau. He assumed a similar post in 1920 at the University of Kiel, where his friend Otto Toeplitz was teaching, remaining there until his death.

In his most important publication, "Algebraische Theorie der Körper" (1910), Steinitz gave an abstract and general definition of the concept of a "field" (*Körper*) as a system of elements with two operations (addition and multiplication) that satisfy associative and cummutative laws (which are joined by the distributive law), the elements of which admit unlimited and unambiguous inversion up to division by zero. Steinitz sought to discuss all possible types of fields and to ascertain their relationships. By means of a systematic development of the consequences of the axioms for commutative fields, he introduced a series of fundamental concepts: prime field, separable elements, perfect fields, and degree of transcendence of an extension. His most important achievement was undoubtedly the proof that for every base field $K$ there exist extension fields $L$ in which all polynomials with coefficients in $K$ decompose into linear factors, and that the smallest possible such field is virtually determined up to isomorphism. Because this smallest field possesses no genuine algebraic extension, Steinitz called it algebraically closed, proving its existence with the aid of the axiom of choice; this is now done by means of Zorn's lemma.

In his basic approach Steinitz was influenced primarily by Heinrich Weber and, in his methods, by Leopold Kronecker; Hensel's discovery in 1899 of the field of $p$-adic numbers provided the direct stimulus for his work. His polished and fully detailed treatment of the subject was the starting point for many far-reaching studies in abstract algebra, including those by E. Artin, H. Hasse, W. Krull, E. Noether, and B. L. van der Waerden. The general concept of the derivative or of differentiation, which Steinitz introduced in special cases, is essential in modern algebraic geometry.

In addition to his epochal paper, Steinitz wrote on the theory of polyhedra, a topic of lifelong interest. He gave two lectures on it at Kiel and prepared a comprehensive treatment during his last years. An almost complete manuscript of a planned book was found among his papers; it was completed and edited by Rademacher in 1934. Dealing chiefly with convex polyhedra and their topological types, the book also includes a detailed historical survey of the development of the theory of polyhedra.

# BIBLIOGRAPHY

Steinitz' works are listed in Poggendorff, IV, 1435; V, 1203; and VI, 2534. His most important writings are "Algebraische Theorie der Körper," in *Journal für die reine und angewandte Mathematik*, **137** (1910), 137–309, which was also separately published, R. Baer and H. Hasse, eds. (Berlin–Leipzig, 1930; New York [in German], 1950); and *Vorlesungen über die Theorie der Polyeder, unter Einschluss der Elemente der Topologie*, Hans Rademacher, ed. (Berlin, 1934; repr. Ann Arbor, Mich., 1945).

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