



ISSN: 2350-0328

**International Journal of Advanced Research in Science,  
Engineering and Technology**

**Vol. 12, Issue 6, June 2025**

# **Srinivasa Ramanujan: A bridge between ancient Indian Knowledge System and modern discoveries**

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**ABSTRACT:** The Indian Knowledge System (IKS) is an extensive and integrated intellectual tradition based on centuries of philosophical, scientific, and cultural exploration. There is a strong bond between IKS and Vedic Mathematics. The famous Indian mathematician Srinivasa Ramanujan has made a lot of contributions to modern mathematics which is based on Vedic mathematics. This paper discusses relevance, contributions, and contemporary applications of IKS in higher education, with a focus on contributions of Srinivasa Ramanujan. It explores Ramanujan's contribution to Number Theory, his works on infinite series and continued fractions. Also tried to find out Ramanujan's impact on modern Mathematics and science by connecting to Indian mathematical tradition. Furthermore it discusses how did Ramanujan's work build upon or diverge from traditional Indian Mathematics and what were the key factors that influenced Ramanujan's Mathematical discoveries

**KEYWORDS:** Indian Knowledge System (IKS), Vedic Mathematics, Srinivasa Ramanujan, taxicab numbers, tau function, Hardy–Ramanujan number, partition function

## **I. INTRODUCTION**

India's intellectual and philosophical heritage stretches back millennia, based on a deeply profound and holistic body of knowledge traditionally known as the Indian Knowledge System (IKS). The system includes a broad range of disciplines, including mathematics, astronomy, linguistics, medicine, and philosophy, and gives deep insights which still have an impact on contemporary thought. One of the strongest aspects of IKS is Vedic Mathematics, a collection of ancient computational methods based on the Vedas, and in the main, the Atharvaveda. These techniques, which are speedful and simple, expose a novel methodology for mathematical thought focused on mental calculation, pattern recognition, and intuition.

The heritage of the Indian Knowledge System is most magnificently represented in its modern avatar, namely, Srinivasa Ramanujan, whose remarkable work in mathematics in the first half of the 20th century amazed the entire academic world. Although untrained in higher mathematics, Ramanujan generated revolutionary findings on number theory, infinite series, continued fractions, and forms of modular forms. His instinctive understanding of mathematical verities, characteristically inspired by religious and conventional paradigms, is a compelling witness to the continuing relevance of India's native intellectual traditions.

This essay delves into the interrelatedness of IKS, Vedic Mathematics, and Ramanujan's brilliance as a heritage of this antiquated system. It seeks to show how these factors not just influenced past and modern mathematical thinking but also present rich pedagogic lessons to upcoming generations. Through an examination of these contributions from a contemporary perspective, we intend to revitalize curiosity about India's dense mathematical past and its prescience in the contemporary global knowledge economy.



## II. THE INDIAN KNOWLEDGE SYSTEM AND VEDIC MATHEMATICS

India has a rich and ancient tradition of knowledge, spanning over thousands of years. From astronomy to medicine, from philosophy to mathematics, India's contributions to the intellectual world are profound. Among the various elements of India's intellectual legacy, the Indian Knowledge System (IKS) and Vedic Mathematics hold a particularly special place. These systems are not only products of ancient wisdom but also serve as pathways for future generations to reconnect with an intellectual tradition that has shaped and enriched human civilization.

Vedic Mathematics is a mathematics system based on the Vedic literature, mainly the Vedas and Sutras (brief maxims) contained in these works. It was rediscovered in the first half of the 20th century by Bharati Krishna Tirthaji, a mathematician and scholar who said that the Sutras give concise and effective ways of carrying out intricate mathematical calculations. Although the origins of the system are usually disputed, the axioms enshrined within Vedic Mathematics have interested mathematicians, teachers, and researchers because of their astounding simplicity and depth.

The heart of Vedic Mathematics is in the Vedic Sutras, which are concise but deep aphorisms that offer formulas for solving mathematical problems in all domains of mathematics, including arithmetic, algebra, geometry, and calculus. Every Sutra outlines an intuitive method of solving mathematical problems in a simplified form, sometimes dispensing with the need for complex calculations. The Sutras promote mental calculation and highlight the significance of recognizing patterns and spatial understanding.

The charm of Vedic Mathematics is not only in its potential to give quick answers but in its focus on mental mathematics. The system inspires students to concentrate on their memory and the capability of doing calculations without the use of pen and paper, improving their mental capabilities and confidence.

Vedic Mathematics is not a gimmick collection, but rather an organized mathematical method; Vedic Mathematics is mistakenly viewed as a set of tricks and shortcuts to certain arithmetic computations. Such a belief has overshadowed the richness, structure, and systematic nature of Vedic Mathematics. The fact is that it offers a properly organized and logically consistent approach to all the arithmetic operations such as addition, subtraction, multiplication, division, squaring, cubing, square root, cube root, fractions, nth power, and even prime number divisibility, even extending to algebraic operations.

## III. SRINVASA RAMANUJAN: THE LEGACY OF IKS

In **modern India**, the legacy continues with brilliant minds such as **Srinivasa Ramanujan**, whose intuitive grasp of number theory, infinite series, and modular forms revolutionized mathematics. In recent decades, India has produced many notable mathematicians who have contributed to diverse fields such as algebraic geometry, number theory, and applied mathematics. Despite having no official education, Ramanujan learnt a lot of new things by trying to understand topics on his own. It is solely determined by his abilities. He is well-versed in Sanskrit. since his family was Brahmin. The majority of India's mathematical knowledge was originally recorded in Sanskrit in the form of "sutras" and "slokas." Indian legends like Aryabhadra and Brahmagupta had already uncovered several European discoveries. Ramanujan may have been inspired by this and recorded his own discoveries in his notebook. Ramanujan proved it in his own method, despite the fact that some of it had already been discovered by someone outside of India.

This is a good explanation for why renowned mathematician G H Hardy undervalued Ramanujan's contributions. Ramanujan's writings were initially perceived by Hardy as a potential "fraud" because to the nine pages of mathematics written by an unidentified mathematician. Some of Ramanujan's formulas were recognised by Hardy, but others "seemed scarcely possible to believe." He eventually recognised Ramanujan's brilliance and worked with him on numerous scientific projects.

In conclusion, the history of mathematics in India reflects an unbroken chain of intellectual development, combining abstract reasoning with practical application. From altar construction in the Vedic period to the development of calculus and beyond, Indian mathematics has been both a scientific pursuit and a spiritual journey, offering insights that continue



to shape global mathematical thought today. And the famous mathematician Srinivasa Ramanujan is not only a legend in mathematical world but also a strong legacy of Indian Knowledge System.

### **i. Biography of Ramanujan:**

Srinivasa Ramanujan FRS (Fellow of Royal Society) (22 December 1887–26 April 1920) was an Indian mathematician, having virtually no formal training in pure mathematics, who made outstanding contributions to mathematical analysis, number theory, infinite series, and continued fractions. Having no access to the broader mathematical community, which was in Europe at the time, Ramanujan developed his own mathematical work in solitude. Consequently, he occasionally rediscovered known theorems as well as creating new work. Ramanujan was described as a natural genius by the English mathematician G.H.Hardy, on a par with mathematicians such as Euler and Gauss. Ramanujan was born into a poor Brahmin family. His acquaintance with formal mathematics started at the age of 10. He showed a natural talent, and was provided with books on advanced trigonometry by S.L. Loney which he learnt by the age of 12; he even found theorems himself, and re-discovered Euler's identity independently. He exhibited exceptional mathematical ability at school, and won awards and honors. By 17, Ramanujan had carried out his own math research into Bernoulli numbers. Ramanujan was awarded a scholarship to attend Government College in Kumbakonam, but lost it when he failed in his non-mathematical studies. He joined another college to pursue independent mathematical studies, serving as a clerk in the Accountant General's office at the Madras Port Trust Office to finance himself. During 1912–1913, he sent specimens of his theorems to three professors at the University of Cambridge. G.H.Hardy, impressed by the greatness of his work, invited Ramanujan to come and work with him at Cambridge. He was elected a Fellow of the Royal Society and Fellow of Trinity College, Cambridge. Ramanujan succumbed to illness, malnutrition, and potentially liver infection in 1920 when he was 32 years old.

In his brief life time, Ramanujan in isolation produced almost 3900 results (largely identities and equations). The majority of his claim have now been vindicated. He announced results which were both new and extremely unorthodox, like the Ramanujan prime and the Ramanujan theta function, and these have inspired an enormous amount of additional work. Though the mathematical mainstream has been quite slow to assimilate some of his key findings, The Ramanujan Journal, an international journal, was instituted to publish mathematics in all branches affected by his work.

During December 2011, as a mark of respect for his contribution to mathematics, the Government of India announced that Ramanujan's birthday (22 December) must be commemorated annually as National Mathematics Day, and also proclaimed 2012 the National Mathematical Year.

### **ii. Ramanujan's impact on Modern Times**

There is a difference in mathematics between having a proof and having an insight. Ramanujan's genius hypothesized a set of formulae that examined in many research papers. Ramanujan's findings are allegedly rich in an exceptional sense. By way of by-product, there were new avenues of research opened up. One example of the most fascinating of these formulae is the infinite series for  $\pi$ , one of which is below.

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{k=0}^{\infty} \frac{(4k)! (1103 + 26390k)}{(k!)^4 396^{4k}}$$

In reference to a trip to the hospital to see Ramanujan, the renowned British mathematician G. H. Hardy coined the term "Hardy–Ramanujan number," which is 1729. In his words, "*I remember once going to see him when he was ill at Putney. I had ridden in taxi cab number 1729 and remarked that the number seemed to me rather a dull one, and that I hoped it was not an unfavorable. "No," he replied, "it is a very interesting number; it is the smallest number expressible as the sum of two cubes in two different ways."* The two different ways are  $1729 = 1^3 + 12^3 = 9^3 + 10^3$ . Generalizations of this idea have created the notion of "taxicab numbers."

The partition function,  $p(n)$ , which counts the number of ways a positive integer may be expressed as a sum of positive integers, regardless of order, was transformed by Ramanujan. He created strong asymptotic formulations for  $p(n)$  that shed light on its structure and growth. He found some amazing congruences for the partition function, including: For every non-negative integers  $k$ ,  $p(5k+4) \equiv 0 \pmod{5}$ , and comparable congruences modulo 7 and 11. These findings established the foundation for further modular form study and exposed surprising modular linkages.



By presenting novel concepts about the characteristics and Fourier coefficients of modular forms, Ramanujan made groundbreaking contributions to the theory of modular forms. His theories, particularly those pertaining to the tau function  $\tau(n)$ , were crucial to the advancement of contemporary number theory and were subsequently validated by the Langlands program.

The theory of modular forms and arithmetic geometry are closely related to the Ramanujan tau function, which is derived from the expansion of the modular discriminant. Highly composite numbers—integers having more divisors than any smaller integer—were introduced by him and methodically researched by him. His research in this field linked the distribution of prime numbers, analytic number theory, and divisor functions, impacting subsequent studies in both algebraic and analytic number theory.

Ramanujan worked on quadratic forms theory and discovered new identities and relations to Lambert series. His identities gave new representations for integers and helped analyze their properties. He proposed and investigated q-series and mock theta functions, which were pretty much unknown previously. These functions have become key objects in number theory, combinatorics, and even string theory nowadays.

### iii. Key Factors that influenced Ramanujan as a Mathematician

Ramanujan's mathematical findings were shaped by a blend of independent learning from classical texts, the rich Indian mathematical tradition, his phenomenal intuition, religious and cultural context, restricted formal education, and subsequent essential guidance by G. H. Hardy. Together, these all conditioned his distinctive approach and resulted in revolutionary advances in number theory and beyond. Several key factors influenced Srinivasa Ramanujan's extraordinary mathematical discoveries, shaping both his unique approach and the depth of his insights.

**Exposure to mathematical text and self study:** Ramanujan was largely auto-didact, with little formal mathematics education. One of the most important influences was the book G. S. Carr's Synopsis of Elementary Results in Pure Mathematics, which presented thousands of theorems written out briefly with minimal proofs. It acted as a basis for Ramanujan's early education and encouraged him to investigate and generalize results on his own. Although the book is brief and outdated, it gave Ramanujan a wide perspective of mathematical results, which he exploited as a launching pad for his own independent discoveries.

**Indian mathematical tradition's influence:** Ramanujan was also greatly affected by the rich tradition of Indian mathematics, such as the writings of early mathematicians such as Brahmagupta and Bhaskara I, and the Kerala school of mathematics. These traditions had sophisticated contributions in infinite series, combinatorics, and number theory, which complemented and directed Ramanujan's interest. Divisors, partition functions, and infinite series had their origins in Indian mathematics, with a cultural and intellectual environment that Ramanujan drew upon and contributed to.

**Religious and cultural environment:** Ramanujan's exposure to a Brahmin family environment provided him with experiences in Hindu religious observance, puranas, and a disciplined way of life, which could have contributed to his introspective and concentrated thinking. His relationship with his mother and the cultural value placed on study and ritual are likely to have reinforced his commitment to mathematics.

**Induction and independent thinking:** Ramanujan's theorems were frequently the result of deep intuition more than formal proof. He possessed an extraordinary faculty for seeing deep mathematical identities and truths, sometimes without very strong justification at first. This led him to concoct a large number of new theorems, conjectures, and identities that were subsequently rigorously established by others. His intuitive approach was both an asset and a liability, in that it contrasted with the formal math education common in the West.

**Academic challenges:** Ramanujan received a fragmented formal education and routinely had difficulties with non-mathematical courses, which restricted his access to standard scholarly opportunities. Yet this also caused him to create mathematics in an unorthodox manner, liberated from some of the straitjacketing of formal curricula. His determination in spite of these disabilities and poverty was a deciding factor in his continued mathematical activity.



**Collaboration with G H Hardy:** The identification and sponsorship of the British mathematician G. H. Hardy when Ramanujan wrote to him with his findings was crucial. Hardy introduced Ramanujan to the larger mathematical world, formalized his methods, and supplied strict proofs for most of his conjectures. This relationship greatly enhanced Ramanujan's influence on contemporary mathematics.

#### **iv. Ramanujan's work for Developing Indian Mathematical Traditions**

**Infinite Series and Trigonometry:** Kerala school (14th–16th centuries) had already discovered independently the infinite series expansion for  $\sin x$ ,  $\cos x$ , and  $\arctan x$  and also a series for  $\pi$ . All these findings, recorded in works such as *Tantrasangraha* and *Yuktibhasa*, provided the foundation for calculus-like methods centuries ahead of Europe. Ramanujan developed these concepts further, deriving novel infinite series for  $\pi$ , the hypergeometric functions, and the mock theta functions, which were more advanced and universal.

**Combinatorics and Number Theory:** Indian mathematicians Brahmagupta and Bhaskara II were the first to develop work on algebra, quadratic equations, and combinatorial problems (e.g., partition-like ideas). Ramanujan's contributions to partition functions and divisor sums generalized these concepts to formal number theory.

**Cultural and Intellectual Continuity:** Ramanujan's initial studies involved exposure to traditional Indian mathematical treatises, which stressed mastery of computation and intuitive recognition of pattern. This fitted in with his intuitive way of finding identities and formulas

#### **v. Ramanujan's Divergence from Traditional Indian Mathematics**

**Abstract and Theoretical Emphasis:** Traditional Indian mathematics, such as the Kerala school, tended to be used for astronomy and everyday calculation (e.g., calendars). Ramanujan's mathematics, on the other hand, was entirely theoretical, playing with abstract things like modular forms, highly composite numbers, and analytic number theory without any practical application in sight.

**Absence of Formal Proofs:** While the Kerala school gave geometric proofs for their series (e.g., in *Yuktibhasa*), Ramanujan tended to work based on intuition and experiment with computation instead of strict proofs. His "notebooks" included results declared without proof, which differed from both Indian and European traditions.

**Integration with Western Mathematics:** Ramanujan's work with G. H. Hardy exposed him to formal Western techniques, allowing him to express his findings in terms of contemporary analytic paradigms

### **IV.CONCLUSION**

Indian Knowledge System and Vedic Mathematics are not relics of the past, but they are ongoing sources of inspiration and guidance for contemporary scholarship and intellectual endeavors. The richly philosophical foundations of the Indian Knowledge System promote the integration of knowledge, calling for balanced development of material and spiritual progress. Vedic Mathematics, with its intuitive and deep techniques, presents a highly effective means of addressing intricate mathematical problems, and hence is a great learning aid in the contemporary era. Adopting and spreading IKS does not only enable us to respect our cultural heritage but also contributes to enriching the worldwide quest for knowledge with eternity-born Indian perspectives.

Knowing and accepting these ancient systems not only give us new perspectives but also give us a glimpse of a world of knowledge beyond time, with a focus on the timeless principles that can enrich our minds and contribute positively to the global society. By valuing and harmonizing the enormity of Indian wisdom, we open up greater knowledge of the universe and human capacity.

Greatest mathematician Srinivasa Ramanujan inherits legacy of Indian knowledge system. Number theory work by Ramanujan was not only original and revolutionary but even established the groundwork for whole fields of study, among which are the contemporary theory of the modular forms, theory of partition, and analytic theory of numbers. Most of his findings were so forward-thinking that their complete meaning wasn't understood for decades after his passing, and they still influence investigation and discovery in mathematics now. Number theory contributions from Ramanujan include



**ISSN: 2350-0328**

# **International Journal of Advanced Research in Science, Engineering and Technology**

**Vol. 12, Issue 6, June 2025**

pioneering research on partition function, modular forms, highly composite numbers, continued fractions, infinite series, quadratic forms, and q-series. His findings have radically shaped the direction and growth of contemporary mathematics

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